THE UNIVERSITY OF ALBERTA

A BIOSYSTEMATIC REVISION OF *ARNICA* L. SUBGENUS *CHAMISSONIS* MAGUIRE

by

WILLIAM SM. GRUEZO

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

IN

PLANT TAXONOMY

DEPARTMENT OF BOTANY

EDMONTON, ALBERTA

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FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled A BIOSYSTEMATIC REVISION OF *ARNICA* L. SUBGENUS *CHAMISSONIS* MAGUIRE submitted by WILLIAM SM. GRUEZO in partial fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY in PLANT TAXONOMY.

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Dedication

To the memory of my mother, Mrs. Marcianita Salem Gruezo.

Abstract

A multidisciplinary systematic revision of *Arnica* L. subgenus *Chamissonis* Maguire was undertaken. Data derived from field and growth room studies, morphology, cytology, pollen viability, flavonoid chemistry and phytogeography support the recognition of 7 taxa in the subgenus, namely: *Arnica parryi* A. Gray, *A. mollis* Hook., *A. chamissonis* Less., *A. longifolia* D.C. Eaton, *A. lanceolata* Nutt. subsp. *lanceolata*, *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, *comb. et stat. nov.* (Basionym: *Arnica amplexicaulis* Nutt.) and *A. ovata* Greene. The circumscription of the subgenus by Maguire (1943) is accepted, but the sectional divisions erected by him are rejected in favor of a more cohesive phylogenetic arrangement.

Arnica lanceolata Nutt. subsp. *lanceolata*, the only member of the subgenus in eastern North America (restricted areas in Gaspé Peninsula, Québec; New Brunswick, Maine, New Hampshire and northern New York State), is treated as the main geographic subspecies on account of publication priority. Its disjunction from the more widely distributed *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo is attributed to the pervasive effect of the Wisconsinan glaciation and the survival of populations in refugia or nunataks. *Arnica ovata* Greene, treated by Maguire (1943) as a synonym of *A. mollis* Hook., is the correct and valid name for plants widely recognized by numerous authors as *A. diversifolia* Greene. *Arnica silvatica* Greene, similarly listed as a synonym of *A. mollis* Hook. by Maguire (1943) is synonymized with *A. ovata* Greene.

Cytological data, augmented by ploidy determination of herbarium material based on pollen stainability, indicate that in subgenus *Chamissonis*, diploid (amphimictic) populations of each species are presently found only in refugial sites within the glaciated zone, or in unglaciated areas mostly south of the maximum limits of Wisconsinan/Cordilleran glaciations. Most populations now occupying formerly glaciated localities are polyploids that reproduce solely *via* apomixis. Such populations are successful colonizers of disturbed habitats, hence their current widespread distribution range.

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Table of Contents

Chapter — Page

I. Introduction 1

Family Asteraceae 1

Genus Arnica 2

Economic Importance of Arnica L. 6

Arnica subgenus Chamissonis 8

Taxonomic History of subgenus Chamissonis 11

Biosystematic History of subgenus Chamissonis 25

II. Materials and Methods 41

A. Field Studies and Collections 41

B. Morphology 42

C. Greenhouse Studies 45

D. Pollen Viability 46

E. Chromosome Numbers 47

F. Flavonoid Chemistry 47

III. Results 50

A. Numerical Analyses 51

Analysis 1. Arnica amplexicaulis & A. lanceolata 52

Analysis 2. Arnica longifolia & A. mollis 55

Analysis 3. Arnica chamissonis-longifolia-parryi-mollis 57

Analysis 4. Arnica subgenus Chamissonis 60

B. Pollen Viability 68

C. Chromosome Numbers 74

D. Flavonoid Chemistry 92

IV. Phytogeography 111

V. Phylogeny 116

VI. General Discussion and Conclusions 139

VII. Taxonomy 144

References 300

Appendix 1. Attributes used in TAXMAP analysis. 321

Appendix 2. Collections used in numerical analyses of Arnica subgenus Chamissonis. 323

Appendix 3. Data Matrices Used in Numerical Analyses. 355

Appendix 4. Sources of Population Samples for Flavonoid Study 388

Appendix 5. Collections examined for Pollen Stainability 394

Appendix 6. Cluster Membership Index of Subgenus Chamissonis using CLUSTAN Ward method of Cluster Analysis 418

Appendix 7. Comparison between chromosome numbers and percent pollen stainability determined for members of Arnica subgenus Chamissonis. 419

List of Tables

Table 1. Morphological characters and other criteria supporting exclusion of *Arnica* L. from Senecioneae (Nordenstam 1977, and references cited therein). 5

Table 2. New taxa or names in *Arnica* L. subgenus *Chamissonis* Maguire that were described or introduced by various authors between 1896 and 1943 and their subsequent taxonomic status. 17

Table 3. Comparison of classification schemes by Rydberg (1922, 1927) of species now considered under *Arnica* L. subgenus *Chamissonis* Maguire. 22

Table 4. Comparison of taxonomic treatments for *Arnica* L. subgenus *Chamissonis* Maguire. 23

Table 5. Previously reported chromosome numbers in *Arnica* L. subgenus *Chamissonis* Maguire..28

Table 6. Flavonoid aglycones in *Arnica* L. subgenus *Chamissonis* Maguire (modified from Merfort *et al.* 1986, Table 1. 38

Table 7. Proposed taxonomic treatment of taxa in *Arnica* L. subgenus *Chamissonis* Maguire in relation to Maguire's (1943) classification. 51

Table 8. Chromosome numbers determined for members of *Arnica* L. subgenus *Chamissonis* Maguire. 75

Table 9. Foliar flavonoid distribution in *Arnica* L. subgenus *Chamissonis* Maguire. 93

Table 10. Distribution of foliar flavonoids in 6 taxa of *Arnica* L. subgenus *Chamissonis* Maguire. 97

Table 11. Spectral, chromatographic and Rf data of flavonoids in *Arnica* L. subgenus *Chamissonis* Maguire. 99

Table 12. Characters and states used in the phylogenetic (cladistic) analysis of *Arnica* L. subgenus *Chamissonis*Maguire. 120

Table 13. Comparison of characters states (primitive *versus* advanced) in 7 taxa of *Arnica* L. subgenus *Chamissonis* Maguire. 137

List of Figures

Figure 1. World distribution of *Arnica* L. (Asteraceae/Compositae. 4

Figure 2. Distribution range of *Arnica* L. subgenus *Chamissonis* Maguire, *circa* 1988. 11

Figure 3. Taxometric map showing the similarities between *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo and *Arnica lanceolata* Nutt. subsp. *lanceolata* complex. . 53

Figure 4. Taxometric map showing the similarities between *Arnica mollis* W.J. Hook. and *A. longifolia* D.C. Eaton.. 56

Figure 5. Taxometric map showing the similarities in *Arnica chamissonis* Less., *A. longifolia*, D.C. Eaton, *A. parryi* A. Gray and *A. mollis* Hook. 58

Figure 6. Taxometric maps showing the similarities among 7 taxa in subgenus *Chamissonis* Maguire. 62

Figure 7. Dendrogram of 200 OTUs of 7 taxa in *Arnica* L. subgenus *Chamissonis* Maguire produced by CLUSTAN Ward's method of clustering 66

Figure 8. Composite 2-dimensional chromatogram of flavonoid of *Arnica* L. subgenus *Chamissonis* Maguire 102

Figure 9. Distribution of *Arnica chamissonis* Less. populations containing Luteolin 7-O-glucoside and/or Luteolin 6-O-Me, 7-O•glucoside in relation to approximate maximum extent of Wisconsinan-Cordilleran glacier complex in North America. 109

Figure 10. Maguire's (1943) probable relationships of 5 subgenera in *Arnica* L. 118

Figure 11. Maguire's (1943) proposed relationships of taxa in *Arnica* L. subgenus *Chamissonis* Maguire. 119

Figure 12. Cladogram of 7 taxa in *Arnica* L. subgenus *Chamissonis* Maguire based on morphological, flavonoid and ecological synapomorphies. 122

Figure 13. Holotype of *Arnica parryi* A. Gray [Colorado, Clear Creek, from the head-waters of Clear Creek & the alpine ridges lying east of "Middle Park", 1861, *C.C. Parryi 10* (GH *s.n.*!)]. 152

Figure 14. Habit and morphology of *Arnica parryi* A. Gray. [Montana: Glacier Co.,

Marias Pass Divide, Clark & Lewis National Forest Campground, vicinity of campsite no. 3, elev. 5216 ft, 29 June 1986, *William Sm. Gruezo & Aida BG. Gruezo WM12000* (ALTA!, WGRZ!)]. 154

Figure 15. Geographical range of *Arnica parryi* A. Gray. 157

Figure 16. Holotype of *Arnica ovata* E.L. Greene [Utah: Alta, Wahsatch Mountains, alt. 11000 ft, 31 July 1879, *Marcus E. Jones 1128* (NDG 062524/HG 46003!)]. 171

Figure 17. Habit and morphology of *Arnica ovata* E.L. Greene. A & B. Holotype (NDG 062524/HG 46003!). C & D. Isotypes: MO 145906! and UT 17376!, respectively. [UTAH: Alta, Wahsatch Mountains, alt. 11000 ft, 31 July 1879, *Marcus E. Jones 1128*]. 173

Figure 18. Leaf morphology variation in holotype of *Arnica diversifolia* E.L. Greene (= *Arnica ovata* E.L. Greene). Note petiole length. [Oregon: from the highest Powder River (Eagle Creek) Mountains, 8-9000 ft alt., steep north slopes, 1897, *Wm. C. Cusick 1810* (NDG 062466/HG 46775!)]. 175

Figure 19. Leaf morphology variation in types of *Arnica silvatica* E.L. Greene (= *Arnica ovata* E.L. Greene). A. Part of holotype (NDG 062554/HG 45924!) showing first pair of short-petiolate cauline leaves. B. Part of isotype (GH *s.n.*!) showing first pair of distinctly long-petiolate cauline leaves. [Colorado: Ruby, stems in large cluster, common in spruce woods, 7 August 1901, *C.F. Baker 715*]. 177

Figure 20. Geographical range of *Arnica ovata* Greene. 180

Figure 21. Holotype of *Arnica mollis* W.J. Hook. [Rocky Mountains: probably in Alberta, *Drummond s.n.* (K *s.n.*!)]. 192

Figure 22. Habit and morphology of *Arnica mollis* W.J. Hook. [Wyoming: Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 120 m west of Mile Post 66, c. 10 m from roadside, in meadows along stream banks, alt. 2348 m (= c.8000t), *William Sm. Gruezo WM11382* (ALTA!, WGRZ!). 194

Figure 23. Geographical range of *Arnica mollis* W.J. Hook. 196

Figure 24. Holotype of *Arnica chamissonis* C.F. Lessing [Alaska, Unalaska Island, *Chamisso s.n.* (LE *s.n.*!)]. 223

Figure 25. Habit and morphology of *Arnica chamissonis* C.F. Lessing. [Alaska, Glenn Hwy (Hwy 1 S), c. 1 km N of Mile post 49, en route to Seward, 30 July 1986, *Wm. & Aida Gruezo WM11923* (ALTA 92006!)]. 225

Figure 26. Geographical range of *Arnica chamissonis* C.F. Lessing. 228

Figure 27. Holotype of *Arnica longifolia* D.C. Eaton [Nevada, Clover Mountains, 9000 ft elev., September 1865, *Sereno Watson 655* (US 46876!)]. 256

Figure 28. Habit and morphology of *Arnica longifolia* D.C. Eaton. ... 160 [Utah, Beaver Co., Tushar Mts., Lake Stream near Three Creeks Reservoir, 8700 ft elev., spruce-*Salix-Ribes-Potentilla-Arnica* riparian community, 15 July 1984, *A. Taye 2743* (BRY 277383!)]. 258

Figure 29. Geographical range of *Arnica longifolia* D.C. Eaton. 261

Figure 30. Holotype of *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo [Oregon, on the rocks of the Wahlamet at the Falls, *Nuttall s.n.* (BM *s.n.*!)]. 277

Figure 31. Habit and morphology of *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo. [Alberta: Waterton Lakes National Park, vicinity of Cameron Lake, NW portion of lake, inside *Picea mariana* forest, on boggy soil and small stream, alt. 1676 m (= 5500 ft), 23 August 1985, *William Sm. Gruezo WM11616* (ALTA!, WGRZ!)]. 279

Figure 32. Geographical range of *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo. 282

Figure 33. Holotype of *Arnica lanceolata* Nutt. subsp. *lanceolata*. [New Hampshire, White Mountains, alt. 4500 ft, *C. Pickering s.n.* (PH 001145! + PH 001146!)]. 289

Figure 34. *Arnica lanceolata* Nutt. subsp. *lanceolata*. Habit and variation in gross morphology. A. *C.G. Pringle s.n.* (PENN 12529! *p.p.*), Brooks, White Mts., New Hampshire; B. *W.W. Eggleston & Alma L. Eggleston 22334* (PH 675161! *p.p.*), Tuckerman's Ravine Trail, Mt. Washington, Coos Co., New Hampshire; C. *J.A. Allen s.n.* (UC 29641! *p.p.*), Mt. Washington, New Hampshire; D. *F.H. Sargent s.n.* (BRY 142222! *p.p.*), Tuckerman's Ravine, by alpine brook, New Hampshire. 291

Figure 35. Geographical range of *Arnica lanceolata* Nutt. subsp. *lanceolata*. 294

1. Introduction

Family Asteraceae

In North America north of Mexico, the Asteraceae (Compositae) is composed of c. 2,250 species (Shetler & Skog 1978) which represent 11.25% of the 20,000 species in 1,100 (Cronquist 1981) to c. 1,200 (Cronquist 1985) genera currently accepted for the family. Cronquist (1985) succintly observes the apparent "inverse relationship between the ease of recognizing a family and the ease of recognizing its component genera". He then cites families such as Liliaceae, Ranunculaceae, Cornaceae, among others as examples where one can easily recognize the genera but difficulty is encountered when delimiting familial boundaries. On the other hand, Asteraceae, Brassicaceae, Apiaceae, Cactaceae, Gramineae (Poaceae), Rubiaceae, Asclepiadaceae and Orchidaceae are in the opposite category, *i.e.* those large and easily recognizable families, but which one finds considerable difficulty in recognizing and defining their component genera (Cronquist 1985).

Asteraceae is characterized by a unique set of highly specialized features, namely: a) the presence of capitulum composed of greatly reduced and modified flowers, b) calyx modified into pappus or absent, c) its syngenesious anthers, and d) inferior ovary. This character combination prompted Cronquist (1981) to assign Asteraceae to an order of its own, Asterales, ranked as the most advanced group within the subclass Asteridae.

Members of Asteraceae are of great economic importance as food plants, *e.g.* ***Cichorium intybus*** L. (chicory), ***C. endivia*** Willd. (endive), ***Helianthus tuberosus*** L. (Jerusalem artichoke), ***Lactuca sativa*** L. (lettuce), [Heywood *et al.* 1977a], *etc.*; as medicinal plants, *e.g.* ***Artemisia dracunculus*** L. (tarragon), ***Erigeron canadensis*** L. (Canadian fleabane), ***Arnica montana*** L. (mountain tobacco or leopard's-bane) [Dobelis *et al.* 1986], ***Achillea ptarmica*** L. (sneezewort), ***Chamaemelum nobile*** (L.) All. (chamomile) [Heywood *et al.* 1977a], *etc.*; as garden ornamentals, *e.g.* ***Tagetes patula*** L. (French marigold), *Chrysanthemum carinatum* Schousboe (annual chrysanthemum), *Dahlia variabilis* L. (dahlia), [Heywood *et al.* 1977a], *etc.*; as flavoring plants, *e.g. Tanacetum vulgare* L. (tansy), *Artemisia dracunculus* L. (tarragon), *A. absinthium* L. (wormwood)[Heywood *et al.* 1977a]; and as sources of dyes (*Solidago virgaurea* L., goldenrod; *Carthamus tinctorius* L., safflower), rubber (*Taraxacum bicorne* L., kok-saghuz; *Parthenium argentatum* Gray, guayule), insecticides (*e.g. Tanacetum cinerariifolium* (Trev.) Schultz Bip., pyrethrum; *Anacyclus pyrethrum* DC. and oil (*Helianthus annuus* L., sunflower; *Carthamus tinctorius* L., safflower)[Heywood *et al.* 1977a). Many members of Asteraceae are also economically significant as noxious weeds, *e.g. Taraxacum officinale* Weber (dandelion), *Cirsium* spp. (thistles), *Achillea millefolium* L. (yarrow), among others [Heywood *et al.* 1977a].

The classification of Asteraceae into 13 tribes established by Bentham (1873 a & b) based on a number of earlier works, *e.g.* Cassini 1826, 1829 & 1834; Lessing 1831, de Candolle 1836-1838) and his own comprehensive study is still largely accepted today (Heywood *et al.* 1977b, Cronquist 1981 & 1985). Many studies, however, have challenged the foundations of Bentham's tribal classification system and consequently, new genera (Robinson & Brettell 1973 a & b, Robinson 1978, *etc.*), revised delimitations at tribal and subtribal levels (Stebbins 1953, Robinson 1981, *etc.*) and new tribes (Robinson & Brettell 1973 c & d, Nordenstam 1977, *etc.*) have been proposed vigorously. This continuing revamp of the traditional classification scheme could be taken as a genuine recognition by modern synantherologists of the extremely high level of morphological, ecological and habital diversifications and radiations that the Asteraceae have undergone since its origin *c.* 30 million years ago in the middle to upper Oligocene (Jansen & Palmer 1987) or much earlier time, *c.* 100 M yr BP in the middle Cretaceous age (Raven & Axelrod 1974).

Genus Arnica

Arnica is an asteraceous genus of 27 species that is most diverse in the montane-alpine zones of western North America. Phytogeographically, it is circumboreal with a single species, *A. unalaschcensis* Less., ranging as far west as Japan, 3 species in the Siberian Territories, 2 species in Europe, 1 species in Greenland, 8 species in eastern North America and 25 species in western North America (Fig. 1).

The generic epithet is thought to be a corruption of the Greek word 'Ptarmica' (Fournier 1947, Cronquist 1955, Abrams & Ferris 1960) which means "sneeze herb" (Fournier 1947) because specimens of the type species *Arnica montana* L., can cause sneezing whenever its leaves are crushed. Alternatively, the name is considered to be a variation of another Greek word 'Arnakis', meaning "a lamb's skin", characteristically referring to the often woolly involucral bracts of the capitulum (Clark 1973).

Arnica is a well-circumscribed genus with the following morphological characters: a) perennial herbs with rhizomes or caudices, b) erect stems, c) opposite, simple, entire to dentate leaves, d) solitary to numerous, multiflowered heads, e) yellow to orange pistillate ray florets (absent in few species), f) perfect yellow disc florets, g) uni- or biseriate involucral bracts, h) flattened, truncate and penicellate style-branches, i) slender, 5-10 nerved achenes, and j) white to tawny, barbellate, subplumose to plumose capillary pappus. It is, however, easily and conclusively separated from superficially similar genera, *e.g. Senecio*, by its opposite leaves and capillary pappus.

Of the numerous asteraceous genera, *Arnica, Hulsea* (Seigler *et al.* 1974), *Schistocarpa, Liabum* and *Munnozia* (Barkley 1985) are presently at the center of controversy with regard to their tribal classification. As for *Arnica*, it has long been traditionally included in the tribe Senecioneae (Cronquist 1981) but other workers (*e.g.* Nordenstam 1977, Schumacher 1966) point to its possible exclusion from Senecioneae and assignment to a tribe of its own, Arniceae, together with a number of related genera, *e.g. Barlettia* A. Gray, *Mallotopus* Franch. & Sav., *Hulsea* Torr. & A. Gray, *Dimeresia* A. Gray, *Amblyopappus* Hook. & Arn., *Peucephyllum* A. Gray, *Psathyrotopsis* Rydb., *Psathyrotes* A. Gray, and *Whitneya* A. Gray (*cf.* Nordenstam 1977). However, its closest affinity is with tribe Heliantheae, as shown by structural, cytological, chemical and serological characters (Table

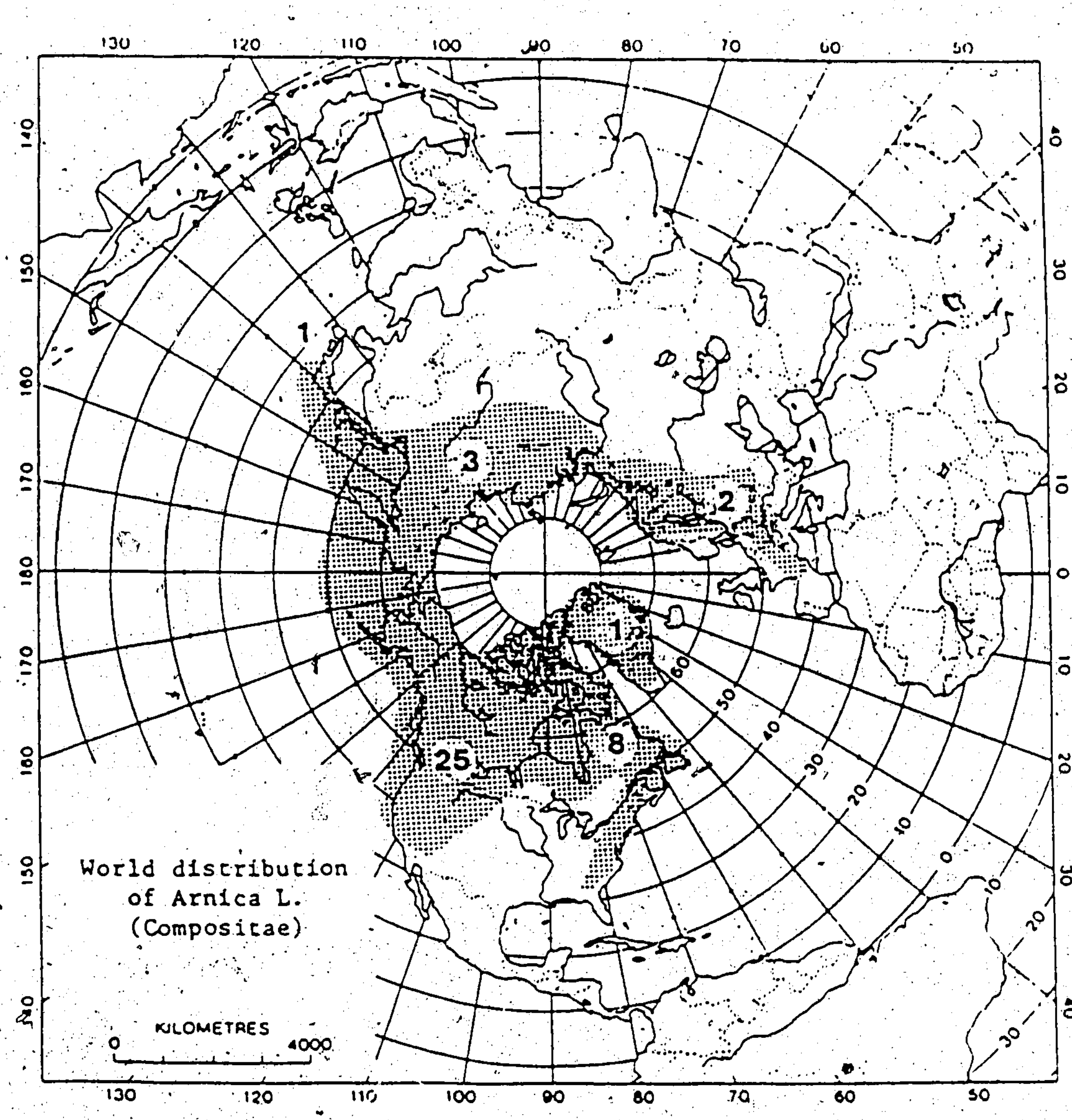

Figure 1. World distribution of *Arnica* L. (Asteraceae/Compositae). Number refers to total species in each major area. (See text for details).

Table 1. Morphological characters and other criteria supporting exclusion of *Arnica* L. from tribe Senecioneae (Nordenstam 1977, and references cited therein).

Opposite leaves: except in *Herodotia, Gynoxys* and *Scrobicaria*, a generic group of Senecioneae *sensu stricto* which are clearly related to the alternate-leaved senecioid taxa and have no relationship with *Arnica*.

Ray-floret micromorphology: "helianthoid" ligule epidermis and ligules with ultraviolet patterns (Baagoe 1977)

Setose receptacle: usually naked or with scale-like projections in Senecioneae.

Thick-walled achene hairs with divergent pointed tips.

Achenial wall with "carbonaceous" layer: present in many Heliantheae.

Abundant corolla hairs, sometimes limited to the junction of limb and tube.

Partly immersed style-base in the nectary (a "helianthoid" character): style-base is on top of the nectary in Senecioneae.

Embryo-sac consistently with 2 antipodal cells: absent from true Senecioneae (*cf.* Afzelius 1924) but occurs in Heliantheae.

"Helianthus type" of pollen (Stix 1960) and "helianthoid" pollen wall pattern (Skvarla & Turner 1966).

Chromosome number, $x = 19$: occurs only in *Adenostyles* and *Urostemon* of Senecioneae.

Chemical profiles out of place in Senecioneae: absence of pyrrolizidine alkaloids and sesquiterpene lactones (*e.g.* furanoeremophilanes) typically characteristic of Senecioneae; present of pseudoguaianolides ("helenanolides"), polyacetylenes and melanins.

Serological test: showed distinct affinities to Heliantheae and other tribes but not to Senecioneae (Schumacher 1966).

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1). For a concise review of the history of the generic concepts in the Asteraceae, see Cronquist (1985), while for the tribe Senecioneae, Barkley (1985) offers some interesting insights.

Economic Importance of Arnica L.

The economic values of the genus *Arnica* L. have largely been derived from human experience with the single European species, *Arnica montana* L., popularly known in that part of the world as Leopard's-bane or Mountain tobacco (Duke 1985, Dobelis *et al*. 1986). In Germany, it is sometimes known as 'Schnupftabakkraut' = "snuffworth" (Dr. Walter Moser, pers. comm. 19 August 1988).

Apparently, the first appearance of *Arnica* in European medical writings was in the 16th century (Fournier 1947, Dobelis *et al*. 1986). During this period, European physicians prescribed drugs extracted from *Arnica* roots, rhizomes and leaves as stimulant, specifically for the heart and circulation (Dobelis *et al*. 1986). Also at about the same time, *Arnica* gained a reputation of being toxic as exemplified by the death of a famous Swiss naturalist Konrad von Gesner in 1565 (Dobelis *et al*. 1986). Apparently, von Gesner tested *Arnica* by ingesting a dose of its extract. His initial written observation was that there had no ill effect. However, after less than an hour later, von Gesner was dead, purportedly of *Arnica* poisoning (Dobelis *et. al*. 1986). Recent studies have confirmed that fatal poisoning may indeed, result following ingestion of aqueous or alcoholic extract of *Arnica* (Wren 1970) as well that of *Arnica*'s cardiac toxicity (Duke 1985). Despite this, *Arnica montana* L. was officially listed in the Pharmacopoeia of the United States from the early 1800's to 1960 (Dobelis *et al*. 1986).

Recently, Duke (1985) provided a summary account of the numerous medicinal applications of *Arnica montana* L. ranging from its use as cure for tumors in general, for liver, intestinal and stomach cancers, as febrifuge, expectorant, sedative, anodyne, hemostat, nervine, stimulant, vulnerary, resolvent, irritant, tonic, sternutatory as well as for abrasions, acne, aches, boils, sprains, wounds, dysentery, epilepsy, diarrhea, rheumatism, baldness, bed sores, halitosis, miscarriage, sore nipples, suppuration, trauma, whooping cough, black eye, paralysis, corms, excoriation, chest ailments, abscess, exhaustion, splenalgia, sea-sickness, sore feet, *etc*. An earlier account of the medicinal values of *Arnica montana* L. by Fournier (1947) mentioned that by 1678 this species had been aptly called "panacèe des chutes (*lapsorum panacea*)". For an alternative medicinal account of this European species, see Fournier (1947) where its history, toxicity, properties, mode of employment, chemical principles and method of cultivation or culture are outlined.

The efficacy of drugs made of *Arnica* extract is attributed to the presence of arnicin - a bitter, amorphous yellowish brown compound - a pseudoguaianolide sesquiterpene lactone (Bently & Trimen 1880, Williams 1960, Morton 1977, Duke 1985) and possibly acting synergistically with arnidiol (= arnisterol)(Pyrek & Baranowska 1973, Morton 1977, Duke 1985), anthoxanine and tannin (Morton 1977, Duke 1985). Although *Arnica* has been long excluded from U.S. Pharmacopoeia (Morton 1977, Dobelis *et al.* 1986), some of its time-tested medicinal uses are still in vogue in many parts of Europe, *e.g.* "Teinture d' Arnica" [1] which is commonly available in many drugstores in Paris, France (Agnès S. Vanende, pers. comm. 1988). As of 1983, dried sample of *Arnica montana* L. had a price of US $47 to US $60 per kilo in New York, New York and Maryland, U.S.A., respectively (Duke 1985).

Additionally, *Arnica* oil extracts have been employed in the perfume industry as essential ingredient of beauty creams, *e.g.* "Yves Rocher crème pour les mains à l'arnica" [2] and lotion called 'Arnica' (Sharples 1938) as well as in antiperspirant and foot deodorant products, *e.g.* 'Lavilin' (Downie 1987).

[1] A 100-ml sample was generously obtained for me by Agnès S. Vanende from Paris, France, 9 February 1988.
[2] A 20-ml sachet was kindly provided by Agnès S. Vanende from Paris, France, 9 February 1988.

In western Canada and U.S., the North American Indians used three other *Arnica* species with similar medicinal values, namely: *A. fulgens* Pursh (Morton 1977, Dobelis *et al.* 1986), *A. sororia* Greene and *A. cordifolia* Hook. (Morton 1977). Evidently, their most common usage in North America was only as salves or liniments on sprains, wounds and sore muscles or swellings (Morton 1977, Dobelis *et al.* 1986).

At present, *Arnica* is classified by U.S. Food and Drug Administration as an unsafe herb mainly due to the presence of choline and 2 unidentified substances which when ingested in aqueous or alcoholic form cause nervous disturbances, violent gastroenteritis, a sudden change in palpitation, increased muscular weakness, collapse and eventually death (Duke 1985). Duke (1985, table 3) also lists 6 other toxic compounds known to occur in *Arnica*: formic acid, heptanoic acid, fumaric acid, isobutyric acid, tannic acid and trimethylamine. For the toxicity level of each compound and distribution in other plant genera, see Duke 1985, table 2. According to the Duke-Rose-Tyler toxicity rating systems, *Arnica montana* L. has a toxicity rank of 1-0-3. This rating is interpreted as 1 = more dangerous than coffee (Duke system), 0 = very dangerous (Rose system), and 3 = safer than coffee (Tyler system)(Duke 1985).

In a number of localities in Alaska, U.S.A. (*e.g.* Girdwood, Seward, Homer), *Arnica chamissonis* Less. has successfully invaded lawns and hedges [see *WM11919* (ALTA!)for exact locality] as well as graveyards [see *WM11926* & *WM11927* (ALTA!)for exact locality] and thus, has been maintained extensively as ornamentals. Dobelis *et al.* (1986) also mention that today *Arnica*, though without citing particular species, but more likely referring to *Arnica montana* L., is cultivated as garden flower.

Arnica subgenus Chamissonis

Subgenus *Chamissonis* is the third (in the order of publication priority) of the 5 subgenera established by Maguire in his comprehensive treatise on *Arnica* (1943). The remainder are *Arctica, Austromontana, Montana* and *Andropurpurea* with 7, 13, 3 and 2 species, respectively. Maguire (1943) recognized 32 species in total within the genus.

Recently, two of the 5 subgenera have been investigated biosystematically, namely: *Austromontana* (Wolf 1981, Wolf & Denford 1984c) and *Arctica* (Downie 1987, Downie & Denford 1988 in press). For subgenus *Austromontana* the number of species has been reduced to only 9 with no intraspecific subdivisions while for subgenus *Arctica* the same number of species is retained, but with improvement in taxonomic delimitations and a better understanding of the phylogenetic relationship of taxa.

In its original circumscription, subgenus *Chamissonis* included a total of 12 taxa, *i.e.* 7 species and 5 subspecies. These taxa were assigned by Maguire (1943) into 3 sections, namely: sect. *Euchamissonis* (3 taxa), sect. *Eulongifolia* (2 taxa), and sect. *Eumollis* (7 taxa).

Among the six morphological characters used by Maguire (1943) to circumscribe subgenus *Chamissonis*, at least three are diagnostic, and a combination of these clearly distinguishes subgenus *Chamissonis* from the other 4 subgenera. These characters include a) four to many (up to *c.* 20) pairs of cauline leaves, or if only three pairs, then these are long-petiolate or broadly ovate, b) stramineous, tawny or deep brown (not white), barbellate, subplumose to plumose pappus, and c) yellow anthers. Thus, subgenus *Chamissonis* is readily separated from subgenus *Arctica* and *Austromontana* by its stramineous, tawny to deep brown and predominantly subplumose to plumose pappus, *versus* the white largely barbellate pappus of these two subgenera, and frequently by its numerous cauline leaves. On the other hand, subgenus *Chamissonis*, *Montana* and *Andropurpurea* share the same stramineous to tawny or deep brown pappus. Subgenus *Chamissonis* is separated from subgenus *Montana* by its numerous, evenly disposed cauline leaves, which if basally positioned, are distinctly petiolate. In subgenus *Montana*, the leaves are generally sessile and in basal rosette. The latter character, however, is also shown by some species in subgenus *Chamissonis*, *e.g.* *A. parryi* A. Gray, and *A. mollis* Hook. It is with the latter taxon that *A. montana* L. of subgenus *Montana* is most closely morphologically related.

The only character separating subgenus *Andropurpurea* instantly from the other 4 subgenera (all with yellow anthers) is its purple anthers, from which its subgeneric name is aptly derived. However, 2 of the 3 species in subgenus *Andropurpurea*, *i.e. A. unalaschcensis* Less. and *A. sachalinensis* Less. have characters that show greater similarity to *A. chamissonis* Less. of subgenus *Chamissonis*. The third species in subgenus *Andropurpurea*, *A. lessingii* Greene, approaches in stature and form *A. frigida* Meyer *ex* Iljin subsp. *frigida* of subgenus *Arctica*.

Subgenus *Chamissonis* is confined predominantly to western North America with disjunct subspecies populations in restricted areas in eastern North America, *i.e.* in Gaspé Peninsula, Québec; New Brunswick, Maine, New Hampshire and northern New York. Its present range approximates that for *A. chamissonis* Less. which is the type of the subgenus. Longitudinally, it occurs from Umnak Island (168° 20' W) of the Aleutian Island archipelago in Alaska to the mouth of the Eastmain River, Québec (78° 12-14' W) while latitudinally, it is found in the vicinity of Anvik River, Alaska (62° 58' N) to as far south as 33° 33' N latitude, in the high mountain pass between McNary and Eagar, Arizona (Fig. 2). Current systematic treatments of this subgenus have been affected considerably by this extensive geographical range and its persistent ability to colonize a vast array of diverse niches in a continuously expanding fashion over time.

Taxonomic History of subgenus Chamissonis

A concise historical taxonomic account of genus *Arnica* is given by Maguire (1943) and since then only a few major works (*e.g.* Ediger & Barkley 1978, Douglas 1982) have been completed on the genus. This being so, the following account is limited to subgenus *Chamissonis* and should serve as a benchmark for the more comprehensive taxonomic revision of the subgenus presented later in this dissertation.

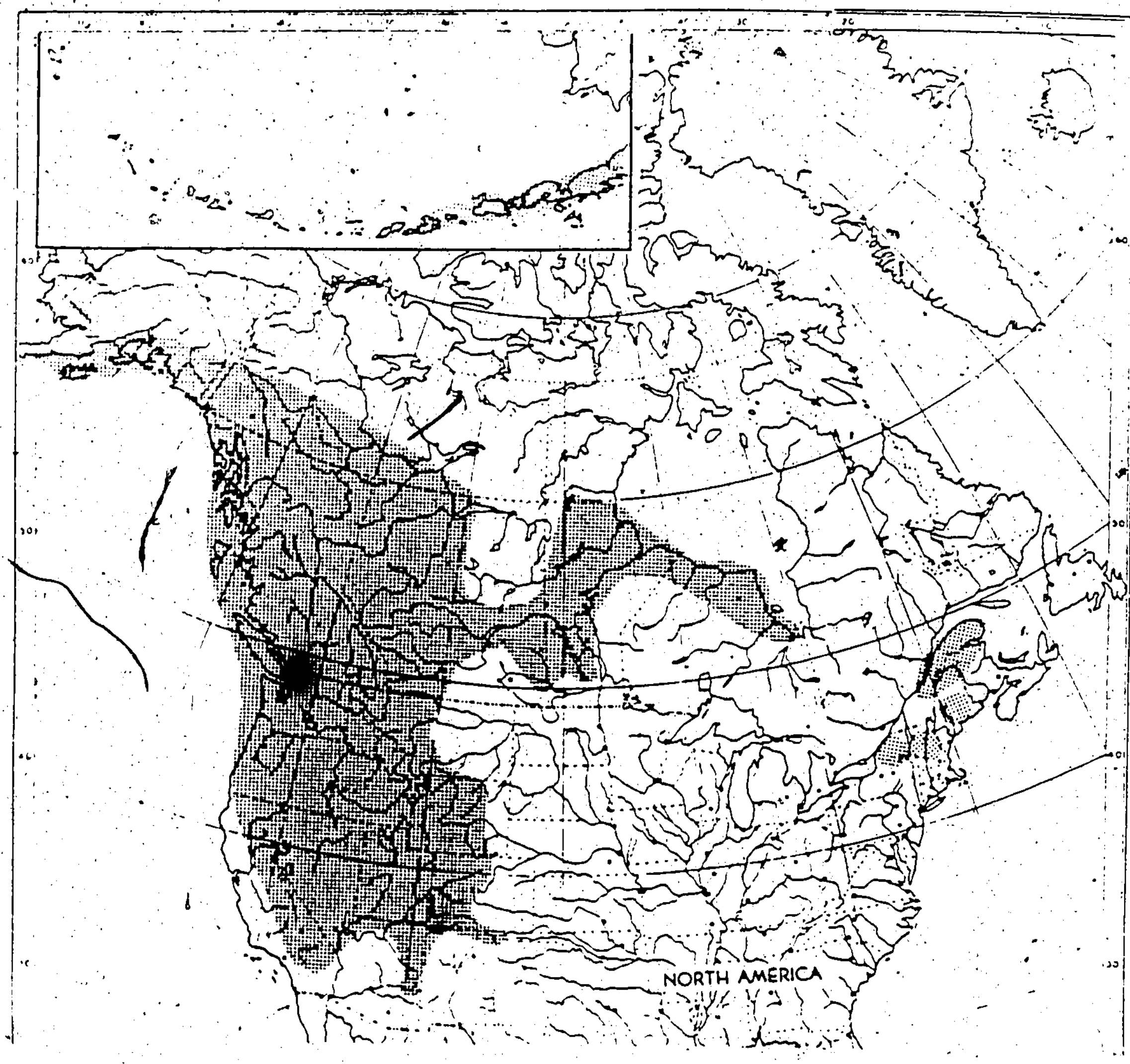

Figure 2. Distribution range of *Arnica* L. subgenus *Chamissonis* Maguire, *circa* 1988.

As pointed above, the division of genus *Arnica* into 5 subgenera was a major thrust in the monograph by Maguire (1943). Thus, the concept of subgenus *Chamissonis per se* is a synthesis or by-product of many taxonomic and floristic studies over a considerable span of time sporadically throughout the scientific literature.

Arnica chamissonis was one of the 3 new species out of the 4 arnicas reported by Ch. F. Lessing (1831) after his studies of the numerous asteraceous collections obtained during the Romanzoff Expedition, to the Alaska Peninsula and vicinity between 1816-1817 (Chamisso 1826). Other taxa included in the account were *Arnica unalaschcensis* Less., *A. obtusifolia* Less., and *A. alpina* L. The first two taxa were treated by Maguire (1943) as conspecific, with the former name being currently in use while *A. alpina* L. *sensu* Lessing (1831) is equivalent to *Arnica frigida* Meyer *ex* Iljin subsp. *frigida* (*fide* Downie 1987, Downie & Denford 1988 in press).

In 1834, *Arnica mollis* was one of the 3 new species proposed by W.J. Hooker in an account of the botany of the northern parts of British North America (= Canada). The other two species were *A. cordifolia* and *A. menziesii*, with the former being a highly polymorphic but distinct species while the latter one was reduced to synonymy under *A. latifolia* Bong. (Maguire 1943, Wolf 1981, Wolf & Denford 1984c). Also in the same publication, Hooker (1834 p. 330) briefly described as new, *A. montana* L. var. *angustifolia* with which he synonymized these names: *A. chamissonis* Less., *A. obtusifolia* Less., *A. unalaschcensis* Less., *A. angustifolia* Vahl, *A. montana* L. *sensu* Br. & *sensu* Rich., *A. alpina* L. *sensu* Less., *A. plantaginea* Pursh and *A. fulgens* Pursh *sensu* Brown. Evidently, this very broad concept of the variety is totally unwarranted as clearly shown by later works (*e.g.* Herder 1867, Maguire 1943, Downie 1987, Downie & Denford 1988 in press). In the present study, *A. montana* L. var. *angustifolia* Hook. is treated as a synonym of *A. chamissonis* Less. with respect to the material upon which Hooker based his circumscription that undoubtedly belongs to *A. chamissonis* Less.

In 1841, Thomas Nuttall reported 6 species of *Arnica*, based on material most of which was collected by him from across the North American continent. Amongst these are 3 new species, *i.e. A. lanceolata, A. foliosa* and *A. amplexicaulis* that were subsequently included in subgenus *Chamissonis* (Maguire 1943). Only *A. lanceolata* Nutt. and *A. amplexicaulis* Nutt. were recognized as specifically distinct by Maguire (1943) while *A. foliosa* was treated as a subspecies of *A. chamissonis* Less.

In 1843, John Torrey and Asa Gray revised the genus *Arnica* for their North American flora. Despite the shortage of good material, they recognized 7 species of which 3 belong to subgenus *Chamissonis* (*A. chamissonis* Less., *A. mollis* Hook., and *A. amplexicaulis* Nutt.) Their interpretation of *A. chamissonis* Less. was broader as they placed *A. montana* L. var. *angustifolia* Hook. and *A. foliosa* Nutt. (*vide supra*) as its synonyms. Its distribution range at this time extended from Unalaska, Rocky Mountains to the Colorados of the West, and to the coniferous regions of subarctic America (Torrey & Gray 1843, p. 450). At the same time, they projected the concept of a bicentric distribution pattern for *A. mollis* Hook. by placing *A. lanceolata* Nutt. as a synonym. This latter taxon was at that period collected only from the moist subalpine and alpine zones of White Mountains in New Hampshire as well as the mountains of New York, near the headwaters of the Hudson River (Torrey & Gray 1843). Only *A. amplexicaulis* Nutt. was retained in a taxonomic state much the same as proposed by Nuttall (1841).

In 1862, Asa Gray in his enumeration of the Rocky Mountains plants introduced a new variety of discoid *Arnica* under the name, "*Arnica angustifolia* Vahl var. *discoidea! latifolia*". He cited "10" as the specimen on which he based the taxon which refers to *C.C. Parry 10*. This collection is also the type of *A. parryi*, a taxon which was later described by Gray (1874).

A year later, A. Gray (1863) described another new variety, *A. angustifolia* Vahl var. *eradiata*, based on a collection from the alpine zone of the Rocky Mountains between latitude 39°-41° [*E. Hall & J.P. Harbour 338* (Holotype, GH *s.n.*!)]. This collection, however, was annotated by Gray as "*A. latifolia eradiata*" (*in sched.*). Moreover, the same collection was also cited as one of the original specimens upon which the circumscription of *A. parryi* was based (Gray 1874 p. 213). Therefore, it is designated here as the holotype of *A. angustifolia* Vahl var. *eradiata* A. Gray and also as paratype of *A. parryi* A. Gray. In 1898, A.A. Heller elevated *A. angustifolia* Vahl var. *eradiata* A. Gray to species rank in his catalogue of North American plants north of Mexico.

In 1864, E.A. Regel described 2 new varieties under *A. chamissonis* Less., *i.e.* var. *typica* and var. *sachalinensis*. Three years later, F.G.T.M. von Herder (1867) in his terse treatment of *Arnica* recognized the 2 varieties of *A. chamissonis* Less. proposed by Regel (1864) and added another new variety, var. *angustifolia*. His recognition of these varieties in *A. chamissonis* Less. was based evidently on a presumed geographic separation between and among populations. Thus, based on limited herbarium material, Herder (1867) specified that var. *typica* was confined to the Alaskan coastal and insular region (Unalaska & Kodiak Islands, Sitka) and var. *sachalinensis* to Sachalin Island, while var. *angustifolia* was an inland variety restricted to Saskatchewan and portions of the Rocky Mountains.

In 1871, *Arnica longifolia* was described as a new taxon by Daniel C. Eaton in the botany section of the report pertaining to the geological exploration of the 40th parallel (S. Watson 1871). In the same paper, Eaton (like Torrey & Gray 1843) considered *A. mollis* Hook. to have a bicentric distribution range in North America, thus implying that *A. lanceolata* Nutt. is conspecific with *A. mollis* Hook. Furthermore, he considered *A. amplexicaulis* Nutt. to be a taxon that "differs scarcely in any respect" (Eaton 1871 p. 187) from *A. mollis* Hook. One other major consideration in his paper was that of *A. chamissonis* Less. being a widespread species with distribution range from "subarctic America and Alaska to Saskatchewan; Oregon; California and Colorado; Carson City, Anderson. On the Truckee River, Nevada, and in Parley's Park and Bear River Canon, Utah;" (Eaton 1871 p. 187). It is obvious from this range description that Eaton did not recognize the varieties proposed by Regel (1864) and Herder (1867), respectively. In 1874, Asa Gray described *A. parryi* as a new species based on a collection by C.C. Parry from the mountains in Colorado. At the same time, he cited *A. angustifolia* Vahl var. *discoidea latifolia* A. Gray and *A. angustifolia* Vahl var. *eradiata* A. Gray as its synonyms. He also listed the material he examined for this new species, *i.e.* collections by C.C. Parry, E.L. Greene, E. Hall & J.P. Harbour from the Colorado mountains as well as subsequent collection of C.C. Parry from Wyoming and Rev. Nevius from the mountains of Oregon (Gray 1874). It is quite evident that Gray's intention was simply to elevate to species rank the conspecific varieties he had proposed earlier (*vide supra*). However, the use of either epithets of the older taxon was not possible as these were already used at the species rank for 2 other entirely different taxa, *i.e. Arnica latifolia* Bong. and *Arnica discoidea* Benth., which were described in 1832 and 1849, respectively. Another taxon recognized by Gray during this period (1874) was *A. foliosa* Nutt. which he referred earlier to *A. chamissonis* Less. *sensu* Torrey & Gray in part (1843). While recognizing this taxon at the species level, he commented that morphologically it blends with var. *incana* and that *A. foliosa* Nutt. and *A. chamissonis* Less. were species that "seem to run together inextricably" (Gray 1874 p. 214).

In 1884, Asa Gray's treatment of *Arnica* for his *Synoptical Flora of North America* included 15 species and 4 varieties. *Arnica amplexicaulis* Nutt. and *A. longifolia* D.C. Eaton were maintained as circumscribed by the original authors while the treatment of *A. foliosa* Nutt. strictly adhered to their previous concept of the taxon (Torrey & Gray 1843) except for the retention of var. *incana* Gray under this species. Similarly, *A. parryi* was retained as a distinct species with the same list of synonyms as presented in his previous work (Gray 1874). A novelty in the form of *Arnica latifolia* Bong. var. *viscidula* was introduced, based on the collections of Greene and Pringle from the High Sierra Nevada region of California. This taxon however, turned out to be conspecific with *A. diversifolia* Greene (Maguire 1943). Both names are treated in the present study as synonyms of *A. ovata* Greene.

The treatment presented by Gray (1884) for *A. chamissonis* Less. was radically different from the one given in the revision of *Arnica* by Torrey & Gray (1843). In this treatment, *A. mollis* Hook. and *A. chamissonis* Less. were synonymized, together with *A. lanceolata* Nutt. which was previously treated as a synonym of *A. mollis* Hook. (Torrey & Gray 1843). Consequently, *A. chamissonis* Less. became a bicentrically distributed species in North America.

Between 1896 and 1943, thirty-five new taxa belonging to subgenus *Chamissonis* were described by E.L. Greene (1896, 1899, 1900, 1901, 1902 & 1910), P.A. Rydberg (1900, 1901, 1905, 1910 & 1927), A. Nelson (1900, 1901, 1904 & 1934), M.L. Fernald (1905), C.V. Piper (1920), H. St. John & F.A. Warren (1931) and B. Maguire (1942). Table 2 provides a list of these taxa and a summary of their subsequent taxonomic status. This table shows that of the 18 new taxa described or introduced by Greene between 1896 and 1902, only two *i.e. A. diversifolia* Greene and *A. parryi* A. Gray subsp. *sonnei* (Greene) Maguire, were recognized by Maguire (1943) and subsequent workers, *e.g.* Cronquist (1955), Ediger & Barkley (1978, at varietal status), Douglas (1982), *etc.* All other taxa described or introduced by other authors (*vide supra*) were synonymized with earlier valid names (Table 2). Nonetheless, this phenomenal increase in the number of taxa in such a brief period of time could be taken as a good indicator of the marked degree of phenotypic plasticity in widely scattered populations of each species over diverse environments.

The first complete attempt to classify the genus *Arnica* was made by Rydberg (1922) in his *Flora of the Rocky Mountains*. In this work, he subdivided the genus, then comprising 40 species, into 12 subgeneric groups (nearly equivalent to sections). Rydberg's grouping of 40 species demonstrated a keen understanding of the morphological relationships between and among taxa but emphasis was placed on minor character differences or morphological discontinuity. In 1927, an expanded version of this classification scheme was presented by Rydberg in the treatment of *Arnica* for his North American flora. In this work, Rydberg increased the number of 'accepted' taxa for the genus *Arnica* to an all-time high of 107 species in 17 subgeneric groups. Except for a minor change in the name of one group *i.e. Eradiatae* (Rydberg 1922) to *Parryanae* (Rydberg 1927), all his previous subgeneric groups

Table 2. New taxa or names in *Arnica* subgenus *Chamissonis* that were described or introduced by various authors between 1896 and 1943 and their subsequent taxonomic status.

Original author/Taxon	Year Published	Maguire (1943)	Subsequent Taxonomic Status Ediger & Barkley (1978)
E.L. Greene			
A. denudata	1896	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. subsp. *foliosa* Nutt. var. *andina* (Nutt.) Ediger & Barkley
A. denudata var. *canescens*	1896	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. sonnei	1896	*A. parryi* A. Gray ssp. *sonnei* (Greene) Maguire	*A. parryi* A. Gray
A. subplumosa	1896	A. mollis Hook.	*A. mollis* Hook.
A. merriamii	1899	*A. mollis* Hook.	*A. mollis* Hook.
A. bernardina	1900	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *bernardina* (Greene) Maguire
A. columbiana	1900	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. crocea	1900	*A. mollis* Hook.	*A. mollis* Hook.
A. diversifolia	1900	*A. diversifolia* Greene	*A. diversifolia* Greene
A. macilenta	1900	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. macounii	1900	*A. amplexicaulis* Nutt. ssp. *genuina* Maguire	*A. amplexicaulis* Nutt.
A. ovata	1900	*A. mollis* Hook.	*A. mollis* Hook.
A. rivularis	1900	*A. mollis* Hook.	*A. mollis* Hook.
A. scaberrima	1900	*A. mollis* Hook.	*A. mollis* Hook.
A. lanulosa	1901	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp.

			foliosa (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. silvatica	1901	*A. mollis* Hook.	*A. mollis* Hook.
A. aspera	1902	*A. amplexicaulis* Nutt. ssp. *amplexicaulis*	*A. amplexicaulis Nutt.*
A. cana	1902	*A. chamissonis* Less. ssp. *incana* (A. Gray) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *incana* (A. Gray) Hulten
A. confinis	1902	*A. mollis* Hook.	*A. diversifolia* Greene
A. rubricaulis	1910	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
P.A. Rydberg			
A. amplexifolia	1900	*A. amplexicaulis* Nutt. ssp. *genuina* Maguire	*A. amplexicaulis* Nutt.
A. tomentulosa	1901	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. coloradensis	1905	*A. mollis* Hook.	*A. mollis* Hook.
A. caudata	1910	*A. longifolia* D.C. Eaton ssp. *genuina* Maguire	*A. longifolia* D.C. Eaton
A. amplifolia	1927	*A. mollis* Hook.	*A. mollis* Hook.
A. arachnoidea	1927	*A. mollis* Hook.	*A. mollis* Hook.
A. borealis	1927	*A. amplexicaulis* Nutt. ssp. *genuina* Maguire	*A. amplexicaulis* Nutt.
A. bruceae	1927	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. ciliaris	1927		*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. elongata	1927	*A. amplexicaulis* Nutt. ssp. *genuina* Maguire	*A. amplexicaulis* Nutt.
A. filipes	1927	*A. amplexicaulis* Nutt.	

		ssp. genuina Maguire	*A. amplexicaulis* Nutt.
A. hirticaulis	1927	*A. amplexicaulis* Nutt. ssp. *genuina* Maguire	*A. amplexicaulis* Nutt.
A. kodiakensis	1927	*A. chamissonis* Less. ssp. *genuina* Maguire	*A. chamissonis* Less. ssp. *chamissonis* var. *chamissonis*
A. Nelson *A. chamissonis* Less. var. *longinodosa*	1900	*A. mollis* Hook.	*A. mollis* Hook.
A. exigua	1900	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. ocreata	1900	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. polycephala	1900	*A. longifolia* D.C. Eaton ssp. *genuina* Maguire	*A. longifolia* D.C. Eaton
A. celsa	1901	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. greenei	1901	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. rhizomata	1901	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. stricta non Greene	1901	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley
A. arcana	1904	*A. longifolia* D.C. Eaton & *A. gracilis* Rydb.	*A. lonchophylla* Greene
A. maguirei	1934	*A. chamissonis* Less. ssp.	

		foliosa (Nutt.) Maguire	*A. chamissonis* Less. ssp. *foliosa* (Nutt.) Maguire var. *maguirei (A. Nelson) Maguire*
A. trina	1934	*A. amplexicaulis* Nutt. ssp. *genuina* Maguire	*A. amplexicaulis* Nutt.
M.L. Fernald *A. mollis* Hook. var. *petiolaris*	1905	*A. lanceolata* Nutt.	*A. lanceolata* Nutt.
C.V. Piper *A. myriadenia*	1920	*A. longifolia* D.C. Eaton subsp. *myriadenia* (Piper) Maguire	*A. longifolia D.C. Eaton*
H. St. John & F.A. Warren *A. amplexicaulis* Nutt. var. *piperi*	1931	*A. amplexicaulis* Nutt.	*A. amplexicaulis* Nutt.
B. Maguire *A. amplexifolia* Rydb. ssp. *prima*	1942	*A. amplexicaulis* Nutt. ssp. *prima* (Maguire) Maguire	

for subgenus *Chamissonis* were maintained. Thirty-eight species, which were later included by Maguire (1943) in subgenus *Chamissonis*, were recognized by Rydberg (1927) of which 9 represented new species. Table 3 shows a comparison of Rydberg's classification schemes (1922 & 1927) of subgenus *Chamissonis*.

Although entirely based on morphology and phytogeographical data available during that time, Maguire in his monograph of the genus *Arnica* (1943) drastically reduced the number of taxa to 50 consisting of 32 species and 18 subspecies. As mentioned earlier (*vide supra*), in this paper he established the 5 new subgenera to accomodate these 50 taxa in a more understandable taxonomic fashion. Despite the absence of biosystematic information on the genus at this time, Maguire's treatment of individual species proves to be substantially acceptable and his classification of taxa approximates a natural order. In subgenus *Chamissonis*, Maguire (1943) recognized 7 species and 5 subspecies or a total of 12 taxa (Table 4).

In the intervening period between 1943 and 1978, all regional and state or provincial floras and floristic studies (*e.g.* Cronquist 1955, Moss 1959, Munz 1959, 1963 & 1968, Hultén 1968, Ferlatte 1974; Gillett & Howell 1961, Cooke 1962, *etc.*) made use of Maguire's (1943) over-all taxonomic treatment of *Arnica*, with minor taxonomic rank changes. Subsequent revision of the genus by R.I. Ediger & T.M. Barkley (1978) for the updated North American Flora resulted only in minor taxonomic modification. Their general delimitation of species and accompanying synonymy closely patterned that of Maguire (1943). Table 4 shows a comparison of taxonomic treatments of *Arnica* subgenus *Chamissonis* that were proposed between 1927 and 1982. This table demonstrates that in subgenus *Chamissonis*, Ediger & Barkley (1978) resurrected some taxa already reduced to synonymy by Maguire (1943) but they recognized these only at varietal level. Comparatively speaking, subgenus *Chamissonis* is quite different from the other two more diverse subgenera in *Arnica*, *i.e.* *Arctica* and *Austromontana*, in that out of the 7 species included in it by Maguire (1943), only 4 species have been taxonomically controversial, namely: *A. chamissonis* Less., *A. amplexicaulis* Nutt.,

Table 3. Comparison of classification schemes by Rydberg (1922, 1927) of species later considered under *Arnica* subgenus *Chamissonis*.

Rydberg (1922)	**Rydberg (1927)**
I. Eradiata	**XIII. Parryanae**
A. parryi A. Gray	*A. parryi* A. Gray
VI. Diversifoliae	**XIV. Diversifoliae**
A. diversifolia Greene	*A. diversifolia* Greene
A. silvatica Greene	*A. silvatica* Greene
	A. sonnei Greene
VII. Longifoliae	**XI. Longifoliae**
A. caudata Rydb.	*A. caudata* Rydb.
A. longifolia D.C. Eaton	*A. longifolia* D.C. Eaton
	A. myriadenia Piper
VIII. Molles	**XII. Molles**
A. amplexifolia Rydb.	*A. amplexifolia* Rydb.
	A. amplifolia Rydb.
	A. arachnoidea Rydb.
A. arcana A. Nelson	*A. arcana* A. Nelson
	A. aspera Greene
	A. borealis Rydb.
A. coloradensis Rydb.	*A. coloradensis* Rydb.
	A. confinis Greene
	A. elongata Rydb.
	A. filipes Greene
	A. hirticaulis Rydb.
	A. kodiakensis Rydb.
	A. lanceolata Nutt.
A. macilenta Greene	*A. macilenta* Greene
A. macounii Greene	*A. macounii* Greene
A. mollis Hook.	*A. mollis* Hook.
A. ovata Greene	*A. ovata* Greene
	A. petiolaris (Fern.) Rydb.
A. rivularis Greene	*A. rivularis* Greene
	A. scaberrima Greene
A. subplumosa Greene	
IX. Foliosae	**IX Foliosae**
	A. bernardina Greene
	A. bruceae Rydb.
	A. cana Greene
A. celsa A. Nelson	*A. celsa* A. Nelson
A. chamissonis Less.	*A. chamissonis* Less.
	A. denudata Greene
A. foliosa Nutt.	*A. foliosa* Nutt.
A. ocreata A. Nelson	
A. rhizomata A. Nelson	*A. rhizomata* A. Nelson
A. rubricaulis Greene	*A. rubricaulis* Greene
A. tomentulosa Rydb.	*A. tomentulosa* Rydb.
	A. trinervata Rydb.

Table 4. Comparison of taxonomic treatments for *Arnica* subgenus *Chamissonis*.

Rydberg (1927)	**Maguire (1943)**	**Ediger & Barkley (1978)**	**Douglas (1982)**
A. kodiakensis Rydb.	*A. chamissonis* Less. ssp. *genuina* Maguire	*A. chamissonis* Less. ssp. *chamissonis* var. *chamissonis*	*A. chamissonis* Less. ssp. *chamissonis*
A. foliosa Nutt. *A. denudata* Greene *A. celsa* A. Nelson *A. tomentulosa* Rydb. *A. rhizomata* A. Nelson *A. rubricaulis* Greene *A. bruceae* Rydb. *A. hirticaulis* Rydb. *A. macilenta* Greene	*A. chamissonis* ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* ssp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley	
A. ciliaris Rydb.		*A. chamissonis* ssp. *foliosa* var. *andina* (Nutt.) Ediger & Barkley	
A. bernardina Greene	*A. chamissonis* ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* ssp. *foliosa* (Nutt.) Maguire var. *bernardina* (Greene) Maguire	
A. cana Greene	*A. chamissonis* ssp. *incana* (A. Gray) Maguire	*A. chamissonis* ssp. *foliosa* (Nutt.) Maguire var. *incana* Hult.	
	A. chamissonis ssp. *foliosa* (Nutt.) Maguire	*A. chamissonis* ssp. *foliosa* var. *maguirei* (A. Nelson) Maguire	
A. longifolia D.C. Eaton	*A. longifolia* D.C. Eaton ssp. *genuina* Maguire	*A. longifolia* D.C. Eaton	*A. longifolia* D.C. Eaton
A. myriadenia Piper	*A. longifolia* ssp. *myriadenia* (Piper) Maguire	*A. longifolia* D.C. Eaton	
A. caudata Rydb.	*A. longifolia* D.C. Eaton ssp. *genuina* Maguire	*A. longifolia* D.C. Eaton	

Rydberg (1927)	**Maguire (1943)**	**Ediger & Barkley (1978)**	**Douglas (1982)**
A. arcana A. Nelson	*A. longifolia D.C. Eaton* ssp. *genuina* Maguire	*A. lonchophylla* Greene	
A. parryi A. Gray	*A. parryi* A. Gray ssp. *genuina* Maguire	*A. parryi* A. Gray var. *parryi*	*A. parryi* A. Gray ssp. *parryi*
A. sonnei Greene	*A. parryi* A. Gray ssp. *sonnei* (Greene) Maguire	*A. parryi* A. Gray var. *sonnei* (Greene) Cronquist	
A. mollis Hook.	*A. mollis* Hook.	*A. mollis* Hook.	*A. mollis* Hook.
A. scaberrima Greene *A. coloradensis* Rydb. *A. arachnoidea* Rydb. *A. rivularis* Greene *A. ovata* Greene *A. silvatica* Greene	*A. mollis* Hook.	*A. mollis* Hook.	
A. diversifolia Greene	*A. diversifolia* Greene	*A. diversifolia* Greene	*A. diversifolia* Greene
A. confinis Greene	*A. mollis* Hook.	*A. diversifolia* Greene	
A. amplexifolia Rydb.	*A. amplexicaulis* Nutt. ssp. *genuina* Maguire	*A. amplexicaulis* Nutt.	*A. amplexicaulis* Nutt. ssp. *amplexicaulis*
A. macounii Greene *A. aspera* Greene *A. filipes* Greene *A. elongata* Rydb. *A. borealis* Rydb. *A. amplifolia* Rydb.	*A. amplexicaulis* Nutt. ssp. *genuina* Maguire	*A. amplexicaulis* Nutt.	
A. lanceolata Nutt.	*A. lanceolata* Nutt.	*A. lanceolata* Nutt.	
A. petiolaris (Fern.) Rydb.	*A. lanceolata* Nutt.	*A. lanceolata* Nutt.	

A. mollis Hook., and *A. diversifolia* Greene. Apparent taxonomic confusion involving *A. chamissonis* Less., *A. amplexicaulis* Nutt., *A. mollis* Hook. as well as *A. lanceolata* Nutt. has been cited earlier (*vide supra*), whereby at one time or another, *A. amplexicaulis* Nutt. and *A. lanceolata* Nutt. were considered conspecific with *A. mollis* Hook., hence projecting a bicentric distribution pattern in North America for the latter taxon. At its worst, *A. mollis* Hook. considered at its broadest circumscription was in turn subsumed under *A. chamissonis* Less., thus making the latter taxon, an impressively bicentric species. On the other hand, *A. diversifolia* Greene has been considered for quite long time as "merely a convenient name for a complex series of hybrids" (Cronquist 1955; see also, Ediger & Barkley 1978; Hultén 1968) involving *A. amplexicaulis* Nutt. or *A. mollis* Hook. and *A. cordifolia* Hook. or *A. latifolia* Bong. (Cronquist 1955, Ediger & Barkley 1978, Wolf 1980) and more recently, between *A. mollis* Hook. and *A. cordifolia* Hook; *A. latifolia* Bong. or *A. rydbergii* Greene (Welsh *et al.* 1987). Whether this is the actual situation or not is one of the prime objectives of the present study.

In general, the persistent confusion in subgenus *Chamissonis* arises from the inherent high level of polymorphism in nearly all species. This situation was further compounded by the aggressive efforts of a number of previous taxonomists to shrink the circumscription of each species, thus leading to a deluge of new names particularly given to almost every minor variant of many dynamically polymorphic populations. Additionally, the absence of a better understanding of the biotic, abiotic and historical parameters that shaped, governed and directed evolutionary developments in these taxa was definitely one of the contributory factors to these existing taxonomic problems in this subgenus.

Biosystematic History of subgenus Chamissonis

The earliest report (Afzelius 1936) on the reproductive behavior in the genus *Arnica* involved three species, *i.e.* *A. alpina* (L.) Olin (=*A. angustifolia* J.M. Vahl subsp.

angustifolia, fide Downie 1987, Downie & Denford 1988 in press), *A. chamissonis* Less., and *A. diversifolia* Greene (= *A. ovata* Greene, in this study). The latter two species are included subgenus *Chamissonis*.

Afzelius (1936) reported that the mechanism of apomixis present in *A. chamissonis* Less. is virtually identical to that of *A. alpina* (L.) Olin. In these two species, apomictic reproduction is accomplished by diplospory then immediately followed by parthenogenetic embryo development. He observed only the occurrence of agamospermy in *A. diversifolia* Greene, a phenomenon recognized in *A. chamissonis* Less. (Afzelius 1936).

The next short study was by Emilio Battaglia (1952) who examined the sexual reproduction in *A. longifolia* D.C. Eaton using plants grown from seeds obtained from the Botanical Garden of the University of Copenhagen, Denmark. He claimed that embryo-sac development in *A. longifolia* D.C. Eaton is identical to the standard *Polygonum*-type, *i.e.* 4 megaspores are usually present but only one is responsible for the development of an 8-celled embryo-sac. He also reported a chromosome number of $n = 5$ for this taxon which he suggested to be the basic chromosome number for the genus (Battaglia 1952). However, a re-examination by Ornduff *et al.* (1967) of the same and only collection of *A. longifolia* D.C. Eaton maintained since 1928 at that botanical garden showed conclusively that Battaglia's count was erroneous. The correct chromosome number as reported by Ornduff *et al.* was 2n = 76; a tetraploid and, accordingly this population was likely to be apomictic.

Three years after the controversial chromosome count of Battaglia (1952), Böcher & Larsen (1955) indicated that the basic chromosome number for *Arnica* is $x = 19$. Subsequent cytological investigations, (e.g. Ornduff *et al.* 1963 & 1967, Löve & Löve 1964 & 1975, Barker 1966 & 1967, Keil & Pinkava 1976, Straley 1982, *etc.*), dealing with more than half the total number of species recognized by Maguire (1943) have confirmed this basic number. As could be expected, a few other reports, *e.g.* Zhukova 1964 & 1966, Chuksanova 1969, presented chromosome numbers not in agreement with $x = 19$. Ornduff *et al.* (1967) and Keil & Pinkava (1976) categorically suggested that counts based on radically different base numbers are best treated as approximations and should be subject to reinvestigation and proper confirmation. Table 5 provides a summary of previously reported chromosome numbers in subgenus *Chamissonis*, up to 1987. By far, subgenus *Chamissonis* is the most cytologically diverse among the 5 subgenera having ploidy levels from diploid (2n = 38) to octoploid (2n = 152) recorded (Ornduff *et al.* 1963 & 1967, Löve & Löve 1964 & 1966, Barker 1966 & 1967, Taylor & Mulligan 1968, Strother 1972, Reveal & Styer 1973, Kovanda 1978, Straley 1979, Wolf 1980, Kyhos & Raven 1982, Downie 1985, and Wolf 1987).

Apart from the pioneer study on reproductive biology in 3 species of *Arnica* by Afzelius (1936), the only comprehensive survey of apomixis in this genus was by Barker (1966). Using the taxonomic classification proposed by Maguire (1943), Barker (1966) studied apomixis in 24 species mainly using emasculation technique supplemented with some chromosome counts. His study included 8 of the 12 taxa or 6 of the 7 species classified by Maguire (1943) in subgenus *Chamissonis*. Despite the limited number of live collections used in the experimental study and relatively small number of herbarium specimens examined for pollen quality, Barker (1966) presented some interesting generalizations concerning taxa in subgenus *Chamissonis*.

Of the 40 herbarium specimens of *A. mollis* Hook. examined for pollen quality using cotton blue lactophenol solution, all had less than 90% stainable pollen, with a single collection yielding a maximum of 80%. For *A. parryi* A. Gray, 37 of the 44 collections had less than 50% stainable pollen and the maximum percent stainability was only 64%. A similar trend was observed in *A. diversifolia* Greene, with only one of 12 herbarium specimens studied showing 70% stainability. On the basis of these observations, Barker (1966) concluded that *A. mollis* Hook., *A. parryi* A. Gray, and *A. diversifolia* Greene are apomictic.

The other three species examined in subgenus *Chamissonis* were *A. chamissonis* Less., *A. longifolia* D.C. Eaton, and *A. amplexicaulis* Nutt. Slightly different observations and conclusions were recorded for these taxa.

Table 5. Previously reported chromosome numbers in *Arnica* L. subgenus *Chamissonis* Maguire.

Taxon	n=	2n=	Locality	Reference
A. amplexicaulis subsp. *amplexicaulis*	33-34		OR*: Clackamas Co.	Ornduff *et al.* (1963)
	c.38		WA: Lewis Co., Mt. Rainier	Barker (1966, 1967)
	19		WA: Clallam Co., Hurricane Ridge	Barker (1966, 1967)
	19		OR: Multnomah Co., Oneonta Gorge	Barker (1966, 1967)
	c.19		BC: No specific locality cited, *Calder 37139*	Ornduff *et al.* (1967)
	c.28	56	BC: Graham Is., Blackwater Creek	Taylor & Mulligan (1968)
	c.28		BC: Graham Is., Mt. Moresby	Taylor & Mulligan (1968)
		56	BC: Moresby Is., Upper Victoria Lake	Taylor & Mulligan (1968)
		c.57	CA: Trinity Co., Trinity Alps	Strother (1972)
		57	WA: Whatcom Co., c.14 km NE of Whatcom-Skagit Co. line	Straley (1979)
		57	AB: Clear Hills, 19 km N of Worsley	Wolf (1980)**
	38		AB: 35 km S of Mountain Park	Wolf (1980)
A. chamissonis subsp. *chamissonis*		60	U.S.S.R.: Arctic-Alpine Botanical Garden	Zhukova (1964)
		60	U.S.S.R.: Tartu	Zhukova (1967)
		38	BC: McBride	Straley (1979)
		57	AK: Glenallen	Wolf (1980)
		57	AK: Valdez	Wolf (1980)
		57	AK: Hwy 9, N of Moose Pass, near Homer turn-off	Downie (1985)
		76	AK: Seward Cemetery	Wolf (1987)
		76	AK: N of Summit Lake, on Kenai Peninsula	Wolf (1987)
		76	BC: 8 km N of Chilkoot Pass	Wolf (1987)
A. chamissonis subsp. *foliosa*		53-57	CA: Nevada Co.	Ornduff *et al.* (1963, 1967)
		c.57	CANADA: Seeds obtained from Toronto Botanical Garden, Ontario	Barker (1966, 1967)
		38	ID: Blaine Co.	Ornduff *et al.* (1967)

		c.57±1	CO: Lake Co.	Orndoff *et al.* (1967)
		60	U.S.S.R.: Botanical Garden	Chuksanova (1969)
	c.19		AZ: Apache Co.,15 mi W of Eager	Keil & Pinkava (1976)
		57	CO: Routt Co., Steamboat Springs	Straley (1979)
		57	MA: Riding Mt., *Löve & Löve S3948*.	Löve & Löve (1982)
		57	YT: 16 km S of Haines Junction, Haines Road	Downie (1985)
A. chamissonis subsp. *incana*		38	CA: Nevada Co., Truckee	Straley (1979)
		57	YT: Km 328 Klondike Hwy, 28 km S of Carmacks	Downie (1985)
A. diversifolia		54-57	AB: Banff Nat'l. Park, east end of Moraine Lake	Taylor (1967)
		57	AB: SW end of Peyto Lake	Straley (1979)
		76	CA: Placer Co., Alpine Meadows Ski Area	Straley (1979)
	38		AB: Waterton Lakes Nat'l. Park, Goat Lake	Wolf (1980)
A. lanceolata		76	NH: Mt. Washington	Löve & Löve (1964)
		76	NH: Mt. Washington, Tuckerman's Ravine	Löve & Löve (1966)
		76	PQ: Gaspé Peninsula, Mt. Logan	Morton (1981)
		76	PQ: Gaspé Peninsula, Mt. Logan	Wolf (1987)
A. longifolia	5		DENMARK: Seeds obtained from Botanical Garden, University of Copenhagen	Battaglia (1952)
		60	U.S.S.R.: Arctic-Alpine Botanical Garden	Zhukova (1964)
		56	U.S.S.R.: Vilap	Zhukova (1967)
		76	DENMARK: Seeds obtained from Botanical Garden, University of Copenhagen	Orndoff *et al.* (1967)
		76	WY: Park Co., Yellowstone Nat'l Park, 1.6 km N of Dunraven Pass	Wolf (1987)
		76	WY: Park Co., Beartooth Lake	Wolf (1987)
A. longifolia subsp. *myriadenia*		c.50	CA: Mono Co., *Raven 20802* (MO)	Kyhos & Raven (1982)
A. mollis		c.38	CO: Jackson Co.	Orndoff *et al.* (1967)

38		CA: Tuolumne Co.	Ornduff *et al.* (1967)
	76	AB: No specific locality cited, *Mosquin 3353*	Ornduff *et al.* (1967)
	c.76	CO: San Miguel Co.	Ornduff *et al.* (1967)
	c.74	AB: No specific locality cited, *Calder 37168*	Ornduff *et al.* (1967)
	76	CA: Trinity Co., Trinity Alps	Strother (1972)
c.38		BC: Manning Provincial Park, c. 150 mi E of Vancouver, 6500 ft	Pojar (1973)
	76	CO: San Juan Co., 2 mi S of Engineer Pass	Keil & Pinkava (1976)
	76 & 152	WY: Albany Co., 14 mi W of Centennial	Keil & Pinkava (1976)
	38	CO: Grand Co., Berthoud Pass, 12400 ft	Kovanda (1978)
	57	BC: Vancouver Is., Forbidden Plateau	Straley (1979)
	57	MT: Flathead Co., Glacier Nat'l. Park, Hidden Lake	Wolf (1980)
	57	WY: Albany Co., 12 km W of Centennial	Wolf (1980)
	57	WY: Carbon Co., Snowy Range Pass	Wolf (1980)
	57	WY: Sublette Co., 16 km NE of Pinedale	Wolf (1980)
	57	UT: San Pete Co., 7 km N of junction of Spring City-Skyline Drive Road	Wolf (1980)
	57	CO: Clear Creek Co., Loveland Pass	Wolf (1980)
	57	CO: Pitkin Co., 0.8 km W of Independence Pass	Wolf (1980)
	57	CO: Pitkin Co., 8.2 km W of Independence Pass	Wolf (1980)
38		AB: Waterton Lakes Nat'l. Park, Goat Lake	Wolf (1980)
38		OR: Wallowa Co., km 11 Hurricane Creek Trail	Wolf (1980)
	38	WY: Carbon Co., Hyw 130, 14.2 km W of Albany Co. line	Wolf (1987)
	38	WY: Teton Co., near Togwotee Pass	Wolf (1987)
	57	CO: Lake Co., near Independence Pass	Wolf (1987)
	57	CO: Lake Co., Fremont Pass	Wolf (1987)
	76	AK: Hatcher Pass, NW of Palmer	Wolf (1987)
	76	CO: Eagle Co., Shrine Pass	Wolf (1987)
	76	CO: La Plata Co., Coal Bank Pass	Wolf (1987)
	76	CO: Rocky Mt. Nat'l Park, 11.6 km up Old Fall River Road	Wolf (1987)

		76	CO: San Juan Co., Red Mt. Pass	Wolf (1987)
		76	MT: Beaverhead Co., near Chief Joseph Pass	Wolf (1987)
		76	OR: Klamath Co., Crater Lake	Wolf (1987)
		76	WY: Albany Co., Brooklyn Lake, E of Snowy Pass	Wolf (1987)
		76	WY: Carbon Co., Hwy 130, 3.2 km W of Albany Co. line	Wolf (1987)
		76	WY: Park Co., near Beartooth Lake	Wolf (1987)
parryi	c.36		WA: Kittitas Co.	Ornduff *et al.* (1963)
		c.76	CO: San Miguel Co.	Ornduff *et al.* (1967)
		57	CO: Routt Co., Rabbit Ears Pass	Straley (1979)
	38		WA: Clallam Co., Olympic Nat'l. Park, Hurricane Ridge	Wolf (1980)
	38		WY: Albany Co., 12 km W of Centennial	Wolf (1980)
	38		UT: San Pete Co., junction of Spring City-Skyline Drive Road	Wolf (1980)
	38		CO: Pitkin Co., 8.2 km W of Independence Pass	Wolf (1980)
		76	MT: Gallatin Co., Targhee Pass	Wolf (1980)
		57	CO: Chaffee Co., near Monarch Pass	Wolf (1987)
		57	CO: San Juan Co., Red Mt. Pass	Wolf (1987)
		57	WY: Carbon Co., Hwy 130, 1.9 km W of Albany Co. line	Wolf (1987)
		76	CO: Eagle Co., Shrine Pass	Wolf (1987)
		76	CO: Lake Co., 4.8 km E of Independence Pass	Wolf (1987)
		76	CO: Lake Co., Fremont Pass	Wolf (1987)
		76	CO: Mineral Creek Co., near Wolf Creek Pass	Wolf (1987)
		76	CO: La Plata Co., Coal Bank Pass	Wolf (1987)
		76	CO: La Plata Co., Rocky Mt. Nat'l. Park, 11.6 km up Old Fall River Road	Wolf (1987)
		76	ID: Fremont Co., Howard Springs	Wolf (1987)
		76	WY: Albany Co., Brooklyn Lake, E of Snowy Pass	Wolf (1987)

		76	WY: Carbon Co., Ryan Park Campground on Hwy. 130	Wolf (1987)
		76	WY: Albany Co., 14.2 km W of Albany Co. line, on Hwy. 130	Wolf (1987)
		76	WY: Albany Co., 3.2 km W of Albany Co. line	Wolf (1987)
		76	WY: Park Co., Yellowstone Nat'l. Park, 4.8 km S of Dunraven Pass	Wolf (1987)
		76	WY: Park Co., Beartooth Lake	Wolf (1987)
		76	WY: Teton Co., Hwy 89, 1.6 km N of Teton Nat'l. Park	Wolf (1987)
A. parryi subsp. *sonnei*		c.97	CO: La Plata Co.	Ornduff *et al.* (1967)
	19		NV: Nye Co., Kawich Range, W of Kawich Peak, stream at Longstreets Ranch, *Beatley & Reveal 10975*	Reveal & Styer (1973)

•Locality abbreviations: AK, Alaska; AB, Alberta; AZ, Arizona; BC, British Columbia; CA, California; CO, Colorado; ID, Idaho; MA, Manitoba; MT, Montana; NV, Nevada; NH, New Hampshire; OR, Oregon; PQ, Quebec; UT, Utah; WA, Washington; WY, Wyoming; YT, Yukon Territory.

••Voucher specimens of taxa in subgenus *Chamissonis* stated to have been deposited in ALTA (Wolf 1980) were not found.

Of 49 herbarium specimens studied for *A. chamissonis* Less., seven had greater than 90% pollen stainability while 30 had less than 60%. Five of the 7 collections were assigned by Barker (1966) under *A. chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire, while the other 2 were under *A. chamissonis* Less. subsp. *incana* (A. Gray) Maguire. Consequently, Barker (1966) concluded that *A. chamissonis* Less. is predominantly apomictic and that only subsp. *foliosa* and subsp. *incana* have amphimictic populations. A similar pattern was observed in *A. longifolia* D.C. Eaton based on pollen quality in 41 herbarium specimens, of which only 5 had greater than 90% stainable pollen. According to Barker (1966), this species appears to be predominantly apomictic with restricted amphimict populations in southwestern Montana, southern Idaho and northern Utah. A lone collection from Plumas County, California (*E.K. Balls 15744*) determined as *A. longifolia* D.C. Eaton subsp. *myriadenia* (Piper) Maguire was reported by Barker (1966) as a sexual population for this subspecies.

A detailed experimental investigation into the pattern of embryological development in *A. amplexicaulis* Nutt. was undertaken by Barker (1966). His complete description of the developmental sequence (Barker 1966 pp. 39-43, plates II & III) confirmed the observation earlier reported by Afzelius (1936) pertaining to *A. chamissonis* Less. and *A. alpina* (L.) Olin. Barker (1966, 1967) also reported a diploid chromosome number for two collections, each from Oneonta Gorge (Oregon) and Hurricane Ridge (Washington), and a tetraploid count from Mt. Rainier (Washington). His pollen quality assessment of 81 herbarium specimens showed that 14 had greater than 90% stainable pollen while 60 had below 50%. Conclusions similar to those for *A. chamissonis* Less. and *A. longifolia* D.C. Eaton were given by Barker (1966) for this taxon. In addition, he indicated the existence of diploid apomicts in *A. amplexicaulis* Nutt. based on pollen quality in only 2 voucher specimens with a diploid chromosome number. These collections are *Calder & Taylor 36440* from Queen Charlotte Islands (British Columbia) and *Calder 37139* from south-central British Columbia (Barker 1966). Meiotic division in both collections was reported as irregular or aberrant (Barker 1966, Ornduff *et al.* 1967). Barker (1966) suggested that these "two plants are either sterile or apomictic". However, he considered them to be apomictic on account of the prevalence of apomixis within the genus.

The over-all significance of Barker's study (1966) is in some of the salient results and interpretation he reported that were confirmed by subsequent workers, *e.g.* Wolf (1980, 1981 & 1987), Downie & Denford (1986a), Downie (1987), and Downie & Denford (1988 in press). Some of these findings are: i) the generally accurate positive correlation of diploidy and amphimixis and that of polyploidy and apomixis, particularly in the latter if aberrant meiosis is present; ii) the absence of well-developed polyploid taxa in unglaciated localities and a similar absence of well-developed diploid taxa in glaciated areas; iii) the apparent biotype depletion in a number of previously widespread taxa that survived in unglaciated zones, and subsequent evolution of polyploid apomict complexes from these survivors, iv) the rapid post-glacial invasion of glaciated areas accomplished by the superbly adaptive polyploid apomict populations, and v) the general morphological similarity between sexual and apomictic elements in nearly all taxa which prevents strict taxonomic segregation at any level (Barker 1966).

Among biogenetic groups of secondary metabolites in plants, the flavonoids are the most extensively used in biosystematic studies. According to Harborne & Turner (1984), their popular appeal to plant systematists is attributed to a number of unique features and advantages: a) their marked structural diversity and ubiquitous occurrence in the higher plants, b) they are rather stable compounds, c) analysis requires only a small amount of material, thus sampling from herbarium specimens is possible, d) easily detected by standard 2-dimensional paper chromatography without the use of chromagenic sprays and their identification can be done using a few simple procedures, and e) availability of abundant publications about flavonoids of many plants and flavonoid profiles of most plant families (*viz*. Hegnauer 1962-1973). Elsewhere, many authors (*e.g.* Alston & Turner 1963a, Edrtman 1963, Alston 1967, Swain 1975, Harborne 1975, Young & Seigler 1981, Denford 1984, Harborne & Turner 1984, *etc.*) have discussed the general taxonomic value of flavonoids.

Biosystematically speaking, flavonoids have been instrumental in tracing pathways of plant migrations (Levy & Fujii 1978, Mastenbroek *et al.* 1983) and pinpointing venues of geographical isolations (Mears 1980, Wolf 1981, Denford 1984, Wolf & Denford 1984a, *etc.*). Moreover, flavonoid analysis has been an invaluable tool in the detection or documentation of hybridization (Turner & Alston 1959, Torres & Levin 1964, Brehm & Ownbey 1965; Levin 1966, 1967 & 1968, Hunter 1967, Crawford 1970 & 1972, Stuessy *et al.* 1973, Ornduff & Bohm 1975, Semple & Semple 1978, Crawford *et al.* 1980, Crawford & Smith 1980, Wolf & Denford 1984b, *etc.*) and polyploidy (Levy & Levin 1971 & 1975, Lewis 1980, Wolf & Denford 1984a) as well in the clarification of phylogenetic or evolutionary relationships of taxa (Denford & Karas 1975, Levy & Levin 1974 & 1975, Young 1981, Wolf 1981, Thorne 1981, *etc.*).

Most previous chemical studies of *Arnica* have been fragmentary, concerned with prospective medicinal compounds (*e.g.* Brunner 1969, Kowalewski *et al.* 1969, Rinn 1970, Evstratova *et al.* 1971, Poplawski *et al.* 1971, Bohlman & Zdero 1972, Pyrek & Baranowska 1973). Evidently, the first report about *Arnica* flavonoids was by Saner & Leupin (1966) who isolated quercetin 3-O-glucoside, quercetin 3-O-glucogalacturonide and kaempferol 3-O-glucoside from leaves of *Arnica montana* L. Subsequent flavonoid investigations of *Arnica*, however, used flower parts mostly obtained from a limited number of plants raised from seeds and/or maintained in botanic gardens (Borkowski *et al.* 1966, Shelyuto *et al.* 1976, Willuhn *et al.* 1983 & 1984, Merfort 1984 & 1985, Kostennikova *et al.* 1985, Merfort *et al.* 1986). Exceptions to these are the recently concluded biosystematic studies of subgenera *Austromontana* (Wolf 1981, Wolf & Denford 1984c) and *Arctica* (Downie 1987, Downie & Denford 1988 in press) where flavonoid profiles of all recognized taxa in each complex were elucidated using foliar samples from numerous natural populations. In *Austromontana*, Wolf (1981) identified a total of 26 flavonoid compounds (14 free aglycones and 12 glycosides) of which only 2 glycosides, namely: quercetin 3-O-diglucoside and quercetin 3-O-gentiobioside are found ubiquitously in all members of this subgenus. In *Arctica*, Downie (1987) isolated 12 flavonoids consisting of 1 flavone aglycone, 3 flavone glycosides, 7 flavonols and 1 unknown. He concluded that flavonoid profiles within this subgenus are relatively simple with only 2 to

6 compounds detected per population. He also indicated that a considerable populational variation in flavonoid content is prevalent within this subgenus.

In a comparative study of methylated flavonoids in flowers of *A. chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire var. *incana* (A. Gray) Hult. and *A. montana* L., Merfort (1984) identified 6 compounds, namely: pectolinarigenin, hispidulin, jaceosidin, 6-methoxykaempferol, betuletol and acacetin. Except for acacetin, which was absent from *A. montana* L., all compounds were common to both taxa. It was in this paper (Merfort 1984) that betuletol was reported for the first time in the Asteraceae.

In a sequel paper, Merfort (1985) isolated the free and methylated flavonoid aglycones from flowers of *A. chamissonis* Less. subsp. *chamissonis* (15 compounds), *A. chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire var. *incana* (A. Gray) Hult. (11 compounds) and *A. montana* L. (7 compounds). The 15 flavonoid aglycones identified from *A. chamissonis* Less. subsp. *chamissonis* are: apigenin (1), luteolin (2), kaempferol (3), quercetin (4), acacetin (5), chrysoeriol (6), isorhamnetin (7), dillenetin (8), hispidulin (9), eupafolin (10), jaceosidin (11), 6-methoxykaempferol (12), pectolinarigenin (13), patuletin (14) and 3,5,7-Trihydroxy 6,3',4' Trimethoxyflavonol (15). The last-mentioned compound was reported for the first time in nature (Merfort 1985). Compounds 1-4, 8, 10, 14 plus diosmetin (16), spinacetin (17) and laciniatin (18) were found in *A. chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire var. *incana* (A. Gray) Hult., while compounds 1, 6, 7, 10, 14, 17 and 18 were isolated from *A. montana* L. (Merfort 1985). From this comparative analysis, Merfort (1985) concluded that *A. chamissonis* Less. and *A. montana* L. were largely identical in their flavonoid pattern.

Subsequently, a wider comparative survey of flavonoids in subgenus *Chamissonis* was undertaken by Merfort *et al.* (1986). This study involved 7 taxa, namely: *Arnica amplexicaulis* Nutt., *A. chamissonis* Less. subsp. *chamissonis* var. *interior* Maguire, *A. chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire var. *incana* (A. Gray) Hult., *A. longifolia* D.C. Eaton, *A. mollis* Hook., and *A. parryi* A. Gray subsp. *sonnei* (Greene) Maguire. The classification and nomenclature adopted in this work (Merfort *et al.* 1986) follow those of Hultén (1946).[3]

Twenty-eight flavonoid aglycones were isolated and identified from the above-listed taxa. Table 6 gives a summary of flavonoid distribution in subgenus *Chamissonis* as reported by Merfort *et al.* (1986). These flavonoid aglycones were composed of 1) the 4 most common free aglycones in nature - apigenin, luteolin, kaempferol and quercetin; 2) 5 frequently encountered 3'- or 4'-methyl ethers, and 3) 11, 6-methoxy-flavones and -flavonols which are typically occurring in the Asteraceae. Two compounds, 6-methoxykaempferol 4'-methyl ether and quercetin 3', 4'-dimethyl ether were first time records for the Asteraceae while patuletin 3', 4'-dimethyl ether was introduced as a new natural product (Merfort 1985, Merfort *et al.* 1986). In addition, 4, 7-methylated flavones and 2 flavanones were reported to occur only in *A. mollis* Hook. From this chemical analysis, Merfort *et al.* (1986) concluded that the pattern of flavonoid aglycones in subgenus *Chamissonis* is largely homogeneous, with every taxon they studied except *A. mollis* Hook., exhibiting similar skeletal types. Nonetheless, Merfort *et al.*(1986) put forward some interesting insights (with respect to sectional divisions of Maguire 1943), such as: 1) the highly homogeneous flavonoid pattern in sect. *Euchamissonis*; 2) the reduced aglycone number of *A. longifolia* D.C. Eaton (11 compounds, sect. *Eulongifolia*) compared with *A. chamissonis* Less. (22 compounds, sect. *Euchamissonis*) ~~and~~ the absence of compounds with 4'-methylation from the former taxon; 3) a similar lower number of aglycones in *A. amplexicaulis* Nutt. (13 compounds) compared with that of *A. mollis* Hook. (21 compounds), both of sect. *Eumollis*, and 4) the uniqueness of *A. mollis* Hook. due to the presence of 7-methyl ethers and 2 flavanones, naringenin 7, 4'-Me and eriodictyol 7, 3'-Me.

Although Merfort *et al.* (1986) have worked out substantially the flavonoid composition of subgenus *Chamissonis*, it is expected that a phytochemical examination of a large number of foliar samples from natural populations throughout the range of this subgenus will throw light on flavonoid variation in different populations and yield valuable

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[3]Voucher specimens for this study (Merfort *et al.* 1986) were examined and annotated according to proposed nomenclature and classification presented in the 'Taxonomy Section' of this thesis.

Table 6. Flavonoid aglycones in *Arnica* subgenus *Chamissonis* (modified from Merfort *et al.* 1986, Table 1).

Compounds	Taxa 1	2	3	4	5	6	7
Apigenin (Ap)	•	•	+	+	+	+	•
Luteolin (Lu)	•	•	•	•	•	•	•
Kaempferol (Km)	•	•	+	•	+	+	•
Quercetin (Qu)	•	•	•	•	•	•	•
Ap 4'-Me	•	•	•	-	+	-	+
Lu 3'-Me	•	•	-	+	+	•	•
Lu 4'-Me	-	-	+	-	-	-	-
Km 4'-Me	•	•	-	-	-	-	+
Qu 3'-Me	+	•	+	•	+	-	+
Qu 3', 4'-Me	+	+	+	-	-	-	-
Ap 6-OMe	+	•	•	•	•	+	•
Ap 4'-Me, 6-OMe	+	•	•	-	+	+	•
Lu 6-OMe	+	•	•	•	•	+	•
Lu 3'-Me, 6-OMe	+	•	•	•	+	+	•
Lu 3', 4'-Me, 6-OMe	-	+	-	-	-	+	-
Km 6-OMe	+	•	+	-	+	+	•
Km 4'-Me, 6-OMe	•	•	+	-	-	+	•
Qu 6-OMe	•	•	•	•	•	•	•
Qu 3'-Me, 6-OMe	-	•	+	•	-	+	+
Qu 4'-Me, 6-OMe	-	-	+	-	-	-	-
Qu 3',4'-Me, 6-OMe	+	+	+	-	-	+	+
Ap 7, 4'-Me	-	-		-	-	+	-
Lu 7, 4'-Me	-	-	-	-	-	+	-
Lu 7, 3'-Me	-	-	-	-	-	+	-

Lu 7, 3',4'-Me	-	-	-	-	-	+	-
Nar 4'-Me	-	+	+	-	-	-	-
Nar 7, 4'-Me	-	-	-	-	-	+	-
Eri 7, 3'-Me	-	-	-	-	-	+	-

Legend: • = major, + = trace, - = absent, Nar = naringenin, Eri = eriodictyol.
1 = *Arnica chamissonis* subsp. *chamissonis* var. *interior*, 2 = *A. chamissonis* subsp. *foliosa*, 3 = *A. chamissonis* subsp. *foliosa* var. *incana*, 4 = *A. longifolia*, 5 = *A. amplexicaulis*, 6 = *A. mollis 4*, 7 = *A. parryi* subsp. *sonnei*. Names adopted by Mertfort *et al.* (1986).

information which in conjunction with morphological, cytological and phytogeographical data, would help to solve current taxonomic problems and clarify phylogenetic relationship of taxa in this complex as well as the entire genus. The impressive results of biosystematic studies in subgenus *Austromontana* (Wolf 1981, Wolf & Denford 1984c) and subgenus *Arctica* (Downie 1987, Downie & Denford 1988 in press) make it imperative to pursue a similar research on subgenus *Chamissonis*. The objectives of this study are four-fold: 1) to clarify the taxonomy, nomenclature and classification of *Arnica* subgenus *Chamissonis*; 2) to understand the role of polyploidy in the evolutionary history of the subgenus and its effect on flavonoid chemistry; 3) to outline possible relationships between present-day distribution and historical factors (*e.g.* glaciations), and 4) to infer accurate phylogenetic relationships between species at the infra- and intra-subgeneric levels.

II. Materials and Methods

A. Field Studies and Collections

During the summer of 1985 and 1986, population studies and collections of materials for use in the other aspects of this research (*vide infra*) were conducted throughout nearly 80% of the entire western North American range of subgenus *Chamissonis* (Fig. 2). From each population, the following were obtained: a) herbarium voucher specimens (1 original plus 2-7 replicates), b) unpressed bulk foliar samples for flavonoid analysis, c) 2 live plants contained in 6-inch plastic pots for cytological and related studies as well as for long-term controlled environment observations, and d) mature achenes (seeds) or immature capitula as additional material for cytological study. Information about types of habitat, associated plant species and other pertinent ecological parameters were noted and selectively documented using color and slide photographs.[4]

The original set of voucher specimens for morphological, cytological and flavonoid studies is deposited at the Vascular Plant Herbarium (ALTA), Department of Botany, The University of Alberta, Edmonton, Alberta, Canada while the second set is in my personal herbarium (WGRZ) housed at the Museum of Natural History, University of the Philippines at Los Banos, College, Laguna 4031, Philippines. The third to eight sets will be distributed to the following herbaria: ALA, BRY, CAN, RM, UC and WS.[5]

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[4]Set of color and slide photographs are filed in the author's collection.
[5]Acronyms are those given in Holmgren & Keuken (1974).

B. Morphology

A total of *c*. 5000 herbarium specimens (including types) originating from over the entire geographical range of subgenus *Chamissonis* was examined during a visit to and/or obtained on loans from the following institutions,[6] : The University of Alaska Herbarium (ALA), Fairbanks, Alaska, U.S.A.; Vascular Plant Herbarium (ALTA), The University of Alberta, Edmonton, Alberta, Canada; Black Hills State College Herbarium (BHSC, here designated), Spearfish, South Dakota, U.S.A.; British Museum (Natural History)(BM), Cromwell Road, London, England; Brigham Young University Herbarium (BRY), Provo, Utah, U.S.A.; National Herbarium of Canada (CAN), National Museum of Natural Sciences, Ottawa, Ontario, Canada; Cornell University Herbarium (CU), Ithaca, New York, U.S.A.; Gray Herbarium (GH), Harvard University, Cambridge, Massachusetts, U.S.A.; Ray J. Davis Herbarium (IDS), Idaho State University, Pocatello, Idaho, U.S.A.; Kew Herbarium (K), Royal Botanic Gardens, Kew, Richmond, Surrey, England; Kluane National Park Herbarium (KLUANE, here designated), Haines Junction, Yukon Territory, Canada; V.L. Komarov Botanical Institute Herbarium (LE), Academy of Sciences of the U.S.S.R., Leningrad; Missouri Botanical Garden Herbarium (MO), St. Louis, Missouri, U.S.A.; Marie-Victorin Herbarium (MT), University of Montreal, Montreal, Québec, Canada; University of Notre Dame Herbaria (NDG, ND), Notre Dame, Indiana, U.S.A.; The New York Botanical Garden Herbarium (NY), Bronx, New York, U.S.A.; Academy of Natural Sciences of Philadelphia Herbaria (PENN, PH), 19th & The Parkway, Philadelphia, Pennsylvania, U.S.A.; The Integrated Herbarium (RSA/POM), Rancho Santa Ana Botanic Garden and Pomona College, Rancho Santa Ana Botanic Garden, Claremont, California, U.S.A.; Rocky Mountain Herbarium (RM), University of Wyoming, Laramie, Wyoming, U.S.A.; W.P. Fraser Herbarium (SASK), University of Saskatchewan, Saskatoon, Saskatchewan, Canada; University Herbarium (UC) and Jepson Herbarium (JEPS), University of California, Berkeley, California, U.S.A.; United States National Herbarium

[6] Acronyms are those found in Holmgren & Keuken (1974), unless otherwise indicated.

(US), Smithsonian Institution, Washington DC, U.S.A.; Garrett Herbarium (UT), Utah Museum of Natural History, The University of Utah, Salt Lake City, Utah, U.S.A.; Intermountain Herbarium (UTC), Utah State University, Logan, Utah, U.S.A.; Waterton Lakes National Park Herbarium (WTON, here designated), Waterton, Alberta, Canada, and Marion Ownbey Herbarium (WS), Washington State University, Pullman, Washington, U.S.A.

A full transcript of information on the labels of each specimen and a registry of collections examined from each herbarium has been prepared and constitutes a supplement to this dissertation.[7] Distribution maps for each taxon recognized in this study were composed using only materials with complete locality data and only after a thorough examination was carried out. All collections studied have been carefully annotated as to final determination and/or as voucher specimens for morphometric, cytological, flavonoid and pollen viability studies.

Herbarium materials were used in the assessement of diagnostic morphological characters, pollen viability determinations; compiling data about flowering period, habitat diversity, altitudinal range and phytogeographical distribution. Initial sets of attributes examined to evaluate their taxonomic value and to assess phenetic relationships within subgenus *Chamissonis* were sifted from previous major works involving genus *Arnica* (*e.g.* Rydberg 1927, Maguire 1943, Ediger & Barkley 1978) and the more recent biosystematic treatment of its 2 larger subgenera, *i.e.* *Austromontana* (Wolf 1981, Wolf & Denford 1984c) and *Arctica* (Downie 1987, Downie & Denford 1988 in press). Observation of characters in the field and greenhouse, however, necessitates a substantial increase in the number of attributes. Appendix 1 gives a complete list of attributes considered in this study. Quantitative measurements were made from collections that showed a ±full complement of attributes. As much as possible, randomly selected specimens from the whole range of each taxon were included in all analyses.

[7]Copy of this 'Supplement' is on file in ALTA.

Numerical analyses of 67 attributes for the 7 taxa recognized in this study were done using TAXMAP classification program (Carmichael *et al.* 1968, Carmichael & Sneath 1969, Carmichael 1983). The TAXMAP method is a density-seeking technique that attempts to simulate the procedure used by the human observer for detecting clusters in 2 or 3 dimensions. In effect, it performs comparison of relative distance between points and then searches for continuous relatively densely populated regions of the space surrounded by continuous relatively empty regions (Everitt 1980). It is a completely non-hierarchical procedure of cluster analysis. TAXMAP program computes the ranges of the variables, normalizes the raw data as fractions of the range and then determines the relative proximity between each pair of operational taxonomic units (OTUs). All characters were weighted equally thus minimizing subjectivity. Weighting of characters was done according to their relative information content (*i.e.* according to number of classes). A full account of TAXMAP clustering procedure is in Carmichael (1983). The results of a TAXMAP analysis are graphically shown as taxometric map which is actually a two-dimensional diagram of the multi-dimensional hyperspace in which the OTUs exist. Circles represent clusters and lines connecting them are the undistorted phenetic distances. Isolated points represent single-member clusters (smc) or isolated OTUs. The main advantage of this clustering technique is its ability to cluster OTUs by direct use of data from the undistorted similarity matrix. OTU relations are clearly specified without reduction in dimensionality. Moreover, the program accomodates ordered and non-ordered classes and provides adjustments for missing data.

Four different TAXMAP analyses were performed involving combinations of the 7 taxa recognized in this study (see Taxonomy section). Taxon combination was determined on the basis of apparent phenetic similarity, except in instances where intra- or interspecific variability was being evaluated. The 4 TAXMAP analyses were: 1) *Arnica amplexicaulis-A. lanceolata*; 2) *A. longifolia-A. mollis* ; 3) *A. chamissonis-A. longifolia-A. parryi-A. mollis*; and 4) all 7 taxa (for names see previous entries above). Appendix 2 lists the collections scored and/or measured for each analysis while Appendix 3 provides the corresponding data matrices.

Additional numerical analyses were performed on the data matrices of Analyses 3, 4, and 5 using the CLUSTAN (Cluster Analysis) package (Wishart 1978). Dendrograms (= phenograms) were produced using Ward's method (Ward 1963) which according to Wishart (1978) is possibly the best of the HIERARCHY options in the CLUSTAN suite of programs. Ward (1963) proposed that at any stage of analysis the loss of information which results from the union of individuals into clusters can be measured by the total sum of squared deviations of every point from the mean of the cluster to which it belongs. Ward's method therefore, finds minimum-variance spherical clusters. Dendrograms resulting from this clustering method have vertical axes showing the error sum of squares (E.S.S.), here roughly equated to phenon level. Every OTU included in the analysis was listed along the horizontal axis according to their calculated cluster affinity. Taxometric maps and dendrograms (= phenograms) were produced with the use of the CALCOMP Plotter of the University of Alberta Computing Systems.

C. Greenhouse Studies

Live plants obtained from the field were maintained throughout the course of study under controlled-environment conditions. All plants were coursed through abbreviated life cycles, interrupted by 8 to 12 weeks of simulated winter condition in cold storage at 2° C. The entire growth phase was under optimal conditions of a) 16-hr photoperiod with minimum light intensity of 365 $uEm^{-2}s^{-1}$ emitted from high energy Na and mercury lamps; b) temperature regime of 18° C during the night and 22° during the day, and c) a relative humidity of 40 to 50 per cent. Growth pattern and morphological attributes were closely monitored for all plants to differentiate between genetic and environmentally-induced characters. Voucher specimens were prepared to document any considerable change in morphology.

Following results of chromosome counts, occurrence of apomixis in polyploid populations was ascertained using a simple emasculation procedure (Barker 1966, Heyn & Joel

1983). Prior to emasculation, already opened disk florets were removed from candidate capitula. For each plant, 2-3 capitula were chosen and the stamens, corolla, stigma and a portion from style of each closed disk floret were excised using a pair of thin surgical scissors. Each capitulum was later enclosed in a thinly perforated polyacetylene bag to prevent contamination. The capitulum was allowed to complete development inside the bag after which achene production was assessed as to number and ability to germinate. No crossing experiments were conducted because only two diploid populations of *A. chamissonis* Less., were sampled during the 2 seasons of field studies.

D. Pollen Viability

Whenever available, a sufficient number of closed but matured disk florets were collected from natural populations during field studies. These florets were placed directly in vials containing stain. In plants grown under greenhouse conditions, disk florets were obtained prior to anthesis and immediately processed. In most cases, however, similar disk florets were removed sparingly from herbarium specimens. Pollen grains were treated with lactophenol-cotton blue (Radford *et al.* 1974) or methyl green-phloxine double stain (Owczarzak 1952) solutions for 12 to 24 hours. With lactophenol-cotton blue stain, fertile pollen grains appeared dark blue while sterile specimens stained lightly or not at all (Radford *et al.* 1974). On the other hand, pollen grains treated with methyl green-phloxine double-stain solution exhibited differential reaction. Viable or "functional" pollen grains expanded and absorbed both dyes whereas sterile ones remained shrunken and took only the methyl green wall stain.

Pollen stainability for each collection was calculated on the basis of 700-800 pollen sample size. A 90 to 100 percent stainability was interpreted as representing a diploid population while below 90 percent as polyploid. Ploidy levels of 1,096 collections were evaluated for the present study.

E. Chromosome Numbers

Mitotic counts were made from root tips collected from plants transported from the field and cultivated in the greenhouse. The procedure adopted was that of Tijo & Levan (1950). Root tips were prefixed in 0.002 M 8-hydroxyquinoline solution (0.058 gm/200 ml water) for 2 to 4 hours at 13°-16° C, and then fixed in absolute ethanol:glacial acetic acid solution (3:1, v/v) for 24 hours. After fixation, root tips were rinsed in distilled water for 5 minutes, blotted dry and stained in 1% acetic orcein in 1N HCl (1:9, v/v) for 20-30 minutes; warming gently from time to time over an alcohol lamp. Subsequently, root tips were mounted on a microscope slide in a drop of 45% acetic acid and squashed with a coverslip.

Meiotic chromosome counts were obtained from immature heads fixed in modified Carnoy's fixative solution (4 chloroform:3 ethanol:1 glacial acetic acid). Following fixation, disk floret buds were transferred to 80% ethanol solution. Squashing and staining were done using the conventional acetocarmine method (Radford *et al.* 1974). Chromosomes were studied and counted using an Olympus BHA PM-10M photomicrographic system. Semi-permanent slides were prepared by sealing coverslip with melted gum mastic-paraffin wax mixture (1:1, v/v). Voucher specimens and slides for all chromosome counts were deposited at the University of Alberta Vascular Plant Herbarium (ALTA).

F. Flavonoid Chemistry

Bulk foliar samples from natural populations were placed in brown paper bags and subsequently air- or oven-dried. These bulk samples were screened for any contaminants before grinding to powder form in a blender. Ten to 30 g (dry weight) of ground sample for each population was extracted twice with 500 ml 85% methanol (MEOH). Each extraction phase was done on a wrist-action shaker for 24 hours. The mixture was filtered in a Buchner funnel under reduced pressure. The filtrate was then evaporated *in vacuo* to *c.* 100 ml. Terpenoids, fats & waxes, tannins, chlorophylls and other low polarity contaminants were removed from the aqueous solution by partitioning with a three-volume excess of chloroform until the solvent became ± colorless. The choloroform fraction was reduced *in vacuo* to *c.* 10 ml. Traces of chloroform were removed *in vacuo* from the solvent-extracted aqueous fraction. This water fraction was partitioned further with an equal volume of ethyl acetate (EtOAc) until the extracting solvent was ±clear. The resulting fractions, water and EtOAc, were reduced *in vacuo* to *c.* 10 ml. The chloroform, water and EtOAc fractions or extracts were analyzed by standard 2-dimensional paper chromatography. Initial results of chromatography showed that in most of the populations of taxa recognized in this study, the free aglycones were usually present in high amount in the chloroform extract. Meanwhile, comparison of the ethyl acetate and water extracts revealed that they are not identical.

Each of the 3 extracts was spotted on Whatman no. 3 MM paper (46 x 57 cm) and separated using BAW (*n*-butanol-acetic acid-water, 6:1:2) and 15% acetic acid solvents (Mabry *et al.* 1970). The chromatographic profile of each population was determined under ultraviolet (UV)light (366 nm) with each chromatogram paper treated with ammonia vapor and Naturstoffreagenz A (NA = diphenyl-boric acid-ethanolamine complex) spray reagent. Diagnostic color reactions were noted on this master (voucher) chromatogram. A total of 143 populations were surveyed for their flavonoid profiles. Appendix 4 lists the sources of population samples for flavonoid study.

Isolation and Identification of Flavonoids

Flavonoid isolation, purification and identification were carried out using the modified procedures of Mabry *et al.* (1970), Ribéreau-Gayon (1972), Neuman *et al.* (1979) and Markham (1982).

Extracts from a select number of populations for each taxon accepted in this investigation were chromatographed on 20 sheets of Whatman no. 3 MM paper following the procedure outline above. After comparison with the respective master chromatogram, equivalent spots from each of the 20 chromatogram papers were cut-out, shredded, combined and eluted in 85% MEOH on a shaker for 24 hours. Each mixture was filtered using a

Buchner funnel and was evaporated under reduced pressure to *c.* 20 ml. This extract was streaked on 2-4 sheets of Whatman no. 3 MM paper (with serrated lower edge) and chromatographed along a single dimension with BAW or 15% acetic acid solvent. Selection of the solvent to be used and the length of time were based on migration patterns and the rates observed during preliminary runs. The resulting band was cut-out, eluted in 85% MEOH and processed using similar extraction procedure to that given above. A purity test for each compound was performed by chromatography using cellulose plates (20 x 20 cm), the latter examined under UV light before and after spraying with NA reagent.

Ultraviolet spectrometry was performed on a Bausch & Lomb Spectronic 2000 spectrophotometer system using procedures prescribed by Mabry *et al.* (1970) and Neuman *et al.* (1979). Spectral scans of pure compounds were recorded at each step-wise addition of diagnostic reagents, *i.e.* sodium methoxide, aluminum trichloride ($AlCl_3$), $AlCl_3$ + 10% HCl, sodium acetate (NaOAc), NaOAc + boric acid. Glycosides and aglycones were co-chromatographed with standards on cellulose and silica gel-coated plates (20 x 20 cm), respectively. These plates were then viewed under UV light, treated with NA reagent and color reactions were noted. Rf values for these compounds were determined using Whatman no. 1 MM paper in 4 solvent systems: BAW, 15% acetic acid, Forestal (acetic acid-HCl-water, 30:3:10) and 80% phenol solutions. Hydrolysis of glycosides was carried out by the addition of 2N HCl (in MEOH) followed by boiling (100° C) in water bath for 1 hour. The mixture was then evaporated to dryness and subsequently partitioned thrice with ethyl acetate after the addition of 10 ml distilled water. The ethyl acetate fraction (containing aglycone) was subjected to the same spectral analysis that was performed on the glycoside. The aqueous fraction (containing sugar) was reduced to a minimum, then co-chromatographed with standards on Whatman no. 1 MM paper using isopropanol-butanol-water (140:20:40) solvent, air-dried, sprayed with aniline hydrogen pthalate reagent and developed by heating at 100° C inside an oven for 10-30 minutes.

III. Results

In the current research study, only 7 of 12 taxa included by Maguire (1943) in his subgenus *Chamissonis* are accepted as taxonomically natural entities. Table 7 outlines the proposed taxonomic treatment for this subgenus in relation to Maguire's (1943) classification. Superficially, it may appear that current species circumscription within the subgenus has been broadened considerably; however, in reality this is not so. The taxon concept presented here reflects that all naturally occurring populations of each species considered in this work vary immensely from one another in many ways, as influenced by, or in response to, prevailing habital and/or environmental conditions. To provide names for each of these myriad variations would, in the ultimate analysis, create more confusion and obstruct our full understanding of the processes and mechanisms behind this array of biotic variation. Consequently, all 5 subspecific names in subgenus *Chamissonis* recognized by Maguire (1943) are placed in synonymy with their respective species proper. No new taxa are described in this revision; however, one taxon is changed in rank, *i.e. A. amplexicaulis* Nutt. to *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo *comb. et stat. nov.* It is under this proposed rank that this taxon is often referred to in the text. *Arnica ovata* Greene, a taxon subsumed by Maguire (1943) in *A. mollis* Hook. is here reinstated to replace *A. diversifolia* Greene, as the correct and valid name for all populations previously known by the latter name. The original circumscription of subgenus *Chamissonis* by Maguire (1943) is accepted and confirmed as taxonomically sound. However, it is important that similar biosystematic studies of subgenera *Montana* and *Andropurpurea* are carried out to further resolve phylogenetic relationships within the entire genus.

A. Numerical Analyses

To expedite cluster interpretation, each OTU (Operational Taxonomic Unit) was coded in such a way that geographic origin of each specimen was immediately discernible. This was accomplished by using a 2-3 letter-code for each major geographical subdivision (*i.e.* province, state or territory) as a prefix to collector or herbarium accession number, whichever

Table 7. Proposed taxonomic treatment of taxa in *Arnica* subgenus *Chamissonis* in relation to Maguire's (1943) classification.

Present study (1988)	Maguire (1943)
	Sect. Euchamissonis Maguire
Arnica chamissonis Less.	*A. chamissonis* Less. subsp. *genuina* Maguire, *nomen. illegit.*
A. chamissonis Less.	*A. chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire *syn. nov.*
A. chamissonis Less.	*A. chamissonis* Less. subsp. *incana* (A. Gray) Maguire *syn. nov.*
	Sect. Eulongifolia Maguire
A. longifolia D.C. Eaton	*A. longifolia* D.C. Eaton subsp. *genuina* Maguire, *nomen illegit.*
A. longifolia D.C. Eaton	*A. longifolia* D.C. Eaton subsp. *myriadenia* (Piper) Maguire, *syn. nov.*
	Sect. Eumollis Maguire
A. lanceolata Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, *comb. et stat. nov.*	*A. amplexicaulis* Nutt. subsp. *prima* (Maguire) Maguire, *syn. nov.*
A. lanceolata Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, *comb. et stat. nov.*	*A. amplexicaulis* Nutt. subsp. *genuina* Maguire, *nomen illegit.* = *A. amplexicaulis* Nutt., *basionym*
A. lanceolata Nutt. subsp. *lanceolata*	*A. lanceolata* Nutt.
A. ovata Greene*	*A. diversifolia* Greene, *syn. nov.*
A. mollis Hook.	*A. mollis* Hook.
A. parryi A. Gray**	*A. parryi* A. Gray subsp. *genuina* Maguire, *nomen illegit.*
A. parryi A. Gray	*A. parryi* A. Gray subsp. *sonnei* (Greene) Maguire, *syn. nov.*

*Maguire (1943) considered this taxon and *A. silvatica* Greene as conspecific with *A. mollis* Hook. *Arnica silvatica* Greene is here treated as a new synonym of the reinstated name, *A. ovata* Greene.

**Arnica arachnoidea* Rydb., a taxon declared conspecific with *A. mollis* Hook. by Maguire (1943) is here considered as conspecific with *A. parryi* A. Gray. This represents a more or less ligulate population in northern Utah, U.S.A.

is available. For examples, AB = Alberta, AK = Alaska, NWT = Northwest Territories, *etc.* A complete list of prefixes is given in footnotes to appropriate appendices. Appendix 2 lists the OTUs included in each of the following numerical analyses while Appendix 3 provides the corresponding data matrices. Sixty-seven phenetic and ecological characters were consistently used to evaluate each collection, and data matrices were designed in such a way that the maximum allowable sample size was nearly always adhered to. In this case, the sample size limit was in accordance with TAXMAP classification program preset maximum of N=200 (Carmichael 1983). Consequently, the same maximum sample size was used in numerical analyses involving the CLUSTAN Cluster Analysis program (Wishart,1978).

Analysis 1. Arnica amplexicaulis & A. lanceolata

As noted previously, *Arnica amplexicaulis* Nutt. is primarily of western North American distribution while *A. lanceolata* Nutt. is an eastern North American taxon with a very restricted geographic range, *i.e.* from the Gaspé Peninsula, Québec southward to the high regions of New Brunswick, Maine, New Hampshire and northern New York. Intensive comparative study of morphological attributes of these two species (*sensu* Maguire 1943) shows remarkable similarity. This suggests that the current recognition of 2 separate species may be artificial and possible only on the basis of geographic separation. An analysis using a TAXMAP classification program therefore was performed to measure the amount of phenetic similarity or dissimilarity between these 2 taxa and furthermore, to determine which taxonomic rank is most appropriate for each taxon.

Seventy-one (71) representative specimens of *A. amplexicaulis* Nutt. (40 OTUs) and *A. lanceolata* Nutt. (31 OTUs) were scored and/or measured for 67 attributes. Locality information and repository of these collections are given in Appendix 2. The resultant taxometric map is shown in Fig. 3. TAXMAP distinguishes 8 clusters and 21 isolated OTUs or single member clusters (smc). *Arnica amplexicaulis* Nutt. is represented by 5 main clusters (Fig.3, numbers 2-6) and 18 isolated OTUs (Fig. 3, numbers 9-26). Cluster 2 contains 9

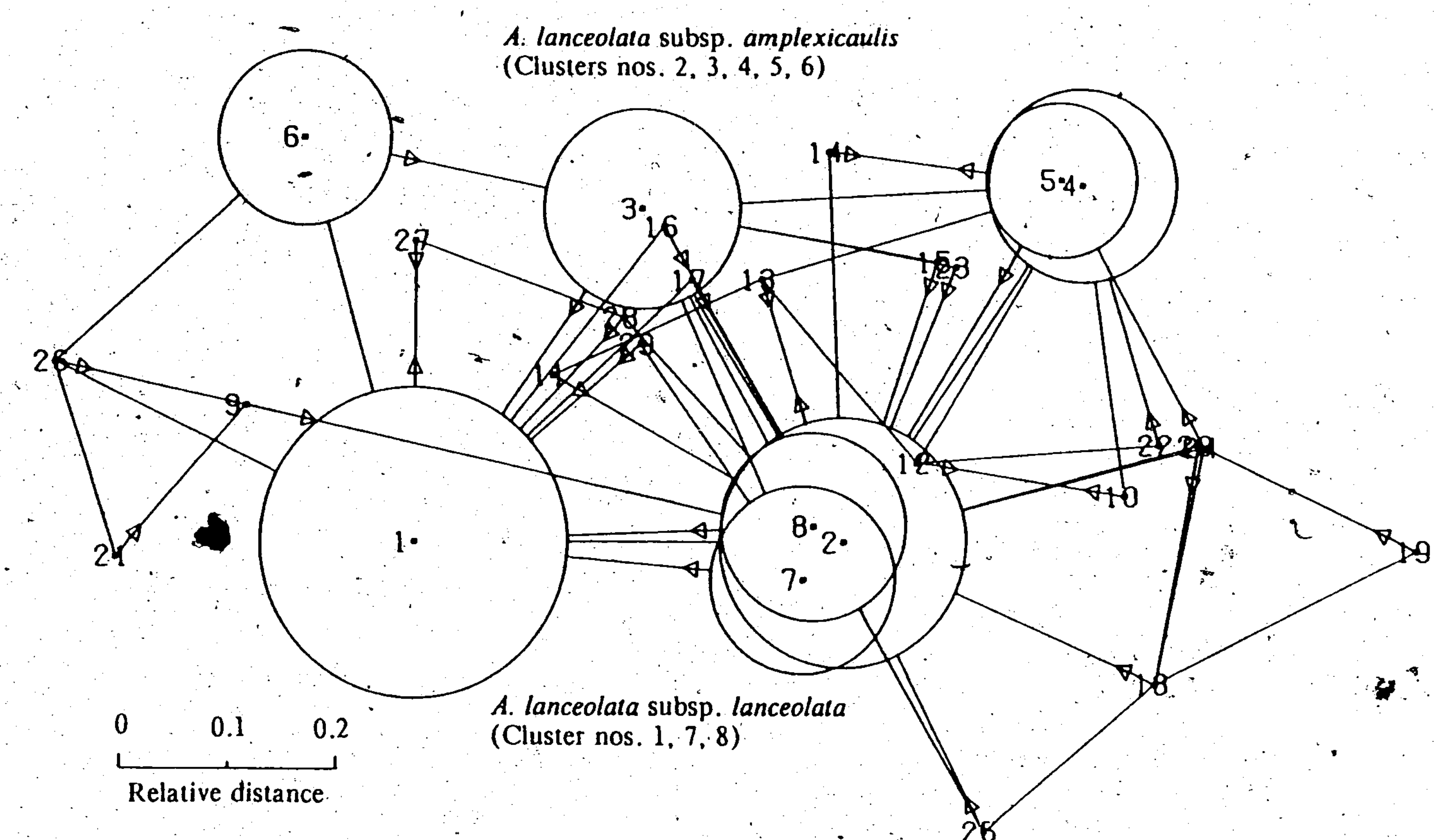

Figure 3. Taxometric map showing the similarities between *Arnica lanceolata* subsp. *amplexicaulis* (40 OTUs) and *A. lanceolata* subsp. *lanceolata* (31 OTUs) complex based on morphological, ecological and distributional data. The diameters of circles represent the maximum distance between any pair of OTUs in the cluster. The lines connecting margins of circles represent the undistorted phenetic distance between the nearest neighbors in the two clusters. The arrows indicate the nearest neighbor to each cluster. Two arrows pointing at each other mean that the clusters are equidistant from each other. For more details and interpretation, see text.

OTUs while Clusters 3 and 4 have 5 and 6 OTUs, respectively. Clusters 5 and 6 contain 3 OTUs each. Altogether, these clusters account for 65% of the total number of representative OTUs for *A. amplexicaulis* Nutt. Except for a single collection from New Hampshire which is an OTU of *A. lanceolata* Nutt., all OTUs present in Clusters 3 and 6 are from Alaska. Clusters 2, 4 and 5 are made up of OTUs coming from the entire range of *A. amplexicaulis* Nutt.

On the other hand, *Arnica lanceolata* Nutt. is represented by 3 main clusters and 3 isolated OTUs (Fig. 3). Cluster 1 contains 26 OTUs, 25 (81% of total sample) of *A. lanceolata* Nutt. and a single OTU of *A. amplexicaulis* Nutt. from Alaska.

An interesting pattern of phenetic relationship is manifested by the taxometric map (Fig. 3). Clusters 3 and 6, including isolated OTUs numbers 9, 21 and 26, all of *A. amplexicaulis* Nutt. are best linked to Cluster 1 of *A. lanceolata* Nutt. rather than Cluster 2 to where these clusters are expected to show closer phenetic distance. Although the 3 isolated OTUs of *A. lanceolata* Nutt. (Fig.3, numbers 27, 28, 29) are situated in the area between Clusters 1, 2 and 3, their closest neighbor however, is Cluster 1. The taxometric map also shows that Clusters 7 and 8 of *A. lanceolata* Nutt. overlap considerably with Cluster 2 of *A. amplexicaulis* Nutt., signifying maximum congruence in morphological attributes of OTUs in these clusters occurs. Nonetheless, Clusters 7 and 8 have Cluster 1 as their nearest neighbor.

The TAXMAP supports strongly the initial observation that *A. amplexicaulis* Nutt. and *A. lanceolata* Nutt. are phenetically similar and that assignment of specimens to these taxa requires locality information. The taxometric map (Fig.3) reveals that *A. amplexicaulis* Nutt. has a much higher degree of morphological variability than *A. lanceolata* Nutt. This is clearly evident from a high number of clusters and isolated OTUs. This high level of intraspecific variation is perhaps attributable to the assortment of polyploidy (see Table 5) present in natural populations and their interactive responses to various environmental conditions.

In conjunction with the current wider range of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, it is postulated that prior to glaciation, this taxon had a continuous geographic distribution across the North American continent. With episodic glaciations, the intervening populations were extirpated, with a few populations surviving in nunataks and possible coastal refugia along the eastern seaboard (Grant, [illegible]). Subsequent evolution of polyploidy maintained these survivor populations to become one of the more or less uniformly agamic arnicas with a very restricted ecology and geographic range in eastern North America. These extant populations are treated as the main geographic subspecies (on account of publication priority), *A. lanceolata* Nutt. subsp. *lanceolata* (see Taxonomy section).

Analysis 2. Arnica longifolia & A. mollis

Ninety-seven collections of *Arnica mollis* Hook. and 48 of *A. longifolia* D.C. Eaton, were scored and/or measured for 67 attributes and analyzed using the TAXMAP classification program. Figure 4 shows the resulting taxometric map. TAXMAP recognizes 18 clusters (Fig. 4, numbers 1-18) and 20 isolated OTUs or smc (Fig. 4, numbers 19-38). Of the 18 main clusters, Cluster 1, which contains 45 OTUs, represents *A. longifolia* D.C. Eaton while Cluster 2 with 43 OTUs is that of *A. mollis* Hook. The remaining 16 clusters contain only 3 OTUs while 4 clusters (Clusters 3, 5, 8 & 10) have 4 OTUs each and 1 cluster (Cluster 12) has 5 OTUs. Of the 20 isolated OTUs, only 4 belong to *A. longifolia* D.C. Eaton (Fig. 4, numbers 19-22) while the rest are *A. mollis* Hook. Evidently, each isolated OTU has its nearest neighbor as either Cluster 1 or 2 corresponding to its taxonomic identity.

A closer analysis of the taxometric map (Fig. 4) shows a considerable overlapping in many of the small-member clusters. Thus, the map projects generally only a maximum of 8 clusters, *i.e.* 2 large-member clusters (Clusters 1 & 2) which are strikingly distinct from each other as measured by the wide phenetic distance between them and 6 satellite clusters whose nearest neighbor is Cluster 2. As earlier mentioned, Cluster 2 and its 6 satellite clusters include

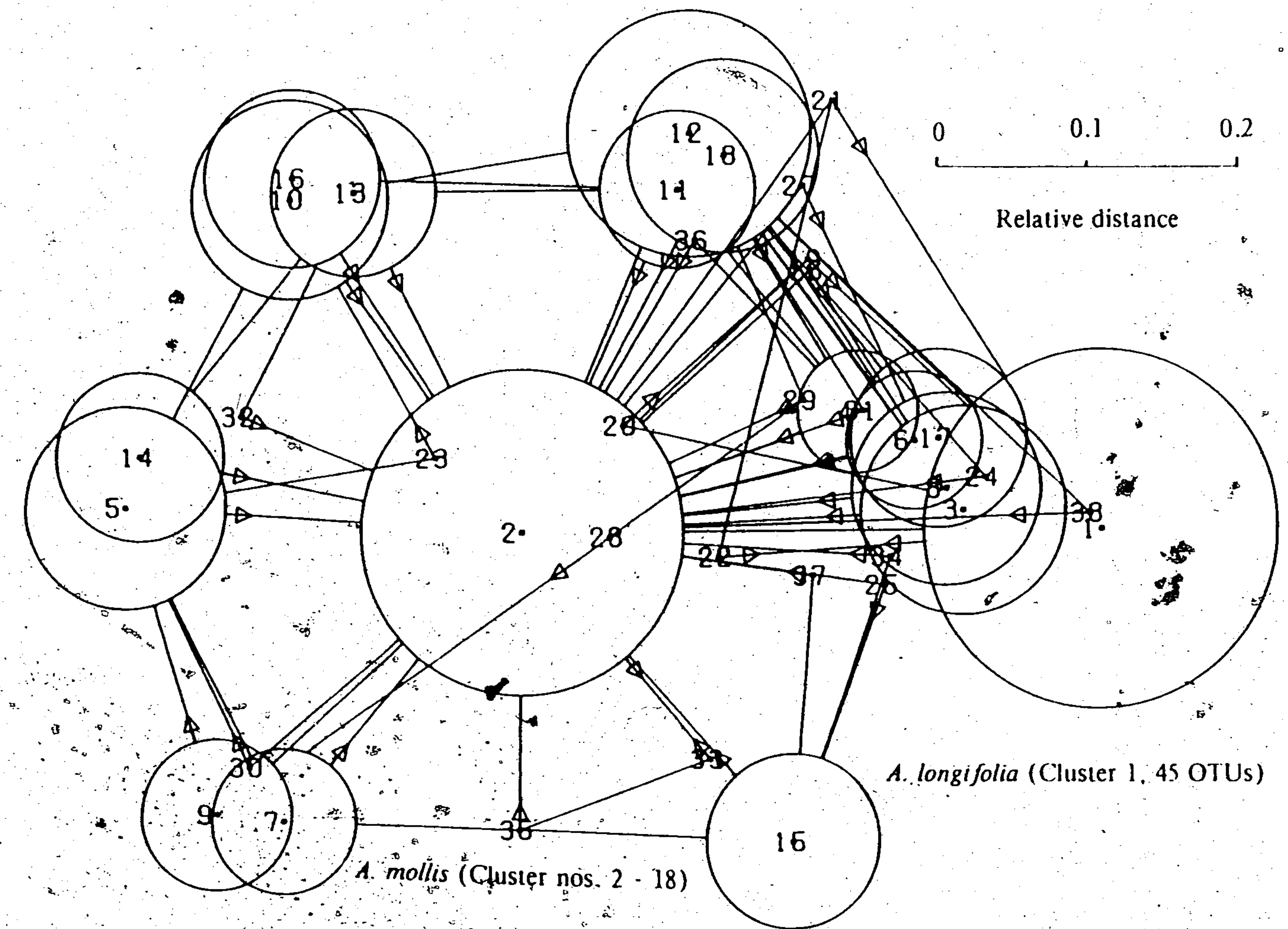

Figure 4. Taxometric map showing the similarities between *Arnica mollis* (97 OTUs) and *A. longifolia* (48 OTUs) based on morphological, ecological and distributional data. For TAXMAP interpretation, see Figure 3.

OTUs of *A. mollis* Hook. whereas Cluster 1 has OTUs representing *A. longifolia* D.C. Eaton. The presence of a few clusters between Clusters 1 and 2 indicates that a slight degree of morphological similarity is shared by these 2 taxonomically distinct taxa. However, the satellite clusters and isolated OTUs comprise a strong evidence of inherent morphological plasticity in each taxon activated in response to variation in habitat.

Analysis 3. Arnica chamissonis-longifolia-parryi-mollis

Initial morphological assessment of *Arnica chamissonis* Less., *A. longifolia* D.C. Eaton, *A. parryi* A. Gray and *A. mollis* Hook. indicates that these 4 taxa form a natural assemblage with *A. chamissonis* Less. as the most probable progenitor. Previously, Maguire (1943) considered *A. chamissonis* Less. as the sole stock from which all other taxa in subgenus *Chamissonis* arose. This phenetic analysis was executed to verify whether this assumption is valid and if indeed, a natural complex exists.

Two hundred (200) representative collections of *A. chamissonis* Less. (69 OTUs), *A. longifolia* D.C. Eaton (48 OTUs), *A. parryi* A. Gray (44 OTUs) and *A. mollis* Hook. (39 OTUs) were scored and/or measured for 67 attributes. Locality data and repository for these 200 OTUs are given in Appendix 2. The resultant taxometric map is presented in Figure 5. TAXMAP yields 21 clusters and 21 isolated OTUs or smc. Despite the rather robust appearance of the taxometric map, all 4 species are clearly separated from each other with sufficient relative phenetic distance. As shown by the following analysis of the taxometric map, it is quite evident that a natural phylogenetic relationship amongst 4 taxa exists.

Of the 21 main clusters, Clusters 1, 2, 4 and 6 contain high number of OTUs and each corresponds respectively to one of the 4 species considered in this numerical analysis. Cluster 1 contains 41 OTUs of *A. longifolia* D.C. Eaton. Cluster 2 has 25 OTUs of *A. parryi* A. Gray. Cluster 4 contains 52 OTUs belonging to *A. chamissonis* Less. while Cluster 6 has 28 OTUs of *A. mollis* Hook. Furthermore, *A. chamissonis* Less. is also represented by 6

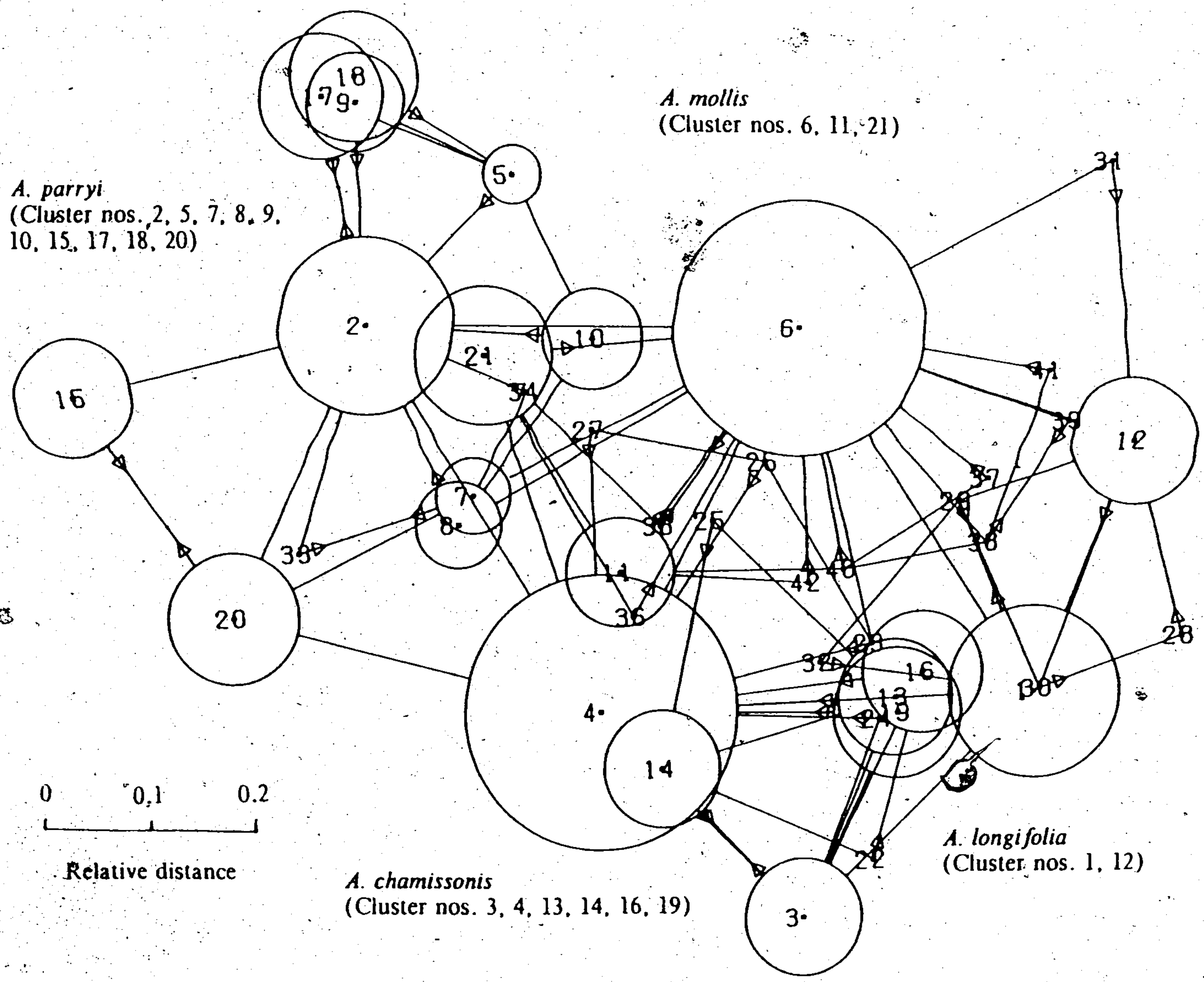

Figure 5. Taxometric map showing the similarities in *Arnica chamissonis* (69 OTUs), *A. longifolia* (48 OTUs), *A. parryi* (44 OTUs) and *A. mollis* (39 OTUs) based on morphological, ecological and distributional data. For TAXMAP interpretation, see Figure 3.

subsidiary clusters, *i.e.* Cluster 3 with 5 OTUs and Clusters 13, 14, 16 and 19 each with 3 OTUs. In addition, 6 isolated OTUs (Fig. 5, numbers 22-27) exist in the space between the large-member clusters, Clusters 1 and 2 which contain OTUs of *A. longifolia* D.C. Eaton and *A. mollis* Hook., respectively.

Only 2 clusters and 5 isolated OTUs account for *A. longifolia* D.C. Eaton (Fig. 5). Of the 2 main clusters, Cluster 1 contains 41 OTUs or 85% of the total representative specimens of *A. longifolia* D.C. Eaton included in the analysis. The other cluster, Cluster 12, contains only 4 OTUs. This cluster and the 5 isolated OTUs (Fig. 5, numbers 28-32) are closely linked to Cluster 1 and are the latter's nearest neighbors.

On the other hand, *Arnica parryi* A. Gray is represented by 10 clusters and 2 isolated OTUs. However, of the 10 clusters only 1 *i.e.* Cluster 2 (Fig. 5) has a high number of OTUs, *i.e.* 25 or 57% of the total number for *A. parryi* A. Gray. The remaining 9 clusters (Clusters 4, 5, 7-10, 15, 17, 18 and 20) contain only 3 OTUs each. These 9 clusters together with the 2 isolated OTUs (Fig. 5, numbers 33 & 34) are peripherally linked to Cluster 2. This being the case, the entire complex can be lumped and conveniently interpreted as one distinct group of clusters representing *A. parryi* A. Gray.

Arnica mollis Hook., the fourth species included in this analysis is accounted for by 3 clusters and 8 isolated OTUs. Cluster 6 (Fig. 5) contains 28 OTUs or 72% of the total number of representative collections for this taxon. Clusters 11 and 21 (Fig. 5) contain 3 OTUs each. Noteworthy is the fact that 3 OTUs in Cluster 11 exhibit greater morphological similarity to *A. chamissonis* Less. while those included in Cluster 21 appear more similar to *A. parryi* A. Gray. Instances like these clearly indicate that *A. mollis* Hook. is more closely related to both *A. chamissonis* Less. and *A. parryi* A. Gray than to *A. longifolia* D.C. Eaton. In reality, it is quite rare to see collections of *A. mollis* Hook. misidentified as *A. longifolia* D.C. Eaton or vice-versa. However, many misidentifications occur in quite a number of collections involving *A. chamissonis* Less., *A. parryi* A. Gray and *A. mollis* Hook.

Further shown in the taxometric map (Fig. 5) are Clusters 13, 16 and 19 which contain OTUs of *A. chamissonis* Less. adjacent or nearly fused to Cluster 1, the latter containing OTUs of *A. longifolia* D.C. Eaton. This supports initial observations of a high degree of morphological congruence in these 2 taxa. In herbarium practice, some collections were identified as either *A. chamissonis* Less. or *A. longifolia* D.C. Eaton. However, closer study reveals that these are mixed collections. An example is *E. Knox 21* (RM 146394!), a collection from Idaho. This was originally identified as *A. chamissonis* Less. and later annotated by Bassett Maguire (*in sched.*) as *A. chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire. This collection, however, consists of 2 entirely different plants, *i.e.* one that was fragmented into 2 parts and mounted on each side of yet another different plant. The former belongs to *A. chamissonis* Less. while the latter is that of *A. longifolia* D.C. Eaton. Finally, the resultant taxometric map (Fig. 5) for these 4 species shows explicitly that *A. chamissonis* Less. is indeed the most probable progenitor from which the other 3 taxa could have originated. It is quite evident though that although considerable evolutionary divergence had occurred in all offshoot species, there still remain sizeable extant populations possessing greater numbers of morphological attributes traceable to the parental species, *i.e. A. chamissonis* Less.

Analysis 4. Arnica subgenus Chamissonis

TAXMAP analysis for all 7 taxa in subgenus *Chamissonis* was performed to measure relative phenetic distances amongst taxa and to determine whether clear-cut taxon distinction would be evident with this numerical method.

A total of 200 OTUs was used in this numerical analysis. Sample size for each taxon was determined in proportion to taxon's geographical range. Thus, *A. chamissonis* Less. which has the widest distribution spectrum is represented by 53 OTUs, whereas *A. longifolia* D.C. Eaton, *A. parryi* A. Gray and *A. mollis* Hook., each has 28 OTUs. *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) and *A. ovata* Greene have 24 and 23 OTUs, respectively. *Arnica* *lanceolata* Nutt. subsp. *lanceolata*, the taxon with the most restricted range, has only 16 representative OTUs. Appendix 2 provides the locality data for all 200 OTUs while data matrix for this analysis is found in Appendix 3.

TAXMAP program sorts out the 200 OTUs into 24 main clusters and 23 isolated OTUs or single member clusters. The resultant taxometric map is shown in Figure 6. Evidently, *A. chamissonis* Less. has the highest number of clusters, with 7 main clusters (Fig. 6, numbers 4, 6, 12, 19, 22, 23, & 24) and 7 isolated OTUs (Fig. 6, numbers 25-31). It is followed by *A. lanceolata* subsp. *amplexicaulis* (Nutt.) Gruezo, represented by 4 main clusters (Fig. 6, numbers 9, 10, 13 & 17) and 4 isolated OTUs (Fig. 6, numbers 42-45). *Arnica ovata* Greene has also 4 main clusters (Fig. 6, numbers 3, 7, 14 & 18) but with only one isolated OTU (Fig. 6, number 47). *Arnica mollis* has 3 main clusters (Fig. 6, numbers 8, 16 & 21) and 6 isolated OTUs (Fig. 6, numbers 36-41) while *A. parryi* A. Gray is represented by similar number of main clusters (Fig. 6, numbers 5, 11 & 20) but has only one isolated OTU (Fig. 6, number 35). OTUs of *A. longifolia* D.C. Eaton are contained largely in only 2 main clusters (Fig. 6, numbers 2 & 15) with 3 isolated OTUs (Fig. 6, numbers 32-34) peripherally closed to both clusters. Nearly all OTUs of *A. lanceolata* Nutt. subsp. *lanceolata* are contained in Cluster 1 with a single isolated OTU, number 46 (Fig. 6) as its nearest neighbor. In the majority of cases, it appears that as far as cluster membership is concerned, taxon distinction is clear-cut. However, spatial ordination of clusters as shown by the taxometric map (Fig. 6) is rather intricately complex, as many of the small member clusters and single isolated OTUs are either nested or nearly fused with larger clusters. Nonetheless, TAXMAP sufficiently recognizes all 7 taxa as distinct from one another. The degree of nesting and overlapping of clusters is indicative of the amount of phenetic similarity in many of the taxa in subgenus *Chamissonis*. This strongly implies that prior to the evolution of polyploidy and the apomictic mode of reproduction, the entire subgenus was one large naturally interbreeding complex throughout most of its previous range.

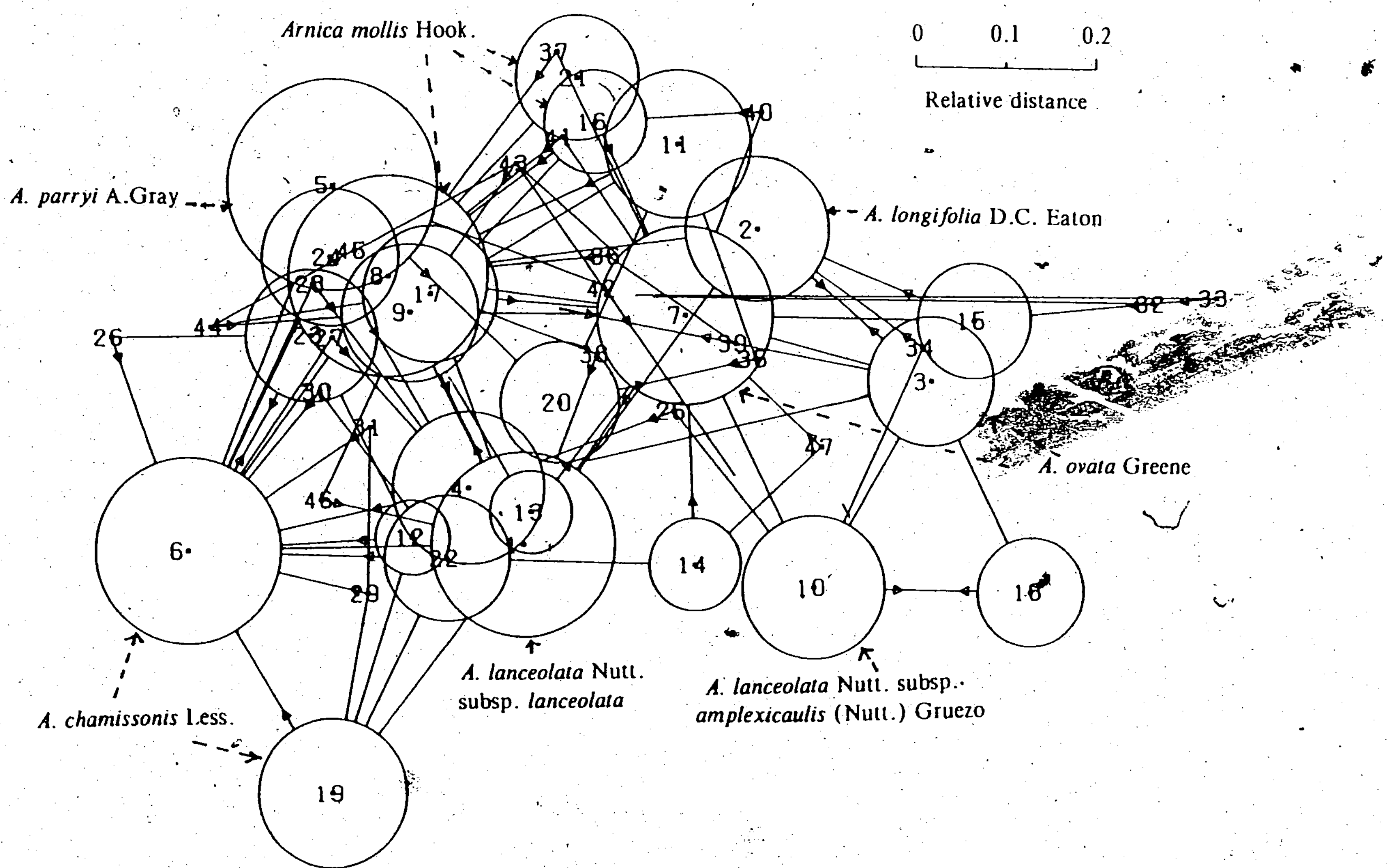

Figure 6. Taxometric map showing the similarities among 7 taxa in subgenus *Chamissonis* Maguire (200 OTUs) based on morphological, ecological and distributional data. For TAXMAP interpretation, see Figure 3.

A closer examination of the taxometric map (Fig. 6) reveals that most of the clusters identified with each taxon can be combined to reflect a certain degree of phenetic polarity. For instance, Clusters 6 (29 OTUs), 4 (8 OTUs) and 19 (4 OTUs) taken together represent an inclusive area for *A. chamissonis* Less. Within this defined region, lie Clusters 12 and 22 of the same species while Clusters 23 and 24 are on the outlier region nearer Clusters 5 (23 OTUs, *A. parryi* A. Gray), 8 (17 OTUs, *A. mollis* Hook.), 9 (7 OTUs) and 17 (2 OTUs) both of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo OTUs present in these 2 clusters have a number of structural characters similar or intermediate to those of either latter named taxa.

Another region that can be delimited and assigned to sets of taxa is the space occupied by Clusters 5 (23 OTUs), 11 (3 OTUs) 20 (3 OTUs) all of *A. parryi* A. Gray; Clusters 8 (17 OTUs), 16 (3 OTUs), 21 (2 OTUs) all of *A. mollis* Hook., and Cluster 9 (7 OTUs) of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo (Fig. 6). An equal area of overlap in Clusters 5 and 8 is clearly shown. Examination of collections (OTUs) included in each of these 2 clusters showed that many share the following characters: a) mostly below midstem or in basal rosette leaves; b) broadly ovate to oblanceolate first pair of cauline leaves, c) distinctly lanceolate-acuminate involucral bracts, and d) presence of numerous gland-tipped hairs mostly on the upper stem and periclinium. On the other hand, OTUs of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo in Cluster 9 resemble few of the morphological characters of OTUs in Cluster 8 (*A. mollis* Hook.), such as: i) often broad hemispherical capitula, ii) lanceolate-acuminate involucral bracts, iii) broadly lanceolate leaves, *etc*. Cluster 9, however is best linked to Cluster 1, the latter containing 15 OTUs of *A. lanceolata* Nutt. subsp. *lanceolata* and 5 OTUs of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo. The inclusion of 5 OTUs of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, and the nested position of Cluster 13 (Fig. 6) with 2 OTUs of same taxon in Cluster 1 plus the closer relative phenetic distance (c. 100 units) between Clusters 1 and 9 strongly supports the present treatment of *these taxa as two geographic subspecies, i.e. A. lanceolata* Nutt. subsp. *lanceolata* and *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo. Overlap of Clusters 5 (*A.*

parryi A. Gray) and 8 (*A. mollis* Hook.) as well as Clusters 11 and 16, each containing OTUs of *A. parryi* A. Gray and *A. mollis* Hook., respectively confirms the closer phenetic similarity of these 2 taxa compared to others. In particular, nearly all ligulate collections of *A. parryi* A. Gray, *e.g.* those currently found in northern Utah and exemplified by the type material of *A. arachnoidea* Rydb. [*P.A. Rydberg & E.C. Carlton 6609* (Holotype, NY *s.n.*!; Isotype, CAN 191136!)] closely resemble some collections of *A. mollis* Hook. This being the case, Maguire (1943) considered *A. arachnoidea* Rydb. as conspecific with *A. mollis* Hook. This treatment, however was incorrect as shown in this study (see Taxonomy section) and confirmed by this numerical analysis. Another distinction exhibited in the taxometric map (Fig. 6) is between *A. chamissonis* Less. and *A. longifolia* D.C. Eaton. Clusters 2 and 15 (Fig. 6) contain 26 of 28 total OTUs of *A. longifolia* D.C. Eaton. These 2 clusters are remarkably far apart from the 7 clusters (*vide supra*) of *A. chamissonis* Less. It should be noted, however that over-all habit of these 2 taxa is similar in that both attain multiple branching and consequently bear numerous heads (up to *c.* 25). Lastly, the taxometric map shows conclusively that *A. ovata* Greene is a phenetically distinct species contrary to previous contentions that it is "merely a convenient name for a complex series of hybrids" (Cronquist 1955, Ediger & Barkley 1978, Wolf 1980, *etc.*) involving *A. amplexicaulis* Nutt. or *A. mollis* Hook. and *A. cordifolia* Hook. or *A. latifolia* Bong. (Cronquist 1955, Ediger & Barkley 1978, Wolf 1980, among others) and recently, between *A. mollis* Hook. and *A. cordifolia* Hook., *A. latifolia* Bong. or *A. rydbergii* Greene (Welsh *et al.* 1987). TAXMAP confirms the closer phenetic relationship between *A. ovata* Greene and *A. amplexicaulis* Nutt. Cluster 17 [*A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo] is the nearest neighbor of Cluster 7 (*A. ovata* Greene) while Clusters 7 and 13 [20 OTUs, *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo] have equal phenetic distance from each other (Fig. 6). Another important point brought up by the taxometric map is that of closer phenetic affinity of *A. ovata* Greene to *A. lanceolata* Nutt. subsp. *lanceolata*. This is shown by the linkage of Cluster 7 to Cluster 1 [*A. lanceolata* Nutt. subsp. *lanceolata*]. These 3 taxa often show nearly similar leaf morphology, *i.e.* narrow to broadly lanceolate with a distinctly dentate to serrate margin. The 2 subspecies of *A. lanceolata* Nutt.

differ only in possessing a sessile first pair of cauline leaves which are distinctly short- or long-petiolate in *A. ovata* Greene. Furthermore, these taxa often have narrow campanulate to ±hemispherical capitula with subplumose stramineous to tawny pappus.

CLUSTER ANALYSIS

Arnica subgenus Chamissonis

Two hundred OTUs representing all 7 taxa currently recognized in subgenus *Chamissonis* were numerically analyzed using CLUSTAN Ward's method. The resultant dendrogram for these 200 OTUs is shown in Fig. 7 while Appendices 2 & 3 provide the locality information and data matrix, respectively.

CLUSTAN recognizes a total of 27 clusters at an arbitrarily drawn phenon level of 4.5 (=E.S.S. value) (Fig. 7, see arrows). Of this total, 4 clusters have greater than 10 OTUs (Clusters 5, 8, 15 & 22), 11 contain between 6 to 9 OTUs each while 7 and 5 clusters have 4 to 5 and 2 to 3 OTUs each, respectively. Five isolated OTUs (Fig. 7, numbers 53, 66, 78, 84 & 118) representing 4 of 7 taxa were also delineated.

Despite the apparently large number of clusters, CLUSTAN Ward's method clearly distinguishes the 7 taxa proportionally to their apparent degree of structural homogeneity. For instance, *A. parryi* A. Gray, the only discoid member of this subgenus, 26 of 28 representative OTUs in this analysis are contained in Clusters 11 (2 OTUs), 22 (18 OTUs), 25 (2 OTUs) and 26 (4 OTUs). A single OTU (OTU no. 84) represents an isolated case while another one (OTU no. 93) was included in Cluster 15 which largely contains OTUs of *A. mollis* Hook. Similar clusters containing only OTUs of a single taxon are Clusters 1, 6, 13 & 23 (*A. chamissonis* Less.) and Clusters 7 and 19 (*A. longifolia* D.C. Eaton). The remaining clusters were categorized according to the taxon where most of the OTUs present in each cluster belong. Hence, Clusters 2 (6 OTUs), 4 (5 OTUs), 9 (5 OTUs), 14 (7 OTUs) 17 (7 OTUs) and 27 (4 OTUs) are largely composed of *A. chamissonis* Less.; clusters 16 (5 OTUs)

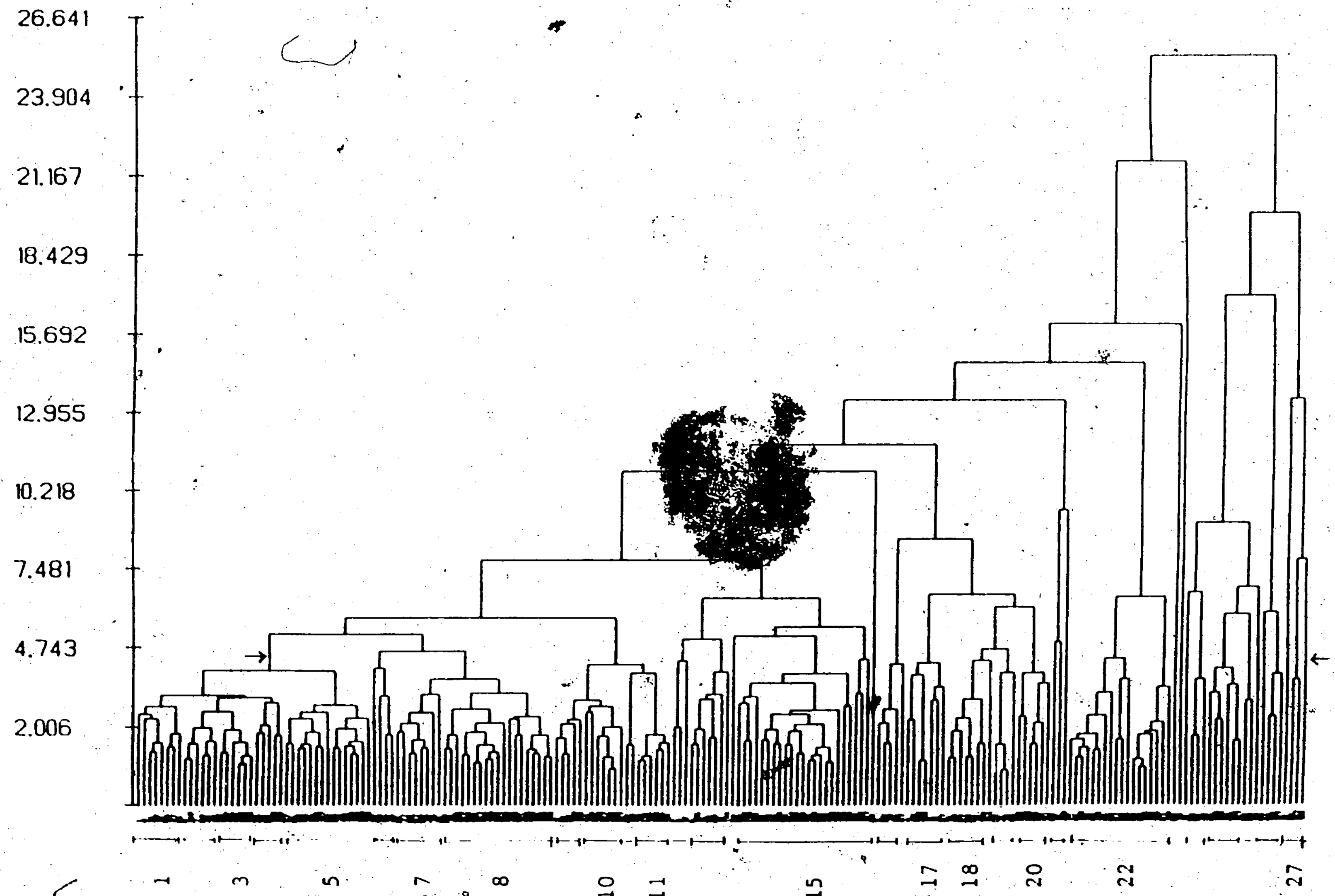

Figure 7. Dendrogram of 200 OTUs of 7 taxa in *Arnica* L. subgenus *Chamissonis* Maguire produced by CLUSTAN Ward's method of clustering. OTU identity at each base node is listed in Appendix 6. The 27 clusters defined at 4.5 E.S.S. value (= phenon level) are described in text.

and 18 (8 OTUs) of *A. longifolia* D.C. Eaton while Clusters 3 and 12, each with 6 OTUs is composed of *A. lanceolata* Nutt. subsp. *lanceolata*. However, 2 clusters defy strict categorization as each consisted of a ±equal number of OTUs belonging to 2 or more taxa. These are Cluster 5 with 5, 4, 3, 2, and 1 OTUs of *A. chamissonis* Less., *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, *A. longifolia D.C. Eaton, A. lanceolata* Nutt. subsp. *lanceolata* and *A. ovata* Greene, respectively; and Cluster 21 with 1 OTU each of *A. chamissonis* Less., *A. mollis* Hook. and *A. lanceolata* Nutt. subsp. *lanceolata*. The occurrence of these sorts of clusters indicates that despite a greater proportion of existing populations of these 7 taxa having attained major degrees of structural distinctiveness, there still remains a small portion of each complex that retains the intermediate phase associated with initial natural hybridization. The dendrogram also shows that few OTUs of closely related taxa are included within certain taxon clusters. This phenomenon suggests that sufficient amount of phenetic confluence exists among these taxa. For example, *A. ovata* Greene is largely represented in Clusters 8 and 10. Cluster 8 contains 19 OTUs of which 13 are *A. ovata* Greene. The other OTUs included in this particular cluster belong to *A. longifolia* D.C. Eaton (2 OTUs) and *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo (3 OTUs) and subsp. *lanceolata (1 OTU). On the other hand, Cluster 10 has 7 OTUs of which 4 are A. ovata* Greene, 2 OTUs belong to *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo and 1 represents *A. chamissonis* Less. The inclusion of OTUs belonging to *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo and subsp. *lanceolata* is quite evident as robust plants of these 2 taxa superficially resemble those of *A. ovata* Greene. Altogether, these 3 taxa exhibit overlap in a number of morphological as well as ecological characters, *e.g.* i) 3-4 pairs of cauline leaves, ii) lanceolate-acuminate involucral bracts, iii) denticulate to dentate-serrate leaf margin, iv) subplumose stramineous to tawny pappus, and v) mesic to nearly hydric habitat specificity. A similarly low and robust forms of *A. chamissonis* Less. and *A. longifolia* D.C. Eaton would approximate to regular plants of *A. ovata* Greene. In *A. chamissonis* Less., polyploid plants (2n = 57, 76) are often with broad lanceolate to nearly ovate leaves with denticulate to sparsely dentate margins. In addition, these populations have distinct short-petiolate cauline leaf pairs, a feature that resembles that of *A. ovata* when numerically scored. Phenetic resemblance between *A. ovata* Greene and *A. longifolia* D.C. Eaton only occurs in a limited number of characters, notably the narrow turbinate capitula, stramineous subplumose pappus and smooth to scarcely hirsute plump achenes.

Another result shown in the phenogram (Fig. 7) is the clear morphological separation between the frequently confused *A. mollis* Hook. and *A. ovata* Greene. Eighteen OTUs of *A. mollis* Hook. are found in Cluster 15. The remainder of 23 OTUs in Cluster 15, however include 3 OTUs of *A. ovata* Greene and 1 each of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo and *A. parryi* A. Gray. As specified above, clusters containing OTUs of *A. ovata* Greene are devoid of any OTU belonging to *A. mollis* Hook. This indicates that *A. mollis* Hook. does not have populations phenetically approaching those of *A. ovata* Greene. On the contrary, there are few populations of *A. ovata* Greene mistakenly considered as *A. mollis* Hook. This specific situation was highlighted in the work of Maguire (1943) when he interpreted the type material of *A. ovata* Greene (Figs. 16 & 17) as conspecific to *A. mollis* Hook. Consequently the distinctions between populations of *A. ovata* Greene (particularly those currently found in northern Utah and a few localities in Colorado) and *A. mollis* Hook. was diffused and the inherent structural polarity was totally misunderstood. Figures 17, 18, and 19 show accurately the set of characters that unite *A. ovata* Greene, *A. diversifolia* Greene and *A. silvatica* Greene into a single well-defined species. For comparative purposes, Figure 22 shows the typical gross morphology of *A. mollis* Hook. For a more detailed differentiation of these 2 taxa, refer to the 'Taxonomy section' (*vide infra*).

B. Pollen Viability

One thousand and ninety-six (1,096) specimens within subgenus *Chamissonis* were examined and scored for pollen stainability (Appendix 5). Barker (1966) had shown conclusively that in genus *Arnica*, pollen quality is a reliable measure of the existing reproductive mode in natural populations. Pollen grains from populations experimentally demonstrated by emasculation technique and embryological examination to be amphimictic were well-developed and have more than 90% stainability. On the contrary, pollen grains of apomictic populations showed various degrees of deformity and stainability of less than 80%. An earlier study by Gustafsson (1947a) indicated a positive correlation between poor pollen quality and apomixis. More significantly, various studies (Gustafsson 1946a, 1946b, 1946c & 1947b, Stebbins 1950) have documented the relationship of apomixis and polyploidy. In *Arnica*, this relationship has been repeatedly confirmed (Wolf 1980, 1981 & 1987; Downie & Denford 1986, Downie 1987) since Barker's study (1966) of apomictic behavior in the genus. In the present study, those populations with polyploid chromosome counts had below 90% stainable pollen (Appendix 7).

ARNICA CHAMISSONIS LESS.

Of 210 collections of *Arnica chamissonis* Less. scored for pollen stainability (Appendix 5), 189 specimens or 90% of the total sample had less than 80% stainable pollen. Of these 189 collections, 138 showed less than 40% stainability. All these collections were from known glaciated areas throughout the geographical range of the species. Only 14 collections (7% of total sample) had a stainability of between 81 and 89%. Those collections with greater than 90% stainable pollen were from sites south of the maximum limits of glaciations, *e.g.* Montana (Glacier Co., east entrance; Beaverhead Co., along Rock Creek, 4 miles above Brown's Lake and at Danaher Ranch, Flathead National Forest), Idaho (Valley Co., S of Warm Lake, Payette National Forest, Sawtooth Mountains; Custer Co., near Boyle's Ranch, Challis Forest; Blaine Co., Alturas Lake; Elmore Co., Bascom's Ranch), Wyoming (Park Co., Fishawk Creek, 0.5-1 mile of confluence with N Fork of Shoshone River, South Absaroka Wilderness, Absaroka Range; Yellowstone National Park, Gibbon Meadow; Teton Co., Snake River bottom, Grand Teton National Park and Buffalo River at Government bridge) and California (Lassen Co., Little Harvey Valley, Lassen National Forest; San Bernardino Co., Bluff Lake, San Bernardino Mountains). Evidently in these localities, *A. chamissonis* Less. was growing in moist mountain meadows situated at elevations of

1,362-2,240 m (4,500-7400 ft). These isolated sites, where amphimictic populations of *A. chamissonis* Less. thrived, had probably escaped alpine glaciations and attendant or subsequent natural or artificial destruction of their habitat. Within the boundary of glaciated zones, contemporary populations of *A. chamissonis* Less. are commonly found along margins of highways and logging or mining roads as well as in newly open or recently disturbed sites. In the Yukon Territory, it is one of the common ruderal species and together with *Arnica angustifolia* J.M. Vahl subsp. *angustifolia*, *A. lonchophylla* Greene subsp. *lonchophylla* (both of subgenus *Arctica*), *A. cordifolia* Hook., and *A. latifolia* Bong. (both of subgenus *Austromontana*) produces massive clonal populations that impart at peak season of flowering an impressive yellow-orange landscape along major highways and gravel roads.

At the southern extremity of its geographical range, *i.e.* Arizona, 3 collections showed 1, 12 and 33% stainable pollen. The presence of presumably polyploid populations in this region, not directly affected by glaciations, is likely to be a product of post-glacial introductions probably m[illegible] migratory waterfowl. This is suggested because all collections from this ar[illegible] been f[illegible]d only within the vicinity of water bodies, *e.g.* around periphery of bogs, in the shallow water of lakes, muddy places around ponds, and in grass-sedge community, at elevations of 2,760-3,088 m (9,115-10,200 ft). Within the glaciated zones, many polyploid populations of *A. chamissonis* Less. inhabit bodies of water that are regular breeding grounds of many North American migratory waterfowl (Smith *et al.* 1964, Gill 1973). However, few populations from intervening areas were growing in similar environments.

ARNICA MOLLIS HOOK.

All 173 collections of *A. mollis* Hook. assessed for pollen viability (Appendix 5) exhibited less than 90% pollen stainability. Of these, 133 specimens or 77% of the total sample had less than 40% viable pollen while 39 collections (23% of total sample) showed stainability of between 41 and 80%. Only a single collection was recorded with 85%.

In general, the present results confirm those of Barker (1966) who tested pollen in 40 collections. Combined with chromosome counts determined for a number of populations for this taxon (*vide infra*), this result conclusively shows that *A. mollis* Hook. is a wholly apomictic-polyploid complex throughout its range of distribution.

ARNICA PARRYI A. GRAY

Pollen fertility in 124 collections of *A. parryi* A. Gray was evaluated (Appendix 5). Seventy-two percent (89 specimens) exhibited less than 40% stainable pollen while 27% (34 collections) had pollen stainability from 41 to 80%. Altogether, 99% (123 specimens) of the total sample had less than 80% viable pollen. The highest percentage reported by Barker (1966) for *A. parryi* A. Gray was 64% (a collection from Marble Mountains, British Columbia) with 37 of 44 specimens tested showing less than 50% stainable pollen. In the present study, a lone collection from Colorado [Fraser, Idlewild Ranger Station, *Earl L. Johnston 329* (RM 117557!)] showed 95% stainable pollen. This finding, coupled with a previous chromosome count of n=19 for a single population in Nevada, [Nye Co., stream at Longstreets Ranch, W of Kawich Peak, Kawich Range; Reveal & Styer (1973) *sub A. parryi* A. Gray subsp. *sonnei* (Greene) Maguire] negates the conclusion by Barker (1966) that this taxon is entirely apomictic-polyploid.

ARNICA LANCEOLATA NUTT. SUBSP. *AMPLEXICAULIS* (NUTT.) GRUEZO

Ninety-eight collections of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo were scored for pollen viability (Appendix 5). Of this total, 73 specimens (75%) showed stainability of less than 40% while 12 collections had greater than 90%. Eighty-four collections (87% of the total sample) exhibited less than 80% stainable pollen and only 2 specimens had a stainability of between 81 and 89%. Except for a single collection of unspecified provenance (*i.e.* Merfort *et al. s.n.!*)[1], all collections with greater than 90% stainable pollen were from

[1]Phytochemical voucher specimen of plants grown from seeds obtained from the Botanical Garden, University of Vancouver (*sic*)[=University of British Columbia],

localities outside the fringes of glaciations, and remarkably restricted to only a few highly localized sites in Washington and Oregon. In Washington, these amphimictic populations were found only on steep moist banks along the Lilliwap River on the west side of the Hood Canal (Mason Co.) and along the trail to Col. Bob Lookout on the Olympic Mountains (Grays Harbor Co.). In Oregon, they were present in at least 6 different stations: on the West Fork of Hood River, Langer (Hood River Co.), Eagle Creek (Clackamas Co.); near Warrendale just above Elowah Falls on McCord Creek, within the spray zone of Wahkeena and Multnomah Falls, Gorge of Columbia River and beside the trail to Larch Mountain. The latter 4 s[illegible] in Multnomah County which is the type region of this taxon.

The present result confirms the trend observed by Barker (1966) for this taxon. *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo is definitely one of the large taxon complexes in subgenus *Chamissonis* which has widesprea[illegible]c-polyploid elements with a few isolated amphimictic-diploid counterparts.

ARNICA LANCEOLATA NUTT. SUBSP. LANCEOLATA

All 98 collections of *A. lanceolata* Nutt. subsp. *lanceolata* examined for pollen viability (Appendix 5) showed extremely deformed or aborted pollen grains. Theoretically, these tests were recorded as 0% stainability. It is quite obvious that in this taxon, there is strong evidence of a breakdown in its pollen production mechanism. With a tetraploid chromosome count ([illegible]76) consistently reported for this taxon (Löve & Löve 1964, 1966; Morton 1981, Wolf 1987), it is undoubtedly wholly polyploid and apomictic. The probability of finding extant diploid populations for this taxon in its present restricted range is predicted to be nil. Incidentally, Barker (1966) excluded this taxon from his study.

¹(cont'd) Vancouver, B.C. Canada (Merfort *et al.* 1986).

ARNICA LONGIFOLIA D.C. EATON

Of 153 collections of *A. longifolia* D.C. Eaton examined for pollen fertility (Appendix 5), 104 (68% of total sample), 127 (83%) and 135 (88%) had less than 40, 80, and 90% pollen stainability, respectively. Eighteen collections (12% of total sample) exhibited pollen viability greater than 90%. This result is remarkably similar to Barker's (1966) pollen stainability tests for 41 collections of this taxon. His finding consisted of 30 (73% of total sample) and 36 (88%) collections showing less than 40 and 90% viable pollen, respectively. Only 5 (12% of total) specimens had greater than 90% stainable pollen.

These amphimictic populations of *A. longifolia* D.C. Eaton are restricted to only a few localities in the adjoining boundary regions of southwestern Montana, central-southern Idaho, western Wyoming and northern Utah. In southwestern Montana, these sexual elements were found growing in only 2 sites, *i.e.* on the east fork of McClellan Creek, Helena National Forest (Broadwater Co.) and along Gold Creek, Beaverhead National Forest (Beaverhead Co.). In Idaho, they were collected from 7 different stations, namely: i) Cathedral Meadows, Salmon National Forest (Lemhi Co.), ii) Bear Creek below Parker Mountain (Custer Co.), iii) granite rock slides near Stanley Lake, Challis National Forest, Sawtooth Mountains (Custer Co.), iv) southwest corner of Franklin Basin, Bear River Range (Oneida Co.), v) in high rough country and vi) South Leigh Creek, both in Palisade National Forest, and vii) Baldy Mountain Camp, Salmon National Forest. In western Wyoming, these presumably diploid populations were recorded from only 4 localities, *i.e.* 1) Lower Slide Lake, Gros Ventre Mountains (Teton Co.), 2) Two Ocean Mountain, Continental Divide (Fremont Co.), 3) Bear Mountain, Wyoming Range (Sublette Co.), and 4)in the junction of Box Canyon Creek and Grey's River (Lincoln Co.). In all these localities, the plants were usually growing on rocky soils on steep slopes or rock screes, as well as at the bottom of canyons, near seeps and springs, in basin meadows and along lake shores from altitudes of 1,756-3,028 m

(5,800-10,000 ft). Together with *A. chamissonis* Less. and *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, this taxon is another excellent example of a complex consisting of broadly dispersed apomictic elements with an isolated enclave of diploids.

ARNICA OVATA GREENE

All of the 240 collections of *A. ovata* Greene (Appendix 5) evaluated for pollen fertility showed less than 30% stainability. A great proportion of pollen grains were deformed. This result places *A. ovata* Greene under the category of a complex entirely devoid of any amphimictic members. Previous and current chromosome reports (see Tables 5 & 8) confirm that throughout its entire distribution range, this taxon is polyploid and apomictic.

C. Chromosome Numbers

Two hundred and three (203) populations representing 6 of 7 taxa in subgenus *Chamissonis* were examined for chromosome numbers (Table 8). Only 3 of the 6 to 8 ploidy levels reported for members of this subgenus (see Table 5) were verified in the present work. These ploidy levels are diploid (2n = 38), triploid (2n = 57) and tetraploid (2n = 76). The latter 2 ploidy levels are the most prevalent throughout the whole range of this subgenus. It is confirmed here that extant diploid populations are rather scarce within the subgenus. Results of pollen fertility study (vide supra) strongly corroborate this.

The basic chromosome number for *Arnica* of x = 19 first determined by Böcher & Larsen (1950, 1955) has been repeatedly confirmed by numerous studies (*e.g.* Ornduff *et al.* 1963 & 1967, Kiel & Pinkava 1976, Wolf 1980 & 1987, Wolf & Denford 1984c). In addition, meiotic irregularities such as the occurrence of rings of four at metaphase I (Strother 1972) as well as a number of uni-, bi-, and multivalents at late diakenesis (Ornduff *et al.* 1967, Strother 1972), and chains, bridges and lagging chromosomes (Ornduff *et al.* 1967) have been well-documented in genus *Arnica*. These meiotic abnormalities have been observed in many instances and are positively correlated with polyploidy and apomictic mode of reproduction.

Table 8. Chromosome numbers determined for members of *Arnica* L. subgenus *Chamissonis* Maguire.

Taxon	2n =	Locality and voucher
A. parryi	76	**U.S.A., Idaho**: Blaine Co., road turn-off on Hwy 75 to Alturas Lake, c.300 m before Alpine Creek parking area, *Wm. Gruezo WM11431* (ALTA 91401!, WGRZ!). **Montana**: Glacier Co., Marias Pass Divide, Clark & Lewis National Forest Campground, vicinity of campsite no. 3, *Wm. & Aida Gruezo WM12000* (ALTA 93005!, WGRZ!); Glacier Co., Marias Pass Divide, Clark & Lewis National Forest Campground, c. 150 m from campsite no. 3, near small creek, *Wm. & Aida Gruezo WM11682* (ALTA 93006!, WGRZ!). **Wyoming**: Albany Co., Medicine Bow National Forest, Hwy 130 Mile post 35, c.1/2 mi before Mt. Meadows Cabins, *Wm. Gruezo WM11323* (ALTA 92174!, WGRZ!); Yellowstone National Park, c. 2 km E of Sylvan Lake, *Wm. Gruezo WM11405* (ALTA!, WGRZ!); Yellowstone National Park, c. 2 km E of Sylvan Lake, roadside, *Wm. Gruezo WM11406* (ALTA 91400!, WGRZ!). **Oregon**: Klamath Co., Crater Lake National Park, on Rim Drive, c.1/4 mi before Sun Notch Viewpoint, *Wm. Gruezo WM11472* (ALTA!, WGRZ!); Klamath Co., Crater Lake National Park, on Rim Drive, c. 300 m from Crater Lake Lodge & Crater Lake Park Headquarters, *Wm. Gruezo WM11476* (ALTA 91403!, WGRZ!).
A. ovata	57	**U.S.A., Alaska**: Denali Hwy (Hwy 8), c. 150 m E of Mile post 35, en route to Tangle Lakes, *Wm. & Aida Gruezo WM11946* (ALTA!, WGRZ!). **Oregon**: Klamath Co., Crater Lake National Park, on Rim Drive c. 1/4 mi before Sun Notch Viewpoint, *Wm. Gruezo WM11474* (ALTA 91298!, WGRZ!). **Wyoming**: Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 42, *Wm. Gruezo WM11349* (ALTA 91[illegible]RZ!).
		Canada, Alberta: Jasper National Park, Mt. Edith Cavell, *Wm. Gruezo WM11550* (ALTA 91296!, WGRZ!), *Wm. Gruezo WM11552* (ALTA 91293!, WGRZ!), *Wm. Gruezo WM11555* (ALTA 91294!, WGRZ!), *Wm. Gruezo WM11558* (ALTA 91295!, WGRZ!), [illegible]*11559* (ALTA 91305!, WGRZ!); Jasper Na[illegible]ld Hills, vicinity of summit, *Wm. Gruezo WM11568* (ALTA 91[illegible]Z!), *Wm. Gruezo WM11571* (ALTA 91308!, WGRZ!); Jasper National Park, The Bald Hills, along rough road to former site of Fire Watch Tower, c.1/4 way up, *Wm. Gruezo WM11580* (ALTA 91311!, WGRZ!), *Wm. Gruezo WM11579* (ALTA 91309!, WGRZ!);

Jasper National Park, The Bald Hills, c. 1.5 km from Maligne Road, rough road to former site of Fire Watch Tower, *Wm. Gruezo WM11583* (ALTA 91312!, WGRZ!); Jasper National Park, The Bald Hills, c. 1 km from Maligne Road, along rough road to former Fire Watch Tower, *Wm. Gruezo WM11584* (ALTA 91313!, WGRZ!); Jasper National Park, The Bald Hills, c. 0.5 km from Maligne Road, along rough road to former site of Fire Watch Tower, *Wm. Gruezo WM11586* (ALTA 91314!, WGRZ!). Banff National Park, Sunshine Village Ski Area, along foot trail to Rock Isle Lake, *Wm. Gruezo WM11591* (ALTA 91315!, WGRZ!), *Wm. Gruezo WM11593* (ALTA 91316!, WGRZ!);

Banff National Park, Sunshine Village Ski Area, vicinity of Meadow Park summit, *Wm. Gruezo WM11595* (ALTA 91317!, WGRZ!); Banff National Park, Parker Ridge, along foot trail to ridgetop, *Wm. Gruezo WM11536* (ALTA 91302!, WGRZ!), *Wm. Gruezo WM11538* (ALTA 91303!, WGRZ!).

c. 9 km S of Mountain Park proper, Cardinal Divide Viewpoint, vicinity of campground, *Wm. Gruezo WM11504* (ALTA 91299!, WGRZ!), *Wm. Gruezo WM11511* (ALTA 91300!, WGRZ!), *Wm. Gruezo WM11516* (ALTA 91301!, WGRZ!). Waterton Lakes National Park, vicinity of Summit Lake, *Wm. Gruezo WM11608* (ALTA 91318!, WGRZ!);

Waterton Lakes National Park, ridgeslope below Carthew Lake overlooking Alderson Lake, *Wm. Gruezo & S.R. Downie WM11619* (ALTA 91319!, WGRZ!); Waterton Lakes National Park, vicinity of Summit Lake, left side of wooden foot bridge on way to Carthew Trail, *Wm. Gruezo WM11622* (ALTA 91320!, WGRZ!);

76 **U.S.A., Wyoming**: Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 42, *Wm. Gruezo WM11350* (ALTA 91297!, WGRZ!).

Canada, Alberta: Waterton Lakes National Park, NW shore of Lake Bertha, along trail c. 400 m from Horse Corral, *Wm. Gruezo WM11667* (ALTA 91726!, WGRZ!). **British Columbia**: Mount Assiniboine Provincial Park (50° 52' N, 115° 38' W), c. 300 m above Rock Isle Lake, along foot-trail to alpine summit, subalpine meadows, *Wm. Gruezo WM11588* (ALTA 91304!, WGRZ!).

longifolia 76 **U.S.A., Idaho**: Blaine Co., Sawtooth National Forest, road turn-off on Hwy 75 leading to Alturas Lake, vicinity of Alpine Creek parking area, *Wm. Gruezo WM11425* (ALTA 92178!, WGRZ!), *Wm. Gruezo WM11430* (ALTA 92177!, WGRZ!); Blaine Co., Sawtooth National Forest, c. 200 m after access road to Alturas Lake Inlet Campground, *Wm. Gruezo WM11433* (ALTA 91433!, WGRZ!); Blaine Co., Sawtooth National Forest, Hwy 75, c. 300 m N of Mile post 154, along roadside bend, *Wm. Gruezo WM11435* (ALTA 91434!, WGRZ!).

Oregon: Klamath Co., Crater Lake National Park, on Rim Drive c. 100 m after the Pinnalli Junction, ***Wm. Gruezo WM11471*** (ALTA 91435!, WGRZ!); Klamath Co., Crater Lake National Park, on Rim Drive c.300 m from Crater Lake Lodge & Crater Lake Park Headquarters, ***Wm. Gruezo WM11475*** (ALTA 91436!, WGRZ!).
Utah: Wasatch Co., Wasatch National Forest, Wasatch Mts., Hwy 152, vicinity of Mile post 19, inside Redman Campground, ***Wm. Gruezo WM11444*** (ALTA 92175!, WGRZ!).
Wyoming: Johnson Co., Big Horn Mts. National Forest, Hwy 16, vicinity of Mile post 44, c. 150 m from Deerhaven Lodge, ***Wm. Gruezo WM11373*** (ALTA 91424!, WGRZ!).
Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 100 m W of Mile post 66, ***Wm. Gruezo WM11380*** (ALTA 91425!, WGRZ!); Sheridan Co., Big Horn Mts. National Forest, Hwy 14, on cut-side of road directly opposite Sibley Lake, ***Wm. Gruezo WM11385*** (ALTA 91426!, WGRZ!).
Big Horn Co., Big Horn National Forest, Hwy 14A, c. 2.7 km E of Pole Creek or c. 44 km E of Lovell, ***Wm. Gruezo WM11391*** (ALTA 91428!, WGRZ!), ***Wm. Gruezo WM11395*** (ALTA 91429!, WGRZ!); Big Horn Co., Big Horn National Forest, Hwy 14A, vicinity of Mile post 38, N side of Observation Point(Scenic area), ***Wm. Gruezo WM11396*** (ALTA 91430!, WGRZ!).
Yellowstone National Park, c. 5 mi E of East Gate Entrance, ***Wm. Gruezo 11404*** (ALTA 91427!, WGRZ!); Yellowstone National Park, c. 2 km N of Dunraven Pass peak, ***Wm. Gruezo WM11408*** (ALTA 91431!, WGRZ!).

Canada, Alberta: Waterton Lakes National Park, NW shore of Lake Bertha, vicinity of Horse Corral, ***Wm. Gruezo WM11666*** (ALTA 91724!, WGRZ!); Waterton Lakes National Park, NW shore of Lake Bertha, along trail c. 400 m from Horse Corral, ***Wm. Gruezo WM11668*** (ALTA 91727!, WGRZ!).

57 U.S.A., **Nevada**: Elko Co., Humboldt National Forest, Ruby Mts., Lamoille Canyon, along loop road at trail head, ***Wm. Gruezo WM11450*** (ALTA 91344!, WGRZ!).

76 U.S.A., **Wyoming**: Albany Co., Medicine Bow National Forest, Hwy 130, c. 200 m E of Mile post 34, ***Wm. Gruezo WM11316*** (ALTA 91321!, WGRZ!); Albany Co., Medicine Bow National, Forest, Nash Fork Campground, vicinity of campsite no. 27, ***Wm. Gruezo WM11328*** (ALTA 91322!, WGRZ!); Albany Co., Medicine Bow National Forest, Nash Fork Campground, vicinity of campsite no. 27 behind out-house, ***Wm. Gruezo WM11337*** (ALTA 91339!, WGRZ!);

Albany Co., Medicine Bow Peak no. 2, Sugarloaf National Forest, c. 200 m from parking area near lake, *Wm. Gruezo WM11338* (ALTA 91323!, WGRZ!). Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 37 nearby sharp roadbend, *Wm. Gruezo WM11343* (ALTA 91325!, WGRZ!);
Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 41 near Mirror Lake, *Wm. Gruezo WM11344* (ALTA 91328!, WGRZ!); Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 42, near lake shore, *Wm. Gruezo WM11349* (ALTA 92171!, WGRZ!); Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 42, near lake shore, cut-side of road, *Wm. Gruezo WM11351* (ALTA 91324!, WGRZ!);
Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 43, roadside ditch, *Wm. Gruezo WM11353* (ALTA 91326!, WGRZ!); Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 43, c. 700 m from roadside turn-out, *Wm. Gruezo WM1135[illegible]* (ALTA 91327!, WGRZ!); Carbon Co., Medicine Bow National Forest, Hwy 130, E of Mile post 49 on way to Saratoga, c.200 m from intersection to French Creek Campground, *Wm. Gruezo WM11360* (ALTA 91329!, WGRZ!), *Wm. Gruezo WM11361* (ALTA 91330!, WGRZ!), *Wm. Gruezo WM11362* (ALTA 91341!, WGRZ!).
Johnson Co., Big Horn Mts. National Forest, Powder River Pass, Hwy 16, S-facing slope, rock out-crops, *Wm. Gruezo WM11368* (ALTA!, WGRZ!); Johnson Co., Big Horn Mts. National Forest, Hwy 16, c. 1.5 km E of Powder River Pass peak, *Wm. Gruezo WM11369* (ALTA!, WGRZ!); Johnson Co., Big Horn Mts. National Forest, Hwy 16, c. 200 m W of Canyon Creek, *Wm. Gruezo WM11371* (ALTA 91332!, WGRZ!).
Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 4.8 km E of Mile post 67, *Wm. Gruezo WM11378* (ALTA 91333!, WGRZ!); Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 120 m W of Mile post 66, *Wm. Gruezo WM11382* (ALTA!, WGRZ!); Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 150 m W of Mile post 66, *Wm. Gruezo WM11384* (ALTA!, WGRZ!).
Big Horn Co., Big Horn National Forest, Hwy 14, c. 1 km E of Camp Bethel & Prune Creek Campground, *Wm. Gruezo WM11387* (ALTA 91336!, WGRZ!); Big Horn Co., Big Horn National Forest, Hwy 14A, c. 1.5 km E of Medicine Wheel Archeological Site turn-off road, *Wm. Gruezo WM11397* (ALTA 91338!, WGRZ!).
Yellowstone National Park, c. 1 km S of Dunraven Pass peak, *Wm. Gruezo WM11407* (ALTA 91342!, WGRZ!); Yellowstone National Park, vicinity of North Twin Lake, *Wm. Gruezo WM11410* (ALTA 91343!, WGRZ!).

Canada, Alberta: Jasper National Park, Mt. Edith Cavell, along foot trail to Mt. Edith Cavell meadows, *Wm. Gruezo WM11549* (ALTA 91503!, ALTA 91504!, WGRZ!), *Wm. Gruezo WM11557* (ALTA 91349!, WGRZ!), *Wm. Gruezo WM11560* (ALTA!, WGRZ!), *Wm. Gruezo WM11561* (ALTA 91306!, WGRZ!);

Jasper National Park, The Bald Hills, along rough road to former site of Fire Watch Tower, subalpine meadows, *Wm. Gruezo WM11572* (ALTA 91353!, WGRZ!), *Wm. Gruezo WM11574* (ALTA 91354!, WGRZ!), *Wm. Gruezo WM11577* (ALTA 91356!, WGRZ!);

Jasper National Park, The Bald Hills, along rough road to former site of Fire Watch Tower, c. 20 m before junction of Skyline trail & Bald Hills trail, *Wm. Gruezo WM11578* (ALTA 91357!, WGRZ!)

Jasper National Park, The Bald Hills, along rough road to former site of Fire Watch Tower, c.1/5 way up, *Wm. Gruezo WM11581* (ALTA 91358!, WGRZ!); Jasper National Park, The Bald Hills, c. 1/6 of the way up to former site of Fire Watch Tower, *Wm. Gruezo WM11582* (ALTA 91360!, WGRZ!);

Jasper National Park, The Bald Hills, vicinity of summit, N-facing steep slope, *Wm. Gruezo WM11569* (ALTA 91351!, WGRZ!).

Banff National Park, Parker Ridge, along foot trail to ridgetop, *Wm. Gruezo WM11534* (ALTA 91345!, WGRZ!), *Wm. Gruezo WM11537* (ALTA 91346!, WGRZ!), *Wm. Gruezo WM11539* (ALTA 91347!, WGRZ!), *Wm. Gruezo WM11541* (ALTA!, WGRZ!);

Banff National Park, Sunshine Village Ski Area, c. 1/2 on the way up to Rock Isle Lake, *Wm. Gruezo WM11592* (ALTA 91362!, WGRZ!);

Banff National Park, Sunshine Village Ski Area, c. 150 m above Sunshine Village Gondola Station, along foot-trail to Rock Isle Lake, *Wm. Gruezo WM11594* (ALTA 91363!, WGRZ!);

Banff National Park, Sunshine Village Ski Area, vicinity of Meadow Park summit, along foot-trail in subalpine meadows, *Wm. Gruezo WM11596* (ALTA 91364!, WGRZ!), *Wm. Gruezo WM11597* (ALTA 91365!, WGRZ!);

Banff National Park, Sunshine Village Ski Area, c. 200 m above Sunshine Village Gondola Station, along trail to Meadow Park summit, in subalpine meadows, *Wm. Gruezo WM11598* (ALTA 91366!, WGRZ!).

Waterton Lakes National Park, vicinity of Summit Lake, along banks of creek outlet N of lake, *Wm. Gruezo WM11605* (ALTA 91367!, WGRZ!); Waterton Lakes National Park, vicinity of Summit Lake, northern portion of lake, *Wm. Gruezo WM11607* (ALTA 91368!, WGRZ!); Waterton Lakes National Park, vicinity of Summit Lake, eastern portion of lake near junction to Carthew Trail, *Wm. Gruezo WM11609* (ALTA 91369!, WGRZ!);

...tional Park, vicinity of Summit Lake, southwestern portion of ...den foot bridge on way to Carthew Trail, *Wm. Gruezo* ...70!, WGRZ!).
...al Park, vicinity of Upper Carthew, by the lakeshore, along ... *Wm. Gruezo & S.R. Downie WM11618*(ALTA 91359!,

...unt Assiniboine Provincial Park, vicinity of Rock Isle Lake, ...lpine summit, *Wm. Gruezo WM11590* (ALTA 91361!, WGRZ!).

U.S.A., Oregon: Klamath Co., Hwy 140, c. 16 mi E of Bly, Fremont National Forest, inside Corral Creek Campground, *Wm. Gruezo WM11467* (ALTA 91412!, WGRZ!).

Canadá, Alberta: Waterton Lakes National Park, Hwy 6 S, inside Belly River Campground, front right side of campsite no. 14, *Wm. Gruezo WM11600* (ALTA 92164!, WGRZ!).

U.S.A., Alaska: Richardson Hwy (Hwy 4), c. 1.1 km S of Mile post 69, *Wm. & Aida Gruezo WM11881* (ALTA 91947!, ALTA 91948!, WGRZ!);
Richardson Hwy (Hwy 4), c. 100 m before Ernestine Station & 125 m S of Mile post 62, *Wm. & Aida Gruezo WM11883* (ALTA 91950!, ALTA 91951!, WGRZ!).
Glenn Hwy (Hwy 1), vicinity of Mile post 59.8, left side of road en route to Anchorage, c. 75 m from Hilltop Cafe & Tesoro Gas Station, *Wm. & Aida Gruezo WM11915* (ALTA!, WGRZ!);
Glenn Hwy (Hwy 1 SE), Turnagain Arm area, vicinity of Mile post 94.3, left side of road en route to Girdwood, *Wm. & Aida Gruezo WM11916* (ALTA!, WGRZ!);
Glenn Hwy (Hwy 1 SE), Turnagain Arm area, c. 2 km E of Girdwood & 0.5 km before railroad crossing, *Wm. & Aida Gruezo WM11918* (ALTA!, WGRZ!);
Girdwood proper, in front of Double Musky Inn, along edge of road canal & lawn of Double Musky Inn, *Wm. & Aida Gruezo WM11919* (ALTA!, WGRZ!);
Girdwood proper, along Alyeska Hwy, c. 0.8 km from junction of Glenn Hwy (Hwy 1 SE) & Alyeska Hwy, *Wm. & Aida Gruezo WM11920* (ALTA!, WGRZ!); Glenn Hwy (Hwy 1 SE), c. 66 mi N of Seward, right side of road en route to Seward, *Wm. & Aida Gruezo WM11921* (ALTA!, WGRZ!);
Glenn Hwy (Hwy 1, S), vicinity of entrance road to Chugach National Forest Campground, Granite Creek, c. 1.5 km S of Mile post 62, *Wm. & Aida Gruezo WM11922* (ALTA!, WGRZ!); Glenn Hwy (Hwy 1 S), c. 1 km N of Mile post 49, *Wm. & Aida Gruezo WM11923* (ALTA!, WGRZ!).

Hwy 9, Moose Pass proper, behind garage of Chevron Gas Station, *Wm. Gruezo WM11925* (ALTA!, WGRZ!). Seward proper, vicinity of Peninsula Ford dealer & Free Mason cemetery, *Wm. & Aida Gruezo WM11926* (ALTA!, WGRZ!); Seward Township, Hwy 9, c. 6 mi N of Seward proper, right side of road en route Seward, *Wm. & Aida Gruezo WM11928* (ALTA!, WGRZ!).

Glenn Hwy (Hwy 1, E), c. 0.5 km E of Mile post 93 or 0.5 km before Eagles Nest Bed & Breakfast Lodge or c. 2.3 mi E of Soldotna, *Wm. & Aida Gruezo WM11931* (ALTA!, WGRZ!).

Kenai Township, Hwy 1, c. 2 mi before Kenai proper, corner of Hwy 1 & McCollum Drive, *Wm. & Aida Gruezo WM11932* (ALTA!, WGRZ!). Hwy 1(S), c. 4 mi N of Kasilof, vicinity of Mile post 103, *Wm. & Aida Gruezo WM11934* (ALTA!, WGRZ!); Hwy 1(S), Ninilchik proper, right side of road to town center & opposite Hylen's camper park signpost/access road, c. 1 km before the townhall, *Wm. & Aida Gruezo WM11935* (ALTA!, WGRZ!).

Sterling Hwy (Hwy 1, S), c. 0.8 km N of Mile post 154 & c. 3.2 km S of Anchor Point, left side of road en route to Homer, *Wm. & Aida Gruezo WM11936* (ALTA!, WGRZ!); Sterling Hwy (Hwy 1, S), c. 1 km S of Mile post 168 & 0.2 km from corner of Green Timber Road & Sterling Hwy, *Wm. & Aida Gruezo WM11937* (ALTA!, WGRZ!);

Sterling Hwy (Hwy 1, S), c. 2.5 km before Homer proper or c. 1.9 km S of Mile post 171, *Wm. & Aida Gruezo WM11939* (ALTA!, WGRZ!); Sterling Hwy (Hwy 1, S), c. 1 km S of Mile post 169, cut-side of road opposite parking area of Homer View Point, *Wm. & Aida Gruezo WM11940* (ALTA!, WGRZ!).

Ninilchik proper, corner of Sterling Hwy (Hwy 1) & Oilwell Road & beside the Calvary Baptist Church & Christian School, *Wm. & Aida Gruezo WM11941* (ALTA 92048!, ALTA 92049!, ALTA 92050!, ALTA 92055!, ALTA 92056!, WGRZ!).

Idaho: Blaine Co., Sawtooth National Forest, Hwy 75, c. 500 m N of Mile post 168, turn-off road to Lake Alturas, *Wm. Gruezo WM11424* (ALTA!, WGRZ!).

Oregon: Klamath Co., Hwy 31, c. 11 mi S of Silver Lake town proper, near junction of fire road c. 500 m from Silver Marsh Campground, *Wm. Gruezo WM11468* (ALTA 91413!, WGRZ!);

Klamath Co., Hwy 31, Paulina Marsh, c. 1.8 km N of Silver Lake town proper, on rough road to Fort Rock, *Wm. Gruezo WM11469* (ALTA 92160!, WGRZ!). Hwy 22, Ochoco National Forest, c. 4 km E of Ochoco Forest Ranger Station, c. 15 m from roadside parking area, *Wm. Gruezo WM11479* (ALTA 91423!, WGRZ!).

Umatilla Co., Hwy 244, Blue Mountains, c. 1.5 km W of Mile post 12, vicinity of Lane Creek Campground, just before entering boundary of Umatilla National Forest, *Wm. Gruezo WM11485* (ALTA!, WGRZ!); Umatilla Co., Hwy 244, c. 100 m W of Mile post 21, within the boundary zone between Umatilla National Forest & Wallowa-Whitman National Forest, *Wm. Gruezo WM11486* (ALTA!, WGRZ!).

Grant Co., Hwy 26, c. 300 m W of Mile post 76, E bank of creek near foot of bridge, *Wm. Gruezo* ***WM11480*** (ALTA!, WGRZ!).

Utah: Wasatch Co., Wasatch National Forest, Wasatch Mts., Brighton town proper, vicinity of Brighton Bowl Ski area, *Wm. Gruezo* ***WM11442*** (ALTA 91411!, WGRZ!).

Wyoming: Albany Co., Medicine Bow National Forest, c. 4.5 mi NW of Centennial, on Hwy 130, *Wm. Gruezo* ***WM11315*** (ALTA 91408!, WGRZ!); Albany Co., Medicine Bow National Forest, Hwy 130, c. 250 m E of Mile post 34, *Wm. Gruezo* ***WM11322*** (ALTA 92179!, WGRZ!).

Johnson Co., Big Horn Mts. National Forest, Hwy 16, Crazy Woman Campground, vicinity of Fisherman parking site, *Wm. Gruezo* ***WM11375*** (ALTA!, WGRZ!); Johnson Co., Big Horn Mts. National Forest, Hwy 16, 1 km W of Mile post 81, *Wm. Gruezo* ***WM11377*** (ALTA!, WGRZ!).

Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 120 m W of Mile post 66, *Wm. Gruezo* ***WM11381*** (ALTA 91409!, WGRZ!). Big Horn Co., Big Horn National Forest, Hwy 14, c. 1 km E of Camp Bethel & Prune Creek Campground, *Wm. Gruezo* ***WM11388*** (ALTA!, WGRZ!).

Park Co., Shoshone National Forest, Hwy 14-16-20, c. 2 mi from Yellowstone National Park gate entrance, vicinity of Pahaska Tepee Tavern Motel, c. 500 m from Pahaska Campground, *Wm. Gruezo* ***WM11403*** (ALTA 91410!, WGRZ!).

Canada, Alberta: Hwy 40, c. 40 km SE of Hinton, vicinity of Luscar Creek, *Wm. Gruezo* ***WM11494*** (ALTA 91414!, WGRZ!).

Hwy 940 (= Forestry Trunk Road), c. 1 km S of Cadomin proper, *Wm. Gruezo* ***WM11495*** (ALTA 91415!, WGRZ!); Hwy 940 (= Forestry Trunk Road), c. 1 km S of Cadomin proper, cut-side of rough road adjacent to small slough, *Wm. Gruezo* ***WM11496*** (ALTA 91416!, WGRZ!);

Hwy 940 (= Forestry Trunk Road), c. 3 km S of Cadomin proper, *Wm. Gruezo* ***WM11497*** (ALTA 91417!, WGRZ!), *Wm. Gruezo* ***WM11498*** (ALTA 91418!, WGRZ!), *Wm. Gruezo* ***WM11499*** (ALTA 91419!, WGRZ!), *Wm. Gruezo* ***WM11500*** (ALTA 91420!, WGRZ!).

Mountain Park, on Hwy 940 (= Forestry Trunk Road), c. 2 km S of Cardinal River Recreational Area, *Wm. Gruezo* ***WM11532*** (ALTA 91432!, WGRZ!).

Waterton Lakes National park, vicinity of Cameron Lake, NW portion of lake inside Picea mariana forest, *Wm. Gruezo* ***WM11617*** (ALTA 91422!, WGRZ!).

British Columbia: Hwy 97, S of Fort Nelson, c. Mile post 250, *Wm. Gruezo* ***WM11267*** (ALTA 91406!, WGRZ!). Hwy 97, inside Buckinghorse Provincial Campground, far end of campground road c. 50 m from Buckinghorse River, *Wm. Gruezo* ***WM11268*** (ALTA!, WGRZ!).

John Hart Hwy (Hwy 97), c. 17.4 km N of Bear Lake proper or 1.6 km N of Red Rocky Creek, vicinity of Davie Lake, *Wm. & Aida Gruezo WM11281* (ALTA 91407!, WGRZ!). Cassiar Hwy (Hwy 37), c. 1 km from Natadesleen Lake, corner of access road to lake, *Wm. Gruezo WM11981* (ALTA 92119!, ALTA 92120!, WGRZ!); Cassiar Hwy (Hwy 37). c. 50 m S of Cranberry River Bridge, *Wm. & Aida Gruezo WM11982* (ALTA 92121!, ALTA 92122!, WGRZ!). Yellowhead Trail (Hwy 16), Moricetown proper, corner of highway & access road to town church or opposite Moricetown Canyon marker, *Wm. & Aida Gruezo WM11983* (ALTA 92124!, ALTA 92123!, WGRZ!);
Yellowhead Trail (Hwy 16), corner of highway & Loiseau Road, c. 22 km W of Houston, *Wm. Gruezo WM11986* (ALTA 92127!, ALTA 92128!, ALTA 92129!, WGRZ!);
Yellowhead Trail (Hwy 16), c. 17 km NW of Ross Lake or c. 41 km NW of Burns Lake, *Wm. & Aida Gruezo WM11987* (ALTA 92130!, ALTA 92131!, WGRZ!);
Yellowhead Trail (Hwy 16, Fraser Lake proper, c. 150 m before the Ministry of Highway & Public Works Maintenance yard, *Wm. & Aida Gruezo WM11988* (ALTA 92132!, ALTA 92133!, ALTA 92134!, WGRZ!);
Yellowhead Trail (Hwy 16), c. 21.2 km W of Prince George, intersection of Domano Blvd. & Yellowhead Trail, *Wm. & Aida Gruezo WM11989* (ALTA 92135!, ALTA 92136!, ALTA 92137!, WGRZ!).
Yukon: Johnsons Crossing, E bank of Teslin River, c. 50 m N of bridge base, c. 5 m from waterline, *Wm. Gruezo WM11153* (ALTA!, WGRZ!); Johnsons Crossing, along SE bank of Teslin River, intermittent mudflats near main posts of bridge at vicinity of boat launch, *Wm. & Aida Gruezo WM11972* (ALTA 92101!, ALTA 92102!, ALTA 92103!, ALTA 92104!, WGRZ!).
Alaska Hwy (Hwy 1), Kluane National Park, c. 100 m N of Km post 1636, c. 1 km from Haines Junction, *Wm. Gruezo WM11245* (ALTA!, WGRZ!); Alaska Hwy (Hwy 1), Km post 1633, on ridge near *Populus* forest, *Wm. Gruezo WM11250* (ALTA!, WGRZ!);
Alaska Hwy, Km post 1512, edge of *Populus* forest, *Wm. Gruezo WM11251* (ALTA!, WGRZ!); Klondike Hwy (Hwy 2), Km post 218.5, north of Carmacks, *Wm. Gruezo WM11253* (ALTA!, WGRZ!), *Wm. Gruezo WM11254* (ALTA!, WGRZ!); Klondike Hwy (Hwy 2), c. 200 m S of Km post 228 just behind the Lake Laberge signboard or c. 2 km N of Lake Laberge & c. 40 m from Fox Creek, *Wm. Gruezo WM11257* (ALTA!, WGRZ!).
Nahanni Range Road (Hwy 10), c. 89 km S of Tungsten (= Cantung) & c. 1 km before Km post 102, *Wm. & Aida Gruezo WM11788* (ALTA 91850!, ALTA 91851!, ALTA 91852!, WGRZ!). Klondike Hwy (Hwy 2), c. 1.6 km S of Km post 460 & c. 4.6 km S of Pelly Crossing, *Wm. & Aida Gruezo WM11822* (ALTA 91890!, WGRZ!).

Alaska Hwy (Hwy 1), c. 1.5 km W of Km post 1390 or c. 3 km S of Beaver Creek, ***Wm. & Aida Gruezo WM11953*** (ALTA 92068!, ALTA 92069!, WGRZ!); Alaska Hwy (Hwy 1), c. 1 km N of Haines Junction proper & 0.5 km S of Kluane National Park Wardens Office, ***Wm. & Aida Gruezo WM11961*** (ALTA 92077!, ALTA 92078!, WGRZ!).
Haines Road (Hwy 3), c. 2 km from Haines Junction en route to Dezadeash, ***Wm. & Aida Gruezo WM11963*** (ALTA 92080!, ALTA 92081!, WGRZ!); Haines Road (Hwy 3), c. 0.5 km S of Km post 240, right side of road en route to Dezadeash, ***Wm. & Aida Gruezo WM11964*** (ALTA 92082!, ALTA 92083!, WGRZ!);
Haines Road (Hwy 3), c. 20 m before Dezadeash Lodge, right side of road en route to Haines, ***Wm. & Aida Gruezo WM11965*** (ALTA 92084!, ALTA 92085!, WGRZ!); Haines Road (Hwy 3), c. 0.6 km S of Km post 222, right side of road en route to Haines Junction, ***Wm. & Aida Gruezo WM11967*** (ALTA 92087!, ALTA 92088!, ALTA 92089!, WGRZ!);
Haines Road (Hwy 3), c. 1.3 km S of Km post 224, both sides of road, ***Wm. & Aida Gruezo WM11968*** (ALTA 92090!, ALTA 92091!, ALTA 92092!, WGRZ!); Haines Road (Hwy 3), vicinity of Km post 230, c. 50 m before Kathleen Lake Lodge and Chevron Gas Station, right side of road en route to Haines Junction, ***Wm. & Aida Gruezo WM11970*** (ALTA 92093!, ALTA 92094!, ALTA 92095!, ALTA 92096!, WGRZ!);
Alaska Hwy (Hwy 1), c. 150 m E of Km post 1590 (between Haines Junction & Whitehorse), ***Wm. & Aida Gruezo WM11971*** (ALTA 92097!, ALTA 92098!, ALTA 92099!, ALTA 92100!, WGRZ!); Alaska Hwy (Hwy 1), c. 7.5 km NW of Teslin proper, vicinity of Mile post 813, inside the compound of Teslin Lake Campground, c. 5 m from shore of lake, ***Wm. & Aida Gruezo WM11973*** (ALTA 92105!, ALTA 92106!, ALTA 92107!, WGRZ!);
Alaska Hwy (Hwy 1), c. 1.2 km E of Km post 1130, W of Rancheria, right side of road en route to Watson Lake, ***Wm. & Aida Gruezo WM11977*** (ALTA 92110!, ALTA 92111!, ALTA 92112!, WGRZ!); Alaska Hwy (Hwy 1), vicinity of Km post 1082, E of Little Rancheria Creek, ***Wm. & Aida Gruezo WM11980*** (ALTA 92116!, ALTA 92117!, ALTA 92118!, WGRZ!).

U.S.A., Alaska: Seward proper, inside the compound of Heroes Cemetery, adjacent to Free Mason Cemetery & across Peninsula Ford dealer, ***Wm. & Aida Gruezo WM11927*** (ALTA!, WGRZ!).

Canada, Yukon: Klondike Highway (Hwy 2), Km post 218.5, north of Carmacks, on sandy shallow roadside depression, ***William Sm. Gruezo WM11254*** (ALTA!, WGRZ!).

A. lanceolata subsp. *amplexicaulis* 57

U.S.A., Alaska: Glenn Hwy (Hwy 1 SE), Turnagain Arm area, vicinity of Mile post 93.8, left side of road en route to Girdwood, *Wm. & Aida Gruezo WM11917* (ALTA 91986!, ALTA 91987!, ALTA 91988!, WGRZ!); Hwy 1, c. 4 km SE of Girdwood, right side of road en route to Girdwood, *Wm. & Aida Gruezo WM11944* (ALTA 92052!, ALTA 92053!, ALTA 92054!, ALTA 92057!, WGRZ!).

Nevada: Elko Co., Humboldt National Forest, Ruby Mts., Lamoille Township, c. 3.9 km E of road corner near Presbyterian Church, *Wm. Gruezo WM11448* (ALTA 91371!, WGRZ!); Elko Co., Humboldt National Forest, Ruby Mts., vicinity of Thomas Canyon Campground, near creek bridge, S bank of Lamoille Creek, *Wm. Gruezo WM11460* (ALTA 91372!, WGRZ!);

Elko Co., Humboldt National Forest, Ruby Mts., Camp Lamoille, c. 2 km from main road, around bridge of Lamoille Creek, *Wm. Gruezo WM11462* (ALTA 91374!, WGRZ!); Elko Co., Humboldt National Forest, Ruby Mts., Lamoille Canyon Campground Power House Picnic Area, near bridge on main road, *Wm. Gruezo WM11463* (ALTA 91373!, WGRZ!), *Wm. Gruezo WM11465* (ALTA 91375!, WGRZ!).

Canada, Alberta: Waterton Lakes National Park, vicinity of Cameron Falls, left side of cement railings, *Wm. Gruezo WM11603* (ALTA 91376!, WGRZ!); Waterton Lakes National Park, vicinity of Cameron Falls, right side of waterfalls on steep ledge near iron-railings, *Wm. Gruezo WM11604* (ALTA 91377!, WGRZ!);

Waterton Lakes National Park, vicinity of Cameron Lake, NW portion of lake, *Wm. Gruezo WM11616* (ALTA 91378!, WGRZ!). Waterton Lakes National Park, vicinity of Lower Bertha Falls, c. 5 m from waterfalls & with clumps c. 5 m from log bridge, *Wm. Gruezo 11669* (ALTA 91728!, WGRZ!); Waterton Lakes National Park, vicinity of Cameron Lake, NW of lake c. 300 m from parking area inside spruce (*Picea mariana*) forest, *Wm. Gruezo WM11673* (ALTA 91732!, WGRZ!);

Waterton Lakes National Park, vicinity of Cameron Lake, NW of lake, along Cameron Lake Footpath c. 0.5 km from parking area, *Wm. Gruezo WM11674* (ALTA 91733!, WGRZ!); Waterton Lakes National Park, vicinity of Cameron lake, NW of lake, along Cameron Lake Footpath, c. 0.55 km from parking area, c. 0.5 km from waterline, *Wm. Gruezo WM11675* (ALTA 91734!, WGRZ!).

ARNICA PARRYI A. GRAY

Only 8 populations of *A. parryi* A. Gray were found during the 2 seasons of field studies. All of these yielded chromosome count of 2n = 76 (tetraploid). These counts coupled with the general result of pollen viability tests involving 124 herbarium specimens (*vide supra*) strengthened the earlier conclusion that *A. parryi* A. Gray is largely polyploid and apomictic with apparently few diploid populations. The only diploid chromosome count for this taxon was by Reveal & Styer (1973) from Nye County, Nevada (see Table 5 for exact locality).

ARNICA OVATA GREENE

Twenty-seven (27) of 29 chromosome counts determined for this species were all 2n = 57 (triploid). The two other counts were both tetraploid (2n = 76), one from a population in the Medicine Bow National Forest, Carbon County, Wyoming and the other from northwest shore of Lake Bertha, Waterton Lakes National Park, Alberta. Thus far, the latter count was the second tetraploid report from this area, the first one being that of Wolf (1980) from a population in Goat Lake. Outside of the glaciated zone, Straley (1979) reported a tetraploid count from the Alpine Meadows Ski Area, Placer County, California.

Arnica ovata Greene is often confused with *A. latifolia* Bong. of subgenus *Austromontana*. The latter taxon has been frequently implicated to be one of the putative parents of *A. ovata* Greene (Cronquist 1955, Welsh *et al.* 1987). In a few instances, *A. ovata* Greene also resembles *A. gracilis* Rydb. (subgenus *Austromontana*), *i.e.* material from the Rocky Mountains of Alberta and determined as such by Wolf (*in sched.*, in ALTA). *Arnica ovata* Greene is certainly a unique low series polyploid-apomictic complex whose resemblance to either of the 2 species mentioned above was likely conserved through the immediate development of apomixis at a much earlier phase of its evolutionary history.

ARNICA LONGIFOLIA D.C. EATON

All 17 chromosome counts for *A. longifolia* D.C. Eaton were 2n = 76, thus confirming previous reports (*e.g.* Ornduff *et al.* 1967, Wolf 1987). Barker (1966) studied 3 collections of living plants and found that chromosome number varied widely in many cells. Due to this, he was not able to obtain an accurate count but since he observed that numbers were generally higher than n = 19, he considered them to be polyploid and apomictic. Current result confirms this general trend; however, pollen fertility tests (*vide supra*) indicate the existence of amphimictic populations in few remote sites in the boundary regions of southwestern Montana, central-south Idaho, western Wyoming and northern Utah.

ARNICA MOLLIS HOOK.

Arnica mollis Hook. is one of the recognized mature polyploid complexes in genus Arnica, with a cytological pattern similar to that of *A. cordifolia* Hook. of subgenus *Austromontana* (Wolf 1980, 1987). Moreover, it is the only taxon within the genus to exhibit high cytological diversity, with ploidy levels from diploid (2 = 38) to octoploid (2n = 152)[Ornduff *et al.* 1967, Kiel & Pinkava 1976, Kovanda 1978, Wolf 1980 & 1987).

Fifty-five (55) tetraploid and 1 triploid counts were determined for *A. mollis* Hook. The triploid count was from Elko County, Nevada (along loop road at trail head of Lamoille Canyons, Ruby Mountains, Humboldt National Forest). The cytogeography of known mature polyploid complexes in genus *Arnica* is such that tetraploids are widely distributed throughout the range with triploids nearly restricted to the front ranges of the Rocky Mountains and diploids if known, are scarce (Wolf 1980 & 1987) and confined to unglaciated sites or geologically known nunataks or refugia. This sort of pattern is partly confirmed with respect to the widespread occurrence of the tetraploid segment of this complex (Table 8).

Apparently, the first report a of diploid count for *A. mollis* Hook. was by Ornduff *et al.* (1967) from Jackson County, Colorado as alluded to by Kovanda (1978). The latter worker also reported a diploid count from the same general region. In connection with the first report, there was evidently an entry error in the table (Ornduff *et al.* 1967, Table 1). An examination of the voucher specimen for this particular count [Colorado, Jackson Co., 9 mi E of Gould, 19 July 1963, *T. Mosquin & J.M. Gillett 5345* (UC M 287589!), determined by R. Ornduff & T.F. Niehaus 1965, *in sched.*] showed that it was labeled by T. Mosquin as "n = *ca.* 38 (about 25II + sticky chains + some univalents". This clearly indicates that the count was tetraploid. In addition, 2 tetraploid counts in the same paper (Ornduff *et al.* 1967) under *A. mollis* Hook. should be transferred to *A. ovata* Greene. There is no doubt that identification of material was erroneous. The respective cytological voucher specimens are: 1) *T. Mosquin 3353* (UC M 287590!) from Alberta [*c.* 10 mi N of Jasper, rocky hillside at margin of *Sphagnum* bog, 22 July 1959, det. by R. Ornduff & T.F. Niehaus, 1965 (*in sched.*) as *A. mollis* Hook.], and 2) *T. Mosquin & J.M. Gillett 5406* (UC M 287591!) from San Miguel County, Colorado [*c.* 1 mi W of Red Mountain Pass, large colonies on alpine NE slope, 11800 ft, 20 July 1963, det. by T. Mosquin (*in sched.*) as *A. mollis* Hook.].

Another report of a tetraploid count was by Strother (1972) from Trinity County, California (Trinity Alps). His close cytological analysis of this population revealed the occurrence of rings of 4 in many cells at metaphase I. This led him to consider that this particular population was probably an autotetraploid. Additionally, he observed that stainability of regular-sized pollen grains was 47% and there was a high frequency of micrograins.

ARNICA CHAMISSONIS LESS.

Arnica chamissonis Less. is the most widely distributed member of subgenus *Chamissonis* with a longitudinal spectrum from the Aleutian Islands, Alaska to the mouth of the Eastmain River, Québec and latitudinally, from Anvik River, Alaska to the high mountain pass between McNary and Eagar, Arizona (Fig.2). However, only 3 ploidy levels are present in this complex, 2n = 38, 57 & 76 (Ornduff *et al.* 1963 & 1967, Barker 1966 & 1967, Kiel & Pinkava 1976, Straley 1979, Wolf 1980 & 1987, Löve & Löve 1982, Packer 1983), with the triploid being the most common throughout its geographical range. Diploid races are rather rare and limited only to a few localities normally outside the limits of glaciation.

Two diploid counts are reported here. One of these was from Klamath County, Oregon while the other was from the delta region of the ice-free corridor of the Rocky Mountains on the border of Alberta and Montana (see Table 8 for exact locality). Two tetraploid counts are also recorded in this study, one each from Alaska and Yukon. Both collections represent the rather low, extremely robust, leafy and fairly tomentose form of *A. chamissonis* Less. which Maguire (1943) doubtfully referred to *A. chamissonis* Less. subsp. *incana* (A. Gray) Maguire. Incidentally, the first report of a tetraploid count was by Wolf (1987) who accounted for the triploid chromosome race in this species as an outcome of hybridization between diploid and tetraploid races.

The other 55 chromosome counts for *A. chamissonis* Less. were all 2n = 57 (triploid), thus corroborating the previous observation that this taxon is a predominantly triploid-apomictic complex. Maguire (1943) commented on the remarkable confluent polymorphism existing in this complex. This degree of polymorphism within the complex is however barely correlated to intraspecific differences in chromosome number. It is, as shown by the results of greenhouse studies, more ecotypic in nature. Any extreme character state that was present in natural populations was gradually diminished under uniform greenhouse conditions.

ARNICA LANCEOLATA NUTT. SUBSP. AMPLEXICAULIS (NUTT.) GRUEZO

Previous chromosome record for this taxon showed only 3 ploidy levels, 2n = 38, 57 & 76 (Barker 1966 & 1967, Ornduff *et al.* 1967, Taylor & Mulligan 1968, Strother 1972, Straley 1979, Wolf 1980, Packer 1983). In the present investigation, triploid counts were obtained from 14 populations originating from coastal Alaska, southern Alberta to as far as northeastern Nevada (Table 8). Using mainly pollen viability data, Barker (1966) inferred that sexual populations of this complex occur on Vancouver Island, British Columbia through the Olympic Peninsula, Washington southward to Tillamook County and in the Columbia

River Gorge of Oregon. Outside of this region, he postulated the prevalence of polyploid and apomictic populations. The present result strongly supports this conclusion.

Strother (1972) reported a triploid count for a population from Trinity Alps, Trinity County, California. At the same time, he observed the occurrence of meiotic irregularities in this taxon, such as the presence of univalents, bivalents and trivalents at late diakenesis. He noted also that pollen stainability was only *ca.* 3% and pollen grains were irregular in size and shape.

A previous chromosome report by Ornduff *et al.* (1963) of n = *ca.* 33-34 for this taxon should be transferred to *A. latifolia* Bong. The collection from which this count was obtained [Oregon, Clackamas Co., plants growing in cold stream among shrubs at the Lookout Springs Guard Station, R6E T4S Sec.16, 19 June 1960, *R. Ornduff 6243* (UC M 169372!)] was erroneously determined as *A. amplexicaulis* Nutt.

ARNICA LANCEOLATA NUTT. SUBSP. LANCEOLATA

As no field studies were conducted in eastern North America where *A. lanceolata* Nutt. subsp. *lanceolata* occurs and no viable seeds were obtained from prospective botanic gardens, discussion of chromosome number in this geographic subspecies is based purely on previous reports. To date, there are only 4 chromosome number reports for this taxon (Löve & Löve 1964 & 1966, Morton 1981, Wolf 1987), all of which were 2n = 76 (tetraploid). Pollen fertility tests on many herbarium specimens (*vide supra*) showed that there is a complete breakdown in the pollen production mechanism in all populations of this taxon. It is therefore quite certain that this disjunct segment of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo is entirely polyploid and apomictic. The inability of extant plants to produce viable pollen grains suggests that they are allotetraploid. More significant, is the fact that polyploidy in this taxon must have evolved prior to Pleistocene glaciations when diploid populations were contiguous to one another. Subsequently, separation due to glaciations and survival in a seemingly harsh environment led to considerable biotype depletion. Present-day populations clearly show the imprint of this phenomenon by their inability to produce viable pollen grains.

Summary:

Overall consideration of the cytological pattern in the seven taxa of subgenus *Chamissonis* shows conclusively that: 1) *A. lanceolata* Nutt. subsp. *lanceolata* and *A. ovata* Greene are both wholly polyploid and apomictic with no extant diploid members. 2) *A. mollis* Hook. exhibits the most complex cytological pattern not only in subgenus *Chamissonis* but in the entire genus. In general, its cytological pattern is identical to the other known mature polyploid complexes - *A. cordifolia* Hook. (subgenus *Austromontana*) and *A. angustifolia* J.M. Vahl (subgenus *Arctica*) [Wolf 1987]. This mature polyploid complex consists of abundant and broadly distributed tetraploids, triploids that are mostly confined to the front ranges of the Rocky Mountains and diploids that are extremely rare and strictly found in ice-free areas and/or refugia. Furthermore, higher ploidy levels in these mature polyploid complexes are best developed in the Colorado-Wyoming region (Wolf 1980, 1987). 3) *A. chamissonis* Less., *A. longifolia* D.C. Eaton, *A. parryi* A. Gray and *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, each represents a widespread polyploid-apomictic complex with a limited number of extant diploids. The latter fraction of the complex is confined to the unglaciated areas south of the maximum limits of glaciations or in geologically known refugial sites. Due to biotype depletion, very little expansion to newly vacated habitats was accomplished by these survivor populations. In contrast, the massive recolonization of nearly all available grounds was attained by the superiorly adapted polyploid segment.

D. Flavonoid Chemistry

One hundred and forty-three (143) populations representing 6 of 7 taxa in subgenus *Chamissonis* were surveyed for their foliar flavonoids (Table 9 & 10). Eighteen (18) flavonoids were isolated, characterized and identified: 6 flavonol and 6 flavone glycosides, 2 methylated and 4 free aglycones. Spectral, chromatographic and Rf data for these compounds

Table 9. Foliar flavonoid distribution in *Arnica* subgenus *Chamissonis*. Locality abbreviations defined in Table 2.

Taxon, Locality & Voucher	Flavonoid compounds* 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A. chamissonis Less. (N=75)															
AB-WM11153	+	+	+	+	+	+	+		+				+	+	+
AB-WM11492	+	+	+	+	+	+							+	+	+
AB-WM11494	+	+	+	+	+	+	+			+	+		+	+	+
AB-WM11495	+	+	+	+	+	+	+						+	+	+
AB-WM11497	+	+	+	+	+	+	+			+			+	+	+
AB-WM11498	+	+	+	+	+	+	+			+			+	+	+
AB-WM11499	+	+	+	+	+	+							+	+	+
AB-WM11532	+	+	+	+	+	+							+	+	+
AB-WM11533	+	+	+	+	+	+	+		+		+		+	+	+
AB-WM11600	+	+	+	+	+	+							+	+	+
AB-WM11723	+	+	+	+	+	+			+				+	+	+
AB-SRD542	+	+	+	+	+	+	+		+		+		+	+	+
AB-SRD733	+	+	+	+	+	+					+		+	+	+
AK-WM11881	+	+	+	+	+	+				+	+		+	+	+
AK-WM11883	+	+	+	+	+	+	+		+		+		+	+	+
AK-WM11914	+	+	+	+	+	+				+	+		+	+	+
AK-WM11915	+	+	+	+	+	+	+						+	+	+
AK-WM11916	+	+	+	+	+	+	+				+		+	+	+
AK-WM11919	+	+	+	+	+	+	+						+	+	+
AK-WM11920	+	+	+	+	+	+				+	+		+	+	+
AK-WM11921	+	+	+	+	+	+	+		+		+		+	+	+
AK-WM11922	+	+	+	+	+	+	+			+	+		+	+	+
AK-WM11923	+	+	+	+	+	+							+	+	+
AK-WM11925	+	+	+	+	+	+	+			+			+	+	+
AK-WM11928	+	+	+	+	+	+							+	+	+
AK-WM11932	+	+	+	+	+	+							+	+	+
AK-WM11934	+	+	+	+	+	+	+		+	+	+		+	+	+
AK-WM11935	+	+	+	+	+	+	+		+	+			+	+	+
AK-WM11936	+	+	+	+	+	+				+			+	+	+
AK-WM11937	+	+	+	+	+	+				+	+		+	+	+
AK-WM11939	+	+	+	+	+	+				+	+		+	+	+
AK-WM11940	+	+	+	+	+	+				+			+	+	+
AK-WM11941	+	+	+	+	+	+		+		+	+		+	+	+
BC-WM11281	+	+	+	+	+	+				+			+	+	+
BC-WM11981	+	+	+	+	+	+	+	+		+	+			+	+
BC-WM11982	+	+	+	+	+	+					+		+	+	+
BC-WM11986	+	+	+	+	+	+	+	+	+	+	+		+	+	+
BC-WM11987	+	+	+	+	+	+	+	+	+		+			+	+
BC-WM11988	+	+	+	+	+	+					+		+	+	+
BC-WM11989	+	+	+	+	+	+	+	+		+	+		+	+	+
ID-WM11424	+	+	+	+	+	+				+			+	+	+
MT-WM11678	+	+	+	+	+	+							+	+	+
MT-WM11679	+	+	+	+	+	+	+	+			+		+	+	+

Taxon, Locality and Voucher	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MT-WM11680	+	+	+	+	+	+							+	+	+
MT-WM11683	+	+	+	+	+	+							+	+	+
MT-WM12001	+	+	+	+	+	+				+			+	+	+
NWT-WM11795	+	+	+	+	+	+		+		+			+	+	+
OR-WM11469	+	+	+	+	+	+				+			+	+	+
OR-WM11479	+	+	+	+	+	+			+				+	+	+
OR-WM11480	+	+	+	+	+	+	+			+	+		+	+	+
OR-WM11485	+	+	+	+	+	+							+	+	+
OR-WM11486	+	+	+	+	+	+		+		+	+		+	+	+
UT-WM11442	+	+	+	+	+	+	+			+			+	+	+
WY-WM11315	+	+	+	+	+	+		+		+	+		+	+	+
WY-WM11375	+	+	+	+	+	+							+	+	+
WY-WM11381	+	+	+	+	+	+							+	+	+
WY-WM11388	+	+	+	+	+	+							+	+	+
WY-WM11403	+	+	+	+	+	+							+	+	+
YT-WM11245	+	+	+	+	+	+	+						+	+	+
YT-WM11250	+	+	+	+	+	+	+		+	+			+	+	+
YT-WM11252	+	+	+	+	+	+	+			+			+	+	+
YT-WM11253	+	+	+	+	+	+				+			+	+	+
YT-WM11257	+	+	+	+	+	+	+	+	+	+	+		+	+	+
YT-WM11774	+	+	+	+	+	+		+		+	+		+	+	+
YT-WM11822	+	+	+	+	+	+	+			+			+	+	+
YT-WM11953	+	+	+	+	+	+		+		+	+		+	+	+
YT-WM11961	+	+	+	+	+	+		+		+			+	+	+
YT-WM11963	+	+	+	+	+	+		+		+	+		+	+	+
YT-WM11964	+	+	+	+	+	+	+	+	+	+	+		+	+	+
YT-WM11965	+	+	+	+	+	+	+			+			+	+	+
YT-WM11967	+	+	+	+	+	+	+	+		+	+		+	+	+
YT-WM11970	+	+	+	+	+	+	+		+		+		+	+	+
YT-WM11973	+	+	+	+	+	+		+	+	+	+		+	+	+
YT-WM11977	+	+	+	+	+	+	+	+	+	+	+		+	+	+
YT-WM11980	+	+	+	+	+	+				+	+		+	+	+
A. longifolia D.C. Eaton (N=11)															
AB-WM11666	+	+	+	+	+	+							+	+	+
ID-WM11432	+	+	+	+	+	+			+	+	+		+	+	+
ID-WM11435	+	+	+	+	+				+	+	+		+	+	+
OR-WM11471	+	+	+	+	+	+			+	+	+		+	+	+
OR-WM11475	+	+	+	+	+	+				+			+	+	+
WY-WM11373	+	+	+	+	+	+		+	+	+			+	+	+
WY-WM11385	+	+	+	+	+	+		+	+	+			+	+	+
WY-WM11395	+	+	+	+	+	+				+	+		+	+	+
WY-WM11396	+	+	+	+	+	+			+	+	+		+	+	+
WY-WM11404	+	+	+	+	+	+				+			+	+	+
WY-WM11408	+	+	+	+	+					+	+		+	+	+

Taxon, Locality and Voucher	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A. parryi A. Gray (N=4)															
ID-WM11431	+	+	+	+	+	+							+	+	+
MT-WM11682	+	+	+	+	+	+			+	+	+		+	+	+
MT-WM12000	+	+	+	+	+	+				+			+		+
WY-WM11405	+	+	+	+	+	+							+		+
A. ovata Greene (N=11)															
AB-WM11536	+	+	+	+	+	+				+			+	+	+
AB-WM11538	+	+	+	+	+	+							+	+	+
AB-WM11558	+	+	+	+	+	+				+			+	+	+
AB-WM11571	+	+	+	+	+	+				+			+	+	+
AB-WM11579	+	+	+	+	+	+				+			+	+	+
AB-WM11584	+	+	+	+	+	+				+			+	+	+
AB-WM11586	+	+	+	+	+	+				+			+	+	+
AB-WM11588	+	+	+	+	+	+							+	+	+
AB-WM11591	+	+	+	+	+	+				+			+	+	+
AB-WM11593	+	+	+	+	+	+							+	+	+
WY-WM11349	+	+	+	+	+	+							+	+	+
A. lanceolata Nutt. ssp. *amplexicaulis* (Nutt.) Gruezo (N=12)															
AB-WM11616		+		+	+	+				+			+		+
AB-WM11667		+		+									+		+
AB-WM11669		+	+	+	+	+		+		+			+		+
AB-WM11673		+		+	+	+							+		+
AB-WM11675	+	+		+	+	+	+	+		+	+		+		+
AB-WM11677		+		+	+	+				+			+		+
AK-WM11917	+	+	+	+	+	+							+	+	+
AK-WM11944	+	+	+	+	+	+							+	+	+
NV-WM11448	+	+	+	+	+	+				+			+		+
NV-WM11460		+		+						+			+		+
NV-WM11463	+	+	+	+	+	+							+	+	+
NV-WM11465	+	+	+	+	+	+				+			+		+
A. mollis Hook. (N=30)															
AB-WM11537	+	+	+	+	+	+				+	+		+	+	+
AB-WM11539	+	+	+	+	+	+							+		+
AB-WM11541	+	+	+	+	+	+			+		+		+	+	+
AB-WM11549	+	+	+	+	+	+				+			+	+	+
AB-WM11551	+	+	+	+	+	+	+						+		+
AB-WM11569	+	+	+	+	+	+				+	+		+	+	+

Taxon, Locality and Voucher	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
AB-WM11570	+	+	+	+	+	+				+	+		+	+	+
AB-WM11572	+	+	+	+	+	+							+	+	+
AB-WM11575	+	+	+	+	+	+		+		+			+	+	+
AB-WM11578	+	+	+	+	+	+							+		+
AB-WM11581	+	+	+	+	+	+				+	+		+	+	+
AB-WM11582	+	+	+	+	+	+		+			+		+	+	+
AB-WM11598	+	+	+	+	+	+							+	+	+
AB-WM11605	+	+	+	+	+	+							+	+	+
BC-WM11590	+	+	+	+	+	+							+	+	+
WY-WM11343	+	+	+	+	+	+								+	+
WY-WM11350	+	+	+	+	+	+							+	+	+
WY-WM11359	+	+	+	+	+	+							+	+	+
WY-WM11360	+	+	+	+	+	+	+	+	+	+	+		+	+	+
WY-WM11361	+	+	+	+	+	+				+	+		+	+	+
WY-WM11368	+	+	+	+	+	+	+	+	+	+	+		+	+	+
WY-WM11369	+	+	+	+	+	+			+	+			+	+	+
WY-WM11371	+	+	+	+	+	+				+			+		+
WY-WM11378	+	+	+	+	+	+							+	+	+
WY-WM11382	+	+	+	+	+	+				+			+	+	+
WY-WM11384	+	+	+	+	+	+				+			+	+	
WY-WM11387	+	+	+	+	+	+				+			+	+	+
WY-WM11397	+	+	+	+	+	+							+	+	+

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*1. Quercetin 3, 7-O-diglucoside; 2. Quercetin 3'-Me, 3-O-diglucoside; 3. Apigenin 4', 6-Me, 7-O-rhamnoside; 4. Quercetin 3-Me, 3-O-glucoside; 5. Kaempferol 6-O-Me, 3-O-glucoside; 6. 4', 7-diOH flavone, 3-O-glucoside; 7. Luteolin 6-O-Me, 7-O-glucoside; 8. Quercetin 3-O-diglucoside; 9. Apigenin 4'-Me, 7-0-diglucoside; 10. Luteolin 7-0-glucoside; 11. Luteolin 3', 7-O-glucoside; 12. Kaempferol 3-O-glucoside; 13. Luteolin 6-OH, 4'-Me; 14. Luteolin 6-O-Me; 15. Free aglycones: Apigenin (15); Luteolin (16); and Kaempferol (17).

Table 10. Distribution of foliar flavonoids in 6 taxa of *Arnica* subgenu *Chamissonis*.

Compounds	Taxa					
	1 (75)*	2 (11)	3 (4)	4 (30)	5 (11)	6 (12)
1. Qu 3,7-O-diglu	75**	11	4	30	11	6
2. Qu 3'-Me, 3-O-diglu	75	11	4	30	11	12
3. Ap 4', 6-Me, 7-O-rham	75	11	4	29	11	6
4. Qu 6-Me, 3-O-glu	75	11	4	30	11	12
5. Km 6-O-Me, 3-O-glu	75	11	4	29	11	10
6. 4', 7-diOH flavone, 3-O-glu	75	9	4	28	11	10
7. Lu 6-O-Me, 7-O-glu	39			3		1
8. Qu 3-O-diglu	18	2		3		2
9. Ap 4'-Me, 7-O-diglu	17	6	1	4		
10. Lu 7-O-glu	42	10	2	16	7	7
11. Lu 3'-Me, 7-O-glu	35	2	1	9		1
12. Km 3-O-glu		2				
13. Lu 6-OH, 4'-Me	75	11	4	30	11	12
14. Lu 6-OMe	75	11	4	30	11	2
15. Apigenin	75	11	4	30	11	12
16. Luteolin	75	11	4	30	11	12
17. Kaempferol	75	11	4	30	11	12
18. Quercetin	75	11	4	30	11	12

* = Total number of populations surveyed.
** = Number of populations containing given compound.

1 = *Arnica chamissonis* Less.; 2 = *A. longifolia* D.C. Eaton; 3 = *A. parryi* A. Gray; 4 = *A. mollis* Hook; 5 = *A. ovata* Greene; 6 = *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo.

are provided in Table 11. A composite 2-dimensional chromatogram depicting the flavonoid profile for this subgenus is presented in Figure 8. Appendix 4 lists the locality information for collections used in this flavonoid survey.

Subgenus *Chamissonis* is moderately rich in foliar flavonoids compared with subgenera *Austromontana* (Wolf 1981) and *Arctica* (Downie 1987), each with a total of 26 and 12 flavonoids, respectively. Of 18 flavonoids, 12 are ubiquitously present in all 6 taxa investigated. These compounds were: Quercetin 3, 7-O-diglucoside; Quercetin 3'-Me, 3-O-diglucoside; Apigenin 4', 6-Me, 7-O-rhamnoside; Quercetin 6-Me, 3-O-glucoside; Kaempferol 6-O-Me, 3-O-glucoside, 4', 7-diOH flavone 3-O-glucoside; Luteolin 6-OH, 4'-Methyl ether; Apigenin, Luteolin, Kaempferol and Quercetin. This set of 12 compounds is often referred to in the succeeding discussion as 'basic flavonoid complement' of subgenus *Chamissonis*. The combination of these compounds chemically delimits subgenus *Chamissonis* and distinguishes it from the other 2 subgenera (*vide supra*) of *Arnica* with known flavonoid profiles. Infrasubgenerically, only a set of 6 additional compounds is of direct use in differentiating one taxon from the other and also in assessing possible phylogenetic linkage. These 6 compounds are referred to in the following discussion as 'diagnostic' compounds. Table 9 outlines the distribution pattern of flavonoids in the 6 taxa studied. From this table, it is evident that a minimal amount of infraspecific variability in flavonoid content is present in all taxa with minor correlation to geographic distribution. It is significant to note however that a number of *A. chamissonis* Less. populations that are now present in higher (once glaciated) latitudes, *e.g.* coastal region of Alaska, south-cental Yukon, northern British Columbia, exhibited full complement and/or generally high number of flavonoids. Unfortunately, this trend cannot be verified for the other taxa due to sample limitation.

Glucose is the most commonly linked sugar in glycosides of subgenus *Chamissonis* with rhamnose being detected only in one methylated flavone - Apigenin 4', 6-Me, 7-O-rhamnoside. The only other sugar reported for genus *Arnica* was galactose (Wolf 1981, Downie 1987) which was not detected in subgenus *Chamissonis*.

Table 11. Spectral, chromatographic and Rf data of foliar flavonoids in *Arnica* subgenus *Chamissonis*.

Flavonoids[3]	Spectral Data[1]: MeOH Band I	MeOH Band II	NaOMe Band I Band II	$AlCl_3$ Band I Band II	$AlCl_3$ & HCl Band I Band II	NaOAc Band I Band II	NaOAc & H_3BO_3 Band I Band II	Colors[2] at 350 nm: UV	$+NH_3$	+NA	Rf's X 100: BAW	HOAc	H_2O	PhOH
Qu 3,7-O-diglu (1)	355	259 270s	407 274	396 272	370 268	379 272	377 264	P	YG	O	32	30	67	30
Qu 3'-Me, 3-O-diglu (2)	356	259	404 275	357 299s 266	360 302s 267	380 330s 271	373 295s 264	P	Y	O	41	22	40	25
Ap 4',6-Me 7-O-rham (3)	328	300 243s 243s	372 311s 253	337 307s	331 301s 236	331 302s	349 307 254	B	Y	Y	45	15	58	87
Qu 6-Me, 3-O-glu (4)	357	268s 259	410 335 274	376 305s 273	369 305s 269	390 327s 273	379 264	P	YG	O	56	46	47	58
Km 6-O-Me, 3-O-glu (5)	337	270	396 327 276	349 308s 278	349 304s 280	382 305 273	349 269	P	YG	G	63	49	34	48
4',7-diOH flavone, 3-O-glu (6)	329	300s	371 311s	341 311s	330	333 302s	348 253	B	Y	Y	90	85	65	70
Lu 6-O-Me, 7-O-glu (7)	340	257 269s	401 271s	407 269	359 270	403 348s	360 263	P	Y	O	48	18	01	66

						265								
Qu 3-O-diglu (8)	359	257 266s	415 279	417 305s 268	395s 363 304s 269	390 272	374 261	P	Y	O	52	35	20	25
Ap 4'-Me, 7-O-diglu (9)	323	266	358 286 245s	382 345 300 277	380 339 298 276	325 269	328 269	P	P	O	58	27	46	39
Lu 7-O-glu (10)	350	254 268s	395 296s 265 265	436 331 298s 276	391 362 298s 275	408 362s 263s 259	372 258	P	Y	O	45	14	01	61
Lu 3'-Me,7-O-glu (11)	331	269	403 266	399s 358 274 262	399s 355 274s 258	407 270	339	P	Y	O	35	02	02	59
Km 3-O-glu (12)	345	269	399 327 279	410 360 295s 272	410 361 295s 274	377 299s 272	346 268	P	G	G	70	45	12	82
Lu 6-OH, 4'-Me (13)	337	285	370 286 245s	362 304 280s	354 302 284	398s 336 284	339 284	P	P	Y	89	06	-	97
Lu 6-O-Me (14)	340	256 268s	400 272s	409 272	360 271	403 267	361 260	P	G	O	84	04	-	86
Apigenin (15)	335	268 284s	386 346	384 345	380 342	380 272	337 269	P	YG	Y	89	10	-	86

			274	302 276	301 276									
Luteolin (15)	351	268 252 242s	400 324s 269s	431 325 295s 275	384 386 295s 275	385 387 267	426s 369 297s 259	P	Y	O	81	04	-	71
Kaempferol (15)	365	298s 268 259s	413 322 276	427 363 308s 272	427 357 307s 273	385 304 275	367 271	Y	Y	G	87	04	-	58
Quercetin[4]	370	300s 270s 257	323 -	451 304s 274	423 362 304s 268	396 330 275	387 301s 264	Y	Y	O	64	03	-	34

[1]Spectral data: MeOH data indicates maximum wavelength (nm) in 100% MeOH.
[2]Color key: P = Purple, Y = Yellow, G = Green, O = Orange, B = Blue (flourescent)
[3]Flavonoid compounds: Ap = Apigenin, Km = Kaempferol, Lu = Luteolin, Qu = Quercetin
Me = methoxyl, glu = glucose, diglu = diglucoside, rham = rhamnose.
[4]Present only as a by-product of hydrolysis of glycoside.

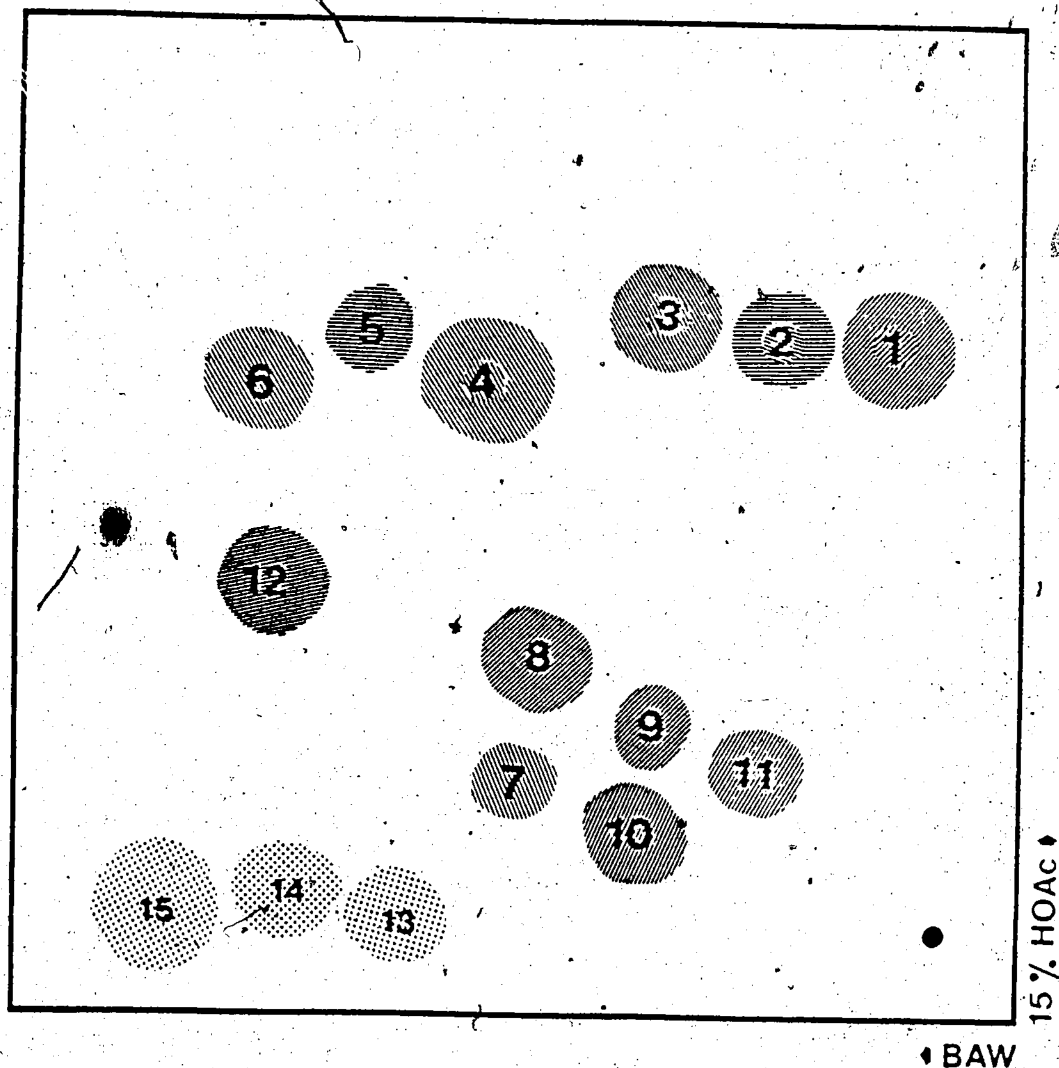

Figure 8. Composite 2-dimensional chromatogram of flavonoids of *Arnica* L. subgenus Chamissonis Maguire. 1. Quercetin 3, 7-O-diglucoside; 2. Quercetin 3'-Me, 3-O-diglucoside; 3. Apigenin 4', 6-Me, 7-O-rhamnoside; 4. Quercetin 3-Me, 3-O-glucoside; 5. Kaempferol 6-O-Me, 3-O-glucoside; 6. 4', 7-diOH flavone, 3-O-glucoside; 7. Luteolin 6-O-Me, 7-O-glucoside; 8. Quercetin 3-O-diglucoside; 9. Apigenin 4'-Me, 7-O-glucoside; 10. Luteolin 7-O-glucoside;11. Luteolin 3'-Me, 7-O-glucoside; 12. Kaempferol 3-O-glucoside; 13. Luteolin 6-OH, 4'-Me; 14. Luteolin 6-O-Me; 15. Free aglycones: Apigenin (15), Luteolin (16), and Kaempferol (17).

Comparison of flavonoid constituents of subgenera *Chamissonis*, *Austromontana*, and *Arctica* shows that 5 compounds were common to all: 1) Luteolin 6-O-Me, 7-O-glucoside; 2) Quercetin 3-O-diglucoside (viscosin); 3) Luteolin 7-O-glucoside; 4) Kaempferol 3-O-glucoside, and 5) Apigenin. Viscosin, a compound claimed by Wolf (1981) and Wolf & Denford (1984a) to be unique to subgenus *Austromontana* was also detected in subgenus *Chamissonis*. Downie (1987) isolated the same compound from members of subgenus *Arctica*. Eight (8) additional compounds are common only to subgenera *Chamissonis* and *Austromontana*. These were 2 flavonoid glycosides (Quercetin 6-O-Me, 3-O-glucoside and Kaempferol 6-O-Me, 3-O-glucoside), 2 methylated derivatives of the flavone Luteolin (Luteolin 6-OH, 4'-Me and Luteolin 6-O-Me) and the 4 most commonly occurring free aglycones in nature (Apigenin, Luteolin, Kaempferol and Quercetin). Of these free aglycones, only Apigenin was reported by Downie (1987) to be present in subgenus *Arctica*. Incidentally, all these free aglycones were consistently detected by Merfort *et al.* (1986) in their study of floral aglycones in subgenus *Chamissonis*. On the otherhand, only a single flavonol glycoside, Quercetin 3, 7-O-diglucoside, is exclusively common to subgenera *Chamissonis* and *Arctica* (Downie 1987).

ARNICA CHAMISSONIS LESS.

Seventeen (17) of 18 compounds isolated from subgenus *Chamissonis* were present in *A. chamissonis* Less. Of 6 diagnostic compounds, Kaempferol 3-O-glucoside was not detected in this species. Luteolin 7-O-glucoside was present in 42 populations while Luteolin 6-O-Me, 7-O-glucoside and Luteolin 3'-Me, 7-O-glucoside were present in 39 and 35 populations, respectively. Quercetin 3-O-diglucoside and Apigenin 4'-Me, 7-O-diglucoside were observed in nearly same number of populations (*c.* 18). *Arnica chamissonis* Less. is one of 2 species in this subgenus that possesses a fairly high number of flavonoids. This taxon has also the distinction of being the only species, thus far, which has nearly full complement of flavonoids (17 out of 18 total) in some populations currently inhabiting the coastal area of Alaska, south-central Yukon and northern British Columbia. Another significant feature in the flavonoid profile of this species was the absence of all diagnostic compounds in 15 populations. Except for 3 populations from the Alaskan coast, all were from lower latitudes, *i.e.* from southern Alberta (4 populations), Montana (3), Wyoming (4) and Oregon (1) (Table 9). During the Pleistocene glaciations, these stations were formerly at glacial margins and beyond it, respectively. Segregation of 75 populations surveyed according to present/absent criterion of 1, 2 or more (and combination thereof) of 6 diagnostic compounds resulted to a maximum array of 21 profile types. This outcome may be a good measure of the amount of interpopulational variation in flavonoid composition of this species. Consequently, this level of flavonoid variation does not support cleavage of this complex into 2 or more species nor does it support recognition of taxa below the species level as proposed and accepted by a number of previous authors (Nuttall 1841, Herder 1867, Gray 1874, Maguire 1943, Cronquist 1955, Ediger & Barkley 1978, Douglas 1982, *etc.*).

ARNICA LONGIFOLIA D.C. EATON

A total of 17 compounds were isolated from 11 populations of *Arnica longifolia* D.C. Eaton (Table 10). Among the 6 diagnostic compounds, Kaempferol 3-O-glucoside was solely found in 2 populations of this species. The same flavonoid was found by Downie (1987) as one of 2 compounds unique to *A. rydbergii* Greene. The phylogenetic significance of this compound being common to these 2 species is rather difficult to determine. However, it should be noted that both species usually inhabit exposed subalpine scree slopes and similar well-drained rocky outcrops. Morphologically, these taxa have narrow, long-lanceolate largely entire leaves and narrow turbinate heads.

Another feature in the flavonoid profile of *A. longifolia* D.C. Eaton was the rare occurrence of Quercetin 3-O-diglucoside, a compound that appears to be gradually phased-out among members of subgenus *Chamissonis* (see Table 10). Another compound that seems to be rare in *A. longifolia* D.C. Eaton was Luteolin 3'-Me, 7-O-glucoside which, as shown earlier, was rather common in many populations of *A. chamissonis* Less. Only

Luteolin 7-O-glucoside was evidently common in many populations surveyed for this particular taxon.

ARNICA PARRYI A. GRAY

Only 4 populations of *A. parryi* A. Gray were examined for their flavonoid profile. Fifteen (15) compounds were detected of which 12 were basic flavonoid complements of subgenus *Chamissonis* (Table 10). This species is poor in diagnostic compounds. Only 3 were present in a single population from Montana: Apigenin 4'-Me, 7-O-glucoside, Luteolin 7-O-glucoside and Luteolin 3'-Me, 7-O-glucoside. A single population from the same general locality exhibited only Luteolin 7-O-glucoside. It seems that *A. parryi* A. Gray is one member of subgenus *Chamissonis* that conservatively retains the basic flavonoid profile of this complex. This implies that less chemical evolution had occurred within this taxon possibly due to limited natural hybridization. This intrinsic limitation may be partly attributable to the discoid floral condition of the more wide-ranging populations of *A. parryi* A. Gray. The discoid (rayless) state of this taxon is here interpreted as a direct evolutionary disadvantage, *viz.* the absence of ligules deprived the plants of a visual means of attracting prospective insect pollinators. Incidentally, Merfort *et al.* (1986) recorded a relatively higher number of floral aglycones (total of 17) for this taxon. However, it should be noted that the material they used for this study was the rare ligulate form of this species and previously referred to as *A. parryi* A. Gray subsp. *sonnei* (Greene) Maguire.

ARNICA OVATA GREENE

Eleven (11) populations of *A. ovata* Greene exhibited a total of 13 flavonoids (Table 10). As in the case of the other species, 12 of these compounds were basic flavonoid complements thus indicating that only one diagnostic compound was elaborated by *A. ovata* Greene. This compound was Luteolin 7-O-glucoside which was detected in 7 populations. A comparison of flavonoid profiles of *A. ovata* Greene, *A. latifolia* Bong. and *A. cordifolia*

Hook. (the latter two species belong to subgenus *Austromontana*) shows that except for the ubiquitous free aglycone Kaempferol, *A. ovata* Greene has no compounds in common with *A. latifolia* Bong. On the otherhand, only one compound, Luteolin 7-O-glucoside, was common to *A. ovata* Greene and *A. cordifolia* Hook. Based on this comparison and the relatively depauperate flavonoid profile of *A. ovata* Greene, the hypothesis of earlier workers (*e.g.* Cronquist, 1955, Welsh *et al.* 1987, *etc.*) that *A. ovata* Greene is a hybrid species with either *A. latifolia* Bong. or *A. cordifolia* Hook. as one of the putative parents is rejected. The present finding conclusively supports the alternative hypothesis earlier presented in this study (*vide supra*) that *A. ovata* Greene is a relatively more primitive taxon that possibly arose at about the same time as that of *A. latifolia* Bong. and *A. cordifolia* Hook. A rather rapid evolution of polyploidy and attendant apomixis in this taxon preserved its morphology that resembles in many aspects those of *A. latifolia* Bong., *A. cordifolia* Hook., and to a lesser extent, certain populations of *A. gracilis* Rydb. as pointed out earlier (*vide supra*). Simultaneous with this event of course, was the retention only of a generally basic flavonoid profile characteristically true for all the members of subgenus *Chamissonis*.

ARNICA LANCEOLATA NUTT. SUBSP. *AMPLEXICAULIS* (NUTT.) GRUEZO

Sixteen (16) flavonoids were isolated from 12 populations of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo. The same 12 basic flavonoids were present in this taxon. However, a number of them were absent in some populations (Table 9). For instance, Quercetin 3, 7-O-diglucoside and Apigenin 4', 6-Me, 7-O-rhamnoside were absent in 6 populations: 5 from southern Alberta and 1 from northeastern Nevada. Other basic compounds absent in a few populations were Kaempferol 6-Me, 3-O-glucoside and 4', 7-diOH flavone, 3-O-glucoside from 2 populations. One remarkable feature in the flavonoid profile of this taxon was the absence of Luteolin 6-O-Me from 75% of populations analyzed. In addition, only 4 of 6 diagnostic compounds were detected, 3 of these were extremely rare in occurrence. These rare compounds were Luteolin 6-O-Me, 7-O-glucoside and Luteolin 3'-Me, 7-O-glucoside, both were found only in a single population from southern Alberta. The third one was Quercetin 3-O-glucoside isolated from only 2 populations similarly found in southern Alberta. Only Luteolin 7-O-glucoside was detected in more than 50% of populations surveyed (Table 10). The absence of 5 basic compounds and rarity of some diagnostic flavonoids in a number of populations indicate that in this taxon a rather different ecological setting might have influenced flavonoid development in some stage of its evolutionary history. It should be noted that amongst *Arnica* species, only this taxon with its 2 subspecies can be strictly classed as hydric elements. The role of water during and after Pleistocene glaciation is in itself a controversial topic amongst biologists and geoscientists especially concerned with survival of biota during this Ice Age. It can be surmissed though that both positive and negative influences were probably simultaneously operational during most of those times thus leaving only a very narrow margin for biota to survive. In the case of *A. lanceolata* Nutt., the water might have speeded up ploidization in populations trapped within or adjacent to the glaciated zones. Additionally, water served as passive agent of seed (achene) dispersal for those already apomictic populations, hence the species were able to attain only a very narrow and localized distribution range, such as what happened profoundly to the disjunct subspecies, *A. lanceolata* Nutt. subsp. *lanceolata* in eastern North America. Beyond the glacial margins, the role of water in the survival of biota might altogether be different or simply not unusual.

ARNICA MOLLIS HOOK.

Thirty (30) populations of *A. mollis* Hook. were surveyed for their flavonoid contents. The resultant profile was nearly identical to that of *A. chamissonis* Less. with a total of 17 flavonoids (Table 10). The main difference between these 2 species in terms of flavonoid constituents was in the frequency of occurrence of diagnostic compounds. In general, *A. mollis* Hook. had very low levels of occurrence of diagnostic flavonoids. For example, Luteolin 6-O-Me, 7-O-glucoside and Quercetin 3-O-glucoside were present only in 3 populations: 1 from Alberta and 2 from Wyoming. Another compound with rather limited occurrence in *A. mollis* Hook. was Apigenin 4'-Me, 7-O-diglucoside. This compound was detected only in 4 populations: 1 from Alberta and 3 from the mountainous regions of

Wyoming. Only Luteolin 7-O-glucoside had a high percent occurrence, being present in more than 50% of total population surveyed. Of 16 populations showing this particular compound, 8 were from various sites in Wyoming, 7 from the Rocky Mountains of Alberta and a single population from Elko County, Nevada (Lamoille Canyon, Humboldt National Forest, Ruby Mountains). Of slightly less occurrence than Luteolin 7-O-glucoside was its methylated derivative, Luteolin 3'-Me, 7-O-glucoside which was recorded only in 9 populations: 6 from Alberta and 3 from Wyoming.

Wolf (1981) and Denford (1984) have indicated a correlation between distribution of Luteolin 7-O-glucoside and its methylated derivative, Luteolin 6-O-Me, 7-O-glucoside in 14 populations of *A. cordifolia* Hook. of subgenus *Austromontana* and the extent of Pleistocene glaciation. They found that except for a few populations in southern Alberta, both compounds were restricted to populations currently situated near or north of the boundary of maximum glaciation. In the present study, this striking correlation is affirmed with respect to the distribution of *A. chamissonis* Less. (Fig. 9). In this species, 42 populations (56% of total sample) showed the presence of Luteolin 7-O-glucoside. Of these 42 populations, 12 were from the Alaskan coastal region, 15 from south-central Yukon, 1 from eastern border of Northwest Territories, 4 from northern British Columbia and 3 from the foothills of the Rocky Mountains in southwestern Alberta. A single population from Idaho, Montana, Utah and Wyoming and 3 from Oregon also showed the presence of this particular compound. A similar pattern was observed in 33 populations where Luteolin 6-O-Me, 7-O-glucoside was isolated. Thirty (30) of 33 populations positive for this compound were from northern sites: 9 from coastal area of Alaska; 10 from south-central Yukon, 7 from southwestern foothills region of Alberta and 4 from northern British Columbia. A single population from Montana, Oregon and Utah also showed the presence of this compound. However, since the frequency of populations showing presence of Luteolin 7-O-glucoside and its methylated derivative was comparatively low, it is postulated that these populations represent recent incursions toward the lower latitudes.

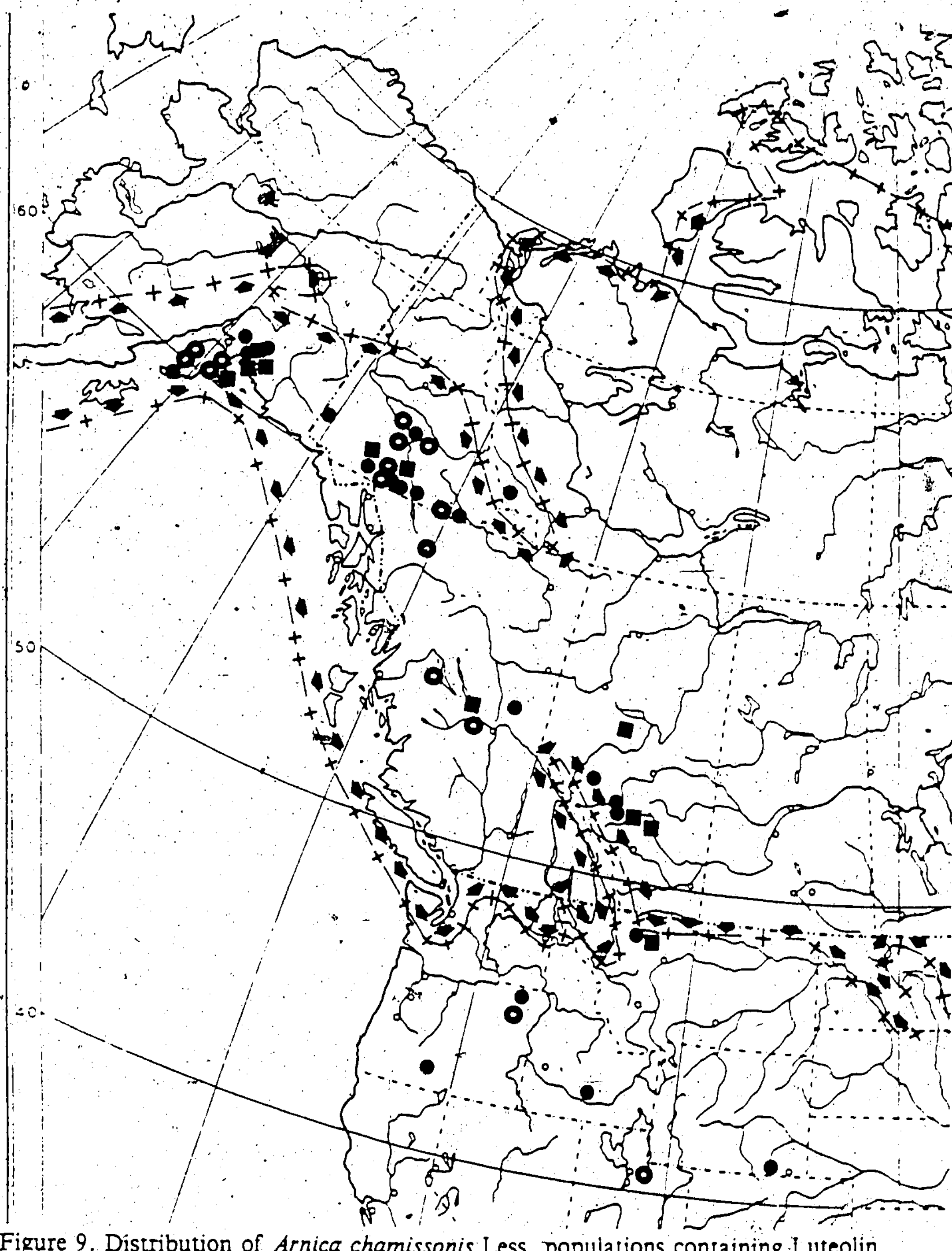

Figure 9. Distribution of *Arnica chamissonis* Less. populations containing Luteolin 7-O-glucoside and/or Luteolin 6-O-Me, 7-O-glucoside in relation to approximate maximum extent of Wisconsinan-Cordilleran glacier complex in North America (modified from Prest 1984). Kodiak Island refugium (Karlstrom & Ball 1969) is not shown. Legend: ● = Luteolin 7-O-glucoside; ■ = Luteolin 6-O-Me, 7-O-glucoside; O = both compounds present; arrows indicate direction of ice flow (modified from Prest 1984).

The evolution of flavonoids and their significance in phylogenetic analysis has been discussed thoroughly by Harborne (1977). From this work, a primitive flavonoid profile is conceived to be made up solely of simple flavonols- those lacking methylation and no hydroxylation at the C6-position. In contrast, the most advanced flavonoid profile would have highly methylated flavones as a main feature and these with hydroxylation at the C6-position. As far as the foliar flavonoid profile of subgenus *Chamissonis* is concerned, it consists of a nearly balanced mixture of simple and relatively methylated-hydroxylated flavonol and flavone glycosides as well as free and methylated aglycones. Compared with the other 2 subgenera in *Arnica* with known flavonoid profiles, subgenus *Chamissonis* is relatively chemically advanced. The prevalence of a basic flavonoid set of 12 compounds in all taxa considered in this study clearly delimits this subgenus as a chemically distinct entity. This strongly supports the circumscription of the subgenus as visualized by Maguire (1943) based solely on structural attributes. The apparent homogeneous flavonoid skeletal pattern in this subgenus has been recently ascertained by Merfort *et al.* (1986) from their study of floral flavonoids. In the current investigation, a similar conclusion can be said to apply with respect to foliar flavonoids. Such remarkable homogeneity in flavonoid pattern in part may be due to early evolution of polyploidy and apomictic reproductive behavior in all taxa of subgenus *Chamisssonis*. Undoubtedly, apomixis *per se* has since acted as a complete block to natural hybridization.

IV. Phytogeography

The circumscription of the 5 subgenera in *Arnica* by Maguire (1943) was evidently influenced by phytogeographical data available to him during that period. Thus, two of 3 originally large subgenera (*sensu* Maguire 1943) were named aptly with reference to the relative geographical disposition of the greater number of their component taxa. These are subgenera *Austromontana* - with more southerly distributed elements and *Arctica* - with the majority of members largely confined to northern high latitudes. Subgenus *Chamissonis*, though its name does not indicate any particular geographical reference, was conceived by Maguire (1943) as a complex whose geographical range variously overlaps with those of *Arctica* and *Austromontana* but which is morphologically discrete from either of these 2 subgenera. As shown in this study, subgenus *Chamissonis* is one of the more naturally delimited complexes in genus *Arnica* with respect to structural, chemical and reproductive attributes. Ecogeographically, however, most of its members are sympatric with a number of taxa in *Austromontana* and *Arctica*, particularly at middle high latitudes. It was also obvious from the work of Maguire (1943) that recognition of few subspecies was often based solely on inferred geographic separation between nearly identical populations, *e.g. A. longifolia* D.C. Eaton subsp. *genuina* Maguire *versus A. longifolia* D.C. Eaton subsp. *myriadenia* (Piper) Maguire.

In the classic work of Hultén (1937), 22 species of *Arnica* were listed as of probable northwest North American (arctic) origin. For eastern North American counterparts of this genus [except *A. acaulis* (Walt.) B.S.P.] Fernald (1925), Wynne-Edwards (1937) and Marie-Victorin (1938) considered them to be descendants of arctic or western cordilleran taxa. Maguire (1943) elaborated on the fundamental concept of Hultén (1937) and drew attention to the 4 radii of expansion for genus *Arnica* with a hypothetical center of origin in arctic or subarctic western North America. Since then, the overall phytogeographical pattern and the concept of a probable area of origin for genus *Arnica* have remained the same.

Of the 4 designated radii of maximum expansion in genus *Arnica*, the one centered in the cordilleran ranges of western North America has the highest number of species (25 of 27 currently accepted species). This remarkably high species diversity and the discovery of relictual diploid species (Wolf 1981; Wolf & Denford 1984c, Downie 1987) in this quadrant attest to the acceptability of the above-mentioned hypothesis. As to the probable age of the genus *Arnica*, the existence of circumboreally distributed taxa, [*e.g. A. angustifolia* J.M. Vahl subsp. *angustifolia, A. lonchophylla* Greene subsp. *lonchophylla*], and east-west disjunct distribution in a number of taxa [*e.g. A. frigida* Meyer *ex* Iljin, *A. angustifolia* J.M. Vahl subsp. *tomentosa* (Macoun) Douglas & Ruyle-Douglas (Downie 1987), *A. lanceolata* Nutt.] indicate that the genus is comparatively old and was probably an element of the Arcto-Tertiary flora. At lower latitudes particularly in the western United States, genus *Arnica* was listed as one of many genera that are well-developed in California but widespread elsewhere (Raven & Axelrod 1978). The evolutionary history of this group of genera was greatly influenced by the spreading aridity prevalent in the western United States during the Upper Tertiary times that ended in the development of a full-Mediterranean climate during the Quaternary period (Raven & Axelrod 1978). In relation to subgenus *Chamissonis* , this particular climatic event could have contributed to the preservation of ligulate populations of *A. parryi* A. Gray in the Californian flora. Conversely, the discoid populations became more widely dispersed into the cooler montane sectors of western United States northward to the Rocky Mountains of Alberta and up to the alpine meadows of southern Yukon. However, ligulate forms of this species were discovered recently in the Rocky Mountains of Alberta as well as in the high regions of Utah and Colorado. This indicates that contrary to Maguire's (1943) conclusion, the ligulate forms of *Arnica parryi* A. Gray are not exclusive to the Sierra Nevada of California. Moreover, their occurrence in those widely separated localities implies differential survival of this relatively primitive form of *A. parryi* A. Gray or sporadic reversal of certain populations to the primitive state in a single character, *viz.* presence of ligules or rays. Finally, this situation indicates that ligulate forms of this taxon were probably more widespread in the geological past.

Except for *A. chamissonis* Less. and *A. lanceolata* Nutt. (with its 2 subspecies), the remaining species in subgenus *Chamissonis* approximate a general phytogeographical pattern with the major high mountain ranges in western North America. Phytogeographical evidence points to the fact that these montane to alpine taxa probably attained their maximum evolutionary developments in this type of habitat prior to the onset of Pleistocene glaciations. Outside of these networks of montane-alpine environment, only *A. chamissonis* Less. was capable of pioneer invasion into newly vacated and repeatedly disturbed locales such as gravel road margins, intermittent sloughs and bogs, shores of lakes, rivers deltas, abandoned crop fields, *etc.* Thus to date, *A. chamissonis* Less. has flourishing populations on the delta region of Eastmain River, Québec. It is predicted therefore that amongst the species of subgenus *Chamissonis*, *A. chamissonis* Less. will likely be the first taxon to regain a pre-Pleistocene distribution pattern across North America.

Cytological study and pollen viability tests reveal that the most widespread contemporary populations of taxa in subgenus *Chamissonis* outside of glaciated areas were predominantly polyploid and apomictic. This result partly contradicts Barker's (1966) assertion that in genus *Arnica* diploids were more widespread in the past and that polyploidy was an inter- or post-glacial phenomenon. If polyploidy was indeed an inter- or post-glacial development then there should have been a preponderance of diploid populations in as many localities as possible beyond the reach of the glacial ice sheets. Furthermore, if such conditions existed then there should have been a far fewer taxa within each subgenus that were morphologically identical as continuous natural interbreeding between sexual species would bring about increased genetic variation.

Another species with an interesting phytogeographical history is *A. lanceolata* Nutt. In the present study, this species is considered as a complex of 2 subspecies: subsp. *lanceolata* and subsp. *amplexicaulis* (Nutt.) Gruezo, with an east-west disjunct distribution pattern. Morphologically, these 2 subspecies are virtually identical (with due allowance for inherent phenotypic plasticity). The structural similarity of these subspecies was earlier acknowledged by Maguire (1943) who postulated that *A. amplexicaulis* Nutt. (subsp. *amplexicaulis*) was the most obvious progenitor of *A. lanceolata* Nutt. (*sensu* Maguire 1943). At the same time, he discounted the possibility of *A. mollis* Hook. as a stock from where *A. lanceolata* Nutt. originated. Instead, he viewed *A. mollis* Hook. as a southern Rocky Mountain and Cascade-Sierran offshoot of *A. amplexicaulis* Nutt. (subsp. *amplexicaulis*). I concur with Maguire's interpretation concerning *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo as the parental stock from where *A. lanceolata* Nutt. subsp. *lanceolata* was derived. However, as no sufficient characters could be used to satisfactorily differentiate the eastern segment from the main western complex other than geographic separation, subspecies rank is conferred to the eastern disjunct populations. However, due to publication priority (ICBN 1983) of *A. lanceolata* Nutt. over that of *A. amplexicaulis* Nutt., the former is the correct specific name. Apart from this nomenclatural status, subsp. *lanceolata* is considered a derivative of subsp. *amplexicaulis*.

In subgenus *Chamissonis*, only these 2 subspecies of *A. lanceolata* Nutt. strictly inhabit hydric sites, *e.g.* along banks of watercourses, within spray zones of waterfalls, on mucky seepsprings produced from snow-melt waters, gravel beaches and river deltas, *etc.* This habitat specificity indicates a high possibility that *A. lanceolata* Nutt. is one of the *Arnica* species that has survived in coastal refugia on both sides of the continent. The present geographical distribution clearly shows that the majority of the populations are concentrated along the coastal outline of northwestern North America. *Arnica lanceolata* Nutt. subsp. *lanceolata* probably survived in the coastal refugium of the St. Lawrence River, Gaspé Peninsula (Québec). The geological support for the recognition of this portion of Gaspé Peninsula as coastal refugial site came from the work of Grant (1977).

In northwestern North America, the concept of an 'ice-free corridor' - a strip of land stretching between the front lobes of the Cordilleran and Laurentide glacier complex is now generally accepted. Packer (1980) succintly outlines the phytogeographical evidence for the existence of the ice-free corridor while stratigraphic, geological and paleopalynological evidence are found in the works of Alley (1973), Stalker (1977), Rutter (1984) and Ritchie (1984), respectively. An earlier phytogeographical study by Packer and Vitt (1974) conclusively demonstrated that the southern end of this corridor, in particular the Mountain Park area of the Canadian Rocky Mountains, is indeed a mountain refugium that supported an alpine flora. In the same paper, possible refugial sites within the boundary of the Canadian Rockies were cited, *e.g.* Whistler Mountain, Willmore Wilderness Provincial Park, Snow Creek and Sunshine Valley in Banff National Park, *etc*. It is interesting to note that it was from the latter locality that a number of the relatively primitive ligulate populations of *A. parryi* A. Gray were found. This record was outside of the presumed restricted range of this form in Sierra Nevada, California as speculated by Maguire (1943). Therefore, it is safe to conclude that this form of *A. parryi* A. Gray was one of the elements that survived Pleistocene glaciations *in situ*. However, due to genetic depletion as a consequence of isolation this form was incapable of extending its range.

V. Phylogeny

The present occurrence of 25 species out of 27 currently accepted in genus *Arnica* in western North America strongly indicates that this region is its probable area of evolution, speciation and diversification. This being so, the postulated arctic origin of this genus outlined by Hultén (1937) and elaborated by Maguire (1943) seems to be accurate. However, caution should be exercised in this sort of interpretation as an area of high species diversity actually may not be the center of origin for particular complex (Johnson & Raven 1970).

Due to relatively rapid evolution and concomitant favorable climatic shifts, as well as the presence of local selective pressures (*e.g.* unique soil types, volcanic activity (Wolf 1981), geological uplifting, *etc.*), genus *Arnica* had radiated into 5 secondary centers of dispersion, namely: 1) Aleutian and Japanese archipelagoes, 2) Pacific coast region, 3) Rocky Mountains, 4) North Atlantic coast and 5) northern and central Europe (Maguire 1943). Of these secondary centers, the Rocky Mountains and Pacific coast regions harbor the greatest number of species. Genus *Arnica* was viewed as monophyletic in origin - all its taxa having evolved from a single hypothetical ancestor, *Protoarnica* (Maguire 1943). Structural, cytological, chemical, reproductive and phytogeographical data overwhelmingly support this monophyletic derivation of the genus (Wolf 1981, Wolf & Denford 1984c, Downie 1987, Downie & Denford 1988 in press). Incidentally, this genus together with a number of closely related genera, has accumulated a combination of attributes (see Table 1) such that many workers (*e.g.* Nordenstam 1977, Schumacher 1966, *etc.*) favor its exclusion from tribe Senecioneae. An erection of a new tribe, Arniceae to accommodate this assemblage of genera, therefore becomes inevitable.

The prototype of, or primitive condition in genus *Arnica* was considered to have the following attributes: 1) large, 1-3 broadly hemispheric-campanulate heads with yellow rays; 2) 2-4 pairs of simple to occasionaly denticulate, linear to lanceolate, largely basally positioned leaves; 3) glabrous to moderately pubescent, unbranched stems; 4) white barbellate pappus, and 5) growth in arctic-alpine conditions, among others. These characters are all present in subgenera *Arctica* and *Austromontana*. Their antitheses are largely found in subgenus *Chamissonis*, and to a lesser extent, in subgenera *Montana* and *Andropurpurea*. A simplistic yet more natural phylogenetic arrangement of genus *Arnica* therefore would consist only of 2 'supercomplexes': 1) the *Arctica* supercomplex which definitely includes subgenus *Austromontana*, with 16 species; and 2) the *Chamissonis* supercomplex including subgenera *Montana* and *Andropurpurea*, with a total of 11 species. At this level of phylogenetic integration, the more primitive supercomplex (*Arctica*) is clearly distinct in having white, barbellate pappus, fewer pairs of mainly basally disposed leaves and few, large, hemispheric-campanulate capitula. On the other hand, the more advanced supercomplex (*Chamissonis*) is characterized by its consistently brown subplumose (rarely barbellate) to plumose pappus, many small turbinate to campanulate heads, and usually many pairs of uniformly positioned leaves on the stem. Within the genus, Maguire's (1943) concept of probable relationships of the 5 subgenera and their component taxa was rather speculative. Figure 10 depicts the proposed relationship of 5 subgenera while Figure 11 outlines taxon relationships within subgenus *Chamissonis* as conceived by Maguire (1943). Obviously, the principal drawback in Maguire's presentation was the absence of direct interlinks between 'presumed' progenitors of each subgenus. Instead, he linked all subgenera directly to the archetype - *Protoarnica*. Within subgenus *Chamissonis*, Maguire (1943) drew 3 primary lines of speciation from *A. chamissonis* Less. (subsp. *genuina* Maguire *sensu* Maguire 1943) and thereafter, 7 secondary lines to completely account for all taxa. In the current investigation, an entirely different phylogenetic picture is presented in the light of new information. Table 12 lists the characters used in the phylogenetic (cladistic) evaluation of subgenus *Chamissonis*. The resultant cladogram is shown as Figure 12. Character polarity used in this analysis is in line with the general pattern adapted by Maguire (1943), and modified by Wolf (1981), Wolf & Denford (1984c), Downie (1987), Downie & Denford (1988, in press). In this way, comparison with taxa outside of subgenus *Chamissonis* is cogent and coherent.

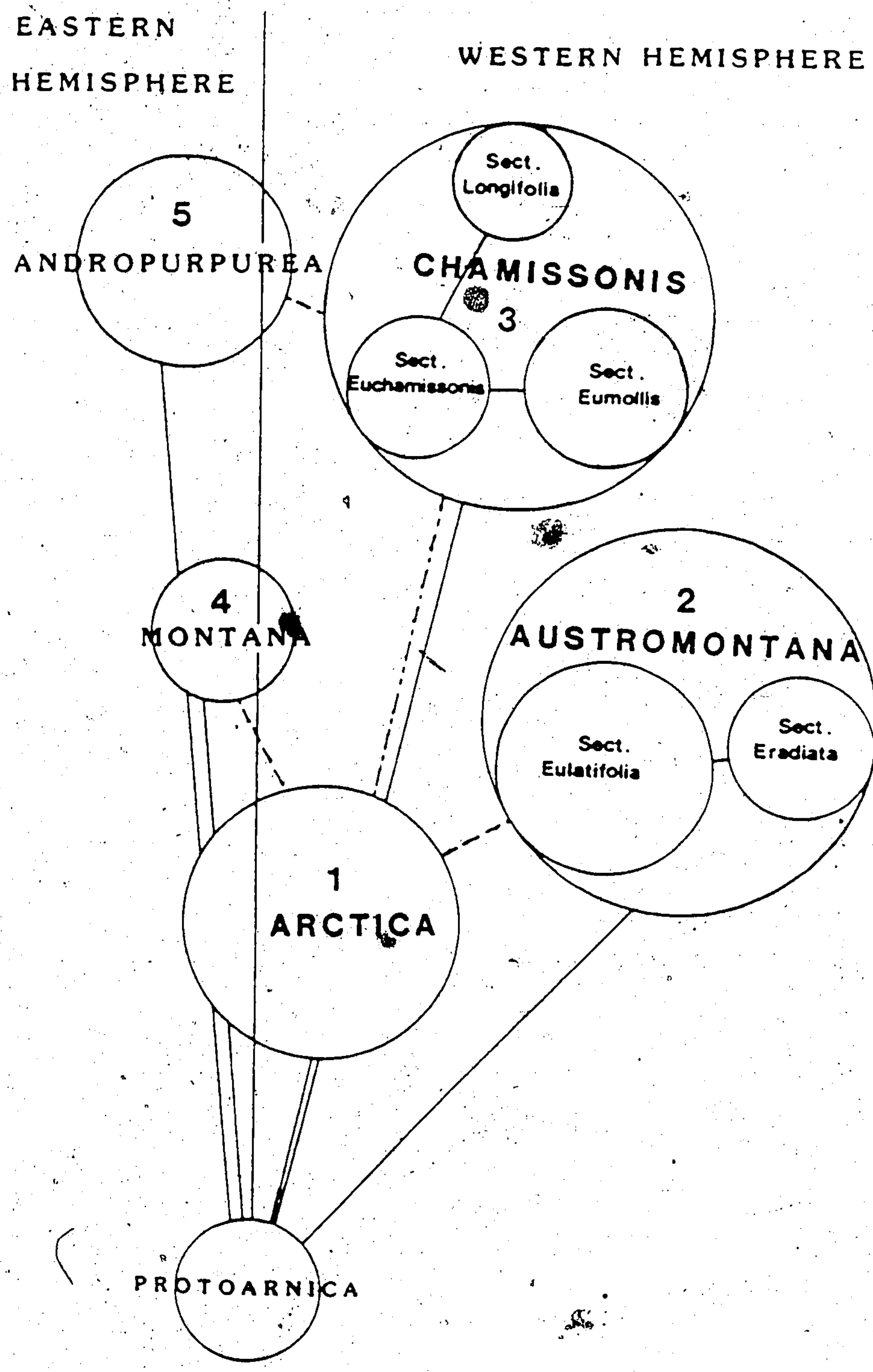

Figure 10. Maguire's proposed probable relationships of 5 subgenera in *Arnica* L. (modified from Maguire 1943, fig. 22).

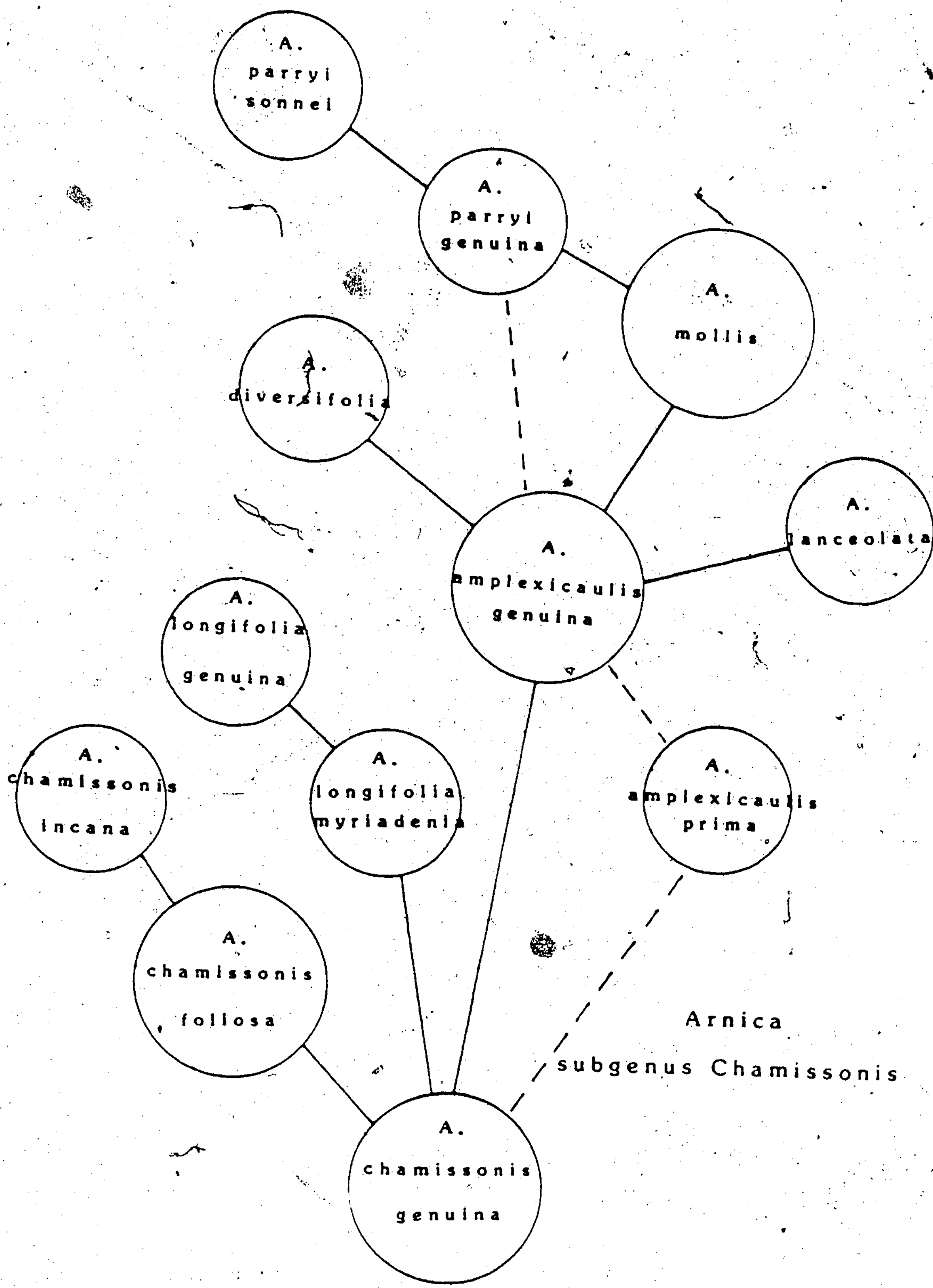

Figure 11. Maguire's proposed relationships of taxa in *Arnica* L. subgenus *Chamissonis* Maguire. (modified from Maguire 1943, fig. 25).

Table 12. Characters and states used in the phylogenetic (cladistic) analysis of *Arnica* subgenus *Chamissonis*. Shared derived characters (synapomorphies) only were used in cladogram construction.

Characters	Plesiomorphous (0)	Apomorphous (1)
A. Underground parts	rhizome	caudex
B. Innovations	present	absent
C. Stem branching	absent	present
D. Leaf position	below midstem	evenly distributed
E. Leaf number (pairs)	2-4	greater than 5
F. Leaf shape	broadly lanceolate to ovate-deltoid	linear to lanceolate
G. Leaf margin	regularly dentate/serrate	entire to denticulate
H. Leaf pubescence	glabrous to moderately pubescent	densely tomentose
I. First cauline leaf petioles	short/long, narrow/broad	sessile
J. Connate leaf sheath	absent	present
K. Involucral bract shape	lanceolate to broadly lanceolate	linear or narrowly lanceolate
L. Dense tuft of white hairs at tip of involucral bracts	absent	present
M. Periclinium glandularity	absent	present
N. Dense axillary hairs at basal leaves	absent	present
O. Capitulum type.	radiate	discoid
P. Capitulum number	1-4	greater than 5
Q. Capitulum shape	broadly hemispheric	turbinate to narrowly campanulate
R. Capitulum color	yellow	yellow-orange
S. Disc floret number	greater than 50	less than 25
T. Disc corolla glandularity	absent	present
U. Ligulate floret teeth	prominently 3-dentate	entire or minutely tridentate
V. Pappus color	stramineous	tawny or deep brown

W. Pappus setae	barbellate to subplumose	plumose
X. Achene color	dark grey	brown or black
Y. Achene glandularity	absent	present
Z. Ecology: moisture gradient	xeric/mesic	hydric
AA. Ecology	subarctic/subalpine	grassland/montane
BB. Kaempferol 3-0-glucoside	absent	present
CC. Luteolin 6-0-methoxy 7-0-glucoside	absent	present

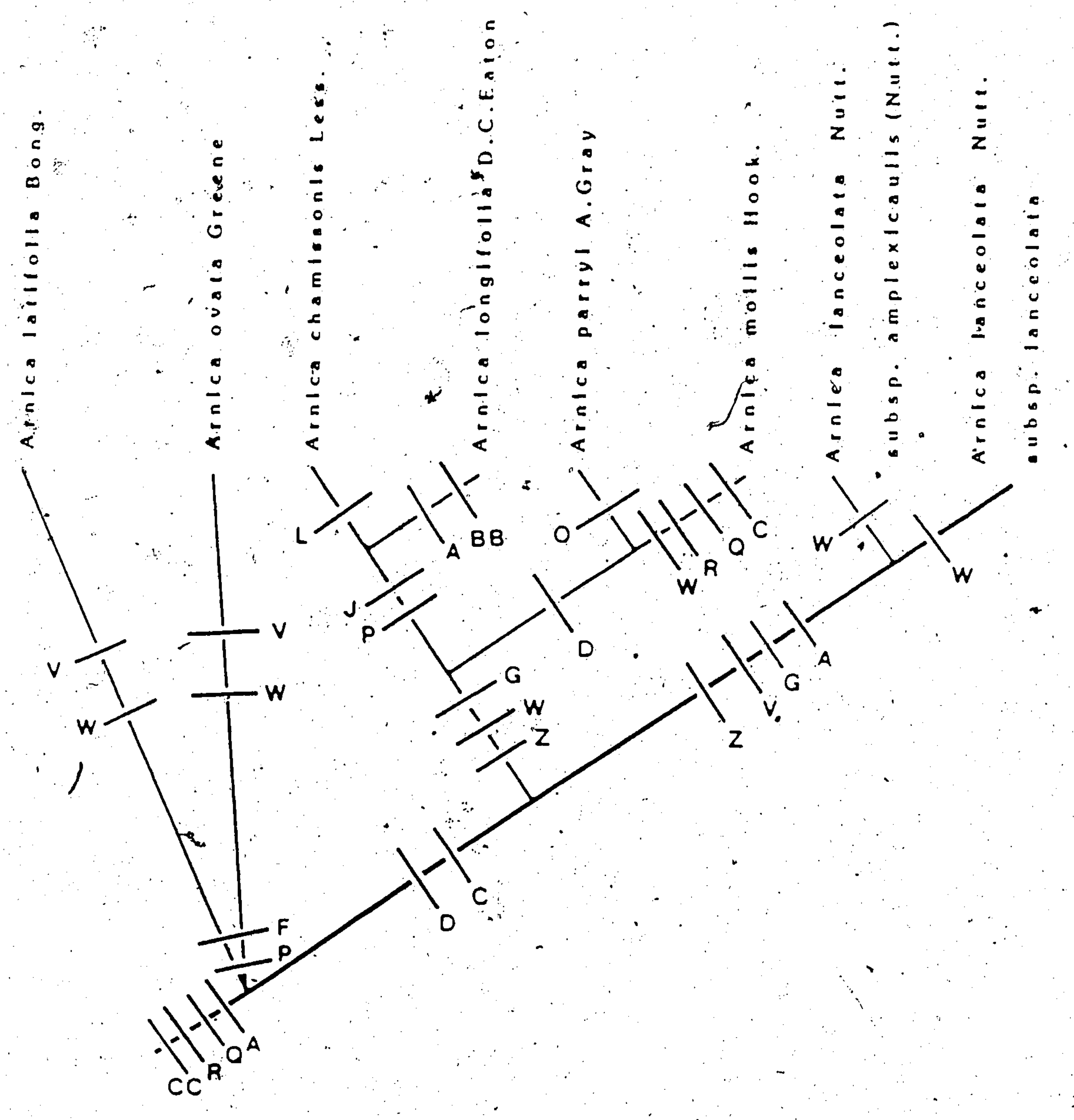

Figure 12. Cladogram of 7 taxa in *Arnica* L. subgenus *Chamissonis* Maguire based on morphological, flavonoid and ecological synapomorphies. One probable sister-species in *Arnica* L. subgenus *Austromontana* Maguire is included (*A. latifolia* Bong.).

Subgenus *Chamissonis* is considered to be monophyletic in origin as all taxa included in it share the same fundamental diagnostic characters: a) 4 to many pairs of leaves, or if only 3 pairs, then these are long-petiolate or broadly ovate to nearly deltoid; b) presence of many, small turbinate-campanulate heads on a multi-branched stems, or if only 3 or less, then these are commonly large and broad hemispherical; c) stramineous, tawny or deep brown subplumose (rarely barbellate) to plumose pappus; d) predominantly temperate montane ecology, and e) a basic complement of 12 flavonoid compounds (*vide supra*). This character combination distinguishes subgenus *Chamissonis* as one of the more advanced subgenera in genus *Arnica*. As clearly shown in the cladogram (Fig. 17), *A. ovata* Greene (= *A. diversifolia* Greene,) is considered the most primitive member of this subgenus. This is diametrically opposed to Maguire's (1943) interpretation that this taxon represents genetically highly complex and hybridizing populations. The main support for this conclusion comes from the analysis of its flavonoid profile. The relatively low number of flavonoids (13 compounds) observed in this species definitively discounted the earlier hypothesis of its hybrid origin, with *A. cordifolia* Hook. or *A. latifolia* Bong. and *A. amplexicaulis* Nutt. (Maguire 1943) or *A. mollis* Hook. (Cronquist 1955, Ediger & Barkley 1978, Wolf 1980) and recently between *A. mollis* Hook. and *A. cordifolia* Hook., *A. latifolia* Bong. or *A. rydbergii* Greene (Welsh *et al.* 1987) as putative parents. Morphologically, *A. ovata* Greene greatly resembles in an admixture way, *A. cordifolia* Hook. and *A. latifolia* Bong., the 2 most primitive species of subgenus *Austromontana* (Wolf 1981, Wolf & Denford 1984c). As a consequence, many herbarium specimens of *A. ovata* Greene were misidentified as either *A. latifolia* Bong. or *A. cordifolia* Hook. As an example, *A.A. Heller 12544* [California, El Dorado Co., south side of Echo Lake, "in granite in moist places, the prevalent tree *Abies magnifica* with some *Hesperopeuce mertensiana, Alnus* the common shrub, Hudsonian", 11 August 1916] was a collection represented by a number of replicates in different herbaria. I examined 5 replicates of this collection (PENN 70750!, PH 598772!, UC 195384!, UC 726616!, and UC 892139!). Three of these replicates were examined by Maguire (*circa* 1940, *in sched.*) and 2 were studied by Wolf (*circa* 1980 *in sched.*) during his biosystematic study of subgenus *Austromontana*. Incidentally, the collection was originally determined, presumably by Arthur A. Heller as simply *Arnica*. The 3 replicates studied by Maguire were annotated (*in sched.*) as follows: PH 598772! and UC 195384! as *A. diversifolia* Greene (= *A. ovata* Greene, in the present study) and UC 892139! ~~as A.~~ *latifolia* Bong. The latter replicate was similarly annotated by Wolf (*in sched.*) as *A. latifolia* Bong. and published as such (Wolf & Denford 1984c p. 287). The other replicate [also from the same herbarium (UC 726616!)] examined by Wolf was annotated as *A. diversifolia* Greene. The fifth replicate I examined (PENN 70750!) was not seen by Maguire and Wolf. My exhaustive study of this particular collection reveals that it is definitely not a mixture of plants referrable to *A. latifolia* Bong. or *A. ovata* Greene, as the case may be. It is unmistakably a homogeneous set and all belong to *A. ovata* Greene. What is remarkable about this set of replicates is that it documents the entire gamut of minor variation in leaf morphology prevalent in this species. In effect, the set represents a combination of specimens that closely resemble the type material of *A. ovata* Greene (*viz.* UC 195384!, UC 726616!, PENN 70750! *p.p.*), *A. diversifolia* Greene (*viz.* UC 195384! *p.p.*, PENN 70750! *p.p.*, PH 598772! & UC 892139!) and *A. silvatica* Greene (*viz.* UC 195384! *p.p.* & PENN 70750!). Other collections that were similarly misidentified (*in sched.*) by Maguire and Wolf as *A. latifolia* Bong. but definitely belong to *A. ovata* Greene are: *Joseph P. Tracy 14439* (UC 582490!) and *Joseph P. Tracy 14654* (UC 582491!), both from the high region of Trinity County, California.

The morphological similarity amongst these taxa includes: a) presence of 2-3 pairs of short-, or long- petiolate, broadly ovate to more or less deltoid, regularly denticulate to dentate-serrate cauline leaves; and b) the narrow, turbinate-campanulate capitula. However, *A. ovata* Greene is distinctly separable from these 2 species by its consistently stramineous, shaggy-subplumose pappus, and often pale yellow-green herbage.

It is postulated here that ploidization and apomixis in *A. ovata* Greene had occurred prior to Pleistocene glaciations, more likely in the montane and subalpine zones of the Rocky Mountains. From this site of ploidization, these apomictic populations were able to expand their range in a NW SE direction, reaching as far as the interior part of southern Alaska and the southeastern corner of Colorado. The presence of Luteolin 7-O-glucoside in widely separated species of *Arnica* [e.g. *A. montana* L. (Europe), *A. sachalinensis* (Regel.) A. Gray (Siberia), *A. chamissonis* Less. (northwestern North America) (Borkowski *et al.* 1966) and northern populations of *A. cordifolia* Hook. (Wolf 1981) indicates that this compound may represent an ancestral pre-Pleistocene condition. This particular flavonoid is ubiquitous in subgenus *Chamissonis* implying that maximum evolution in this complex must have taken place during pre-Pleistocene times. The above assertion concerning *A. ovata* Greene therefore might be correct.

It is also apparent from the cladogram (Fig. 12) that *A. chamissonis* Less., though still shown here as one of the more primitive members of subgenus *Chamissonis*, is no longer the sole progenitor. Instead it is hypothesized that there were at least 3 tiers of extinct ancestors before the contemporary species within the subgenus came into existence. The first ancestral stock had: a) long, soft, naked, rhizomatous underground structure with innovations, b) few, entire, broadly lanceolate to ovate, basally disposed leaves; c) few, large, campanulate-hemispheric capitula borne at the end of simple stems; d) whitish brown or stramineous, barbellate-subplumose pappus; and e) temperate, subalpine-montane ecology. Subsequent expansion to different habitats led to the evolution of the second set of ancestors which had: i) short, thick, freely-rooting rhizomes; ii) multi-branched stems bearing numerous heads; iii) many evenly distributed cauline leaves; iv) small, turbinate-campanulate capitula; v) stramineous to tawny, subplumose to plumose pappus, and vi) temperate, subalpine-montane, lowland to coastal environments. Subsequent ancestors had attained limited structural and chemical modifications as ploidization and apomixis became prevalent among populations. Therefore the populations that were subjected to the catastrophe of glaciation were already largely apomictic-polyploid and had reached their maximum distribution in North America.

The developmental tendency that permeated the evolutionary history of subgenus *Chamissonis* is presented below.

HABIT. Generally, genus *Arnica* consists of herbaceous perennials with underground parts either of long, thin, naked rhizomes or short, thick, woody caudices. In subgenus *Chamissonis*, both types are present, with each apparently correlated with formation of a distinct growth habit. *Arnica chamissonis* Less. which retains the more primitive rhizomatous underground structure with conspicuous nodal scales correspondingly produces solitary plants. On the other hand, *A. longifolia* D.C. Eaton which has thick woody caudex (advanced condition) produces thick cluster of plants all arising from a common point. The only other species in subgenus *Chamissonis* which has thick woody caudex is *A. lanceolata* Nutt. and this likewise produces clonal clumps of plants. The evolution of the caudex may be an adaptation to highly unstable, fully exposed habitats, e.g. rock-outcrops and steep talus slopes for *A. longifolia* D.C. Eaton and banks of upland watercourses, intermittent streams and snow-melt run-off sites and reservoir as well as delta and tidal zone of rivers at low elevations for *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, and subsp. *lanceolata*. Outside of subgenus *Chamissonis*, caudices are present only in *A. viscosa* A. Gray and *A. venosa* H.M. Hall (both of subgenus *Austromontana*) which occupies more or less similar type of habitat (Wolf 1981, Wolf & Denford 1984c). The remaining species in the subgenus have invariably rhizomatous underground structures. However, in of *A. ovata* Greene and *A. mollis* Hook., an intermediate form is often present. These species have short stout rhizomes that are densely covered with coarse fibrous rootlets or remnants of scales. This structure is different from those found in *A. chamissonis* Less. or *A. longifolia* D.C. Eaton that I am inclined to call this type of underground structure as 'pseudocaudex'. This is with reference to the ability of this structure to produce similar, though partially tufted, plant formation typical of caudices. Phylogenetically, this intermediate structure is significant as it indicates clearly that the evolutionary shift was from rhizome to caudex. Incidentally, *A. ovata* Greene and *A. mollis* Hook. grow equally well in moderately protected habitats such as gaps in moist upland woods, sedge meadows along streambeds, on wet grassy slopes of lush ravines formed by small creeks, etc.

STEM. In *Arnica*, the taxonomic value of the stem lies in whether it is simple or profusely branched below the middle. The simple condition of the stem includes primary branching at apical portion commonly in bifurcate or trifurcate fashion. This is considered as primitive state which consequently gives rise only to 1-3 capitula. Only *A. ovata* Greene and *A. mollis* Hook. can be strictly classed as having simple stems. *Arnica parryi* A. Gray is unique in that some populations exhibit stems with pronounced arcuate multiple branching pattern. *Arnica chamissonis* Less., *A. longifolia* D.C. Eaton, *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo and subsp. *lanceolata are predominantly with multi-branched stems but plants with simple stems are likewise common.*

The presence of secondary branches is used here to elucidate phylogenetic affinity of *A. lanceolata* Nutt. Previous workers (Torrey & Gray 1843, Fernald 1905, Marie-Victorin 1935, Fernald 1950) treated this taxon as conspecific with *A. mollis* Hook. However, the presence of a similar pattern of secondary branching in *A. amplexicaulis* Nutt. and *A. lanceolata* Nutt., in addition to their great morphological confluence indicates that the latter is simply a derivative or disjunct segment of the former. Greenhouse plants of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo monitored in the current study were almost identical with cultivated plants (J.K. Morton, pers. comm. 31 January 1986) of *A. lanceolata* Nutt. subsp. *lanceolata* [*cf. J.K. Morton NA4030* (ALTA 86187!, CAN 471348!]. These findings decisively support the proposed taxonomic treatment here for the eastern populations as a geographic subspecies of the more widely dispersed western counterpart.

Stem vestiture, although highly variable within each species, is partially useful in distinguishing certain taxa in subgenus *Chamissonis*. For example, *A. longifolia* D.C. Eaton and *A. chamissonis* Less. have some populations that show greater similarity but can be segregated immediately on the basis of indument. *Arnica longifolia* D.C. Eaton has nearly glabrous stems (and leaves) with but few stipitate glands while *A. chamissonis* Less. has sparsely or moderately pubescent to densely white tomentose stems (and leaves). The only other species within the subgenus with more or less glabrous stem is *A. ovata* Greene. The rest of the species are with a wide variation in indument.

No taxonomic value is conferred to difference in stem height of species within subgenus *Chamissonis*. This character is highly influenced by edaphic factors, (*e.g.* amount of soil moisture and duration of its availability, soil type, amount and kind of nutrients) as well as altitude and photoperiodic exposures. In many instances, much of the taxonomic confusion in subgenus *Chamissonis* is attributable to complete disregard for this sort of phenotypic plasticity. For example, Aven Nelson (1934) described *A. maguirei* A. Nelson on the basis of an "extraordinarily tall *Arnica* with its simple wand-like stem carrying its numerous large thin leaves" (Nelson 1934, p. 581). This kind of population stature was typical of moisture and nutrient riched sites. We collected 2 similar populations: 1 from inside the Belly River Campground, southern Alberta [WM11601 (ALTA!)] and another from vicinity of Mile post 59.8, Glenn Highway, Alaska [WM11915 (ALTA!)]. From the latter site, 2 adjacent patches of the same population were sampled. One group was growing on relatively dry, grassy, gravelly road shoulder while the second patch was on an intermittent shallow drainage adjacent to a dumpsite and only c. 15 m away. The one growing near the dumpsite attained a height of *c*. 1.5 m, and have thick stout stems with strikingly broad lanceolate, partially denticulate leaves. The roadside population had a height of only *c*. 30 cm, with thin stems and narrow lanceolate, nearly entire leaves. The Belly River population was nearly identical to the type material of *A. maguirei* A. Nelson which was collected from Lower St. Mary's Lake, Montana. Under greenhouse condition, these 3 populations became virtually indistinguishable from one another and were similar to the rest of *A. chamissonis* Less. plants collected elsewhere and maintained inside the greenhouse.

LEAVES. The number, position, shape, margin, apex, and petiole length and width of leaves in genus *Arnica* are all primarily important in species and intraspecific delimitations. Within subgenus *Chamissonis*, leaf characters of individual species are always a mixture of primitive and advanced states and therefore, provides uncertainty in designating each taxon as 'primitive' or 'advanced'. The basic number of leaves in this subgenus is from 5-12 pairs with few populations of *A. longifolia* D.C. Eaton having up to 20 pairs. However, 3 species (*A. mollis* Hook., *A. ovata* Greene, and *A. parryi* A. Gray) have only 2-4 pairs.

Leaves in subgenus *Chamissonis* are generally evenly distributed except in *A. parryi* A. Gray where leaves are often in basal clusters or confined to below midstem, with only a pair of highly reduced cauline leaves near the inflorescence. A similar condition was also present in some populations of *A. mollis* Hook. As to leaf position, this subgenus therefore is relatively 'advanced'.

The leaf shape, margin, apex and nature of the petiole are all very useful in separating taxa within subgenus *Chamissonis*. These attributes, together with capitulum characters, were used in differentiating *A. ovata* Greene from *A. mollis* Hook. (see Taxonomy section). *Arnica longifolia* D.C. Eaton is the best example to cite as typical populations have remarkably long, narrow lanceolate-elliptic leaves with prominently acuminate to caudate apex. The leaves are all sessile, with the first and second cauline leaves having connate sheaths similar to those present in *A. chamissonis* Less. Both are considered advanced character states.

The degree of polymorphism in genus *Arnica* is largely assessed in terms of leaf characters. In subgenus *Chamissonis*, at least 3 species are considered as highly polymorphic: *A. chamissonis* Less., *A. lanceolata* Nutt., and *A. mollis* Hook. For example, the ecotypic variations present in the leaves of *A. chamissonis* Less. are astoundingly high that at least 24 different names were proposed by previous workers (see list of synonyms *sub* 'Taxonomy section') to accommodate them. These variations include extreme conditions: a) entire, very narrow lanceolate-elliptic, sessile to short-petiolate, scantily pubescent leaves typical of populations inhabiting grassland boundary and similar drier, marginal habitats; and b) irregularly denticulate to coarsely dentate, broad lanceolate to ovate, sessile to long-petiolate, often basally congested, moderately to densely white tomentose-lanate leaves, characteristic of moisture and nutrient-filled habitats at medium to high elevations, and in high latitude localities. In the latter stations, lower temperature regime and shorter growing cycle were determinant factors for the low, compact stature (hence basally congested leaves) and increased tomentosity. A similar nature of indument was present in few isolated populations south of the 49° parallel and reported to thrive in standing water. In connection with the latter habitat description, it should be noted that probably the growth cycles of these populations were not entirely completed under water condition. This means that the densely white tomentum, seemingly diagnostic for these populations, is simply an adaptation to dry, 'grassland type' of habitat which follows seasonal or intermittent water flooding of the area. The effect of the latter event was evident from the early rapid production of remarkably tall, thick, hollow, relatively smooth, leafless stems followed by formation of smaller, congested, densely tomentose leaves. The latter characters were indicative of dry conditions. It view of this, populations previously referred to as *Arnica incana* A. Gray or *Arnica chamissonis* Less. subsp. *incana* (A. Gray) Maguire were considered only as extreme ecotypic variation of the more widespread, polymorphic species. Tomentosity is greatly reduced in populations maintained under greenhouse condition.

The leaf size, shape, margin, apex and indument in some ligulate populations of *A. parryi* A. Gray were similar to those of *A. chamissonis* Less. This particular condition prompted Jepson (1925) to treat *A. sonnei* Greene (= ligulate form of *A. parryi* A. Gray) as a variety of *A. foliosa* Nutt. There were also instances where ligulate form of *A. parryi* A. Gray found in the mountainous regions of Utah closely resembles *A. mollis* Hook. and therefore, classified with the latter taxon. This was the case when Maguire (1943) and Ediger & Barkley (1978) placed *A. arachnoidea* Rydb. [Type: Utah, Big Cottonwood Canyon, below Silver Lake, 4 July 1905, *P.A. Rydberg & E.C. Carlton 6609* (Holotype, NY *s.n.*!; Isotype, CAN 191136!)] as a synonym of *A. mollis* Hook. Additional collections of ligulate *A. parryi* A. Gray from the same general locality were also misidentified as *A. mollis* Hook. or *A. diversifolia* Greene (= *A. ovata* Greene) (See 'Taxonomy section' for more detailed discussion and examples).

The cladogram (Fig. 12) clearly shows that the above-mentioned morphological similarity, indeed reflects that certain degree of phylogenetic affinity exists among *A. chamissonis* Less., *A. parryi* A. Gray, and *A. mollis* Hook. Comparison of flavonoid profiles indicates that *A. parryi* A. Gray is apparently more primitive than *A. mollis* Hook. and *A. chamissonis* Less. However, a few other attributes seem to partially contradict this general trend.

INFLORESCENCE. Plesiomorphous characters of the inflorescence in genus *Arnica* include: solitary, broad hemispheric, ligulate capitula with white barbellate pappus (Maguire 1943). Except for the white pappus color, combinations of these characters are also present in some members of subgenus *Chamissonis*. Some populations of *A. mollis* Hook. have solitary, broad hemispheric, radiate capitula but with tawny to deep brown plumose pappus. The stramineous-tawny to brown pappus color, considered apomorphic, is found in 3 subgenera of *Arnica*, namely: *Chamissonis, Montana,* and *Andropurpurea*.

Except for *A. parryi* A. Gray, the only discoid member of subgenus *Chamissonis*, the remaining members of this subgenus are all radiate and with capitulum shape ranging from turbinate-campanulate to broad-hemispheric. The radiate and broad hemispheric conditions are plesiomorphic while turbinate and campanulate states are apomorphous characters. *Arnica chamissonis* Less. has commonly campanulate heads with stramineous to tawny, barbellate to subplumose pappus. Similar characters are found in *A. longifolia* D.C. Eaton except that the turbinate shape of capitulum is more dominant in this species. Both species have many to numerous heads (up to 25). Except for the barbellate pappus character which is plesiomorphic, these 2 species have relatively apomorphous capitulum characters. In *A. ovata* Greene, the common number of heads is from 1-3, and these are commonly turbinate with stramineous, shaggy subplumose pappus. The low number of capitula is plesiomorphic while the rest of the other characters are considered relatively advanced.

A certain level of polymorphism in capitulum characters is present in *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo and subsp. *lanceolata*. In this complex, capitulum shape varies from small turbinate to large campanulate or nearly broad hemispheric. The small turbinate capitula have generally stramineous, barbellate to slightly subplumose pappus. On the other hand, the large campanulate to nearly broad hemispheric heads have tawny to deep brown, subplumose to plumose pappus.

Shape and apex of involucral bracts in subgenus *Chamissonis* are useful in separating a number of species. In *A. chamissonis* Less., this structure is usually narrow-lanceolate with acute to obtuse apex. Its apex has a distinct tuft of white hairs on the inside, a character unique to this species and considered to be apotypic. *Arnica longifolia* D.C. Eaton and *A. parryi* A. Gray have very narrow to nearly linear, acuminate involucral bracts. In the latter taxon, numerous stipitate-glandular hairs are often present, hence are quite diagnostic. *Arnica mollis* Hook. has generally broad-lanceolate involucral bracts with acute to acuminate, commonly purplish apices. In *A. ovata* Greene and *A. lanceolata* Nutt., both narrow- and broad- lanceolate involucral bracts with acute to acuminate apices are present. In genus *Arnica*, the ovate to broad lanceolate involucral bract is treated as plesiotypic.

Overall evaluation of capitulum characters in subgenus *Chamissonis* shows that each species has combination of plesiomorphic and apomorphic states. It becomes necessary therefore to consider as many characters as possible so that a certain level of character polarity can be established (Table 12).

ACHENES. In subgenus *Chamissonis*, achenes are linear or fusiform to smooth- or angular-cylindric, and vary from creamy or chestnut brown to waxy black. Wolf (1981) considered dark grey, glandless achenes as primitive while brown or black glandular achenes as advanced. In subgenus *Chamissonis*, brown and black achenes with variable number of glands are observed. Achene pubescence is similarly variable in this subgenus and no taxonomic value is assigned to this character. The smooth, nearly linear-fusiform brown achenes are typical of *A. chamissonis* Less. and *A. longifolia* D.C. Eaton. Black achenes are, however, also present in these 2 species. *Arnica mollis* Hook., *A. ovata* Greene, and *A. lanceolata* Nutt. have generally plump, angular-cylindric achenes which are either creamy to dark brown. *Arnica* *parryi* A. Gray has smooth to unequally hirsute, waxy black achenes.

ECOLOGY. Subgenus *Chamissonis* is predominantly in temperate montane to subalpine environment. A number of species however, are capable of inhabiting subarctic and alpine environments as well as grassland ecotones and other dry, marginal habitats. The arctic-alpine environs were postulated to be the center of origin for the genus in as much as the greatest concentration of species is currently found in this ecological setting. As a phylogenetic criterion, this is considered plesiotypic.

Wolf (1981) considered mesic habitats as plesiomorphous character. In subgenus *Chamissonis*, mesic-xeric sites are inferred as the primitive condition while completely or predominantly hydric stations as advanced. The latter condition is strictly true only for *A. lanceolata* Nutt. and its 2 subspecies. The only species capable of exploiting both ecological extremes is *A. chamissonis* Less. At its limits of ecogeographic range, this species occupies partially xeric, open and extremely disturbed habitats. It is also found in intermittently hydric localities *e.g.* along shallow drainage canals, lakeshores, periphery of marshes, bogs, and mudflats *etc*. Other members of this subgenus are predominantly found in mesic environments.

FLAVONOID CHEMISTRY. Bate-Smith (1962) suggested that the first advantage to be gained from studies of systematic distribution of flavonoids was the production of a more natural phylogenetic system that incorporates both structural and chemical manifestations of the metabolic machinery in plants. Since that time, numerous studies were published dealing with characterizations of novel flavonoids, determination of their biosynthetic relationships and comparative analysis of their natural distribution (*cf.* Hegnauer 1962-1973, Harborne *et al.* 1975, Whalen 1978, Gornall *et al.* 1979, Gottlieb 1982, *etc.*). Consequently, within the past decade or so, there were a number of reviews on the usefulness of flavonoids in evaluation of taxonomic systems and in the elucidation of angiosperm phylogeny (Harborne 1977, Crawford 1978, Giannasi 1978, Young 1981). Amongst these reviews, Harborne (1977) claimed that Bate-Smith's (1962) predictions have been amply fulfilled and an evolutionary picture for the flavonoids is now clearly visible. By listing the primitive and advanced states of flavonoid evolution, Harborne (1977) showed the considerable predictive values of flavonoids and their full potential in placing correctly plant taxa with known flavonoid profile in the most natural phylogenetic sequence. On the other hand, Crawford (1978) severely criticized Harborne's (1977) optimistic conclusion and negated the biological significance of his generalizations. Furthermore, Crawford (1978) stated that from an evolutionary perspective, one would not expect to find flavonoid distribution of phylogenetic significance in the angiosperms as a whole, but only below the familial or generic level. Obviously, his conclusion was that in order for flavonoids to be of real phylogenetic value in the angiosperms, research emphasis should be focused on the biosynthesis of the compounds (specifically enzymology and genetics) and not on the products (*i.e.* the compounds) of the metabolic pathways. Giannasi (1978) acknowledged the usefulness of flavonoids despite their ubiquity and sometimes contradictory occurrences in angiosperms. He concluded though that more surveys and some consistent form of statistical analysis and quantification of flavonoid distribution should be designed so that creative treatments of flavonoid information can be accomplished beyond the generic or familial level. Indeed, to date there were comparatively fewer studies (Harborne 1977, Gornall *et al.* 1979, Young 1981) that attempted to use flavonoid data at higher taxonomic levels.

At the generic level, 3 trends in flavonoid evolution are apparent: i) reduction in number of flavonoids accompanied by structural simplication with phyletic advancement as shown in the studies of Soltis (1980), Bohm & Wilkins (1978), Mabry (1974) Averett (1973), *etc.*; ii) increase in number and structural complexity (Whalen 1978, Pacheco *et al.* 1985, Crawford & Smith 1983a, *etc.*), and iii) neither towards reduction or increase in number nor complexity with phyletic lines (Giannasi 1975, Crawford & Smith 1983b, Valant-Vetschera 1982, 1985 & 1987) In *Arnica*, the directionality of flavonoid evolution tends to increase in number and structural complexity. This main pattern of flavonoid evolution generally supports the phylogenetic relationship (Fig. 10) proposed by Maguire (1943), based largely on morphological attributes. Thus, comparison of flavonoid profiles of subgenera *Arctica*

(Downie 1987), *Austromontana* (Wolf 1981, Denford 1984) and *Chamissonis* shows that *Arctica* had the lowest number of flavonoids (12), with *Chamissonis* and *Austromontana*, each with 18 and 26 compounds, respectively. Only 2 of 12 compounds in *Arctica* were methylated (Kaempferol 6-O-Me, 3-O- glucoside and Luteolin 6 O-Me, 7-O-glucoside), with the remainder consisting of 7 flavonol, 3 flavone glycosides and 1 unknown (Downie 1987). Subgenus *Austromontana* had 12 glycosides and 14 free aglycones. This subgenus exhibited a wide array of both simple and highly complex compounds such as mono-methyl ethers of simple flavonols Kaempferol and Quercetin and simple flavones Luteolin and Apigenin, as well as highly methylated derivatives of the latter 2 compounds (Wolf 1981). Due to the presence of Luteolin 7-O-glucoside, Kaempferol 3-O-glucoside and Quercetin 3-O-glucoside in a number of *Arnica* species in widely separated areas of distribution, Wolf (1981) suggested that these compounds may represent the ancestral condition in *Arnica*. The same compounds were isolated in subgenus *Arctica* (Downie 1987). In the present study, only Luteolin 7-O-glucoside was present consistently in 6 species studied while Quercetin 3-O-glucoside was detected only in 4 taxa, namely: *A. chamissonis* Less., *A. longifolia* D.C. Eaton, *A. mollis* Hook. and *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo. Kaempferol 3-O-glucoside was rare in subgenus *Chamissonis*, being detected in 2 of 11 *A. longifolia* D. C. Eaton populations surveyed.

The preponderance of 9 methylated foliar flavonoids in subgenus *Chamissonis* indicates that this complex is chemically more advanced than subgenus *Arctica* and might be as advanced as subgenus *Austromontana*. Only 2 methylated derivatives of Kaempferol and Luteolin had been reported in *Arctica* (Downie 1987) whereas 14 methylated compounds were detected in *Austromontana*. Floral flavonoid studies by Merfort *et al.* (1986) led to the isolation of 24 methylated aglycones in subgenus *Chamissonis*, thus indicating that this complex is relatively more advanced than *Austromontana*. Five flavonoid compounds were common to *Chamissonis, Austromontana* and *Arctica*: 1) Apigenin; 2) Luteolin 6-O-Me, 7-O-glucoside; 3) Kaempferol 3-O-glucoside; 4)Luteolin 7-O-glucoside; and 5) Quercetin 3-O-diglucoside. These compounds may be useful in defining chemically the genus *Arnica* and may also represent its primitive condition.

In *Arnica*, the selection of the presumed progenitor for particular subgenus was based on the following criteria: i) possession of many 'primitive' attributes, ii) extreme polymorphic habit, iii) high ploidy series, iv) ancient and diverse flavonoid chemistry, v) broad geographic distribution, vi) non-specific habitat preference, and vii) arctic-alpine ecology (Downie 1987). Within subgenus *Chamissonis*, a number of species exhibit some or all of these criteria and therefore, difficulty in the selection of 'presumed' progenitor arises. However, based on analysis of all available evidence and appropriate evaluation of historical factors that governed and shaped present-day distribution pattern, it is postulated here that all taxa within subgenus *Chamissonis* had evolved probably at about the same period, during pre-Pleistocene times. From purely phylogenetic consideration, the order of phyletic advancement in this subgenus might be as follows (from primitive to advanced status): 1) *A. ovata* Greene, 2) *A. parryi* A. Gray, 3) *A. chamissonis* Less., 4) *A. mollis* Hook., 5) *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, 6) *A. lanceolata* Nutt. subsp. *lanceolata* and 7) *A. longifolia* D.C. Eaton. Evidence for this proposed phylogenetic arrangement is summarized in Table 13 and diagrammatically presented in Figure 12.

Table 13. Comparison of character states (primitive *versus* advanced) in 7 taxa of *Arnica* subgenus *Chamissonis*.

Characters	Taxa						
	1*	2	3	4	5	6	7
A. Underground parts	0**	1	0	0	0	1	1
B. Innovations	0	0	0	0	0	0	0
C. Stem branching	1	1	1	0	0	1	1
D. Leaf position	1	1	0	1	1	1	1
E. Leaf number (pairs)	1	1	1	0	0	1	1
F. Leaf shape	1	1	0	0	0	1	1
G. Leaf margin	1	1	1	1	0	0	0
H. Leaf pubescence	1	0	1	1	0	0	0
I. First cauline leaf petioles	0	1	0	1	0	1	1
J. Connate leaf sheath	1	1	0	0	0	0	0
K. Involucral bract shape	0	1	1	0	1	1	1
L. Dense tuft of white hairs at tip of involucral bracts	1	0	0	0	0	0	0
M. Periclinium glandularity	1	1	1	1	1	1	1
N. Dense axillary hairs at leaf base	1	0	1	0	0	1	1
O. Capitulum type	0	0	1	0	0	0	0
P. Capitulum number	1	1	1	0	0	1	1
Q. Capitulum shape	0	1	1	0	1	1	0
R. Capitulum color	0	0	0	1	0	0	0
S. Disc floret number	0	0	0	0	0	0	0
T. Disc corolla glandularity	0	0	0	0	0	0	0
U. Ligulate floret teeth	1	1	1	1	1	1	1
V. Pappus color	0	0	0	1	0	1	1
W. Pappus setae	0	0	0	1	0	0	1

X. Achene color	1	1	1	1	1	1	1
Y. Achene glandularity	1	1	1	1	1	1	1
Z. Ecology: moisture gradient	0	0	0	0	0	1	1
AA. Ecology	1	0	0	0	0	0	0
BB. Kaempferol 3-O-glucoside	1	1	0	1	0	1	1
CC. Luteolin 6-O-Me, 7-O-glucoside	1	1	1	1	1	1	1

1* = *Arnica chamissonis* Less.; 2 = *A. longifolia* D.C. Eaton; 3 = *A. parryi* A. Gray; 4 = *A. mollis* Hook; 5 = *A. ovata* Greene; 6 = *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo; 7 = *A. lanceolata* Nutt. subsp. *lanceolata*.

** = 0 - plesiomorphous; 1 - apomorphous; characters defined in Table 12.

VI. General Discussion and Conclusions

In this investigation, the original circumscription of subgenus *Chamissonis* by Maguire (1943) is considered to be taxonomically sound. However, a suggestion that subgenera *Montana*,[9] and *Andropurpurea* should be included in subgenus *Chamissonis* (see footnote, for correct name to use in the event of a union) is presented here. This is supported by initial data from structural features, flavonoid chemistry, cytology, and distributional range. Likewise, the possibility of uniting subgenera *Arctica* and *Austromontana* under the former name, is intimated here to be more phylogenetically appropriate. When this taxonomic re-arrangement is finally accomplished, genus *Arnica* then would consist only of 2 'supercomplexes'- *Arctica* and *Arnica*, each with 16 and 11 species, respectively. However, before any major taxonomic revision involving subgenera is to be proposed, similar biosystematic studies on the remaining 2 subgenera must be conducted to ascertain their true phylogenetic affinity.

In the present study, subgenus *Chamissonis* is composed of 6 species and 2 subspecies; 5 names previously accepted by Maguire (1943) are placed under synonymy. No new taxa are proposed here. One change in rank, *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo *comb. et stat. nov.* (Basionym: *A. amplexicaulis* Nutt.), is, however, recommended. *Arnica ovata* Greene, a taxon previously treated by Maguire (1943) as a synonym of *A. mollis* Hook. is resurrected to replace *A. diversifolia* Greene, as the correct and valid name for plants previously known under the latter epithet. *Arnica silvatica* Greene and *A. arachnoidea* Rydb., 2 taxa that were similarly treated by Maguire (1943) as synonyms of *A. mollis* Hook. are here synonymized with *A. ovata* Greene and *A. parryi* A. Gray, respectively. The lectotype of *A.*

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[9]Nomenclaturally, this taxon should be known as subgenus *Arnica* in as much as it contains the type of the genus, *i.e.* *Arnica montana* L. However, it was unfortunate that subgenus *Montana* was the fourth subgenus to be validly published, after subgenera *Arctica, Austromontana*, and *Chamissonis* (Maguire 1943). If a 2-'supercomplex' system of classification is to be proposed in *Arnica*, then the 2 eligible names are subgenus *Arctica* which will include *Austromontana* and subgenus *Arnica* which automatically replaces subgenus *Montana* and will include subgenera *Chamissonis*, and *Andropurpurea*.

subplumosa Greene chosen by Maguire (1943) is here rejected and a new lectotype is designated from material actually examined by E.L. Greene and that predated the publication date. *Arnica coloradensis* Rydb., another taxon considered by Maguire (1943) as conspecific with *A. mollis* Hook., should now be treated conspecitic with *A. rydbergii* Greene. *Arnica ovalis* Rydb., a taxon treated by Wolf & Denford (1984c) as conspecific with *A. mollis* Hook. and recently re-evaluated by Downie (1987) as conspecific with *A. rydbergii* Greene, is best treated as conspecific with *A. rydbergii* Greene. *Arnica granulifera* Rydb. was originally treated by Maguire (1943) as conspecific with *A. latifolia* Bong. but was recently transferred to the synonymy list of *A. mollis* Hook. by Wolf & Denford (1984c) is accepted as conspecific with *A. latifolia* Bong.

In subgenus *Chamissonis*, 3 species are highly polymorphic throughout their range: *A. chamissonis* Less., *A. lanceolata* Nutt. [with its 2 subspecies, subsp. *lanceolata* and subsp. *amplexicaulis* (Nutt.) Gruezo], and *A. mollis* Hook. However, the remaining members of this subgenus also exhibit a variable amount of phenotypic plasticity. This inherent polymorphism principally accounts for the complicated taxonomy present in this subgenus. Greenhouse studies resolved the problem of differentiating between environmentally-induced and genetically-based characters. In *A. chamissonis* Less., the degree of pubescence and apparent difference in length of the petiole were used to separate this complex into 3 subspecies (Maguire 1943). This treatment is considered to be untenable and therefore is rejected. In this highly polymorphic species, there is an ecotypic variation in pubescence. The nature of the petiole is also markedly variable within and between populations that to separate each individual plant to corresponding suite and confer each a separate name is an exercise in futility.

Although a polyploid series to octoploid level [2n = 152 in *A. mollis* Hook. (Keil & Pinkava 1976)] has been recorded for subgenus *Chamissonis*, only 3 ploidy levels (2n = 38, 57, 76) were confirmed during this study, with the latter two levels being the most prevalent. Barker's (1966) hypothesis that no well-developed apomictic populations occur in unglaciated areas and no well-developed sexual populations occur in glaciated localities is confirmed in this work. Within the boundary zone of Pleistocene glaciations, amphimictic populations survived *in situ* on those geologically- and biologically-confirmed nunataks or refugial sites (*cf.* Packer & Vitt 1974). The correlation is also supported by pollen viability tests on numerous herbarium specimens. Populations with normal pollen grains and 90% or more stainability were inferred to be amphimictic while those with highly deformed, irregular pollen grains (micrograins) with stainability of less than 80% were interpreted as polyploid and apomictic. The latter mode of reproduction was confirmed using simple emasculation procedures. All species examined exhibited 85-95% viable achene production following emasculation. This segment of the study confirmed previous observations on a positive correlation between polyploidy and apomixis (Gustafsson 1946a & 1947b, Stebbins 1950) as well as the presence of high percentage of stainable pollen and survival of diploids in non-glaciated localities (Barker 1966).

The composite flavonoid profile for subgenus *Chamissonis* consists of 18 compounds: 6 flavonol and 6 flavone glycosides, 2 methylated and 4 free aglycones. The subgenus is moderately rich in foliar flavonoids compared with subgenera *Arctica* [12 compounds (Downie 1987)] and *Austromontana* [26 compounds (Wolf 1981)]. The structural pattern of foliar flavonoids is largely homogeneous confirming earlier conclusion by Merfort *et al.* (1986) involving floral flavonoids. Phylogenetically however, this subgenus is more chemically advanced than *Arctica* and *Austromontana* having elaborated a total of 24 (Merfort *et al.* 1986) and 12 highly methylated floral and foliar flavonoids, respectively. The flavonoid composition of the 6 taxa studied is defined by a basic complement of 12 compounds common to all. This basic complement differentiates subgenus *Chamissonis* from the 2 subgenera with known flavonoid profiles (*vide supra*). Taxon differentiation within the subgenus is possible using a set of 6 diagnostic flavonoid compounds. The preponderance of Luteolin 7-O-glucoside, Kaempferol 3-O-glucoside and Quercetin 3-O-glucoside in *Chamissonis*, *Arctica* and *Austromontana* suggests that this set of compounds may represent the primitive condition in genus *Arnica*. In general, overall trend in flavonoid evolution in subgenus

Chamissonis is toward an increase in the number and structural complexity with an increase in phyletic lines. However, a 'depauperate' flavonoid condition was observed in taxa where biotype depletion occurred as a consequence of isolation which may be due to glaciations or other natural factors [*e.g.* volcanism (Wolf 1981), unique soil types, *etc.*]. In *A. parryi* A. Gray, loss of ligules earlier in its evolutionary history is believed to have led to instant reproductive isolation. This was due to pollinators being unable to visually detect presence of flowers, hence leading to failure to effect cross-fertilization. The biological consequence of this event was catastrophic when logically extended to massive blockade of natural interspecific hybridizations. A similar case might be postulated for the discoid members of subgenus *Austromontana*: *A. discoidea* Benth., *A. viscosa* A. Gray, *A. venosa* H.M. Hall and *A. spathulata* Greene (Maguire 1943, Wolf 1981, Wolf & Denford 1984c). In addition to the causal factors enumerated by Wolf (1981) and Wolf & Denford (1984c) responsible for transforming these discoid species (Wolf 1981, Wolf & Denford 1984c) to rare endemics, the loss of their ligules was undoubtedly critical to their survival, especially for those species that were unable to evolve polyploidy and apomixis, *e.g. A. viscosa* A. Gray and *A. venosa* H.M. Hall (Wolf 1981, Wolf & Denford 1984c). This particular event, therefore, might partially account for their relatively 'depauperate' flavonoid profiles and very restricted range.

Cluster analyses using TAXMAP program (Carmichael 1983) and CLUSTAN Ward's method (Wishart 1978) clearly separated the 200 representative OTUs within subgenus *Chamissonis* into 7 discrete taxa, thus supporting the proposed taxonomic revision (see 'Taxonomy section'). These numerical analyses also reveal the amount of intraspecific variations present in each taxon. These measure indirectly the breadth of evolutionary advancement that accrued within the subgenus throughout its developmental history.

Cladistic analysis using 29 attributes suggests that *A. chamissonis* Less. is not the sole progenitor of the species within subgenus *Chamissonis*. Cladistically, *A. ovata* Greene is the most primitive member of this subgenus, retaining marked morphological similarity with the 2 most primitive species in subgenus *Austromontana*: *A. latifolia* Bong. and *A. cordifolia* Hook.

The remarkable structural integrity of this taxon was probably maintained through early evolution of polyploidy and apomictic behavior. *Arnica ovata* Greene appears to be entirely polyploid and apomictic throughout its present range. The evolution of other species proceeded through at least three tiers of ancestors. The ultimate by-products were the contemporary species which have a mosaic of primitive and advanced character states in each.

In subgenus *Chamissonis*, habitat specificity had evolved only in a single species: *A. lanceolata* Nutt. and its 2 subspecies, subsp. *lanceolata* and subsp. *amplexicaulis* (Nutt.) Gruezo. The species grows only on hydric sites from sea level to *c.* 1100 m. Additionally, this taxon is the only one in subgenus *Chamissonis* that has disjunct populations in eastern North America. The eastern disjunct is treated taxonomically as a geographic subspecies, *A. lanceolata* Nutt. subsp. *lanceolata*, of the western main complex. This eastern subspecies is a wholly tetraploid-apomictic and has a highly localized range. Its western counterpart, *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, has widely distributed polyploid populations in glaciated areas and few, isolated amphimictic populations restricted to similar hydric stations beyond the fringes of the glacial ice-sheets. Continuous pre-Pleistocene distribution range of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo across the North American continent is postulated. Disjunction was attributed to Pleistocene glaciations. Survival of the eastern segment in nunataks (for the high-altitude element) and on coastal refugia (for low-elevation counterpart) particularly in the St. Lawrence region of the Gaspé Peninsula (Grant 1977) is the most credible explanation for the existence of this particular taxon in its present highly restricted geographic range.

Finally, the 3 sectional divisions in subgenus *Chamissonis* established by Maguire (1943) are considered highly artificial in the light of present evidence, hence they are rejected.

VII. Taxonomy

Arnica Linnaeus, Sp. Pl. 884, 1753.

= *Arnicula* Kuntze, Rev. Gen. iii, II. 135, 1898; Post & Kuntze, Lexic. 45, 1903.

Type species: *Arnica montana* L.

Perennial partly aromatic herbs arising from long, thin, naked rhizomes or short, thick, woody caudices; when originating from rhizomes, plants usually in single array, when from caudices generally in clumps or distinct tufts; *stems* erect, simple or variously branched above and/or below midsection, nearly glabrous, puberulent to densely villous-woolly, usually with short- or long-stipitate glands; *leaves* (1-) 2 to as many as 15 (-20) pairs, opposite (reduced topmost ones occasionally subopposite or alternate), simple, sessile or with narrow- to broad-winged petioles, margins entire, denticulate to prominently dentate-serrate; rather of 2 positional types: basal and cauline; *basal leaves* (1-) 2 to many, in dense rosette, in a number of taxa withered or absent before or during anthesis, evident only from remnants of leaf-bases or nodal scales, always short- to long-petiolate or oblanceolate; *cauline leaves* all sessile or first and second lowermost pairs with narrow- to broad- winged, short or long petioles; *capitula* solitary to few and large or many to numerous (up to 40) and small, in either cymose or corymbose (rarely paniculate) arrangement, radiate or discoid, turbinate, campanulate to broadly hemispheric; *receptacle* nearly flat to convex, with fimbrillate or villous stramineous to tawny hairs; *periclinium* distinct, nearly glabrous or sparsely pubescent to densely woolly-villous with white, yellowish to purplish short or long glandular or non-glandular hairs; *involucral bracts* biseriate or barely uniseriate, 10-20, narrowly to broadly lanceolate, rarely linear or oblanceolate; *ligulate florets* (when present) pistillate, fertile, (6-) 8-18 (-22), sulphur or lemon- to deep yellow or bright orange, narrowly to broadly oblong with entire or 3-denticulate apical margins; *disc florets* nearly uniform, perfect, fertile, 10-120 (-250), lemon- to deep yellow or bright orange, rarely cream-colored, tubular, funnelform to goblet-shaped, corolla-limb distinctly 5-lobed, upper lobe-surfaces nearly glabrous to papillose; *anthers* bright yellow to deep purple, entire to minutely auriculate-sagittate at base; *styles* slender, exserted, its apex bifurcately reflexed or revolutely coiled, ± flattened, truncate, outer surfaces penicillate to papillose, inner surfaces with introsely marginal stigmatic lines; *achenes* linear, subterete, fusiform, or cylindrical, 4-10 mm long, 5- to 10-nerved, glabrous to variously pubescent with short, stiff or long, lax white bifid or trifid hairs, often solely glandular or glands interspersed among hairs, whitish- to deep brown or silvery gray to waxy black; *pappus* of a single row of 10-50, ivory white, stramineous to tawny, barbellate, subplumose to plumose, capillary bristles; *base chromosome number*, x. = 19.

About 27 species of circumboreal distribution, with a large number of taxa predominantly found in the boreal and montane regions of western North America.

Subgenus **Chamissonis** Maguire, Brittonia 4(3): 460, 1943.

Plants solitary and arising from long thin naked rhizomes or few to numerous, loosely clumped to tightly tufted and arising from short coarse thick woody branching and densely covered with imbricate scales or remnants of leaf-bases and/or freely rooted caudices; *stems* nearly glabrous or variously pubescent-pilose -villous below to remarkably densely white tomentose throughout, or scantily to densely stipitate-glandular above, simple or cymosely branched at inflorescence to paniculately branched at or slightly below midstem; *basal leaves* 1-2 (-3) pairs, oblong or ovate to lanceolate-elliptic or oblanceolate, usually withered during anthesis; *cauline leaves* 3-12 (-20) pairs, barely reduced upward (except in *A. parryi*), sessile or subsessile or with distinct connate-sheathing bases or with lowermost pair narrow- or broad- winged long petiolate, broadly ovate or ±round to narrowly or broadly lanceolate, elliptic-lanceolate to oblanceolate, acute or acuminate to prominently caudate, nearly glabrous to puberulent-viscid with short or long stipitate glands or scantily to densely lanate-pilose, villous or tomentose throughout, its base acute or obtuse to ±truncate or subcordate; *capitula* 1 to 15 (-20), in cymose to paniculate arrangement, radiate (except in prevalent form of *A. parryi* where these are absent or underdeveloped), turbinate to campanulate or conspicuously broad hemispheric; *involucral bracts* (8-) 10-20 (-25), slightly to prominently biseriate, nearly linear to narrowly or broadly lanceolate, acute to acuminate or round-obtuse, ± glabrate-scabrid or scantily to densely uniformly pilose throughout or with distinct tufts of white short or long hairs at inside of apex and/or with few to numerous short-or long-stipitate glands; *ligulate florets* (8-) 10-20 (-22), lemon-yellow or pale to bright or deep yellow, strap-shaped to narrowly or broadly oblong-elliptic, (6-) 10-20 (-25) mm long x (2-) 3-8 (-10) mm wide, its apex subentire to shallowly bi- or tridentate; *disc florets* (20-) 30-200 (-250), narrowly tubular or funnelform to ±goblet-shaped, (5-) 7-10 (-12) mm long, its base scantily to densely hirsutulous with white or brownish simple or bifid hairs, often nearly glabrous and with many to numerous short-stipitate glands; *pappus* of (15-) 18-25 (-35) bristles, whitish brown or stramineous to tawny or deep brown, in the latter case with distinct amber-like deposits inside setae, barbellate to subplumose or strikingly plumose; *achenes* (30-) 50-200 (-230), ±linear or fusiform to smooth- or angular- cylindric, (3-) 5-7 (-8) mm long x 1-2 mm wide, whitish brown with uniform purplish spots to chestnut brown or waxy black, sparsely hispidulous or hirsutulous with simple or bifid white or brownish hairs, often nearly glabrous and with few to many short-stipitate glands.

KEY TO THE SPECIES OF SUBGENUS *CHAMISSONIS*

1. Capitula discoid (rarely with ampliate or well-developed ligules), immature heads nodding; larger leaves usually below midstem, upper ones extremely reduced .... *Arnica parryi* A. Gray

1. Capitula radiate, immature heads erect or nearly so; larger leaves evenly distributed on the stem, upper ones not extremely reduced 2

2. Cauline leaves (2-) 3 (-4) pairs; capitula 1-3 (rarely 4-5) 3

2. Cauline leaves 5 or more; capitula 5 to as many as 20 (rarely less than 5) 4

3. Lowest cauline leaves short- or long- petiolate, broadly ovate, elliptic to ±orbicular or deltoid, base subcordate to ±truncate or obtuse; margin sparsely denticulate-dentate to distantly serrulate-serrate; capitula small to medium, 10-16 (-18) mm high x (8-) 10-15 (-18) mm broad, campanulate-turbinate .... *Arnica ovata* E.L. Greene

3. Lowest cauline leaves sessile (very rarely subsessile), narrowly to broadly lanceolate, lance-elliptic or oblanceolate, base acute to attenuate; margin entire to scarcely denticulate rarely dentate; capitula large, 15-20 mm high x 25-30 mm wide, broad hemispheric to campanulate .... *Arnica mollis* W.J. Hook.

4. Plants solitary arising from long, thin, soft, naked rhizomes; involucral bracts with pilose tuft within apex .... *Arnica chamissonis* C.F. Lessing

4. Plants tufted arising from short, thick, woody, covered with scales or remnants of leaf-bases, caudex; involucral bracts without pilose tuft within apex or evenly pilose

throughout 5

5. Leaves entire to scarcely distantly denticulate, narrowly lanceolate or lance-elliptic, acuminate to caudate, with conspicuous connate-sheath; capitula 5 to as many as 20, turbinate rarely campanulate .... *Arnica longifolia* D.C. Eaton

5. Leaves narrowly to broadly ovate or lance-elliptic, rarely entire or scarcely denticulate to evenly dentate or saliently serrulate-serrate, without conspicuous connate-sheath; capitula 1 to 7, campanulate rarely broad hemispheric or turbinate 6

6. Capitula usually small, (10-) 12-14 (-16) mm high x 10-13 (-15) mm broad; pappus stramineous to tawny barbellate to subplumose; plants of western North American distribution .... *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, *comb. et stat. nov.*

6. Capitula usually large, (10-) 15-18 mm high x 15-20 (-25) mm broad, pappus tawny to dark brown subplumose to plumose; plants of eastern North American distribution .... *Arnica lanceolata* Nutt. subsp. *lanceolata*.

TREATMENT OF INDIVIDUAL TAXA

Order of species follows the sequence in the key (*vide supra*).

1.**Arnica parryi** A. Gray, Amer. Nat. 8: 213, 1874; T. Howell, Fl. NW Amer. 1: 374, 1897; P.A. Rydberg, Colorado Agric. Bull. 100: 389, 1906; S.F. Blake *in* I. Tidestrom, Contrib. U.S. Nat. Mus. 25: 606, 1925; G.N. Jones, Univ. Wash. Publ. Biol. 7: 166, 1938; *Arnica parryi* A. Gray subsp. *genuina* Maguire, Brittonia 4(3): 481, 1943, *nomen illegit.*; A. Cronquist *in* R.J. Davis, Flora of Idaho, p. 690, 1952; A. Cronquist *in* R. Ferris, Illus. Fl. Pac. States 4: 422, fig. 5724, 1959; E.H. Moss, Flora of Alberta, 1st ed., p. 449, 1959; J.P. Anderson, Flora of Alaska & adjacent parts of Canada, p. 496, 1959; E. Hultén, Flora of Alaska & Neighboring Territories, p. 922, 1968; W.A. Weber, Rocky Mountain Flora, 4th ed.(revised), p. 115, 1972; A. Cronquist *in* C.L. Hitchcock & A. Cronquist, Fl. Pac. NW, p. 484, 1973; S.L. Welsh, Anderson's Flora of Alaska, p. 121, 1974; R.D. Dorn, Man. Vasc. Pl. Wyoming 1: 298, 1977; R.I. Ediger & T.M. Barkley, N. Am. Fl. ser. II, pt. 10, p. 27, 1978; H.J. Scoggan, Fl. Canada, pt. 4, 1477, 1979; L. Arnow *et al.*, Flora of Central Wasatch Front, Utah, p. 102, 1980; J.G. Packer, Moss's Flora of Alberta, 2nd ed.(revised), p. 539, map 1022, 1983; S.L. Welsh *et al.*, A Utah Flora, p. 144, 1987.
TYPE: COLORADO, Clear Creek, from the head-waters of Clear Creek & the alpine ridges lying east of "Middle Park", 1861, *C.C. Parry 10* (HOLOTYPE, GH *s.n.*!, UC 658868! PHOTO 430 of GH; ISOTYPE, PH *s.n.*!) Fig. 13; Generalized illustration, Fig. 14.

Arnica angustifolia Vahl var. *discoidea latifolia* Gray, Amer. J. Sc. 83: 238, 1862. TYPE: same as that for *A. parryi* A. Gray (*vide supra*).

Arnica angustifolia Vahl var. *eradiata* A. Gray, Proc. Acad. Phila. 1: 68, 1863. = *Arnica eradiata* (A. Gray) Heller, Cat. Amer. Pl. 7: 130, 1898. TYPE: COLORADO, Rocky Mountain alpine flora, latitude 39°-41°, 1862, *E. Hall & J.P. Harbour 338* (HOLOTYPE, GH *s.n.*!).[10] This collection was determined by A. Gray (*in sched.*) as "*A. latifolia eradiata*".

Arnica parryi A. Gray subsp. *sonnei* (Greene) Maguire, Brittonia 4(3): 482, 1943; = *Arnica sonnei* Greene, Pittonia 3: 104, 1896; R.M. Lloyd & R.S. Mitchell, Flora of White

[10] This collection is mounted on the same herbarium sheet together with the holotype of *A. parryi* A. Gray and *A. angustifolia* Vahl var. *discoidea latifolia* A. Gray.

Mts. Calif. & Nevada, p. 165, 1973; = *Arnica foliosa* Nutt. var. *sonnei* (Greene) Jepson, Man. Fl. Pl. Cal. 1157, 1925. = *Arnica parryi* var. *sonnei* (Greene) Cronquist *in* Ferris, Contr. Dudley Herb. 5: 105, 1958; A. Cronquist *in* R. Ferris, Illus. Fl. Pac. States 4: 422, 1959. **TYPE**: CALIFORNIA, Placer Co.; 3 miles from Truckee, woods on Truckee River, shady places, 4 July 1886, *C.F. Sonne 5* (ISOTYPES, BM *s.n.*!, GH *s.n.*!, UC 193459!; UC 658897! PHOTO 436 & 437 of UC 193459).

Arnica parryi A. Gray var. *crinita* Osterhout, Muhlenbergia 6: 47, 1910. **TYPE**: COLORADO, Larimer Co., Mt. Cameron, 15 August 1908, *G.E. Osterhout 3814* (HOLOTYPE, RM 159541!; ISOTYPE, RM 62078!; UC 658898! PHOTO 435 of RM 62078).

Arnica arachnoidea Rydb., N. Amer. Fl. 34: 353, 1927. *Synon. nov.* **TYPE**; UTAH, Big Cottonwood Canyon, below Silver Lake, 4 July 1905, *P.A. Rydberg & E.C. Carlton 6609* (HOLOTYPE, NY *s.n.*!; ISOTYPE, CAN 191136!; UC 658808! PHOTO 422, 423 & 424 of NY *s.n.* + PHOTO 425, 426 & 427 of CAN 191136).

Plants 1.5 to 5 (-6) dm high, erect or ascending from dark brown elongate moderately to densely rooted rhizomes; *stems* solitary, simple or usually arcuately branched at inflorescence, nearly glabrate to puberulent or scantily to profusely woolly-villous or lanate-pilose with long lax white multiseptate hairs toward the base gradually replaced with long- or short- stipitate glands above; *basal leaves* 1 to 2 pairs, ovate or nearly round- to oblong-ovate, subsessile or short-petiolate, much-smaller than cauline leaves, usually withered at anthesis; *cauline leaves* (2-) 3-4 pairs, lower ones commonly confined to below midstem or nearly appearing as basal rosette, large, round- or oblong- ovate, ovate-lanceolate to narrowly or broadly lanceolate, distinctly long- or short- petiolate, mostly entire to seldom sparsely denticulate, lamina (4-) 5-20 (-22) cm long x (1-) 2-4 (-6) cm wide, scantily to moderately pilose with white hairs and with few short stipitate glands on the upper surface, its base obtuse or cuneate to truncate, upper cauline leaves (above midstem) extremely reduced, (1.4-) 2-6 (-8) cm long x (0.3) 0.5-1 (-1.5) cm wide, sessile, nearly linear to narrowly elliptic-lanceolate; *capitula* (1-) 3-9 (-14), commonly discoid or very seldom with ampliate or slightly to fully developed ligules, turbinate to narrowly campanulate, (15-) 17-20 (-24) mm high x 10-14 (-18) mm wide, buds characteristically nodding or ±pendulous; *periclinium* short, narrow, with many to numerous white or translucent short or long gland-tipped hairs; *involucral bracts* barely biseriate, (8-) 10-16 (-20), linear to narrowly lanceolate, (10-) 12-15 (-17) mm long x 1-3 mm wide, acute to acuminate, sparsely pilose throughout with dense

Figure 13. Holotype of *Arnica parryi* A. Gray [Colorado, Clear Creek, from the head-waters of Clear Creek & the alpine ridges lying east of "Middle Park", 1861, *C.C. Parryi 10* (GH *s.n.*!)].

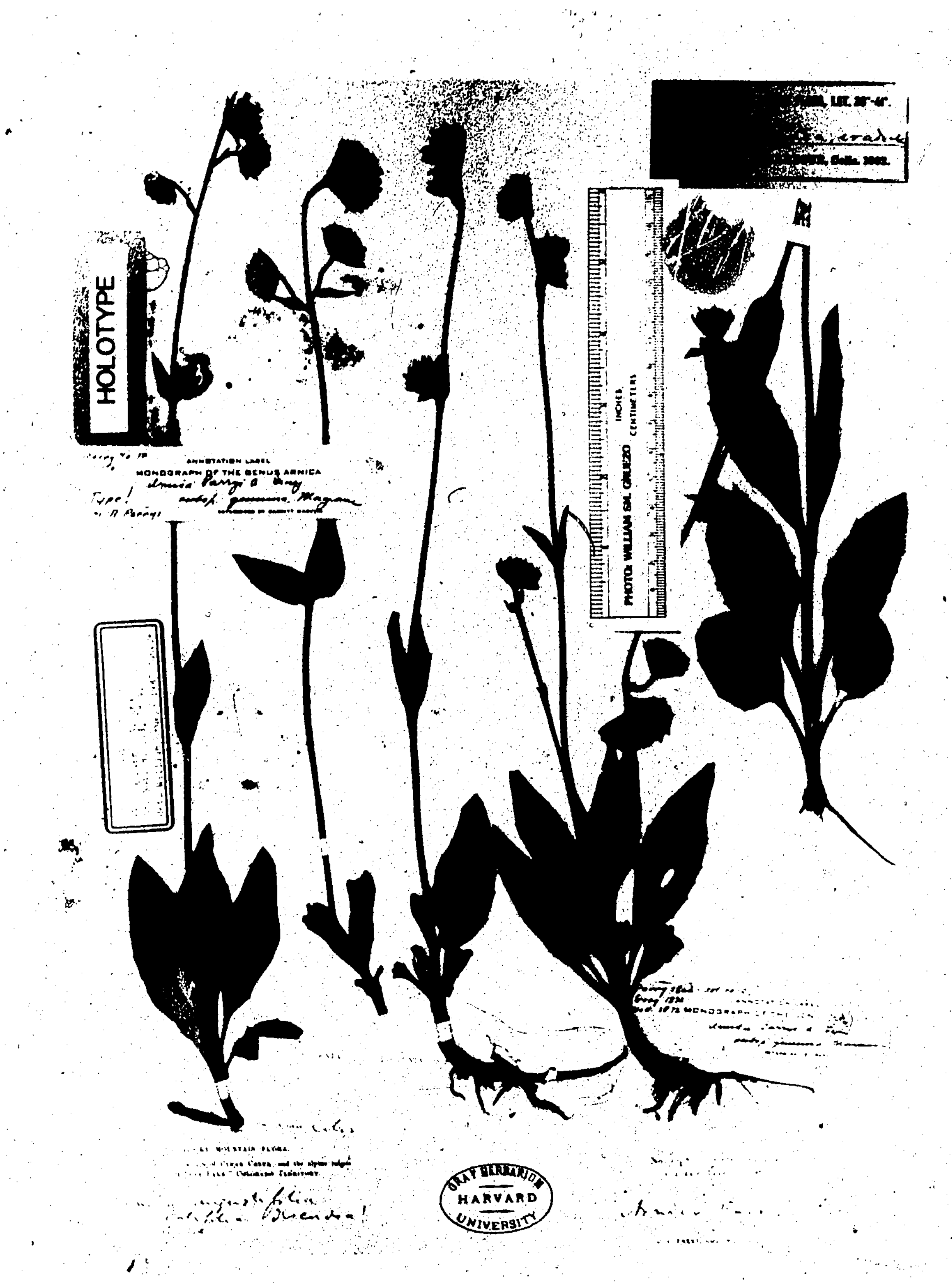

HOLOTYPE
ANNOTATION LABEL
MONOGRAPH OF THE GENUS ARNICA
INCHES
CENTIMETERS
GRAY HERBARIUM
HARVARD
UNIVERSITY

Figure 14. Habit and morphology of *Arnica parryi* A. Gray. [Montana: Glacier Co., Marias Pass Divide, Clark & Lewis National Forest Campground, vicinity of campsite no. 3, elev. 5216 ft, 29 June 1986, *William Sm. Gruezo & Aida BG. Gruezo WM12000* (ALTA!, WGRZ!)].


5 CM

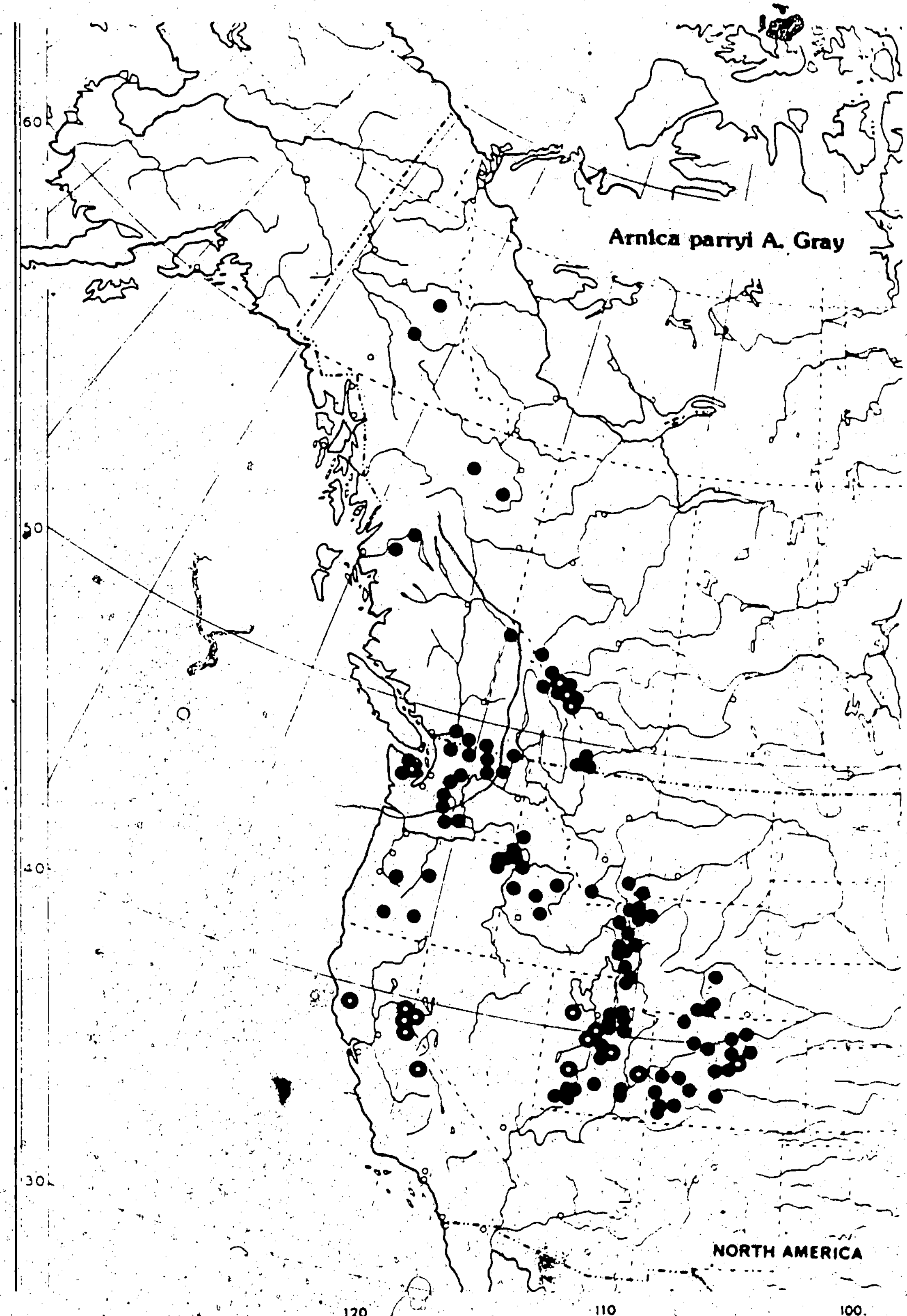
prominently gland-tipped hairs; *ligulate florets* generally absent or very seldom present, 5-10, ampliate to poorly or well-developed, 5-15 (-17) mm long x 3-5 mm wide; *disc florets* (18-) 25-45 (-55), bright yellow, (6-) 8-10 (-13) mm high, funnel form to goblet shaped, base of tube sparingly to densely pilose with short or long white hairs, rarely with short stipitate glands; *achenes* (25-) 30-50 (-60), round- to prominently angular- cylindric, 4-5 (-7) mm long, glabrous or with few short-stipitate glands to densely hirsute throughout or one-fourth to one-half from above with short or long white hairs, dark brown to waxy black; *pappus* of (25-) 30-40 (-45) bristles, whitish brown to stramineous rarely tawny, barbellate to slightly subplumose. *Chromosome number*, 2n = 38, 57, 76.

ECOLOGY AND DISTRIBUTION. Up to the present, *A. parryi* has not yet been recorded from Alaska and Northwest Territories. It is found only in few localities in Yukon usually on dry slopes or ledges of steep ravines as well as alpine meadows beyond the timberline. It is apparently more common in British Columbia (see Douglas 1982, fig. 51 for additional locality) on subalpine and alpine meadows and on gaps or grassy slopes of coniferous (e.g. spruce-pine) forests or aspen woods. In Alberta, it is listed as rare (Packer & Bradley 1984, Argus & White 1978) and confined only in the Rocky Mountain Range on mesic to xeric subalpine-alpine slopes and margins or openings of pine-spruce, larch-fir forests as well as in avalanche tracts, cliffs and screes.

South of latitude 49°, *A. parryi* is evidently well-known on similar habitats from numerous localities in Washington, Idaho, Wyoming, Utah and Colorado; with fewer records from Montana, Nevada, Oregon and California. In the latter range, only the ligulate form is present which is restrictedly abundant in the Sierra Nevada Mountains and only rarely extending northward to the Cascade Mountains of southern Oregon. Similar ligulate form of *A. parryi* A. Gray is, however also present in some isolated sites in Alberta, Washington, Utah and Colorado (Fig. 15).

In addition to the counties in Utah listed by Welsh (1983) and Welsh *et. al.* (1987), A. parryi is also found in the counties of Utah [roadside to Bald Mountain, *R. Collins & K.*

Figure 15. Geographical range of *Arnica parryi* A. Gray.
(solid dot = discoid form; white-center dot = ligulate form).


Arnica parryi A. Gray
NORTH AMERICA
60
50
40
30
120
110
100.

Harper 470 (BRY 204884!)], Juab [Mt. Nebo, on road to Privateer Mine, *F. Peabody 588* (BRY 179989!)], San Juan [Mt. Mellenthin, Horse Canyon, *Bassett Maguire et al. 15360* (PH 781092!)] and Tooele [Stansbury Mountains, North Willow Lake, *A. Taye 624* (BRY 220224!)]. In these localities, *A. parryi* is represented by its ligulate form.

The flowering period for *A. parryi* generally commences in early May and lasts up to middle to late September. It is usually found growing from an altitude of 550 m (18,000 ft) to as high as 3,810 m (12,500 ft) in the southern part of its geographical range.

SPECIMENS EXAMINED. CANADA. ALBERTA. **Jasper National Park**, mountains north of Cavell Creek, subalpine slopes, *J.M. Macoun Geol. Surv. Canada 96017* (CAN 109757!). **Banff National Park**, vicinity of Sunshine Ski Lodge, Fatigue Pass, *A.E. Porsild & A.J. Breitung 13763* (CAN 109761!); Banff National Park, vicinity of Sunshine Ski Lodge, south of Healy Creek, *A.E. Porsild & A.J. Breitung 15936 (CAN 109738!); Banff National Park, Mt. Borgeau & Mt. Brett, A.E. Porsild & A.J. Breitung 13762* (CAN 109758!); Banff National Park, Lake Louise, *M.O. Malte & W.R. Watson 1060* (CAN 291716!); Banff National Park, Lake Louise, *Stewardson Brown 723* (PH 529829!); Banff National Park, Rocky Mts., head of Lake Louise, *Macoun Geol. Surv. Canada 65500* (CAN 109765!); Banff National Park, Lake Louise, spruce forest along trail to Lake Agnes, *A.E. Porsild & A.J. Breitung 15746* (CAN 109763!); Banff National Park, Moraine Lake, near Lake Louise, *H.J. Scoggan 16332* (CAN 307516!); Banff National Park, upper drainage of North Saskatchewan River, valley of Mistaya River, between Saskatchewan Crossing & Waterfowl Lakes, *A.E. Porsild & A.J. Breitung 14639* (CAN 109759!); Banff National Park, Lake Agnes, *Macoun Geol. Surv. Canada 14759* (CAN 109771!) Banff National Park, Lake Louise, *Macoun Geol. Surv. Canada s.n.* (CAN 109770!); Rocky Mountains, Mt. Poget, *Macoun Geol. Surv. Canada 65501* (CAN 109764!). **Crowsnest Pass**, *J.H. Hudson 3023* (SASK 54194!). **Waterton Lakes National Park**, Chief Mountain International Highway, *A.J. Breitung 16871* (UC 985836!); Waterton Lakes National Park, Chief Mountain International Highway, *August J. Breitung 16006* (ALTA 16945!); Waterton Lake, Sheep Mountains, *Macoun Geol. Surv. Canada 11599* (CAN 109768!, NDG 062539/HG 45908!).

BRITISH COLUMBIA. **Spinel Lake**, *John M. Gillett & M. Boudreau 17836* (CAN 412204!). Northern British Columbia, mountain above Redfern Lake, *Mrs. J. Norman Henry 297* (PH 680092!). **Smithers**, Hudson Bay Mountain, *J.W. Eastham 12077* (ALTA 16946!, CAN 109776!). **Babine Trail**, 11 miles south of Takla Lake, *T.T. McCabe 8022* (UC 649846!). Alta Lake, lower alpine meadows of Sproat Mountain, *T.T. McCabe 2979* (UC 551122!). West of Mt. Sophie Mountain, along the Dewdney Trail, *J.M. Macoun Geol. Surv. Canada 64986* (CAN 109775!). Mount McLean, Lillooet, *W.B. Anderson 6305* (WS 79711!); **Rocky Mountains**, headwaters of Fraser River, *W. Spreadborough Geol. Surv. Canada 19634* (CAN 109767!). Yoho National Park, near Sherbrooke Lake, *W.C. McCalla 8484* (ALTA 68817!); Rocky Mountains, Kicking Horse Lake, *Macoun Geol. Surv. Canada 14760* (CAN 109769!); Rocky Mountains, Kicking Horse Lake, *Macoun Geol. Surv. Canada 14761* (CAN 109766!); Rocky Mountains, Lake Louise, *Edith M. Farr s.n.* (PH 37778!); Lake Louise, B.C., *Mrs. Charles Schaffer s.n.* (PH 12544!); Rocky Mountains, mountain NE of Pollock, *R.L. Taylor & D.H. Ferguson 2912* (WS 243531!). Cathedral Provincial Park, Quinescoe Lake, *G.W. Douglas & M.J. Ratcliffe 11505* (BRY 207800!). North of Chilliwack River, *J.M. Macoun Geol. Surv. Canada 26935* (CAN 109774!); Chilliwack Valley, *J.M. Macoun Geol. Surv. Canada 26935* (NDG 062527/HG 45905!). First Summit west of Skagit River, *J.M. Macoun Geol. Surv. Canada 69318* (CAN 109772!, NDG 062609!). Cascade Range, near head of

McGillivray Creek, *J.M. Macoun Geol. Surv. Canada 96018* (CAN 109773!, *p.p. mag.*). Near international boundary between Kettle & Columbia rivers, *J.M. Macoun Geol. Surv. Canada 64986* (NDG 062536/HG 45911!, WS 26615!).

YUKON TERRITORY. Canol Road, Rose-Lapie River Pass, mile 105, schist mountain east of lake, *A.E. Porsild & A.J. Breitung 10935* (ALTA 29670!, UC 994743!); Canol Road, south & east slopes of Mt. Sheldon, steep ravines & ledges opposite mile 222, *A.E. Porsild & A.J. Breitung 11777* (ALA 40956!, UC 994742!).

U.S.A. CALIFORNIA. Yosemite National Park, vicinity of Lake Tenaya, *H.M. Hall & E.B. Babcock 3515* (UC 63060!). **Placer Co.**, Sierra Nevada Mts., Squaw Valley on Truckee River, wet shady places, *C.F. Sonne s.n.* (UC 197311!); Sierra Nevada Mts., meadows along Truckee River, *C.F. Sonne 377*, (PH 548776!, JEPS 35894!); woods near Truckee, *C.F. Sonne s.n.* (UC 193459!).[11] **Lake Co.**, Mt. Sanhedrin, on overhanging creek bank, transition zone at 5300 ft alt., in the semi-arid section of inner North Coast Ranges, 40-50 mi from Pacific Ocean, *H.M. Hall 9464* (UC 174027!). **El Dorado Co.**: Lake Valley, *M.S. Baker s.n.* (UC 62940!); Sierra Nevada Mts., south end of Fallen Leaf Lake, Canadian zone at 6400 ft alt., *H.M. Hall 8781* (UC 148943!); steep slope trail from Echo Lake to Fallen Leaf, on Echo side of summit, 7600 ft elev., *Gladys L. Smith 2264* (JEPS 71778!); Sierra Nevada Mts., Glen Alpine Creek, Canadian zone at 7700 ft alt., half-dry soil, loose, rays 10-12, often only 1-3, *H.M. Hall 8816* (UC 148931!); Glen Alpine Springs, *Helen D. Geis 67* (UC 468978!); Half Moon Lake, alt. 8000 ft, *L.R. Abrams 12767* (UC 483411!); Half Moon Lake, T12N R17E S7, meadow on northside of lake, elev. 8160 ft, gravelly soil, rays 12-17, *Johnnie L. Gentry Jr 2147 & Earl Jensen* (BRY 81956!); Mt. Tallac below summit area at 8750-9250 ft elev., in grassy meadow, *Gladys L. Smith & Alasdair H. Neilson 2755* (JEPS 71784!); Summit area of Mt. Tallac, 9250-9735 ft elev., *Gladys L. Smith & Alasdair H. Neilson 2793* (JEPS 72233!); Glen Alpine Region, Mt. Tallac, *Alice Eastwood 1182* (UC 892204!); Mt. Tallac, near the summit, *Helen D. Geis s.n.* (UC 176405!); Lake Tahoe Region, between Fallen Leaf Camp & Glen Alpine Lodge, *John Thomas Howell 1306* (JEPS 35895!); Lake Tahoe, open woods above Meeks Bay, alt. 6225 ft, *W.C. McCalla 6261* (ALTA 68818!). **Mariposa Co.**: Bridalveil Creek Canyon, above the falls, *R.F. Hoover 3769* (JEPS 20964!). Southern Sierras, Marble Fork, *G.B. Grant 4899* (UC 467700!); Donner, Sept. 1888, *T.S. Brandegee s.n.* (UC 220231!). Exact locality unknown (not stated): *Geol. Surv. California 1800* (UC 29584!); *Mrs. R.M. Austin 309* (UC 91032!); *Mrs. R.M. Austin s.n.* (NDG 062540/HG 45907!); *Frederick W. Oettinger 1087* (UC 1-408811!); *A. Gray s.n.* (GH *s.n.*!).

COLORADO. Larimer Co., head of Poudre Canyon at Cameron Pass in the Rocky Mts., ca. 70 miles due W of Fort Collins, *E. Neese 16150* (BRY 275158!, CAN 491308!); near Cameron Pass, *Geo. E. Osterhout 270* (RM 169586!); Mt. Cameron, *Geo. E. Osterhout 3815* (RM 169584!). **Jackson Co.**, 3 miles west of Cameron Pass at The Crags campground, *C.L. Porter & Marjorie W. Porter 8491* (UC M-187530!). **Routt Co.**, near head of Walton Creek, 0.8 mile N of US Hwy. 40, *D.H. Wilken & R. Henrickson 14006* (BRY 262882!); Routt Forest, Black Mountain, *R.K. Gierisch 2734* (RM 471058!); Routt National Forest, trail from Slavonia to Mica Creek, along Gilpin Creek, ca. 12 miles E of Clark, *W.A. Weber 7093* (WS 211541!); Hahn's Peak, *Leslie N. Goodding 1701* (RM 52153!, UC 69436!). **Boulder Co.**, slope of Caribou Hill, above Nederland, *George Neville Jones 34669* (UC M-283404!); Lake Eldora, *I.W. Clokey 3163* (CAN 191153!, RM 95447!, UC 892209!). **Grand Co.**, Berthoud Pass, *Frank Tweedy 5827* (RM 47867!); top of Berthoud Pass, *Alan A. Beetle 2251* (ND 011149!, RM 153743!, RM 471064! as *B-2251*); near Berthoud Pass, Idaho Springs, *Otto Degener & Leroy Peiler 16734* (RM 193991!); near Rabbit Ears on U.S. 40, *C.L. Porter & Marjorie W. Porter 7612* (RM 256075!, UC M-090194!); Rabbit Ears, *L.N.G. (= Leslie N. Goodding ?) 1552* (RM 52154!); Milner Pass, *C.B. Clokey & I.W. Clokey 4390* (CAN 191146!, ND 011147!, PH 591428!, RM 90097!, UC 535651!, WS 70620!).

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[11] B. Maguire wrote on the herbarium sheet "no. 5" and annotated it as isotype of *Arnica sonnei* Greene.

Arapahoe Forest, 21 Aug. 1911, *R.T. Guthrie 57* (RM 471063!); Arapahoe National Forest, near Triangle Lake, *Aven Nelson & Ruth A. Nelson 4505* (RM 191945!); Arapaho Forest, near St. Louis R.S. (=Ranger Station), *Upson s.n.* (RM 471104!); Arapahoe National Forest, along the Pawnee Lake Trail, *Aven Nelson & Ruth A. Nelson 4476* (RM 191944!, UC 724274!, WS 133087!). **Gilpin Co.**, Teller Lake, *H.M. Hall 10483* (UC 217145!). **Clear Creek Co.**, NW of Loveland Pass, *Barry C. Johnston 2231* (BRY 206937!); Empire, *Frank Tweedy 5819* (RM 47866!); Pike Forest, Geneva Creek, *Ralph K. Gierisch 2660* (RM 471059!); Pike Forest, Hall Valley, *R.T. Guthrie 62-G* (RM 471060!); mountains about the head waters of Clear Creek, high mountains about Gray's Peak, *H.N. Patterson 76* (PH 709181!, UC 194475!). **Summit Co.**, Route 6, Loveland Pass, *F.W. Pennell, Joseph Ewan & R.L. Schaeffer Jr. 24[illegible]02* (PH 814012!); Loveland Pass, alpine meadows on south side of Pass, *T. Mosquin 4856* (UC M-287584!); near Breckenridge, *Kenneth K. Mackenzie 98* (PH 523922!, RM 30564! *p. p.*). **Pitkin Co.**, West Sopris Creek, *Jean Langenheim 1395* (UC M-181492!). **Chaffee Co.**, Monossos or Monassos (?) Creek, *I.W. Clokey 3471* (CAN 191154!, RM 93448!, U[illegible]892208!, WS 36632!). Monarch Pass, near the Gunnison-Chaffee Co. line, between Gunnis[illegible] Salida along U.S. Highway 50, *E. Neese 15904* (BRY 274639!); **Gunnison Co.**, Schofield [illegible], *Larry C. Higgins 3787* (BRY 93653!); ca. 3 miles north of Gothic, *Larry C. Higgins 3780* (BRY 93633!); Gothic, at the Rocky Mt. Biological Laboratory, *Larry C. Higgins 2210* (BRY 80883!); Gothic, at the Rocky Mt. Biological Laboratory, *Larry C. Higgins 2285* (BRY 80855!); Red Mt., 2 miles east of Gothic (8 miles north of Crested Butte), *Edgar T. Wherry s.n.* (PENN/PH s.n.!); Gothic Mountain, *J.M. Coulter s.n.* (PH 709182!); 2 miles north of Lake Brennan near base of Ruby Peak, *Reed C. Rollins 1447* (ND 011150!, RM 471062!); Gunnison Watershed, Rogers, *C.F. Baker 792* (NDG 062537/HG 45910!, RM 33185!, RM 169594!, UC 29645!); Queen's Basin, *(RM 257009!, UC M-086619!)*. **Delta Co.**, Grand Mesa near Grand Mesa post office, *U.T. Waterfall 11674* (UC 993975!). **Montrose Co.**, Uncompaghre Forest, head of Little Red, *Lancaster, Doran & Bunderson 59* (RM 471057!); Uncompahgre National Forest, Ranger Station, *Ernest P. Walker 552* (RM 75652!); Uncompaghre Divide, *Edwin Payson 204* (RM 80973!). **Ouray Co.**, Little Ouray Mountain, *Edw. L. Greene s.n.* (NDG 062535/HG 45912!). **San Miguel Co.**, Uncompahgre National Forest, Lone Cone, *Vlad Siplivinsky 4773* (BRY 253527!); about 1 mile west of Red Mt. Pass, *T. Mosquin & J.M. Gillett 5408* (UC M-287583!), chromosome number from this collection- 2n= ca. 76, det. T. Mosquin 1964. **San Juan Co.**, San Juan Range, 2 miles north of Molas Pass, *C.L. Porter & Marjorie W. Porter 10497* (RM 283425!). **La Plata Co.**, La Plata Mountains, Little Kate Mine, *C.F. Baker, F.S. Earle & S.M. Tracy 496* (RM 13666!, RM 169593!); Little Kate Mill above La Plata, *C.F. Baker, Earle & Tracy 596* (NDG [illegible]2525/HG 34142!). **Montezuma Co.**, Montezuma Forest, east side Lone Cove or Cone (?), north of West Beaverburn, *Frank H. Rose R-96* (RM 471061!). Mt. Harvard, *C.L. Shear 3788* (RM 150274!); Sierra Sangre de Cristo, limestones(?), *T.S. Brandegeē s.n.* (UC 177089!). Alpine woods near Georgetown, *Harry N. Patterson s.n.* (NDG 062528/HG 45903!). Fraser, Idlewild Ranger Station, *Earl L. Johnston 329* (RM 117557!). Estes Park, *W.S. Cooper 230* (RM 57640!). San Isabel Forest, *C.E. Taylor 369* RM 471073!). Rocky Mt., Lat. 39-41, alpine & subalpine, *C.C. Parry 10 (not the type!)* (GH *s.n.*!, PH *s.n.*!); Rocky Mt., Lat. 39-41, *C.C. Parry s.n.* (GH *s.n.* !); Rocky Mt. Alpine Flora, Lat. 39-41, *E. Hall & J.P. Harbour 338* (GH *s.n.*!, PH *s.n.*!); Rocky Mountains alpine flora, Lat. 39°-41°, *E. Hall & J.P. Harbour 938* (PH s.n.!). Southwestern Colorado, Sierra La Plata, *T.S. Brandegee 1122* (UC 178530!).

IDAHO. Nez Perce Co., about forest, alt. (2000-)3500 ft, *A.A. & E. Gertrude Heller 3439* (NDG 062541/HG 45906!, PH s.n.!, UC 91033!, WS 26600!); forest, *A.A. & E. Gertrude Heller s.n.* (RM 9034!); Black Pine Camp, woods near meadows, *R.E. Rodock 69* (WS 183533!). **Idaho Co.**, Seven Devils Mts., ca. 14 1/2 miles WSW of Riggins & 1/2 mile northward on Forest Service trail 56 (toward Dry Diggins Lookout) from its junction with trail no. 112, Canyon National Recreation Area, formerly Nez Perce National Forest, *R.T. Bingham & C.J. Miller 425* (WS 286868!); Seven Devils Mts., Nez Perce National Forest, Rapid River Trail, *Aven Nelson & Ruth A. Nelson 2996* (RM 177971!, UC 614295!). **Lemhi Co.**, near roadside between Fly & Sleeping Deer Mts., 32 miles NW of Challis, *C.L.*

Hitchcock & C.V. Muhlick 11364 (UC 968683!, WS 155982!). **Fremont Co.**, along road to Squirrel Meadows, east of Ashton, near Idaho-Wyoming border, *Arthur Cronquist 1725 (ND 011146!); woods at Idaho-Wyoming Line, along road between Ashton & Cave Falls, Arthur Cronquist 1749* (RM 186929!); Upper Snake River Area, Chick Creek Road, 2 miles north of Chick Creek *D.W. Lindsay 1626* (BRY 109233!). **Custer Co.**, near Cape Horn, *J.F. Macbride & Edwin B. Payson 3598* (RM 86107!, UC 256370!). **Washington Co.**, Weiser Forest, east branch of Weiser River, *Harley J. Helm 310* (RM 471144). **Blaine Co.**, Sawtooth Primitive Area, meadowland 2 miles below lowermost of lakes at Head, Alpine Creek, NW of Alturas Lake, *C.L. Hitchcock & C.V. Muhlick 10469* (CAN 191144!, PH 838851!, RM 198572!, UC 968673!). Sawtooth National Forest, road turn-off on Highway 75 leading to Alturas Lake, c. 300 m before Alpine Creek parking area, *William Sm. Gruezo WM11431* (ALTA!, WGRZ!). **Bonneville Co.**, Targhee National Forest, Range 45E TWP 2S Sec. 36, very close to Palisades Reservoir, *Dieffenbach, Glennon, Holte, Mel, Pearson & Vieth TNF-1014* (RM 471146!); Caribou Range, Anderson Gulch, along road to Caribou City (ghost town), 15 airline miles south of Palisades Dam, T3S R44E Sec. 27, *Noel H. Holmgren 5461 & Vernon Marttala* (BRY 106775!, UC 1-381429!); Caribou Mountain, *Edwin B. Payson & George M. Armstrong 3527* (PH 617126!, RM 98210!).

MONTANA. **Park Co.**, Woodie Basin, about a mile south of Cooke City, *Jean G. Witt 1324* (WS 184742!). **Gallatin Co.**, Gallatin Forest, Upper Bear Basin, *Eric P. White 84* (RM 471065!); Bozeman & vicinity, Gallatin Basin, *J.W. Blankinship 311* (CAN 191155!, PH 519484!). **Beaverhead Co.**, Beaverhead National Forest, Sec. 33 T3S R18W, *Orville Sparrow 153* (RM 471066!). Midvale, Squaw Mountain, *L.M. Umbach 528* (RM 169590!). Summit, G.N. Ry., *R.S. Williams s.n.* (RM 24209!).

NEVADA. **Washoe Co.**, 3 mi W of summit of Mt. Rose Highway, alt 8500 ft, *L.S. Rose 38279* (UC 892116!); 4 1/2 mi south of Mt. Rose, rocky slope, moist bank under aspens, elev. ca. 8300 ft, *C.L. Hitchcock & J.S. Martin 5563* (UC 722762!, WS 95763!); Ineline or Incline (?), *C.L. Brown s.n.* (UC 196032!). Dinsmore camp, Hunter Creek canyon, elev. 6000 ft, *P.B. Kennedy 1616* (UC 127952!).

OREGON. Wallowa Co., vicinity of Hat Point, on west rim of Snake River Canyon, *Bassett Maguire & Arthur H. Holmgren 27025* (CAN 191151!, UC 739036!, WS 170010!); 16 miles southeast of Imnaha, dry meadow along Hat Point Road, *Marion Ownbey & Ruth P. Ownbey 1835* (PENN/PH s.n.!, RM 183744!, WS 101662!); SE of Joseph, *R. Daubenmire 6234* (WS 249946!); Wallowa Mts.: head of the Wallowa River, *Wm. C. Cusick 2491a* (WS 26597!); summit of Lookout Mt., west rim of Hell's Canyon of Snake River, *L. Constance & C.D. Jacobs 1420* (WS 69195!). **Union Co.**, Whitman (Minam) Forest, head of Big Canyon, *W.D. Foreman 12* (RM 471137!); Whitman (Minam) Forest, 1/2 mile west of Taylor Green Camp, *Rolland Huff 16H* (RM 471136!). **Crook Co.**, Ochoco Mts. between Prineville & Mitchell, Twp.14S R20E S1 or 2, northwest edge of the Big Summit Prairie, *Arthur Cronquist 7501* (UC M-000107!, WS 210443!). **Lane Co.**, Tipsoo Butte, S fork McKenzie River, NW 1/4 S28 T17S R5E, *James C. Hickman 87-4* (UC 1 501153!); Rebel Peak, Sec.19 T18 R6E, *L.E. Detling 7019* (WS 276338!). **Lake Co.**, Fremont National Forest, Squaw Butte Spring, Sec.27 T38S R21E, *Donovan Yingst DY-26* (RM 471143!). **Klamath Co., Crater Lake National** Park, below the engineers camp, *A.A. Heller 12628* (PENN 68057!, PH 598803!, UC 726624!, WS 150236!). Crater Lake National Park, inside Crater Lake proper, on Rim Drive, c. 1/4 mile before Sun Notch Viewpoint, *William Sm. Gruezo WM11472* (ALTA!, WGRZ!). Crater Lake National Park, inside Crater Lake proper, on Rim Drive c. 300 m from Crater Lake Lodge & Crater Lake Park Headquarters, *William Sm. Gruezo WM11476* (ALTA!, WGRZ!). Ochoco Forest, *Douglas C. Ingram B-82* (RM 471141!). Ochoco National Forest, *G.C. Blake C-105/17280* (RM 471142!). Powder River Mountains, *Wm. C. Cusick s.n.* (UC 91031!); Powder River Mountains, *C.V. Piper s.n.* (WS 26595!). Mountains, 5000 ft alt., *Wm. C. Cusick 1793* (NDG 062538/HG 45909!, UC 91030!, UC 29647!).

UTAH. Cache Co., Cache Forest, head of Jubo Creek, *Geo. W. Craddock GWC-30* (RM 471151!). **Summit Co.**, 3 miles W of Bald Mt., *Bassett Maguire, A.G. Richards & Ruth Maguire 4315* (RM 140649!, UC 53007!); Uinta Mountains, 1/2 mile NE of Trial Lake, *B.F. Harrison 10778* (BRY 18874!, UC 712076!). **Tooele Co.**, Stansbury Mts., North Willow Lake, meadow below lake, elev. 8500 ft, *A. Taye 624* (BRY 220224!). **Utah Co.**, along roadside to Bald Mt., top of loop road, N facing slope, 8800 ft elev., *R. Collins & K. Harper 470* (BRY 204884!). **Juab Co.**, Mt. Nebo, on road to Privateer Mine, 2 mi off Nebo loop road, 9000 ft elev., *F. Peabody 588* (BRY 179989!). **Salt Lake Co.** alt. 9000 ft, *A.O. Garrett s.n.* (PH 524194!); Salt Lake Co., Silver Lake, alt. 8700 ft, *A.O. Garrett 1330* (RM 52686!). Big Cottonwood Canyon, near Silver Lake, *A.O. Garrett 1572* (RM 52682!); Brighton, Big Cottonwood Canyon, *A.O. Garrett 6966* (BRY 90868!); head of Little Cottonwood Canyon, *A.O. Garrett 8478* (UC 892202!); Brighton, spruce belt, 9000 ft elev., *W.P. Cottam 7063* (BRY 90869!). **Duchesne Co.**, Uintah Mts., Mirror Lake, *Geo. J. Goodman 6357* (UC M-081747!); Uinta Mts., 14.5 km & 27 degrees NE of Tabiona, T1N R7W S24 N1/4, USM, McAfee-Rock Creek drainage, *S. Goodrich 19136* (BRY 256937!). **Wasatch Co.**, Uinta National Forest, head of Vat Creek, 20 miles E (108 degrees) of Heber City, T1S R10W, *S. Goodrich 16013* (BRY 227006!); Uinta National Forest, head of N.F. Phelps Brook, 22 miles due E of Heber City, T1N R10W Sec.2 SW1/4 USM, *S. Goodrich 17447* (BRY 240719!); Uinta Mts., Wasatch National Forest, 18 miles due E of Kamas, Broadhead Meadows, T2S R9E Sec.16 NW1/4, *S. Goodrich 21316* (BRY 271565!); Wasatch Mts., Alta, *Marcus E. Jones s.n.*(RM 49077!). **Carbon Co.**, CC Price-Ferron, ca. 11 miles ENE of Fairview, T13S R6E Sec.10, *S. Welsh & S. Clark 15467* (171547!). **Sanpete Co.**, Manti-Lasal National Forest, Pleasant Creek, *Mont E. Lewis 4353* (BRY 168965!); Sanpete Co., Manti-La Sal National Forest, Bean Ridge area, *Mont E. Lewis 4949* (BRY 178998!); Manti-La Sal National Forest, head of Black Canyon, *Mont E. Lewis 5150* (BRY 179152!, RM 306628!); Intermountain Forest & Range Expt. Station, Manti National Forest, head S. Fork-Cove Creek, Sec.36 T14S R5E, *Lincoln Ellison 4618* (RM 471147!). **Grand Co.**, La Sal Mts., *Edwin B. Payson & Lois B. Payson 4095* (RM 102251!, UC 275313!). **Sevier Co.**, Mount Terrill, 6 miles north of Johnson Valley Reservoir, T24S R2E, *N. Duane Atwood 10617 & A. Taye* (BRY 273414!); Dixie-Sevier Forest, Brian Head, *H.W. Johnston 50-G* (RM 471150!); Divide between Sevier & Beaver Rivers, near Belcnap Peak, *P.A. Rydberg & E.C. Carlton 7353* (RM 59857!) **Piute Co.**, Tushar Mts., 9 miles due west of Marysvale, T27S R5W Sec.35, *S. Welsh, K. Taylor & D. Atwood 14018* (BRY 159742!). Marysvale, *Marcus E. Jones 5890* (RM 14268!, UC 159378!). **Beaver Co.**, Tushar Mts., near Anderson Meadow, *A. Taye 2934* (BRY 277648!). **San Juan Co.**, La Sal Mountains, meadow east of Geyser Pass, *Bassett Maguire & Ruth Maguire 26165* (CAN 191143!, WS 170084!); La Sal Mts., north of La Sal Pass, 30 km (19 miles) air distance southeast (123 degrees) of Moab, T27S R24E S26 (W1/2), *Noel H. Holmgren 10690, Patricia K. Holmgren & Marianne H. Welsh* (BRY 283441!); La Sal Mts., Manti-La Sal National Forest, southern slope of Mt. Tukuhnikivatz, T27S R24E S23 SW, *Vlad Siplivinsky & Hans Beck 4407* (BRY 253383!). **Iron Co.**, near Cedar Breaks National Monument, *Larry C. Higgins 4589* (BRY 100128!); Dixie National Forest, Midway Valley, *Irwin H. Johnson J-134* (RM 471149!). **Garfield Co.**, ca. 22 miles SW of Panguitch Lake in Lowder Creek, T36S R8W Sec.19, *D. Atwood 6945* (BRY 186937!). **San Juan Co.**, La Sal Mts., vicinity of Mt. Mellenthin, Horse Canyon, 11000 ft elev., *Bassett Maguire, A.G. Richards, Ruth Maguire & Ruth Hammond 15360* (PH 781092!). Manti Forest (Great Basin Expt. Station), Manti Canyon, *Raymond Kienholz 70* (RM 471148!).

WASHINGTON. Ferry Co., Graves Mountain, dry park-like summit, *Earle F. Layser 1804* (WS 270987!). **Okanogan Co.**, Loomiston, on Mt. Chapaca, *A.D.E. Elmer 582* (RM 12031!, WS 26598!); open rocky summit of Muckamuck Lookout, near Conconully, *Robert Bigelow 53* (PH 692050!); dry hillside east end of Hart's Pass, *Chas. B. Fiker 2704* (WS 87526!); near Blue Lake, in Lime Belt, *Chas. B. Fiker 493* (WS 75569!). **Whatcom Co.**, Grouse Ridge, ca. 7 miles S of Glacier *G.W. & G.G. Douglas 4716* (ALTA 53594!). **Clallam Co.**, on moist protected slopes along Hurricane Ridge, *F.G. Meyer 1081* (WS 122675!). Olympic Mts., Hurricane Ridge, *W.C. Muenscher & M.W. Muenscher 10006* (PH 781133!, UC 604335!); Olympic Mts., *A.D.E. Elmer 2622* (WS 26604!); Olympic Mts., *J.B. Flett 130*

(WS 26599!). **Chelan Co.**, south slope base of Bryan Butte at head of Falls Creek, T30N R20E, *George H. Ward & Anne M. Ward 707* (WS 179206!); lower open slopes of Mt. Stuart, *J. William Thompson 7688* (PH 693027!, UC 471017!, WS 100601!); Wenatchee Mts., alpine slopes of Chumstick Mt., Entiat Ridge, *J. William Thompson 14968* (CAN 191149!, PH 832707!, UC 749651!, WS 152665!); Wenatchee National Forest, at 2 mile-mark, 8-mile Lake trail, Icicle Creek drainage, *A.R. Kruckeberg 5431* (UC M-292127!); Wenatchee Forest, meadow on TW Viollete ranch, *Frank B. Lenzie 21* (RM 471140!); Wenatchee Forest, NW1/4 Sec.22 T26N R15E, *Frank B. Lenzie 381* (RM 471138!); Wenatchee Forest, head of White River, *F.G. Renner & R.E. Nickles 729* (RM 471139!). **Jefferson Co.**, Marmot Pass, open alpine slopes, *J. William Thompson 7953* (PH 692973!). **Kittitas Co.**, 37 miles northwest of Cle Elum, slopes above Hyas Lake, *C.L. Hitchcock 8050* (RM 195239!, UC 710969!, WS 130138!); Cascade Mts., Hyas Lake, *H. St. John & L.A. Thayer 7361* (WS 63138!); Kittitas, Chelan & King Cos., in & near the Cascade Mountains, *G.R. Vasey 536* (WS 26612!); Wenatchee Mts., *J.S. Cotton 1653* (WS 23518!); Cascade Mts., Goat Mountains, *O.D. Allen 137* (CAN 191145!, RM 10166!, UC 29648!, UC 91027!, WS 26601!); Township 17 & 18, Range 21, Valley of the Swauk River, *S.P. Sharples 276* (CAN 191151!); Township 17 & 18, Range 21, Valley of the Swauk River, *S.P. Sharples 277* (CAN 191150!). **Pierce Co.**, Mt. Rainier, alpine meadows on Cowlitz Ridge, *J. William Thompson 12709* (ND 011151!, PH 744400!, UC 892203!, WS 76965!); Mt. Rainier Park, Interglacier, grassy slopes, J.B. Flett 3265 (WS 52612!); Mt. Rainier, rich meadows, *C.V. Piper 2159* (WS 26596!); Rainier National Park, *J.M. Grant s.n.* (RM 102833!); Mt. Rainier, Inter Fork of Whili River, *J.M. Grant s.n.* (PH 628724!); northeast corner of Mt. Rainier National Park, dry south-facing meadow on slope above Bear Park, *M.J. Hartmann 423* (WS 270785!); east side of Mt. Rainier, on slopes, *W.C. McCalla 5200* (ALTA 68815!); west side of Mt. Rainier, on steep open slopes below Gobbler's Knob, *W.C. McCalla 5190* (ALTA 68816!). **Lewis Co.**, Mt. Rainier National Park, upper slopes [illegible]ge on the east side of Mt. Rainier, *Jerry F. Franklin 571* (RM 471135!). **Yakima** [illegible]adows of Mt. Adams, *J. William Thompson 11137* (ND 011148!); Cascade [illegible]e slopes near Dewey Lake, *J. William Thompson 15152* (WS 152635!); Mt. [illegible] meadows, *L.F. Henderson 547* (WS 79690!); Ahtanum Watershed, North [illegible]anum Creek, dry rocky hillside, *F.E. Bernath 132F* (WS 75939!); Mt. Paddo, [illegible]'s Vale, SE side of Mt. Adams, *Wilhelm N. Suksdorf 6337* (WS 79765!); Mt. Paddo, SE side of Mt. Adams, Wodan Valley, *Wilhelm N. Suksdorf 12933* (WS 79764!); Mt. Paddo, SE side of Mt. Adams, on Bird Creek, *Wilhelm N. Suksdorf 12904* (WS 79762!); Mt. Paddo (Adams), hillsides, *W.N. Suksdorf 774* (UC 29646!, UC 91028!, WS 79761!); Mt. Adams, alpine hillsides, *L.F. Henderson 4711* (CAN 191148!); Mt. Paddo (Adams), hillsides *W.N. Suksdorf s.n.* (CAN 191142!); Mt. Paddo, dry places, *Wilhelm N. Suksdorf 6337* (UC 892200!).

WYOMING. Big Horn Co., Big Horn Mountains, *E.C. Moran 1433-M (BRY 23057!)*. **Park Co.**, Absaroka Mts., north fork of Shoshone River drainage, near head of Kitty Creek, T51N R109W Sec.12 SW1/4, *E.F. Evert 2402* (RM 334606!). **Yellowstone National Park Co.**, west rim of Grand Canyon at Lower Falls, *F.H. Sargent s.n.* (BRY 142214!); Yellowstone National Park, Upper Geyser Basin, in open woods, *Aven Nelson & Elias Nelson 6286* (NDG 062529/HG 45902!, RM 169581!, RM 20782!). Yellowstone National Park, Norris, on partly shaded slopes, *Aven Nelson & Elias Nelson 6148* (RM 20781!); Yellowstone National Park, moist woods along east side of Sylvan Lake at Sylvan Pass, *Thomas W. Nelson, Jane P. Nelson, James L. Nelson & Kathy M. Nelson 3219* (RM 354755!); Yellowstone National Park, c. 2 km east of Sylvan Lake, roadside, *William Sm. Gruezo WM11405* (ALTA!, WGRZ!); Yellowstone National Park, c. 2 km east of Sylvan Lake, roadside, *William Sm. Gruezo WM11406* (ALTA!, WGRZ!). Yellowstone National Park, Shoshone Creek, edge of creek, *Ray J. Davis 4882* (WS 182396!); Yellowstone National Park, 1942 Witch Creek Fire Scar, west of Flat Mountain, *Dale L. Taylor 67-144* (RM 283723!). **Teton Co.**, Grand Teton National Park, south of Lupine Meadow Parking area, start of trail to Garnet Canyon, *Richard J. Shaw 2435* (BRY 234305!); Tillery Lake, T48N R116W S17, in lodgepole pine forest, *Robert W. Lichvar 4743* (BRY 249284!, RM 339116!); western exposure near the summit of Teton Pass, *Bassett Maguire, George Piranian & B.L.

Richards Jr. 12577 (CAN 191147!, PH 781103!); Wind River Range, 8 miles west of To-gwo-tee Pass, meadows, *C.L. Porter & Marjorie W. Porter 10296* (CAN 305083!, RM 280945!, UC M-312277!); Moose ponds west of Moose, *W.G. & Ragnhild Solheim 3905* (RM 248353!); Targhee National Forest, Teton Canyon, Treasure Mountain Scout Camp, *Loran C. Anderson 204* (RM 254238!, UC M-035101!, WS 243855!); Teton Forest Reservation, *T.S. Brandegee s.n.* (UC 91029!). **Natrona Co.**, Casper Mt., Camp Wyoba area, dry open area, *Robert L. Tresler 53* (RM 273809!); Casper Mt., Camp Wyoba area, open hillside, *Robert L. Tresler 105* (RM 273825!). **Sublette Co.**, in moist coniferous woods along Middle Piney Lake, 25 miles west of Big Piney, *Fred G. Meyer & Lillian E. Meyer 2399* (UC 758423!). **Lincoln Co.**, Sec.15 T29N R118W, *Arthur H. Holmgren 16570, Jack Payne & Marty Lee* (BRY 193665!, RM 319232!, UC 1 442408!); Wyoming National Forest, in spruce woodland at Salt River Range, vicinity of La Barge meadows, *Bassett Maguire, George Piranian & B.L. Richards Jr. 12626* (PH 781107!); T31N R116W Sec.33, Wyoming Range, 1/2 mile north of Kinney Creek in Greys River drainage, ca. 12 air miles SE of Afton, *Orval C. Harrison 298* (RM 337274!); Star Valley-Greys River in the Afton area, Willow Creek, Salt River drainage, 2 & 7/10 miles east of canyon mouth, Sec.19 T33N R117W, *Orval C. Harrison 11* (RM 292504!). **Albany Co.**, Medicine Bow Mts., Medicine Bow National Forest, 4 miles west of Snowy Range Pass, *George Neville Jones 36559* (UC M-289954!); Albany Co., Medicine Bow Natl. Forest, Hwy 130 mile post 35, c. 1/2 mile before Mt. Meadow Cabins, *William Sm. Gruezo WM11323* (ALTA 92174!); Snowy Range, S.H. Knight Science Camp, *Ronald L. Hartman 3051* (RM 295477!); Medicine Bow Mts., University of Wyoming Camp, *R.F. Daubenmire s.n.* (WS 26074[illegible]). **Carbon Co.**, Bridger Peak, sparingly timbered flats, *Leslie N. Goodding 1998* (PENN 39273!, PH 523719!, RM 52155!, UC 69435!); T12N R86W S11, Sierra Madre Mts., ca. 17.5 air miles SW of Encampment, ca. 26 air miles E of Dixon, *B.E. Nelson 4198 & William Blunt* (RM 329350!); west slope of the Sierra Madre, in Battle Creek Canyon near the mouth of Haskins Creek, *C.L. Porter & Marjorie W. Porter 9707* (RM 274982!, UC M-303990!); Sierra Madre, moist creek bottoms near Battle Lake, *Marion Ownbey 402* (WS 110562!). La Plata Mines, *Elias Nelson 5074* (RM 12654!, UC 34283!). Wyoming Forest, 3 miles from head of Blind Bull Creek on trail, *Chas. H. McDonald 606* (RM 408646!). Wyoming Forest, Middle Beaver Creek, 3 mile above Boundary, *C.H. McDonald & Leo E. Fest McD & F-37* (RM 408645!). Hayden Forest, West side of Smith Creek, North Encampment, Slate Road, *Frank H. Rose 183* (RM 402831!). Battle Lake, *Aven Nelson 4156* (RM 10609!). Fort Park on Heinrick Creek, *Johnston & Hedgack 308* (RM 87558!). Mountains of Southern Wyoming, near Encampment Creek, road to Hog Park, *Geo. E. Osterhout 36* (RM 169585!). North Park in edge of Wyoming Hilton's, *Geo. E. Osterhout 974* (RM 169588!). Buffalo River, north of Government Bridge, mountainside, *Elmer D. Merrill & E.N. Wilcox 1148* (RM 323[illegible]).

With the exception of a few relatively developed ligules, the holotype of *Arnica parryi* A. Gray var. *crinita* Osterhout [*G.E. Osterhout 38[illegible]* (RM 159541!] is over-all a typical *A. parryi*. Obviously, Osterhout (1910) in proposing the variety utilized the presence of ray florets as main character to segregate his taxon from the species proper. In addition, he cited the denser glandularity of upper portion of stem and more pubescent achenes as equally diagnostic features. These latter characters, however are highly variable in *A. parryi* A. Gray and hence of no value for infraspecific delimitation The holotype of *A. parryi* A. Gray var. *crinita* Osterhout alone exhibits this variation in achene pubescence. Specifically, the achenes of the plant on the right side are nearly glabrous to very scantily hirsute compared with the achenes from the other two plants, all of which formed the holotype. On the opposite extreme of morphological variation in *A. parryi* A. Gray are plants represented by collections originally identified as *A. sonnei* Greene [= *A. parryi* A. Gray subsp. *sonnei* (Greene) Maguire]. This taxon has experienced considerable changes in taxonomic rank over the past (vide supra), understandably so because of incomplete information on stability of characters used to distinguish it from *A. parryi*. Interestingly, it is also the presence of ligulate florets in conjunction with densely lanate-villous pubescence of stem and leaves and its quite robust stature, that was employed by Greene (1896) to establish it as a distinct species. Evidently, Osterhout (1910) was completely unaware of this ligulate taxon whose direct affinity to *A. parryi* was clearly indicated by Greene (1896), when he proposed *A. parryi* var. *crinita*.

My examination of a fairly large number of collections establishes that the ligulate populations of *A. parryi* A. Gray occur sporadically throughout the range of the discoid form (Fig. 15, white center dots), contrary to what Maguire (1943) has concluded, *i.e.*, *A. parryi* A. Gray subsp. *sonnei* (Greene) Maguire being restricted only to the Sierra Nevada Mountains of California. Furthermore, on many occasions the ligules become wanting in populations that should normally exhibit them; this was earlier noted by Greene (1896) when he described *A. sonnei*. Therefore, on the strength of present geographical data and morphological analysis, *A. sonnei* Greene is treated here as a synonym of *A. parryi* A. Gray, and the existence of ligulate forms in places simply exhibits a highly random genetic reversal to a primitive state, or survival *in situ* of this forms in glacial refugia or unglaciated sites.

Noteworthy are collections from a number of localities in Utah (*vide supra*) as these complete the range of morphological diversity in *A. parryi* A. Gray. Due to this inherent diversity alone, these collections have been identified at one time or another as either *A. mollis* Hook., *A. diversifolia* Greene (= *A. ovata* Greene, in this study) or *A. chamissonis* Less. In one occasion, Maguire (*in sched.*) on examining a collection from Silver Lake, Salt Lake County [*A.O. Garrett 1330* (RM 52686!)] suggested it to be a hybrid between *A. mollis* and *A. chamissonis* subsp. *foliosa*. Subsequently, the same collection is cited by Maguire (1943) as a good example of *A. arachnoidea* Rydb., a taxon which he considered as a synonym of *A. mollis* Hook. (see further discussion below). Only in one instance, has a ligulate collection from Utah [*S. Welsh, K. Taylor & D. Atwood 14018* (BRY 159742!) from Piute County] been identified and recorded as *A. parryi* A. Gray (Welsh 1983). Recently, Welsh *et al.* (1987) mentioned the existence of ligulate populations in another county (*i.e.*, San Juan County) of Utah (*vide supra*, for exact locality).

Jepson (1925) made a taxonomic transfer of *A. sonnei* as a variety of *A. chamissonis* Less., a disposition which suggests that a certain degree of phyletic relationship exists between these 2 taxa.

Arnica arachnoidea Rydb. has been treated in the past as a synonym of *A. mollis* Hook. (Maguire 1943, Ediger & Barkley 1978). The type material [*P.A. Rydberg & E.C. Carlton 6609* (Holotype, NY *s.n.*!; Isotype, CAN 191136!) show the following characters that are definitely attributable to *A. parryi* (*sensu lato*), namely: a) nodding immature heads (3 of these appeared erect as a consequence of mounting), b) presence of moderately dense lanate-pilose (hence, 'arachnoid') pubescence along the petioles, leaf-bases as well as on the surfaces of basal and cauline leaves, c) barbellate to ±subplumose stramineous pappus, d) extremely hirsute and ±glandular, whitish brown achenes, and e) ±linear to narrowly or broadly lanceolate pilose involucral bracts with hairs characteristically tipped with conspicuous brownish black ± globose glands.

The superficial resemblance of *A. arachnoidea* Rydb. to *A. mollis* Hook. is through the presence of sessile or broadly winged, short-petioled lanceolate cauline leaves. However, some of the basal and lower cauline leaves show also the presence of distinct ±narrow- to broad-winged petioles. Additionally, the presence of minimally developed ligules on capitula that appear to be 'broadly hemispheric' (this shape is due to pressure from plant press during drying) could lead one to consider this taxon as a minor variant of *A. mollis* Hook.

In the alternate (narrower) circumscription of *A. parryi* A. Gray where two subspecies are considered, *A. arachnoidea* Rydb. might be taken to represent a higher altitude form of *A. parryi* A. Gray subsp. *sonnei* (Greene) Maguire (= *A. sonnei* Greene). This taxon, however, is not recognized in the current treatment principally as the presence of ray florets is not a stable character to be of diagnostic value in separating *A. parryi* into 2 subspecies. Ligulate forms of *A. parryi* A. Gray occur at random and quite sporadically throughout the geographic range (Fig. 15, white-center dots).

2. **Arnica ovata** Greene, Pittonia 4: 161, 1900. **TYPE**: UTAH, Alta, Wahsatch Mountains, alt. 11000 ft, 31 July 1879, *Marcus E. Jones 1128* (HOLOTYPE, NDG 062524/HG 46003!; ISOTYPES, MO 145906!, UT 17376!; UC 658855! PHOTO 401, 402 & 402a of MO 145906). Fig. 16. Generalized illustrations, Figs. 17-19.

Arnica latifolia Bong. var. *viscidula* Gray, Syn. Fl. N. Amer. 1: 381, 1884. H.M. Hall & C.C. Hall, A Yosemite Flora, p. 263, 1912; F.J. Smiley, Univ. Calif. Publ. Bot. 9: 387, 1921; W.L. Jepson, Man. Fl. Pl. Calif., p. 1157, 1925. **TYPE**: Sierra Nevada Mountains, 25 September 1883, C.G. Pringle 2 (HOLOTYPE, GH *s.n.*!; CU *s.n.*! & UC 658857! PHOTO 388, 389 & 390 of GH). TYPE: High Sierra, 13 October 1874, *E.L. Greene 41*[illegible] (PARATYPE, UC 658887! PHOTO 391, 392 & 393 of GH).

Arnicc diversifolia Greene, Pittonia 4: 171, 1900, *syn. nov.*; P.A. Rydberg, N. Amer. Fl. 34: 355, 1927; S.F. Blake *in* I. Tidestrom, Contrib. U.S. Nat. Mus. 25: 606, 1925; G.N. Jones, Univ. Wash. Publ. Biol. 7: 166, 1938; B. Maguire, Brittonia 4(3): 475, 1943; E. Hulten, Lund Univ. Arsskr. N.F. Avd. II, 46: 1592, 1950; A. Cronquist *in* R.J. Davis, Flora of Idaho, p. 688, 1952; E.H. Moss, Flora of Alberta, 1st ed., p. 447, 1959; A. Croquist *in* R. Ferris, Illus. Fl. Pac. States 4: 421, fig. 5723, 1959; J.P. Anderson, Flora of Alaska & adjacent parts of Canada, p. 495, 1959; E. Hulten, Flora of Alaska & Neigboring Territories, p. 921, 1968; A. Cronquist *in* C.L. Hitchcock & A. Cronquist, Fl. Pac. NW, p. 484, fig. 7a, 1973; L.J. Clark, Wild Flowers of British Columbia, p. 509, 1973; S.L. Welsh, Anderson's Flora of Alaska, p. 119, 1974; W.J. Ferlatte, Flora of Trinity Alps N. Calif., p. 38, 1974; R.I. Ediger & T.M. Barkley, N. Amer. Fl. ser. II, pt. 10, 24, 1978; H.J. Scoggan, Fl. Canada, pt. 4, 1475, 1979; J.G. Packer, Moss's Flora of Alberta, 2nd ed.(revised), p. 537, map 1014, 1983; S.L. Welsh *et al.*, A Utah Flora, p. 143, 1987. **TYPE**: OREGON, from the highest Powder River (Eagle Creek) Mountains, alt. 8-9000 ft, steep north slopes, 1897, *Wm. C. Cusick 1810* (HOLOTYPE, NDG 062466/HG 46775!); ISOTYPES,[12] CU *s.n.*!, CU *s.n.*! & UC 658857! PHOTO 387 of CU, GH *s.n.*!, CU *s.n.*! & UC 658857! PHOTO 385 of GH, MO 145893!, CU *s.n.*! & UC 658857! PHOTO 386 of WS 26575, US 326309!).

Arnica silvatica Greene, Pl. Baker 3: 27, 1901, *syn. nov.* = *Arnica subplumosa* var. *silvatica* (Greene) A. Nelson, New Man. Rocky Mt. Bot. 573, 1909. **TYPE**: COLORADO, (Gunnison Watershed), Ruby, common in spruce woods, stems in large clusters, 9500 ft, 7 August 1901, *C.F. Baker 715* (HOLOTYPE, NDG 062554/HG 45924!; ISOTYPES, GH *s.n.*!, POM 53816!, POM 53818!, WS 26558!; UC 658874! PHOTO 412 & 413 of POM 53818 + PHOTO 414 of US 956763).

Arnica confinis Greene, Ottawa Nat. 15: 281, 1902. **TYPE**: BRITISH COLUMBIA, Chilliwack Valley, between Lat. 49° & Lat. 49° 10', & Long. 121° 25' & Long. 122°, Tarni Hy Mountain, rocky slopes, alt. 6000 ft, 29 August 1901, *J.M. Macoun Geol. Surv. Can. 26933* (HOLOTYPE, NDG 062426/HG 46834! *p.p.min.*; ISOTYPES, CAN 109755!, UC 658896! PHOTO 418 & 419 of CAN 109755; GH *s.n.*!, *p.p.*), UC 658896! PHOTO 415, 416 & 417 of GH *s.n.*). (For complete discussion on status of type material, see under *A. mollis* Hook.).

[12] The isotype cited by Maguire (1943) to be at The Botanical Museum (C), University of Copenhagen, Denmark is not extant in that institution (Bertel Hansen, pers. comm. 16 June 1987)

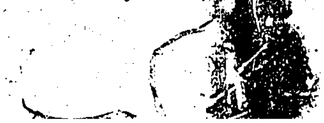
Plants generally pale yellow-green, 1 to 5 dm high, arising from thick freely rooted rhizomes; *stems* solitary or in loosely formed clumps, simple or branched only at inflorescence, glabrate-puberulent with short-stipitate glands and white hairs, scarcely hirsute to villous with white or translucent multiseptate hairs; *basal leaves* 1 pair (rarely 2 pairs), very small round-ovate, with short and broad-winged petioles, usually withered or decayed at time of anthesis; *cauline leaves* 2-3 (rarely 4) pairs, 4-10 cm long x 2-6 cm wide, gradually reduced upwards, first and sometimes second lowermost pairs with distinctly short- or long-, narrow or broad winged petioles, upper pairs sessile, broadly ovate to ±deltoid, subentire or irregularly denticulate to coarsely dentate-serrate, base obtuse to truncate or subcordate, p[illegible]ith short minute hairs and short-stipitate glands; *capitula* 1 to 3 (-5), small, 10-[illegible] high, narrowly turbinate rarely narrowly campanulate; *periclinium* scarcely to moderately pilose with white or translucent hairs and with numerous short-stipitate glands; *involucral bracts* (9-) 12-15 (-20), slightly [illegible]eriate, (7-)[illegible](-16) mm long x 2-3 mm wide, linear to narrowly lanceolate, acute to acuminate; [illegible]y to moderately pilose with short whitish hairs and with abundant short-stipitate glands; *ligulate florets* (8-) 10-14 (-16), pale yellow, (8-) 10-15 (-20) mm long x 4-6 mm wide, its apex shallowly tridentate; *disc florets* broadly tubular or funnelform, (6-) 8-10 (-12) mm long, base of tube nearly glabrous or scantily to moderately pilose with short [illegible]ff or long lax white hairs; *achenes* (30-) 35-55 (-65), fusiform to round- or angular- cylindric, whitish brown to blackish brown, with many short-stipitate glands, sparsely to moderately pilose with soft short or long white or translucent hairs; *pappus* of (15-) 18-22 (-28) bristles, whitish brown to stramineous or seldom slightly tawny, consistently subplumose. *Chromosome number*, 2n = 57, 76.

ECOLOGY AND DISTRIBUTION. On wet grassy slopes of lush ravines formed by small mountain creeks, talus slopes of abandoned cirques, on rocky soil below the trimline, at border of solifluction tongues in alpine tundra of south-central and interior Alaska; minor drainage with pockets of fine soil among coarse rock material on Marble Mountain nunatak at Juneau Icefield, on gently sloping valley sides as well as on rock slide at base of cliffs, wet margin of lakes and near stream inlet up to alpine woods and talus slopes of British

Figure 16. Holotype of *Arnica ovata* E.L. Greene [Utah: Alta, Wahsatch Mountains, alt. 11000 ft, 31 July 1879, *Marcus E. Jones 1128* (NDG 062524/HG 46003!)].


HOLOTYPE
HOLOTYPE OF
M.E. Jones 1128 (SDC!)
Arnica ovata Greene, Pittonia 4: 161, 1900.
= Arnica diversifolia Greene
Pittonia 4: 171, 1900. Synon. nov.
det. William Sa. Gruezo 10 January 1988
HOLOTYPE
Jones 1128
Arnica ovata Greene,
Pittonia 4: 161, 1900.
det. W.Sa. Gruezo May 1986
PHOTO: WILLIAM SA. GRUEZO
46004

Figure 17. Habit and morphology of *Arnica ovata* E.L. Greene. A & B. Holotype (NDG 062524/HG 46003!). C & D. Isotypes: MO 145906! and UT 1737[illegible] respectively. [UTAH: Alta, Wahsatch Mountains, alt. 11000 ft, 31 July 1879, [illegible]us E. Jones *1128*].



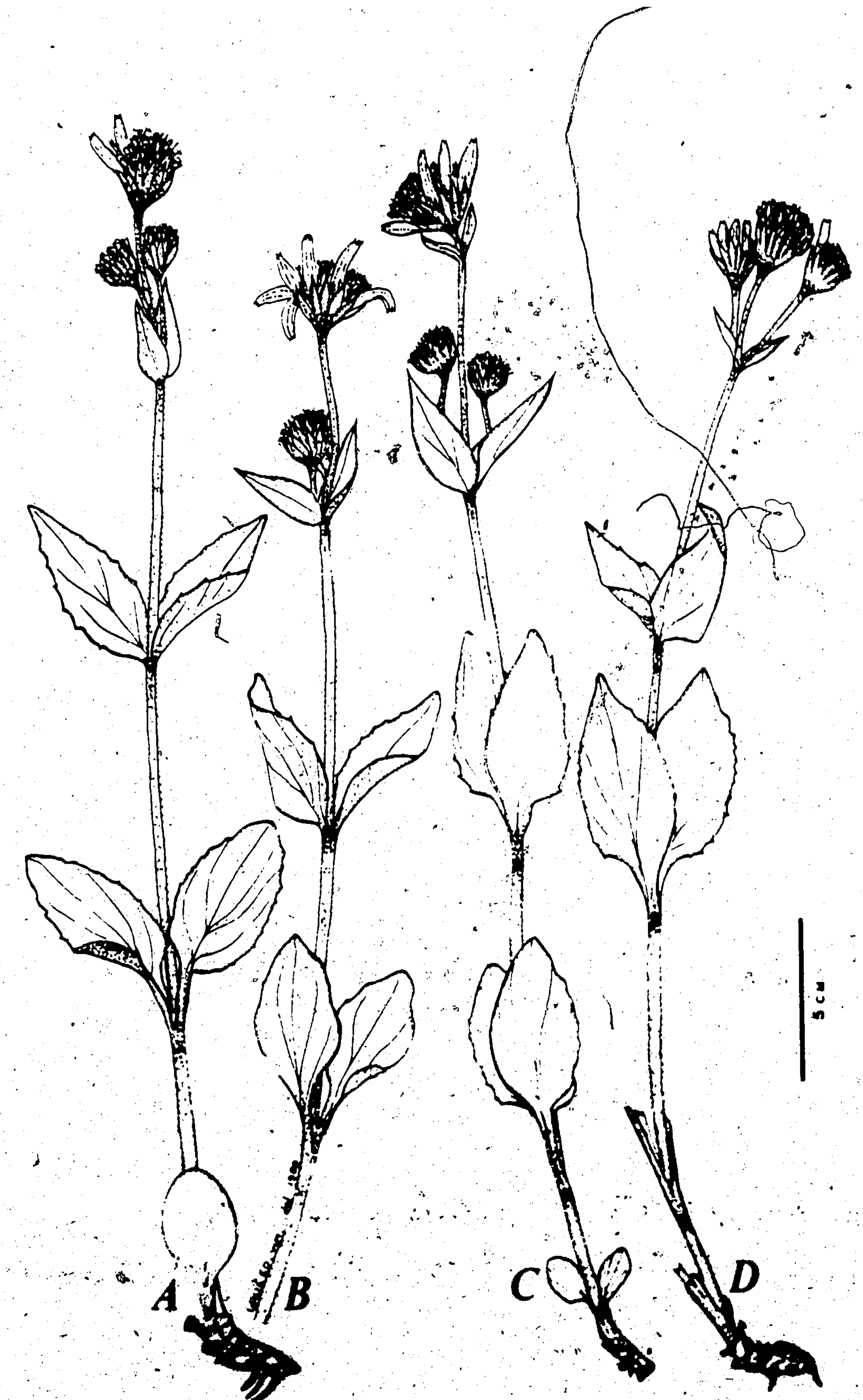

A
B
C
D
5 cm

Figure 18. Leaf morphology variation in holotype of *Arnica diversifolia* E.L. Greene (= *Arnica ovata* E.L. Greene). Note petiole length. [Oregon: from the highest Powder River (Eagle Creek) Mountains, 8-9000 ft alt., steep north slopes, 1897, *Wm. C. Cusick 1810* (NDG 062466/HG 46775!)].

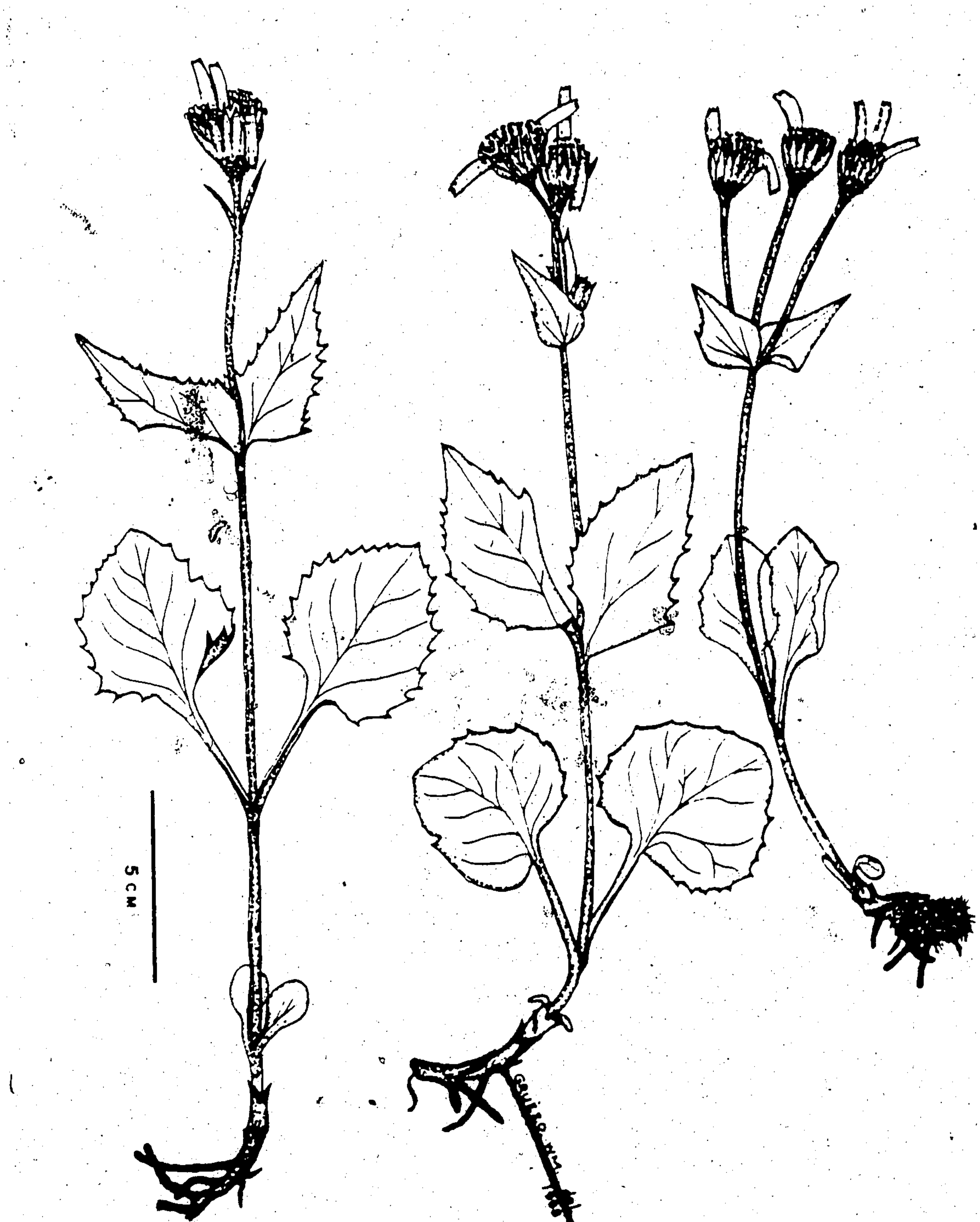
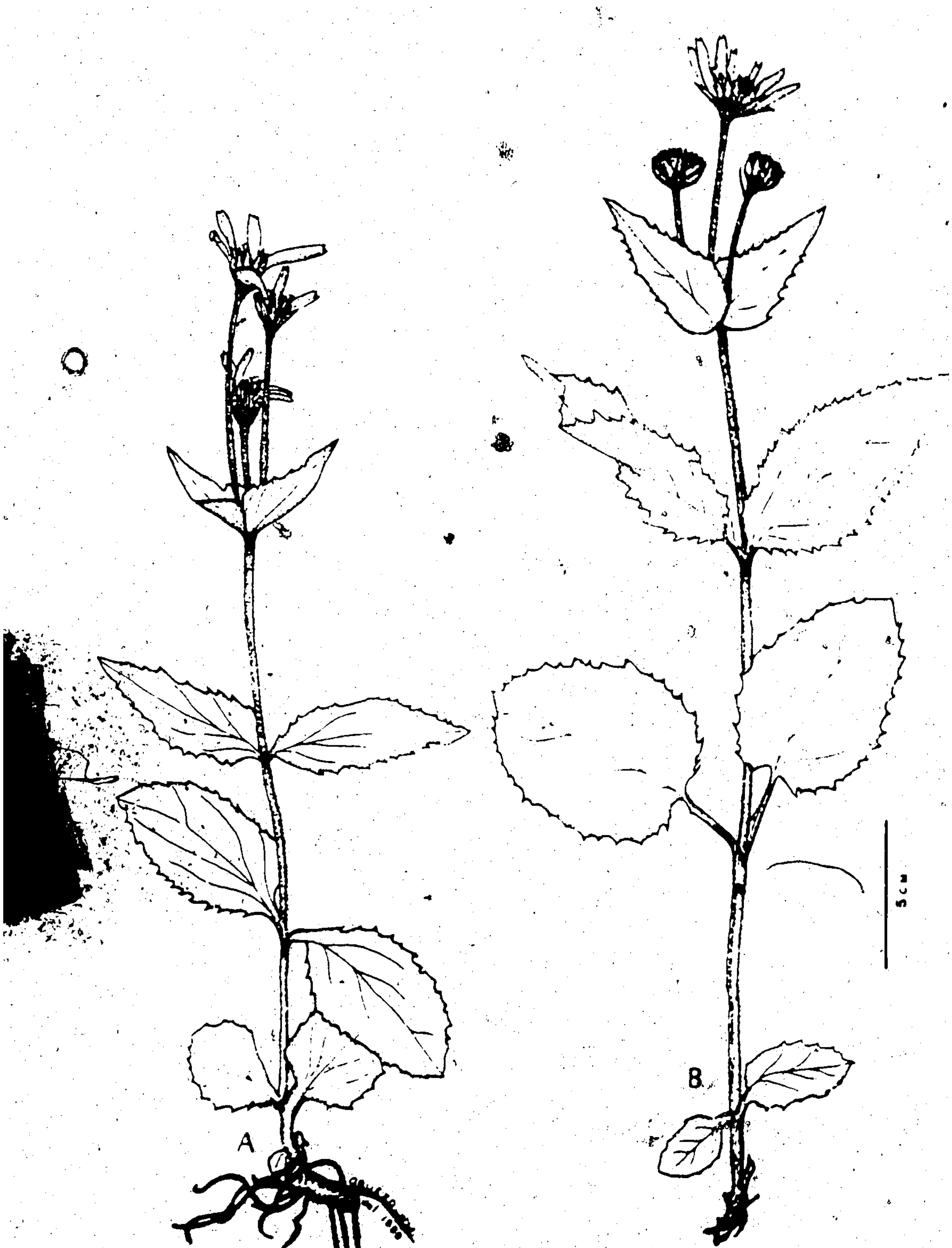

5 CM

Figure 19. Leaf morphology variation in types of *Arnica silvatica* E.L. Greene (= *Arnica ovata* E.L. Greene). A. Part of holotype (NDG 062554/HG 45924!) showing first pair of short-petiolate cauline leaves. B. Part of isotype (GH *s.n.*!) showing first pair of distinctly long-petiolate cauline leaves.

[Colorado: Ruby, stems in large cluster, common in spruce woods, 7 August 1901, *C.F. Baker 715*].



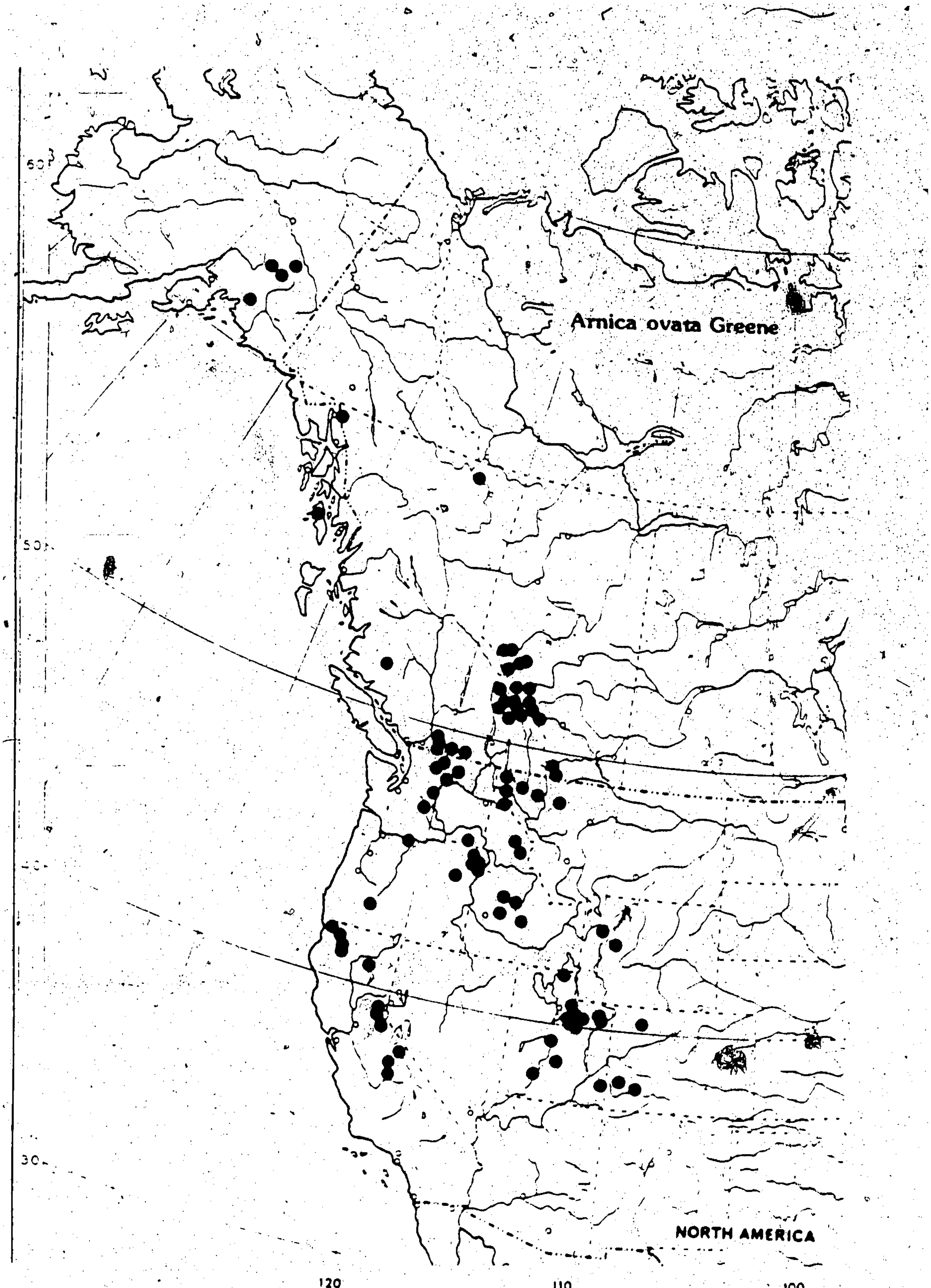
A
B
5 cm

Columbia, westward to the open spaces near brooks and streams, open slopes bordering spruce woods, avalanche gully, subalpine-alpine meadows and rocky alpine summits in the Rocky Mountains of Alberta south to the Cascades Mountains of Washington and the Wallowa Mountains of Oregon as well as along the rim of the lake at Crater Lake National Park; then farther south to the cirque on south side of Preston Peak, the High Lake Basins of Salmon Mountains up to the Trinity Mountains, then to Crescent Cliffs of Lassen Volcanic National Park, south to the Lake Tahoe Region and frequent in many places in the Sierra Nevada Mountains; apparently absent in Nevada. It is also known to occur on the slopes of Kootenai Mountains in Montana as well as in grass-sedge meadows along shores of lakes and in mountain meadows. In Idaho, it is found on cliffs on the cirque below lake at Seven Devils Mountains, near late snow-bank on ridge to the east of Castle Peak in the White Cloud Range southeast to the To-gwo-tee Pass area and Horseshoe Mountain, Wind River Range of Wyoming, then farther south to Utah, at first in the Mt. Naomi Region, Bear River Range then to the Wasatch Range, the Uinta Mountains, Mt. Timpanogos to Mt. Nebo, the Burro Pass and La Sal Mountains of Grand County, ending at the Tushar Mountains in Piute County. In Colorado, this species is known only in three localities, namely: in moist rocky hillsides of the Fish Creek Falls, Routt County; in dry meadows of the Uncompahgre National Forest, Montrose County and in Ouray, Ouray County which is its southeasternmost range (Fig. 20).

Elevational distribution is from 200-3,660 m with flowering period from early July to middle of September.

SPECIMENS EXAMINED. CANADA. ALBERTA. Vine Creek , SE into the Athabasca River between Grassy Ridge & De Smet Range, *L.R. Hettinger 420* (ALTA 45572!); Vine Creek, flows SE into the Athabasca River, between Grassy Ridge & De Smet Range, *L.R. Hettinger 392* (CAN 40982!). About 10 mi N of Jasper, *T. Mosquin 3353* (UC M-287590!); **Jasper Natl. Park**, Mount Edith Cavell, *J.M. Macoun Geol. Surv. Can 96054* (CAN 109683!); mountains N of Cavell Creek, *J.M. Macoun Geol. Surv. Can. 96055* (CAN 109688!); Mount Edith Cavell, *J.M. Macoun Geol. Surv. Can. 96065* (CAN 109684!); Mount Edith Cavell, *J.M. Macoun Geol. Surv. Can. 96066* (CAN 109687!); Mount Edith Cavell, *J.M. Macoun Geol. Surv. Can. 96071* (CAN 109685!); Mount Edith Cavell, *A.E. Porsild 21147* (CAN 288120!); Mount Edith Cavell, foot of Angel Glacier, *A.E. Porsild & A.J. Breitung 14485* (CAN 109694!); Jasper Natl. Park, Mt. Edith Cavell, moraine just beyond the terminus of the highway, 17 August 1946, *G.H. Turner 5245* (ALTA-65875!); Jasper Natl.

Figure 20. Geographical range of *Arnica ovata* Greene.



Arnica ovata Greene
NORTH AMERICA
60
50
40
30
120
110
100

Park, Mt. Edith Cavell (52° 40' N, 118° 03' W), along foot trail to Mt. Edith Cavell meadows (alpine summit), *William Sm. Gruezo WM11550* (ALTA 91296!, WGRZ!); *William Sm. Gruezo WM11552* (ALTA 91293!, WGRZ!), *William Sm. Gruezo WM11555* (ALTA 91294!, WGRZ!), *William Sm. Gruezo WM11558* (ALTA 91295!, WGRZ!), *William Sm. Gruezo WM11559* (ALTA 91305!, WGRZ!); Jasper Natl. Park, side of trail in small valley above bath house of Miette Hot Springs, alt. 4600 ft, 16 August 1946, *G.H. Turner 5437* (ALTA 65872!); Jasper Natl. Park, river bank above Athabaska Falls, 15 August 1946, *G.H. Turner 5109* (ALTA 65873! *p.p.mag.*); Jasper Natl. Park, 2 km E of Signal Mt. summit, near timberline, elev. 2042, 18 August 1974, *T.D. Lee & W.M. Peterson s.n.* (ALTA 56116! *p.p.min.*); near Three-Slide Shelter Cabin, *R.M. Anderson s.n.* (CAN 109626!); Fitzhugh Mt., *J.M. Macoun Geol. Surv. Can. 96053* (CAN 109686!); dry slope near fire tower on Pyramid Mt., *A.E. Porsild & A.J. Breitung 16353* (CAN 109689!); The Bald Hills, 2 km SE of lookout, seasonal alpine ponds, *P. Kuchar 529* (ALTA *s.n.*!); The Bald Hills, *P. Kuchar 530* (ALTA 49259! *p.p.*); The Bald Hills, *P. Kuchar 532* (ALTA 49259! *p.p.*); Below (N of) the Bald Hills, *P. Kuchar 577* (ALTA *s.n.*!); The Bald Hills, 1 1/2 km S of Look-out, *P. Kuchar 581* (ALTA 49246!); **Banff Natl. Park**, Bow River Pass, *A.E. Porsild & A.J. Breitung 14931* (CAN 109690!); vicinity of Sunshine Ski Lodge, south of Healy Creek, Brewster Rock, *A.E. Porsild & A.J. Breitung 13506* (CAN 109702!); vicinity of Sunshine Ski Lodge, Citadel Peak, *A.E. Porsild & A.J. Breitung 14013* (CAN 109693!); vicinity of Sunshine Ski Lodge, south of Healy Creek, Citadel Mt., *A.E. Porsild & A.J. Breitung 15969* (CAN 109701!); alpine tundra above Sunshine Ski Lodge, Continental Divide, 12 mi SW, *F.J. Hermann 13195* (ALTA 16892!); vicinity of Sunshine Ski Lodge, south of Healy Creek, Twinn Cairn Mountain, *A.E. Porsild & Johannes Lid 19682* (CAN 293149!); vicinity of Sunshine Ski Lodge, south of Healy Creek, Wa-wah Ridge, Twinn Cairn & Standish Hump, *A.E. Porsild & A.J. Breitung 14158* (CAN 109696!); vicinity of Sunshine Ski Lodge, south of Healy Creek, Wa-wah Ridge, Twinn Cairn & Standish Hump, *A.E. Porsild & A.J. Breitung 13363* (CAN 109698!); vicinity of Sunshine Ski Lodge, south of Healy Creek, Wa-wah Ridge, Twinn Cairn & Standish Hump, *A.E. Porsild & A.J. Breitung 13390* (CAN 109699!); vicinity of Sunshine Ski Lodge, south of Healy Creek, screes & cliffs along south & west base of Citadel Mt., *A.E. Porsild & Johannes Lid 19569* (CAN 293147!); headwaters of North Saskatchewan River, ridge bet. Mount Athabasca & Saskatchewan Glacier, near mile 114 on Banff-Jasper Highway, *A.E. Porsild & A.J. Breitung 14575* (CAN 109695!); Mount Wilson on North Saskatchewan River, *A.E. Porsild & A.J. Breitung 16115* (CAN 109624!); Lake Agnes, *M.O. Malte s.n.* (CAN 197182!); Lake Agnes, *M.O. Malte & W.R. Watson 1129* (CAN 291695!); vicinity of Lake Louise, *A.E. Porsild & A.J. Breitung 12822* (CAN 109691!); along rocky stream near Lake Louise, *Aven Nelson & Ruth A. Nelson 3056* (RM 177974!); **Rocky Mountain Park**, Mount Oyliner (?), *J.M. Macoun Geol. Surv. Can. 14744* (CAN 109704!); Rocky Mountain Park, summit of Ottertail Pass, *J.M. Macoun Geol. Surv. Can. 65527* (CAN 109708!); **Front Range Rocky Mountains**, Prospect Mountain, 10 mi SW of Cadomin, *P. Mortimer 474* (ALTA 75213!); Prospect Mountain, 10 mi SW of Cadomin, *P. Mortimer 447* (ALTA 75214-B!); Prospect Mountain, 10 mi SW of Cadomin, *P. Mortimer 423* (ALTA 75214-A!); **Spreading Creek**, *P. Achuff & L. Allen 1412 (Ref. no. 9396)* (CAN 465849!); **Tent Mountain** near Crowsnest Pass, *G. Ringius 1376* (ALTA 85848!); Mountain Park, on Hwy 940 (= Forestry Trunk Road), c. 9 km S of Mountain Park proper, Cardinal Divide Viewpoint, vicinity of campground, *William Sm. Gruezo WM11504* (ALTA 91299!, WGRZ!), *William Sm. Gruezo WM11511* (ALTA 91300!, **Waterton Lakes Natl. Park**, rocky slope above Bertha Lake, *W.C. McCalla 7233* (ALTA 68726!); E-facing scree slope W of Bertha Lake, *P. Kuchar 2920b* (ALTA 46078!); Bertha Lake, *M.O. Malte & W.R. Watson 2724* (CAN 291696!); talus slopes above Upper Rowe Lake, *Keith Shaw 2300* (BRY 126741!); exposed rocky slope above Lower Rowe Lake, *August J. Breitung 16371* (ALTA 16921!); Goat Lake, *G. Armstrong & J. Nagy 4976* (ALTA 82474!, CAN 346920!); Waterton Lakes Natl. Park, ridgeslope below Carthew Lake overlooking Alderson Lake (49° 02' N, 113° 59' W), alpine meadows, *William Sm. Gruezo & Stephen R. Downie WM11619* (ALTA 91319!, WGRZ!); Waterton Lakes Natl. Park, vicinity of Summit Lake (49° 01' N, 114° 02' W), SW portion of lake, leftside of wooden foot bridge on way to Carthew Trail, margins of small stream, *William Sm. Gruezo WM11622* (ALTA 91320!, WGRZ!); Twin Lakes, *G. Armstrong & J. Nagy 5109* (CAN

346910!); Lone Lake, *J. Kuijt, G. Armstrong & J. Nagy 4935* (ALTA 82478!, CAN 346908!, WTON 3421!); Ruby Lake, *J. Nagy 2483 & W. Blais* (ALTA 82470! *p.p.mag.*); Sheep Mt., *John Macoun Geol. Surv. Can. 11605* (ALTA 76787!); Sheep Mt., *Macoun Geol. Surv. Can. 11604* (CAN 109630! *p.p.min.*); Sofa Mt., *J. Kuijt, G. Armstrong & J. Nagy 5165* (ALTA 82459!); Crypt Lake, *J. Kuijt, M. Gadd, G. Armstrong & J. Nagy 4398* (ALTA 82468!, CAN 346909!).

BRITISH COLUMBIA. **Juneau Icefield**, approximately 4 mi northwest of Camp 26 (FGER) on Marble Mountain Nunatak, *D.R. Lubin 082* (ALA V75361!); B.C.-Yukon border, White Pass, *Alice Eastwood 896* (CAN 109664!, UC 892095!); Peak, 15 mi SW of Kleena Kleene, *T.T. McCabe 566* (UC 542857!); Hudsons Bay Mt., c. 5 mi W of Smithers, *G.W. Douglas 7980* (BRY 127522!); **Liard River Basin**, Fairy Lake, west end of lake near stream inlet, *G.W. Argus & E. Haber 10148* (CAN 410884!); **Mount Revelstoke Natl. Park**, between Millar Lake & Jade Lake, south of Mount Williamson, *J.H. Soper 12495, M.J. Shchepanek & A.F. Szczawinski* (CAN 342318!); **Rainbow Mountains**, Mount Brilliant, *H.M. Laing 688* (CAN 205453!); **Yoho Natl. Park**, c. 1 mi N of Celest Lake, 4 mi NW of Takakkaw Falls, *C.L. Hitchcock & J.S. Martin 7690* (WS 113104!, *p.p.*); Field, Mount Stephen, *Viljo Kujala & Aarno Cajander s.n.* (CAN 394051!); Yoho Valley, *Macoun Geol. Surv. Can. 65515* (CAN 109713!); Yoho Valley, Emerald Lake, *Macoun Geol. Surv. Can. 65518* (CAN 109709!); **Kicking Horse Lake**, Rocky Mts., *Macoun Geol. Surv. Can. 14748* (CAN 109707!); **Vicinity of Field**, Canadian Rockies, Burgess Trail, *Stewardson Brown 535* (PH 529822!); Close to Alberta-B.C. boundary, 10 mi E of Field, half-way upslope above N end (side) of Ross Lake, 9 September 1943, *G.H. Turner 3899* (ALTA 16868!, ALTA 65869!); **Mount Assiniboine**, Sunburst Lake Camp, 32 mi from Banff, *Edith Scamman 6721* (CAN 245390!); **Selkirk Mts.**, mountains at Rogers Pass, *Macoun Geol. Surv. Can. 14745* (CAN 109717!); Selkirk Mts., Rogers Pass, *Macoun Geol. Surv. Can. 14747* (CAN 109715!); Selkirk Flora, small peak above timberline, *Charles H. Shaw 993* (PH/PENN 43874!); **Skagit Valley**, *J.M. Macoun Geol. Surv. Can. 69335* (WS 31390!); First Summit W of Skagit River, *J.M. Macoun Geol. Surv. Can. 69333* (CAN 109714!); Second Summit W of Skagit River, *J.M. Macoun Geol. Surv. Can. 69335* (CAN 109711!); **Glacier**, *M.O. Malte s.n.* (CAN 197181!); Glacier, *Charles Schaffer s.n.* (PH/PENN 37773!); Glacier Natl. Park, Hermit Hut Trail, *Erich Haber 1467 & M.J. Shcheponek* (CAN 363168!); **Tamy Hy Mountain**, Chilliwack River, *J.M. Macoun Geol. Surv. Can. 26932* (CAN 109710!); mountains S of Chilliwack River, *W. Spreadborough Geol. Surv. Can. 77005* (CAN 109712!); **Mount Cheam**, *J.K. Henry s.n.* (NDG 062532/HG 45899!); **Crater Mountain**, c. 13 mi WSW of Keremeos, *G.W. & G.G. Douglas 4704* (BRY 207799!, BRY 207937!); One mile S of **Flathead Summit**, *T.T. McCabe 4980* (UC 576255!).

YUKON:, Kluane National Park, Auriol Range, *c.* 6.4 km SW of Haines Jct., *G.W. & G.G. Douglas 10567* (BRY 177581!); Frances Lake, Simpson Tower, meadow near tree-line, *R. Rosie 524* (CAN 412628!); St. Elias Mts., in valley S of Serpentine Creek valley, *A.M. Pearson 67-337* (CAN 316856!).

U.S.A. ALASKA. Alaska Range, Tangle Lakes area, mountain E of Landmark Gap, *Olav Gjaerevoll 1315* (CAN 225194!); Alaska Range, along Denali Highway, Tangle Lakes, ridge due north of Tangle Lake, *Galen Smith 2049* (ALA 10626!, UC M-076867!); Denali Highway (Hwy 8), c. 150 m E of Mile post 35, right side of road en route to Tangle Lakes, *William Sm. Gruezo & Aida BG. Gruezo WM11946* (ALTA %%, WGRZ!). **Tanacross Quad**, Robertson drainage, *Jack Winters Jr. 407* (ALA 84195!); **Mt. Hayes Quad**, Mile 25 Denali Highway, *R. Backer 85* (ALA 95293!); **Willow Road**, *G.M. Frohne s.n.* (ALA 21808!); Willow Road, *G.M. Frohne 54-140* (ALA 21868!); Willow Road, *G.M. Frohne s.n.* (ALA 23834!); **Central Pacific Coast District**, Spencer Glacier, *Les & Teri Viereck 2069* (ALA 8506!); **Valdez Township**, approx. 2 mi off of Richardson Highway, near Thompson Pass, *Bee Cumby 282* (ALA V071646!); **Prince of Wales Island**, Virginia Mt., 7 mi S of Point Baker, north slope of Virginia Mt., *D. Jaques 1442* (BRY 105907! *p.p.*).

CALIFORNIA. **Siskiyou Co.**, Preston/Klamath Natl. Forest, cirque S side of Preston Peak, *C.A. Ground 763* (RM 470845!); N side of Black Mt., Marble Mt. Wilderness Area, *Gilbert Muth 476* (JEPS 82425!); Salmon Mts., The High Lake Basins in the vicinity of English Peak, Marble Mt. Wilderness Area, 1/2 mile NNE of English Peak & within English Lake Basin, *Frederick W. Oettinger 1441* (UC I-409369!); Upper-Wright Lake, *Eleanor Burks Hart 915* (UC 609312!); **Trinity Co.**, Trinity Mts., Upper Canyon Creek Lake, *Annie M. Alexander & Louise Kellogg 5463* (UC 933431!); Devil's Canyon Mts. at head of White's Creek, *Joseph P. Tracy 14624* (UC M-199249!); Devil's Canyon Mts., around White's Creek Lake, head of N Fork of White's Creek, *Joseph P. Tracy 14654* (UC 582491!); Mary Blaine Mt., *Joseph P. Tracy 14439* (UC 582490!); **Mariposa Co.**, Cathedral Trail, *J.W. Congdon s.n.* (WS 226886!); **Nevada Co.**, Donner Pass near the railroad crossing, *A.A. Heller 7029* (PH 506993!, RM 46658!, UC 57885!); Sierra Nevada Mts., Frog Lake on Mt. Stanford, *C.F. Sonne s.n.* (UC 91024!); Sierra Nevada Mts., South Fork San Joaquin, *H.M. Hall & H.P. Chandler 688* (UC 29590!); **Placer Co.**, above Kneelands Mill, *C.F. Sonne s.n.* (UC 193561!); **El Dorado Co.**, Sierra Nevada, Lake Tahoe Region, Dicks Lake, *Annie M. Alexander & Louise Kellogg 3494* (UC M-03803!); SE side of Angora Peak, *G.L. Stebbins Jr. 2031* (UC 593472!); S side of Echo Lake *A.A. Heller 12544* (PH/PENN 70750!, PH 598772!, UC 195384!, UC 726616!, UC 892139!); near Grouse Lake, 2 1/2 mi NE of Wrights Lake, *G. Thomas Robbins 1341* (UC 747151!); **Mono Co.**, Quadrangle Bridgeport, Mono Natl. Forest, 2 mi E of Green Lake, *T.M. Hendrix 482* (UC 577718!, UC M-119303!); **Madera Co.**, along grade into (W of) Jackass Meadow, *Alex Hawkes 5208* (UC I-328177!); Quadrangle Mt. Lyell, 2 mi N of Harriet Lake, *C.W. Hanks 348* (UC M-119307); **Inyo Co.**, Inyo National Forest, John Muir Wilderness, Sierra Nevada Mts. (East Slope), lake basin below Chocolate Mt. & Hurd Peak, Inconsolable Range, open forest of *Pinus balfouriana*, in moist meadow near stream along trail to Mary Louise Lakes, *Randall Bayer, Roberto Deluca & Daniel Lebedyk CA-737* (ALTA 92223!); **Lassen Co.**, Lassen Volcanic Natl. Park, Crescent Cliffs, *F.G. Anderson s.n.* (UC 892184!); **Del Norte Co.**, northeastern corner of Del Norte Co., at the Siskiyou Co. boundary, trail to Twin Valley from Poker Flat, *Ruby Van Deventer 264* (JEPS 35903! *p.p. mag.*).

COLORADO. **Routt Co.**, Fish Creek Falls, *Leslie N. Goodding 1635* (PH 523856!, RM 169623!); **Montrose Co.**, Rocky Mountain Forest & Range Experiment Station, Uncompahgre Natl. Forest, *K.H. Lancaster, C.W. Doran & V.L. Bunderson 47* (RM 471116!); Rocky Mountain Forest & Range Experiment Station, Uncompahgre Forest, *K.H. Lancaster, C.W. Doran & V.L. Bunderson 67* (RM 471115!); **Ouray Co.**, Ouray, *G.E. Osterhout 5229* (RM 169925!).

IDAHO. **Boundary Co.**, SE of Mt. Roothaan, *R.F. Daubenmire 44359* (WS 260931!); **Bonner Co.**, *R.F. Daubenmire 43164* (WS 181724!); **Kootenai Co.**, Packsaddle Mountain near Lakeview, *A.A. Heller 753* (NDG 062403/HG 46816!); about Lake Pend D' Oreille near Lakeview, *A.A. Heller 753* (PH *s.n.*); **Clearwater Co.**, gravelly floodplain of North Fork of Clearwater River, above Pete Ott Camp, *R.F. Daubenmire s.n.* (WS 181830!); gravelly floodplain of North Fork of Clearwater River, above Pete Ott Camp, *R.F. Daubenmire s.n.* (WS 260938!); **Idaho Co.**, Seven Devils Mts., Seven Devils Lake, *J.H. Christ 12585* (WS 261668!); **Custer Co.**, Mount Hyndman, *Ray J. Davis 1693* (WS 100099 *p.p.mag.*); White Cloud Range, Challis Natl. Forest, ridge to E of Castle Peak, *C.L. Hitchcock & C.V. Muhlick 10899* (UC 968678!); **Blaine Co.**, near Redfish Lake, *J.F. Macbride & Edwin B. Payson 3691* (RM 86114! *p.p.mag.*); **Elmore Co.**, Boise Forest, head of Big Rattlesnake Creek, *R.B. Johnson RBJ-181* (RM 471102!).

MONTANA. **Glacier Co.**, Glacier Natl. Park, Upper Park Creek, about shores of Lake Isabel, *Bassett Maguire & George Piranian 15366* (PH 781128!); **Flathead Co.**, Picnic Lakes, *Fred Zwickel 101* (WS 200574!); Big Fork, slopes of Kootenai Mts., *L.M. Umbach 591/01* (PH 769902!).

OREGON. **Wallowa Co.**, Wallowa Mts., on N slope of Eagle Cap Peak, *C.W. Sharsmith 3908* (WS 90122!); Wallowa Mts., Lake Basin, cliff below Mirror Lake, *L.*

Constance & C.D. Jacobs 1357 (WS 69132!); Aneroid Lak[illegible] mi S of Wallowa Lake, *Lewis S. Rose 36541* (ND 011128!); rocky slopes in the Eagle Cap Peak Basin, *Bassett Maguire & Arthur H. Holmgren 27104* (UC 739038!); Wallowa Mts., stony slopes along Slikcrock Creek in vicinity of Hurricane Creek, *Bassett Maguire & Arthur H. Holmgren 27047* (UC 739041!, WS 169999!); head of Wallowa River, cliffs, *Wm.C. Cusick 2488* (JEPS 20956!, NDG 062465/HG 46776!, NDG 062467/HG 46777!, RM 31435!, UC 29619!, WS 26576!); Wallowa Mts., at head of Keystone Creek, *Wm.C. Cusick 2463* (JEPS 20951!, NDG 062468!, RM 31437!, UC 29585!, WS 26519!); **Hood River Co.**, near Hood River, *Thomas Howell s.n.* (PH/PENN 12542! *p.p.*); **Baker Co.**, Blue Mts., NE of Lookout Peak, drainage into Hoffner Lake, Anthony Lakes, *Bassett Maguire & Arthur H. Holmgren 26963* (PH 824342!, WS 169998! *p.p.*, UC 739035! *p.p.*; CAN 191034! & CAN 453260! are determined here as *Arnica latifolia* Bong.); **Klamath Co.**, Crater Lake Natl. Park, along the rim of the lake, *A.A. Heller 12578* (PH/PENN 68061!, PH 598654!, WS 150238!), Crater Lake National Park, inside Crater Lake proper, ~~on~~ Rim Drive, c. 1/4 mi before Sun Notch Viewpoint, cut-side of road on edges of shallow depressions, *William Sm. Gruezo WM11474* (ALTA 91298!, WGRZ!).

UTAH. Cache Co., Bear River Range, 2 mi NW of Tony Grove Lake, along trail to Mt. Naomi, *Bassett Maguire 16102* (CAN 191035!, UC 738815!); Bear River Range, 2 mi NW of Tony Grove Lake, along trail to Mt. Naomi, 18 August 1938, *Bassett Maguire 16141* (UC 738813! *p.p.*); Bear River Range, Mt. Naomi Region, at saddle of Mt. Naomi, *Bassett Maguire, Dean A. Hobson & Ruth R. Maguire 14154* (PH 781101! *p.p.*); Bear River Range, Mt. Naomi Region, S slopes at White Pine Lake Basin, *Bassett Maguire, Dean A. Hobson & Ruth R. Maguire 14081* (PH 781121! *p.p.*); **Summit Co.**, c. 6 mi due NE of Kamas, near summit of Hoyt Peak, *E. Neese & J.L. Neese 9851* (BRY 218710!, RM 340588!); **Salt Lake Co.**, Wasatch Mts., S side of Big Cottonwood Canyon, Mill D. Canyon, *E. Neese & J.L. Neese 10790* (BRY 225708!); Salt Lake Co., Big Cottonwood Canyon, *A.O. Garrett 1670* (RM 52685!); Big Cottonwood Canyon, *A.O. Garrett 1975* (RM 56655!); Little Cottonwood Canyon, *A.O. Garrett 1386* (RM 54079!); Wasatch Range, Little Cottonwood Canyon, White Pine Fork, 2 mi below White Pine Lake (trail), *B. Albee 5139* (BRY 228828!); headwaters of Little Cottonwood Creek, above Alta, *P.A. Rydberg 6843* (RM 59718!); Wasatch Range, 3 mi S of Brighton, S side of Lake Catherine, *Bassett Maguire 17419* (UC 738649!, WS 170183!); **Uintah Co.**, Ashley Natl. Forest, *Sherel Goodrich 6456* (BRY 164117!); Ashley Natl. Forest, *Sherel Goodrich 6457* (BRY 164113!); Uinta Mts., Ashley Natl. Forest, 3 mi NW of Paradise Park Reservoir, *Sherel Goodrich 6472* (BRY 214498!); **Duchesne Co.**, Uinta Mts., head of Duchesne River, near Mirror Lake, 20.5 mi, 80 degrees from Kamas, *S. Goodrich 14738* (BRY 216603!); Uinta Mts., head of Duchesne River, near Mirror Lake, 20.5 mi, 80 degrees from Kamas, *S. Goodrich 14753* (BRY 216667!); **Utah Co.**, Mt. Timpanogos, Timpooneke Trail, *K. Allred 972* (BRY 125693!); Wasatch Forest, Mt. Timpanogos, *V.N. West 8* (RM 470843!); Mt. Timp. (= Timpanogos), *Cottam 1395* (BRY 15861!); above Hidden Lake, *A.O. Garrett 3456* (RM 106891!); Utah Co., North Canyon Road towards Bald Mt., to Mine site, *R. Collins & K. Harper 500* (BRY 204913!); **Juab Co.**, N up Mt. Nebo, Nebo Basin Trail, *R. Collins & K. Harper 581* (BRY 204996!); Mt. Nebo, tail from Andrews Creek Canyon, *K. Thorne & J. Chandler 3411* (BRY 268012!); c. 7 mi W of CCC Camp, *R. Foster & J. Henriod 7031* (BRY 186737!); **Grand Co.**, trail to Burro Pass, *Bassett Maguire 26166* (UC 738647!); La Sal Mts., *Edwin B. Payson & Lois B. Payson 4036 (RM 102252!)*; **Sanpete Co.**, Manti-Lasal Natl. Forest, Skyline Drive, S of Towhead, *Mont E. Lewis 4960* (BRY 178894!); **Piute Co.**, Tushar Mts., Beaver District, head of Bullion Creek, c. 9 mi due WSW of Marysvale, *S. Welsh & J. Henriod 18145* (BRY 187676!); Tushar Mts., Beaver District, Mt. Belknap, Beaver Creek basin, 9 mi WSW of Marysvale, *S. Welsh, M. Welsh & J. Henriod 17897* (BRY 186660!). **San Juan Co.**, La Sal Mts., north flank of Mt. Mellenthin, *B.F. Harrison 12500* (BRY 36282!). Utah, La Sal Forest, Ducket Cabin near West Mt., *Orange A. Olsen 0-122* (RM 470844!).

WASHINGTON. Okanogan Co., North Fork of Bridge Creek, *A.D.E. Elmer 693* (WS 26528!); SW of Conconully, trail to Big Granite Mt., *Chas. B. Fiker 1374* (WS 68838!); Crescent Mine vicinity, Mining Claim Forest Serv. Prop., *R. & D. Naas 3915* (WS 285435!);

trail S of Harts Pass, E boundary, Sec. 24-Forest Serv. Prop., *R. & D. Naas 3941* (WS 285470!); **Skagit Co.**, North Cascades, town of Diablo, 17.25 mi SE, *R. & D. Naas 3457* (RM 470842!); **Yakima Co.**, Cascade Mts., in Chinook Pass, *J. William Thompson 15138* (CAN 191037!; UC 749375!, WS 152638!); **Columbia Co.**, Blue Mts., below Table Rock, *L. Constance, J.F.G. Clarke, W. Staats & G. Van Vleet 1258* (WS 69426!); **Chelan Co.**, Wenatchee Forest, Maple Pass Area, 18 mi WSW of Mazama, *Ralph & Dorothy Naas 2691* (RM 471081!); Mt. Stuart Region, moist slopes along Ingalls Creek, *J. William Thompson 7723* (PH 692782!).

WYOMING: **Fremont Co.**, To-gwo-tee Pass area, scattered alpine areas on the tops of Lava Mountain & Two Ocean Peak, *Richard W. Scott 720* (RM 279825!).

Based on single set each of material, E.L. Greene described in the same paper (Greene 1900) 2 new *Arnica* species, namely: *A. ovata* (p. 161) and *A. diversifolia* (p. 171). Subsequently, Maguire (1943) placed *A. ovata* Greene as a synonym of *Arnica mollis* Hook. based on interpretation that the former taxon is simply an alpine phase of the latter, while *A. diversifolia* Greene has been considered as "seemingly, the least well-defined specific population" (Maguire 1943, p. 476). Unfortunately, Maguire was unable to examine the holotype of *A. ovata* Greene deposited at the Greene Herbarium, Notre Dame University. Altogether, the holotype [Figs. 16, 17A & B (NDG 0625241/HG 46003!)] and isotypes [Fig. 17C & D (MO 145906! and UT 17376!) of *A. ovata* Greene are definitely not reduced in stature (35-40 cm tall) compared with that of *A. mollis* Hook. (15-70 cm high) so as to be taken as "the probable alpine ecotype of the more prevalent montane form" (Maguire 1943, p. 479) *i.e. A. mollis* Hook.

In the present study, the types of *A. ovata* Greene and *A. diversifolia* Greene are considered to simply represent the opposite extremes of a morphological continuum, especially with regard to leaf characters. There is virtually no sufficient difference between these taxa in the characters of the capitula, ligulate and disc florets, achenes and pappus. Collections from Klamath County, Oregon [*WM11472* (ALTA!)] and Denali Highway, Alaska [*c.* 150 m E of Mile post 35, subalpine tundra, *WM11946* (ALTA 92059!, ALTA 92060!) exhibit the intermediate clinal variation in leaf morphology of *A. ovata* Greene.

Arnica diversifolia Greene (= *A. ovata* Greene) was first reported from Yukon by Porsild (1974a) citing a single collection from the St. Elias Mountains [valley south of

Serpentine Creek, southwestern Yukon, *A.M. Pearson 67-337* (CAN 316856!)]. Later, the same collection is annotated by H.L. Dickson (*in sched.*, 1 October 1979) as *Arnica amplexicaulis* Nutt. subsp. *prima* (Maguire) Maguire and subsequently by D.F. Brunton (*in sched.*, February 1980) as *A. diversifolia* Greene. Both annotations were done in connection with the 'Rare and Endangered Plants Project' of the National Herbarium of Canada. However, it is under the latter name that the Pearson collection is listed and used in the distribution map for the above-mentioned project (Douglas *et al.* 1981).

Incidentally, among the taxa included in subgenus *Chamissonis*, *A. ovata* is the only one that has been commonly referred to as "merely a convenient name for a complex series of hybrids" (Cronquist 1955, Ediger & Barkley 1978) involving *Arnica amplexicaulis* or *Arnica mollis* and *Arnica cordifolia* or *Arnica latifolia* (Cronquist 1955, Ediger & Barkley 1978, Wolf 1980, among others) and recently, between *A. mollis* and *A. cordifolia, A. latifolia* or *A. rydbergii* (Welsh *et al.* 1987). However, ironically enough, such an assumption has never been reflected in its taxonomic history; hence, there is but one taxonomic synonym, *i.e.* *Arnica latifolia* Bong. var. *viscidula* A. Gray that has been placed under it (Maguire 1943, Cronquist 1955, Ediger & Barkley 1978). In comparison, *A. mollis* Hook. has at least, 13 different taxonomic synonyms (Maguire 1943) while *A. amplexicaulis* Nutt., *A. latifolia* Bong. *A. cordifolia* Hook. and *A. rydbergii* Greene have 9 (Maguire 1943), 18 (Wolf 1981, Wolf & Denford 1984c), 13 (Wolf 1981, Wolf & Denford 1984) and 7 (Downie 1987, Downie & Denford 1988 in press), different taxonomic synonyms, respectively.

With the present treatment of 2 taxa as synonyms of *A. ovata* Greene (*vide supra*), the amplitude of morphological variability frequently referred to by previous workers (*e.g.* Cronquist 1955, Ediger & Barkley 1978, Welsh 1974, Wolf 1980, Welsh *et al.* 1987) is now amply substantiated. As circumscribed in the present investigation, *A. ovata* is distinguished from its close allies, namely: *A. cordifolia* and *A. amplexicaulis* as well as *A. latifolia* and *A. mollis* by the following constant characters: a) (1-) 3-5 (-7) medium-size turbinate heads, b) shaggy whitish brown to stramineous (seldom tawny) subplumose pappus, c) broadly ovate, lance-ovate to ± deltoid or orbicular, sparsely and distantly denticulate to prominently dentate-serrate leaves, d) obtuse to truncate or subcordate leaf-base, e) very short and slightly broad-winged petioles of basal leaves (subsessile), f) conspicuously thin, narrow to slightly broad-winged petioles of lowermost pair of cauline leaves, and g) pale yellow-green herbage.

The apparent morphological variability exhibited by this species is largely a by-product of polyploidy and subsequent apomictic mode of reproduction.

3. **Arnica mollis** Hook., Fl. Bor. Amer. 1: 331, 1834; C.V. Piper & R.K. Beattie, Fl. NW Coast, p. 386, 1915; F.J. Smiley, Univ. Calif. Publ. Bot. 9: 385, 1921; S.F. Blake *in* I. Tidestrom, Contrib. U.S. Nat. Mus. 25: 607, 1925; W.L. Jepson, Man. Flowering Plants Calif., p. 1157, 1925; G.N. Jones, Univ. Wash. Publ. Biol. 7: 166, 1938; B. Maguire, Brittonia 4(3): 477, 1943; H.M. Raup, Sargentia 6: 252, 1947; A. Cronquist *in* R.J. Davis, Flora of Idaho, p. 690, 1952; A. Cronquist *in* R. Ferris, Illus. Fl. Pac. States 4: 420, fig. 5722, 1959; E.H. Moss, Flora of Alberta, 1st ed., p. 448, 1959; J.P. Anderson, Flora of Alaska & adjacent parts of Canada, p. 496, 1959; E. Hulten, Flora of Alaska & the Neighboring Territories, p. 920, 1968; W.A. Weber, Rocky Mountain Flora, 4th ed.(revised), p. 115, fig. 165, 1972; A. Cronquist *in* C.L. Hitchcock & A. Cronquist, Fl. Pac. NW, p. 484, fig. 7b, 1973; R.M. Lloyd & R.S. Mitchell, Fl. White Mountains Calif. & Nevada, p. 165, 1973; W.J. Ferlatte, Fl. Trinity Alps N. Calif., p. 39, fig. 16,[13] 1974; S.L. Welsh, Anderson's Flora of Alaska, p. 121, 1974; A.E. Porsild, Rocky Mountain Wild Flowers, p. 396, fig. 234(color), 1974; R.D. Dorn, Man. Vasc. Pl. Wyoming 1: 298, 1977; R.I. Ediger & T.M. Barkley, N. Am. Fl. ser. II, pt. 10, p. 25, 1978; H.J. Scoggan, Fl. Canada, pt. 4, 1476, 1979; H. Gilkey & L.R.J. Dennis, Handbook NW Plants, p. 451, fig.*s.n.*, 1980; L. Arnow *et al.*, Flora Central Wasatch Front Utah, p. 102, 1980; J.G. Packer, Moss's Flora of Alberta, 2nd ed.(revised), p. 539, map 1021, 1983; S.L. Welsh *et al.*, A Utah Flora, p. 144, 1987. **TYPE:** ROCKY MOUNTAINS, probably in Alberta, *Drummond s.n.* (HOLOTYPE, K; UC 658858! PHOTO 394, 395 & 397 of K; ISOTYPE, CAN 109742! with no. 598, GH *s.n.*!; UC 658858! PHOTO 396 of CAN 109742) (Fig. 21; Generalized illustration, Fig. 22).

Arnica subplumosa Greene, Pittonia 3: 104, 1896. **LECTOTYPE** (here designated): WYOMING, Union Peak, 13 August 1894, *Aven Nelson 995* (NDG 062566/HG 45934!; ISOLECTOTYPES, RM 3571!, UC 91138!). **REJECTED LECTOTYPE** (by Maguire 1943): COLORADO, Gunnison Watershed, Divide between Ouray & Telluride, above timber, stem clustered, common on rich slopes, 10 August 1901, *C.F. Baker 760* (NDG 062564/HG 45936!). For details, see discussion below. **SYNTYPE** (here designated): WYOMING, Teton Peaks, 21 August 1894, *Aven Nelson 933* (NDG 062565/HG 45935!, RM 3571! - this is at the same time a paratype of *Arnica chamissonis* Less. var. *longinodosa* A. Nelson (*vide infra*). For details, see discussion below.

Arnica merriamii Greene, Pittonia 4: 36, 1899. **TYPE:** CALIFORNIA, Mt. Shasta, 18

[13]Drawing of involucral bracts in 3 partially imbricate series or tiers is inaccurate.

July 1898, *C. Hart Merriam 25* (HOLOTYPE, US 1677707!; UC 658858! PHOTO 398, 399 & 400 of US 1677707).

Arnica crocea Greene, Pittonia 4: 159, 1900 non L.; *Arnica crocina* Greene, Torreya 1: 42, 1901; TYPE: BRITISH COLUMBIA, Canoe River, headwaters of Columbia River, alt. 5800 ft, 11 August 1898, *W. Spreadborough Geol. Surv. Canada 19645.* (ISOTYPE, CAN 109751!).

Arnica rivularis Greene, Pittonia 4: 163, 1900. TYPE: OREGON, subalpine stream-banks of the Powder River (Eagle Creek) Mountains, alt. 5000 ft (1538 m), 28 August 1897, *William C. Cusick 1795*, (HOLOTYPE, NDG 062551/HG 45921!; ISOTYPES, GH *s.n.*!, UC 658855! PHOTO 403 of UC 29597, UC 130794!, WS 26641!, UC 658855! PHOTO 404 of WS 26641, UC 658855! PHOTO 405 of CU).

Arnica scaberrima Greene, Pittonia 4: 165, 1900; *Arnica mollis* Hook. var. *scaberrima* (Greene) Smiley, Univ. Cal. Publ. Bot. 9: 386, 1921. TYPE: CALIFORNIA (Southeastern California), moist places in Little Kern River, perennial, 1 1/2 ft tall, flower yellow, alt. 9-10,000 ft, April-September 1897, *C.A. Purpus 5260* (HOLOTYPE, US 328648!, UC 658810! PHOTO 406 of US 328648; ISOTYPES, GH *s.n.*!, UC 91045!).

Arnica chamissonis Less. var. *longinodosa* A. Nelson, Bot. Gaz. 30: 199, 1900. TYPE: WYOMING, Centennial Valley, 17 August 1895, *Aven Nelson 1702* (HOLOTYPE, RM 5837!; UC 658810! PHOTO 408 & 409 of RM).
TYPE: WYOMING, La Plata Mines, 23 August 1895, *Aven Nelson 1785* (PARATYPE, RM 5141!; UC 658810! PHOTO 410 & 411 of RM).
TYPE: WYOMING, Teton Peaks, 21 August 1894, *Aven Nelson 933* (PARATYPE, RM 3571! - this is at the same time a syntype of *Arnica subplumosa* Greene, *vide supra*).
TYPE: WYOMING, Yellowstone National Park, Lewis River, in bogs, 9 August 1899, *Aven Nelson & Elias Nelson 6379* (PARATYPE, RM 169905!).
TYPE: UTAH, Marysvale, head of Bullion Creek, alt. 11500 ft, 23 August 1894, *Marcus E. Jones 5883* (PARATYPES, RM 14267!, UC 159399!)

Arnica confinis Greene, Ottawa Nat. 15: 281, 1902. TYPE: BRITISH COLUMBIA, Chilliwack Valley, between Lat. 49° & Lat. 49° 10', & Long. 121° 25' & Long. 122°, Tarni Hy Mountain, rocky slopes, alt. 6000 ft, 29 August 1901, *J.M. Macoun Geol. Surv. Can. 26933* (HOLOTYPE, NDG 062426/HG 46834! *p.p.mag.*; ISOTYPES, CAN 109755!, UC 658896! PHOTO 418 & 419 of CAN 109755; GH *s.n.*!, *p.p.*), UC 658896! PHOTO 415, 416 & 417 of GH *s.n.*).

Arnica amplifolia Rydb., N. Amer. Fl. 34: 354, 1927. TYPE: IDAHO, Bitter Root Forest Reserve, head of Bear Creek, alt. 2050 m, 26 August 1897, *John B. Leiberg 2934* (HOLOTYPE, NY *s.n.*!, UC 658894! PHOTO 428 & 429 of NY *s.n.*).

Plants 1.5 to 7 dm high, loosely forming clumps; *stems* few to several arising from short, thick or stout rhizomes, simple or branched only at inflorescence, nearly glabrous or sparsely to moderately pilose with long lax white hairs and short- to long- stipitate glands; *basal leaves* 1 to 2 pairs, usually oblong to oblanceolate or broadly lanceolate, subsessile or with short broad-winged petiole, mostly entire to sparsely denticulate, base acute or obtuse but never subcordate or truncate; *cauline leaves* (2-) 3 (-4) pairs, 4-20 x 1-4 cm, all sessile or lowermost pair subsessile or with short broad-winged petiole, broadly elliptic, elliptic-lanceolate or narrowly to broadly lanceolate, nearly entire to irregularly denticulate, base acute to obtuse but never subcordate or truncate, sparsely to moderately pubescent with short- or long stipitate glands or soft silky hairs; *capitula* 1 to 3 (rarely 5-7), in loose cyme, commonly large broad hemispheric to campanulate, 15-20 x 25-30 mm; *periclinium* short, broad, scarcely to moderately pilose with short- or long- white multiseptate hairs and/or with dense short- and long- stipitate glands; *involucral bracts* (8-) 10-20 (-22), conspicuously biseriate, 10-20 x 2-4 mm, broadly lanceolate or rarely narrowly lanceolate or oblanceolate, ±acuminate, sparsely to moderately pubescent-pilose with short- or longwhite or translucent hairs or with moderately to densely short- and long- stipitate glands; *ligulate florets* (10-) 12-20 (-22), (8-) 10-20 (-25) mm long x (4-) 6-8 (-10) mm wide, bright to deep yellow, it apex irregularly tridentate with teeth 1-1.5 mm long; *disc florets* (40-) 50-180 (-210), usually tubular to funnelform, seldom goblet-shaped, (7-) 8-10 (-11) mm long, base of tube moderately to densely pilose with white short or long multiseptate hairs, rarely with short-stipitate glands; *pappus* of 16-24 bristles, distinctly tawny to deep brown, with conspicuous sporadic deep amber-like deposits inside setae, strikingly plumose (very seldom subplumose) with setae 0.6-0.8 mm long; *achenes* (50-) 60-200 (-230), (4-) 5-7 (-8) mm long x 1-1.5 mm wide, round-cylindric rarely slightly angular, mostly short-stipitate glandular, sparsely hirsutulous with simple or bifid white to brownish hairs, commonly greyish brown to waxy black. *Chromosome number*, 2n = 38, 57, 76, 95, 114, 133, 152.

ECOLOGY AND DISTRIBUTION. Quite abundant and a typical element in the montane, subalpine and alpine zones of major western North American mountains and mountain ranges south of 54° latitude. Remarkably rare in Yukon Territory and might be altogether absent in Alaska. Douglas (1982, fig. 49) gives a fairly widespread range in British Columbia presumably largely based on collections at UBC which I have not examined. However, current circumscription of this taxon appears to be substantially different from the one adopted by Douglas judging from his illustration (Douglas 1982, fig. 50; for further discussion, see under *Arnica ovata* Greene) (Fig. 23).

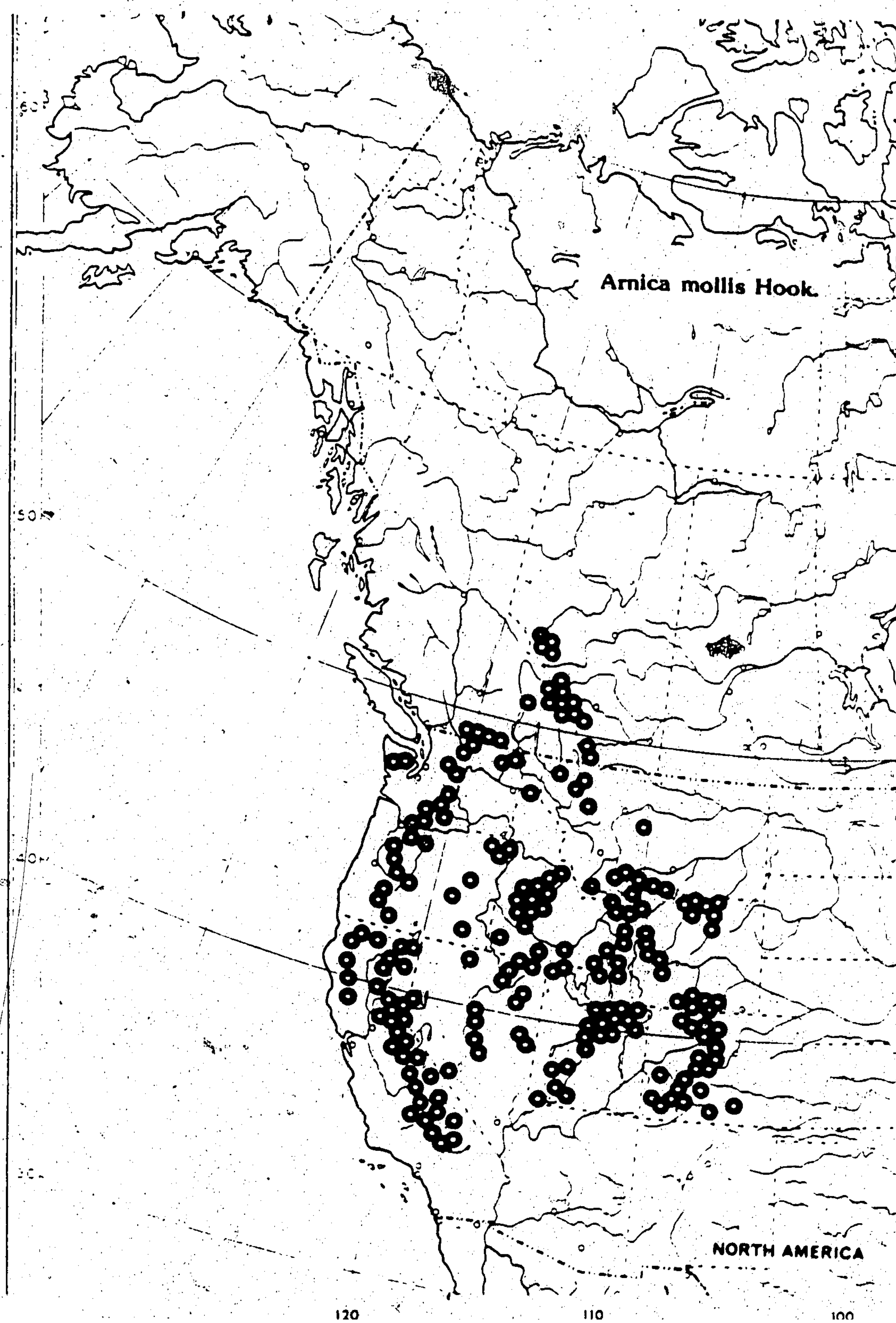
Figure 21. Holotype of *Arnica mollis* W.J. Hook. [Rocky Mountains: probably in Alberta, *Drummond s.n.* (K *s.n.*!)].


HOLOTYPE
MONOGRAPH OF THE GENUS ARNICA

Figure 22. Habit and morphology of *Arnica mollis* W.J. Hook. [Wyoming: Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 120 m west of Mile Post 66, c. 10 m from roadside, in meadows along stream banks, alt. 2348 m (= c.8000t), *William Sm. Gruezo WM11382* (ALTA!, WGRZ!).


5 CM

Figure 23. Geographical range of *Arnica mollis* W.J. Hook.


Arnica mollis Hook.
NORTH AMERICA
60
50
40
30
120
110
100

Arnica mollis W.J. Hook. is best developed in wet or sedge meadows along streambeds, brooks in rocky cirques, in avalanche tracks or snowflush sites, in moist grassy crevices of rockslides or scree slopes, along margins of *Sphagnum* bogs as well as swampy grounds near lakes. It is also frequently encountered in wide gaps of moist upland woods (*e.g.* lodgepole pine, Douglas fir, ponderosa pine, spruce-fir, *etc.*). Elevational range is from 1000 to nearly 4000 m. It starts to bear flowers from early June to late September.

SPECIMENS EXAMINED: CANADA. ALBERTA. Vine Creek, flows SE into the Athabasca River, bet. Grassy Ridge & De Smet Range *L.R. Hettinger 438* (ALTA 45571!); **Jasper Natl. Park**, 1 km NE of Signal Mountain summit, *T.D. Lee & W.M. Peterson s.n.* (ALTA 56163!, ALTA 56156!); dry slope near fire tower on Pyramid Mountain, *A.E. Porsild & A.J. Breitung 16352* (CAN 109736!); Shovel Pass, alt. 7000-8000 ft, *E.M. Kindle 93490* (CAN 109725!); Shovel Pass, low ground near brooks, alt. 6500 ft, *J.M. Macoun Geol. Surv. Canada 96056* (CAN 109724!); Shovel Pass, low ground near brooks, alt. 6500 ft, *J.M. Macoun Geol. Surv. Canada 96057* (CAN 109723!); The Bald Hills, *P. Kuchar 513* (ALTA 49373!); Mt. Edith Cavell, subalpine meadow watered by brook, *A.E. Porsild 21150* (CAN 288121!); Mt. Edith Cavell, subalpine meadow watered by brook, elev. 7000 ft, *A.E. Porsild 21149* (CAN 288122!); above Mt. Cavell Chalet, alt. 7200 ft, *G.C.D. Griffiths s.n.* (ALTA 38369!); Mt. Edith Cavell, high dry alpine pastures, *T.T. McCabe 8353* (UC 649302!); Sunwapta Pass, shoulder of Wilcox Mountain, *E.H. Moss 11146* (ALTA 16944!). **Banff Natl. Park**, Lake Agnes, alt. 6800 ft, *M.O. Malte & W.R. Watson 1130* (CAN 291715!); subalpine meadows west of Amethyst Lake, *George W. Scotter 17150* (ALTA 76411!); Lake Louise, alpine slopes near Lake Agnes, *A.E. Porsild & A.J. Breitung 15772* (CAN 109730!); Banff-Jasper Road, meadow on Bow Summit, alt. 6800 ft, *W.C. McCalla 11488* (ALTA 68810!); moist meadow below the road between Bow Lake & Bow Summit, alt. c.6700 ft, *W.C. McCalla 7722* (ALTA 68811!); Bow Pass, west slope of Cirque Mt. *A.E. Porsild & A.J. Breitung 16223* (CAN 109726!); alpine meadow above summit of Bow Pass, *W.C. McCalla 6770* (ALTA 68813!); Bow River Pass, alpine slopes & screes west of pass, elev. 7200-8300 ft, *A.E. Porsild & A.J. Breitung 14930* (CAN 109734!); Bow River Pass, alpine slopes & screes west of pass, elev. 7200-8300 ft, *A.E. Porsild & A.J. Breitung 14932* (CAN 109727!); vicinity of Mt. Temple Ski Lodge, alpine slopes between 6200-8500 ft elev., *A.E. Porsild & A.J. Breitung 12754* (CAN 109735!); vicinity of Sunshine Ski Lodge, south of Healy Creek, Wa-wah Ridge, Twinn Cairn & Standish Hump, alpine slopes & ridges bet. 7200 & 8550 ft elev., *A.E. Porsild & A.J. Breitung 13365* (CAN 109728!); vicinity of Sunshine Ski Lodge, south of Healy Creek, Wa-wah Ridge, Twinn Cairn & Standish Hump, alpine slopes & ridges bet. 7200 & 8550 ft elev., *A.E. Porsild & A.J. Breitung 13391* (CAN 109737!); vicinity of Sunshine Ski Lodge, south of Healy Creek, Wa-wah Ridge, Twinn Cairn & Standish Hump, alpine slopes & ridges bet. 7200 & 8550 ft elev., *A.E. Porsild & A.J. Breitung 13449* (CAN 109732!); vicinity of Sunshine Ski Lodge, south of Healy Creek, forested lower slopes & rocky alpine summits between 7200 & 9300 ft elev., *A.E. Porsild & A.J. Breitung 13607* (CAN 109731!); vicinity of Sunshine Ski Lodge, south of Healy Creek, Wa-wah Ridge, Twinn Cairn & Standish Hump, alpine & ridges between 7200 & 8550 ft elev., *A.E. Porsild & A.J. Breitung 14159* (CAN 109740!); vicinity of Sunshine Ski Lodge, south of Healy Creek, screes & cliffs along south & west base of Citadel Mt., 8400 ft elev., *A.E. Porsild & Johannes Lid 19572* (CAN 293159!); vicinity of Sunshine Ski Lodge, Simpson Pass & Monarch Mt., alpine forest & slopes between 7200 & 8400 ft elev., *A.E. Porsild & A.J. Breitung 13716* (CAN 109741!); vicinity of Sunshine Ski Lodge, Simpson Pass & Monarch Mt., alpine forest & slopes between 7200 & 8400 ft elev., *A.E. Porsild & A.J. Breitung 13717* (CAN 109739!); Sunshine area, alt. 7900 ft, *George W. Scotter 17236* (ALTA 76402!); Simpson Pass summit, *N.B. Sanson s.n.* (CAN 465335!); Simpson Pass summit, *N.B. Sanson s.n.* (CAN 465334!) Simpson Pass summit, *N.B. Sanson s.n.* (CAN 465338!); Simpson Pass summit, ravine on Step Mt. *N.B. Sanson s.n.* (CAN 465339!); Simpson Pass summit, *N.B. Sanson s.n.* (CAN 465336!); , Step Mt., *N.B. Sanson s.n.* (CAN 465337! *p.p. mag.*); Pipestone Pass, alt. 7000 ft, *Mrs. Chas. Schaffer 814* (PH 532141!). **Kananaskis Provincial Park**, S lower slope of Mt. Indefatigable, elevation above 5300 ft, *N.G. Kondla 1836* (ALTA 79308!); c. 10 miles N of Coleman, *J.H. W. & E.H. M. s.n.* (ALTA 16943!); Rocky Mountain Park, summit of Ottertail Pass, alt. 7000 ft, *Macoun Geol. Surv. Canada 65512* (CAN 109744!); Rocky Mountain Park, summit of Ottertail Pass, alt. 7000 ft, *Macoun Geol. Surv. Canada 65517* (CAN 109743!). **Waterton Lakes Natl. Park**, Lineham Lakes c. 7 mi W of Waterton Townsite, in subalpine meadow *G.W. & G.G. Douglas 7927* (BRY 127417!); Twin Lakes Trail, alt. 5900 ft, dry subalpine meadow, *W. Blais & J. Nagy 2273* (ALTA 82466!, CAN 340741!); along subalpine brook in cirque W of Goat Lake, elev. 6800 ft, *August J. Breitung 17269* (ALTA 16941!); shoreline of Summit Lake, alt. 1935 m (= 6350 ft), *P. Kuchar 2844* (ALTA 46082!); wet place near spring, forested E slope along trail to Bertha Lake, elev. 6300 ft, *A.J. Breitung 14037* (ALTA 16942!); moist ground at edge of Bertha Lake, alt. 5800 ft, *W.C. McCalla 7224* (ALTA 68812!); along brook at Bertha Lake, elev. 6000 ft, *August J. Breitung 17430* (UC 985838!).

BRITISH COLUMBIA. Selkirk & Rocky Mts., Spellemacheen Valley, alt. 6000 ft, *Charles H. Shaw 412* (PH 526017!); Selkirk Mts., Roger's Pass, alt. 4500 ft, *J.M. Macoun Geol. Surv. Canada 14722* (CAN 109747!); Roger's Pass, *Charles Schaffer s.n.* (PH s.n.!); **Glacier Natl. Park**, along Cougar brook in the valley bet. Cougar Mt. & Cheops Mt. alt. 6000 ft, on damp subalpine meadow, *J.H. Soper 12595, M.J. Shchepanek & A.F. Szczawinski* (CAN 342459!); along Cougar brook in the valley bet. Cougar Mountain & Cheops Mountain, alt. 6200 ft, *J.H. Soper 12610, M.J. Shchepanek & A.F. Szczawinski* (CAN 342460!); on the slopes & in the valley N of Mt. Fidelity Avalanche Research Station, *J.H. Soper 13280 & D.R. Given* (CAN 368405!); **Mt. Revelstoke Natl. Park**; bet. mile 13 & mile 14 on Mt. Revelstoke road, alt. 5500 ft, *J.H. Soper 12472, M.J. Shchepanek & A.F. Szczawinski* (CAN 342324!); north of the summit of Mt. Revelstoke on trail to Eva Lake, *J.H. Soper 12549, M.J. Shchepanek & A.F. Szczawinski* (CAN 342325!); along road from the Trans-Canada Highway to the summit of Mt. Revelstoke, roadside near mile 12, alt. 5400 ft, *D.R. Given 73460 & J.H. Soper* (CAN 368285!); Mount Revelstoke, boggy ground near timberline, *T.T. McCabe 5423* (UC 576247!); Rocky Mts., Nub Mt., on exposed summit at 8500 ft, *R.L. Taylor & D.H. Ferguson 3798* (WS 243532!); along trail to Ashnola Range, in moist boggy area in coniferous woods at 6500 ft elev., *J.A. Calder, J.A. Parmelee & R.L. Taylor 19585* (RM 257955!); Yoho Valley, *Macoun Geol. Surv. Canada 65525* (CAN 109748!); Sunburst Lake Camp at Mt. Assiniboine, 32 mi from Banff, elev. 7200 ft, *Edith Scamman 6719* (CAN 245392!); N of Chilliwack Lake, alt. 3500 ft, dry slopes, *J.M. Macoun Geol. Surv. Canada 26931* (CAN 109749!); Mt. Cheam, N of Chilliwack River, *J.R. Anderson Geol. Surv. Canada 34074* (CAN 109752!). **Cathedral Provl. Park**, Lakeview Mt., elev. 2185 m, *G.W. Douglas 11470* (BRY 207797!); Lakeview Mt., elev. 2320 m, *G.W. Douglas & M.J. Ratcliffe 11486* (BRY 207796!); Mt. Queest, alt. 6000 ft, damp mountain prairies, *J.M. Macoun Geol. Surv. Canada 14721* (CAN 109746!); Scout Lake, *R. Hainault 7665* (ALTA 54938!); mountains of Griffin Lake, alt. 6000 ft, *J.M. Macoun s.n.* (CAN 109745!).

U.S.A. **CALIFORNIA. Modoc Co.**, Warner Mts., Emerson Peak, in rockslide below cliff, NE, *Annie M. Alexander & Louise Kellogg 5055* (UC 936191!, WS 217591!); Warner Mts., S slope of Eagle Peak, *Annie M. Alexander & Louise Kellogg 5080* (UC 936190!); Warner Mts., Lily Lake, Pine Creek, alt. 7000 ft, *Louis C. Wheeler 3855* (ND 011143!/212201!); S Fork of Davis Creek, alt. 6700 ft, *L.S. Smith 147* (JEPS 35913!, RM 470721!). **Siskiyou Co.**, head of Shackleford Creek, elev. 5500 ft, *Geo. D. Butler 336* (JEPS 35690!, UC 165319!); Shackleford Creek, alt. 4000 ft, *Geo. D. Butler 1773* (UC 166159!); Shackleford Canyon, ridges & meadows near Marble Mt., North Coast Ranges, alt. 6000 ft, *Harley P. Chandler 1700* (UC 129317!); Mt. Shasta, in the heather meadows along Squaw Valley Creek, alt. 7000-8000 ft, *Wm. Bridge Cooke 25594* (WS 189120!); Mt. Shasta, Squaw Creek Meadow, along Squaw Creek from middle meadow to lower meadow, mostly near creek, elev. 7500 ft, *Wm. Bridge Cooke 11652* (UC 618864!); Mt. Shasta, common along creeks in Panther Creek meadows, elev. 7000 ft, *Wm. Bridge Cooke 17795* (WS 184873!); Mt. Shasta, common along the creeks in Panther Creek meadows, elev. 7500 ft, *Wm. Bridge Cooke 13738* (ND 011136!); Mt. Shasta, Panther Meadows, along small stream, alt. 7500 ft, *Philip A. Munz 24174* (UC M-188087!); Mt. Shasta Natl. Forest, S slope of Mt. Shasta, Panther Creek Meadows, elev. c. 7200 ft, *Robert F. Thorne & Fred Oettinger 38974* (UC I-408807!); Salmon Mts., The High Lake Basins in the vicinity of English Peak, Marble Mt. Wilderness Area, *Frederick W. Oettinger 625* (UC I-408813!); Salmon Mts., The High Lake Basins in the vicinity of English Peak, Marble Mt. Wilderness Area, N-facing slope about 0.2 mi due NE of Charmaine Lake, elev. 6200 ft, *Frederick W. Oettinger 1470* (UC I-409283!); Salmon Mts., The High Lake Basins in the vicinity of English Peak, Marble Mt. Wilderness Area, along the steep narrow bedrock gorge below "Tom's Lower Pond", elev. 6100 ft, *Frederick W. Oettinger & R.F. Thorne 1251* (UC I-409284!). **Shasta Co.**, Lassen Volcanic Natl. Park, Dersch Meadows, alt. 6500 ft, *E.G. Anderson s.n.* (UC 892183!); Lassen Volcanic Natl. Park, lower part of Brokeoff Trail, alt. 7500 ft, *E.G. Anderson s.n.* (UC 892185!); Upper Kings Creek, bet. King Creek Falls & Lassen Peak Highway (89), elev. c. 7200 ft, *George W. Gillett 446* (JEPS 12522!). **Trinity Co.**, ridge W of Upper Canyon Creek, rocky meadow, elev. 7750 ft, *William J. Ferlatte & Alice Q. Howard 1295* (JEPS 74632!); Trinity Alps, ridge W of Upper Canyon Creek, elev. 7500 ft, *William J. Ferlatte & Alice Q. Howard 1298* (JEPS 74634!); Devil's Canyon Mts., along streamlets in rocky cirque at head of White's Creek, alt. 6800 ft, *Joseph P. Tracy 14608* (JEPS 20980!, UC 582487!). **Tehema Co.**, Yolla Bolly Mts., Last Camp, border of boggy meadows, E-facing exposure, elev. c. 7100 ft, *Todd & Virginia Keeler-Wolf 543* (JEPS 75797!). **Nevada Co.**, Castle Peak near the highest point, alt. 9000 ft, *A.A. Heller 7098* (PH 507176!, UC 57883!); Sierra Nevada Mts., rocky heights above Coldstream, elev. 8000 ft, *C.F. Sonne s.n.* (UC 91132!); Summit, road from Webber Lake to Meadow Lake, *C.F. Sonne 23* (NDG 062193!/HG 45987!); on road to Meadow Lake, near Summit, *C.F. Sonne 191* (NDG 062194!/HG 45988!). **Lake Co.**, (?)un Sokneefeldee am Luow K., alt. 7600-8000 ft, *C.A. Purpus 1230* (UC 134181!). **Placer Co.**, Sierra Nevada Mts., vicinity of Donner Pass, c. 80 mi NE of Sacramento, alt. 7000-7800 ft, *John H. & Hazelle A. Thomas 6213* (JEPS 22905!); on Truckee River, meadows, *C.F. Sonne s.n.* (UC 91145!); Sierra Nevada Mts., canyon above Coldstream, *C.F. Sonne s.n.* (UC 91137!); Sierra Nevada Mts., above Coldstream, *C.F. Sonne s.n.* (UC 193451!); Sierra Nevada Mts., above Coldstream, *C.F. Sonne 378* (JEPS 35865!); Sierra Nevada Mts., canyon above Coldstream, *C.F. Sonne 888* (NDG 062203!/HG 45989!). **El Dorado Co.**, Sierra Nevada Mts., Velma Lake, alt. 8000 ft; *H.M. Hall 8807* (UC 148938!); Sierra Nevada Mts., Maggies Peaks, 7100 ft alt., *H.M. Hall 8811* (RM 73168!, UC 148930!); Half-moon Lake, in the Sierra Nevada at 2500 m alt., in meadow along N side of lake, *H.M. Hall 8817* (RM 106386!, UC 175940!); Sierra Madre Mts., Half-moon Lake, 8100 ft alt., *H.M. Hall 8824* (UC 149003!); Sierra Nevada Mts., vicinity of Lake Tahoe, shores of Half-moon Lake, alt. 8200 ft, *H.M. Hall & H.P. Chandler 4701* (UC 53878!); Sierra Nevada Mts., Ralston Peak, Cup Lake, *Herbert McLean Evans s.n.* (UC 311654!); El Dorado Natl. Forest, Barrett Camp, elev. 6350 ft, *P.B. Kennedy 28* (UC 205837!); Desolation Valley Wilderness Area, grassy meadow on ridge S & above Lake Schmidell, elev. 8500 ft, *G. Thomas Robbins 1799* (UC 747169!); Meyer's to Markleeville, stream bank, *Beryl O. Schreiber 781* (UC 614818!); Echo Summit, wet springy place across from U.S. Highway maintenance station, elev. 7385 ft, *Gladys L. Smith 1943* (JEPS 71781!). **Alpine Co.**, Echo Summit Project, on road to Woods Lake, after turn-off from main highway, elev. 8300 ft, *Gladys L. Smith 2249* (JEPS 71777!); Sierra Nevada Mts., East Blue Lake, NW end of lake, alt. 8100 ft, *Carl B. Wolf 5260* (UC 892205!). **Mono Co.**, McMillan Lake, near northern end of Flatiron Ridge, watershed of Molybdenite Creek, E slope of Sierra Nevada, elev. 9200 ft, *Annie M. Alexander & Louise Kellogg 4161* (CAN 325205!, JEPS 35689!); Sweetwater Mts., Deep Creek, alt. 10200 ft, *Annie M. Alexander & Louise Kellogg 4059B* (UC 702113!); Sierra Nevada, Cabin Creek, tributary to Slate Creek, alt. 10300 ft, *Philip A. Munz 20032* (RM 245264!); 2 mi E of Kennedy Peak, alt. 9400 ft, *W.A. Peterson 517* (UC 573291!); Bridgeport Quadrangle, 3 1/4 mi N of Peeler Lake, elev. 8700 ft, *W.A. Peterson 527* (UC M-119302!); Ink Rocks, alt. 10800 ft, *W.A. Peterson 531* (UC 573642!); on W slope of Tioga Crest, alt. 11000 ft, *Carl W. Sharsmith 2782* (UC 712190!). **Toulumne Co.**, Yosemite Natl. Park, Benson Lake, 8200 ft alt., *W.L. Jepson 4517*

(JEPS 20958!); Yosemite Natl. Park, Wilson Canyon, edges of Wilson Creek, *Richard Snow 290* (UC M-093107!); Sierra Nevada, Yosemite Natl. Park, S end of Tiltill Mt., alt. 8500 ft, *Herbert L. Mason 12053* (UC M-093881!) Yosemite, Toulumne Meadows, grassy bank of Dog Lake, alt. 8700 ft, *P.A. Munz 7555* (RM 96968!, UC 284159!); northeastern part of Yosemite Natl. Park, 1/2 mi W of Crown Point, alt. 9400 ft, *E. Sawyer 416* (UC 579330!); Yosemite Natl. Park, Tioga, *Alice Eastwood 620* (UC 892173!); Yosemite, *J.B. Sembert s.n.* (UC 73983!); along Herring Creek, just above Strawberry & Pinecrest resort areas, elev. c. 5500 ft, *Adele Lewis Grant 100* (JEPS 35685!); Bridgeport Quadrangle, Burro Resv., Matterhorn Canyon near junction of Smedberg Lake, elev. 8500 ft, *A.H. Hawbecker s.h.* (UC M-119296!); Sierra Nevada, Yosemite Natl. Park, head of Matterhorn cirque, alt. 10800 ft, *Carl W. Sharsmith 3825* (UC 712189!); Eagle Meadow, *R.F. Hoover 1482* (JEPS 35907!); Eureka Valley, *R.F. Hoover 3640* (JEPS 20965!, UC 767460!); Sierra Nevada, on W slope of Mt. Dana, alt. 11000 ft, *Carl W. Sharsmith 249* (UC 712188!); Sierra Nevada, W base of Mt. Dana, adjacent to Dana Meadows, alt. 9950 ft, *Carl W. Sharsmith 417* (UC 712187!). **Inyo Co.**, Big Pine Creek, near confluence of south fork, elev. 8000 ft, *Annie M. Alexander & Louise Kellogg 2564* (UC 671667!); Onion Valley, W of Independence, alt. 9000 ft, *Annie M. Alexander & Louise Kellogg 3168* (CAN 249683!, RM 249834!, UC M-036099!, WS 218335!); Sierra Nevada, Flower Lake, Kearsarge Pass trail, W of Independence, alt. 10500 ft, *Annie M. Alexander & Louise Kellogg 3295* UC 694317!); Sierra Nevada, Cottonwood Lakes, SW of Pinedale upper end of third lake, alt. 11000 ft, *Annie M. Alexander & Louise Kellogg 3336* (UC 703959!). **Fresno Co.**, region of Dinkey Creek, alt. 5300 ft, *H.M. Hall & H.P. Chandler 350* (PH s.n.!); Blaney Meadows, 7800 ft alt., *Peter H. Raven 4875* (JEPS 120[illegible]); Hutchinson Meadows, c. 9400 ft alt., *Peter H. Raven 4920* (JEPS 12039!); Sierra Nevada, Second Recess, 9000 ft elev., *Peter H. Raven 6147!* (JEPS 12041!); Sierra Nevada, trail below Lake Italy, *Peter H. Raven 7724* (JEPS 12042!); W wall of Goddard, canyon (S Fork, San Joaquin River) above upper (12.S.) end of Great Rocky Salix Meadow 10000 to 10100 ft, with red cliffs making up E wall (Blackcap Mt. Quad.), *Chas. H. Quibell 7124* (UC M-215459!). **Tulare Co.**, Alta Meadows, *Katharine Brandegee s.n.* (UC 131539!); Alta Meadows, *Katharine Brandegee s.n.* UC 131541!); Upper Kern Canyon, c. 3 1/2 mi N of Tyndall Creek, c. 9900-9925 ft, *Charlotte N. Smith 1485* (JEPS 50716!); Sequoia Natl. Park, Garfield Grove of Big Trees, on S Fork of Kaweah River, elev. c. 6000 ft, *W.L. Jepson 4662* (JEPS 35864!); Mt. Silliman, Kaweah River Basin, *Ralph Hopping 386* (UC 467696!); Mt. Silliman, Kaweah River Basin, *Ralph Hopping 387* (UC 467694!); Mt Silliman, *Katharine Brandegee s.n.* (UC 131540!); Mt. Silliman, *Katharine Brandegee s.n.* (UC 131581!); Mt. Silliman, *Katharine Brandegee s.n.* (UC 220230!). **Mariposa Co.**, Yosemite Natl. Park, Isberg Pass Trail, moist meadow, *Beryl O. Schreiber 1901*, (UC 551714!); Tenaya Trail, *J.W. Congdon s.n.* (UC 91140!); border of a lakelet outside Yosemite Park limits S of Tioga Pass, elev. 9940 ft, *A.A. Heller 15454* (PH 828355!). **Butte Co.**, Jonesville, elev. 5000 ft, *H.F. Copeland 1122* (UC 492750!). **Lassen Co.**, southeastern extremity of Warner Mts., Upper Silver Creek, elev. 8200 ft, *Frances Payne 99* (JEPS 35883!); Lassens Peak, alt. 9000 ft, *Mrs. R.M. Austin s.n.* (UC 134179!). **Amador Co.**, steep, somewhat rocky slope above State Highway 88, close to turn-off for Kirkwood Lake, elev. c. 7700 ft, *G. Thomas Robbins 3763* (JEPS 15964!). **County not stated on label:** Lake Tahoe, Deer Park, *Miss M.E. Parsons s.n.* (UC 29592!); On road to Deer Park, alt. 6500 ft, *Miss Harriet A. Walker 2020* (UC 159242!); Tahoe Forest, alt. 6600 ft, *G.E. Poore 18* (RM 471088!); On State Survey, *H.N. Bolander s.n.* (UC 29598!); No locality information on label, *H.N. Bolander 186* (UC 29594!).

COLORADO. Larimer Co., summit of North Park Range, *Leslie N. Goodding 1822* (PH 523771!, RM 52144!, RM 169906!, UC 69441!); mountains W of North Park, W side along road to Steamboat Springs, *George E. Osterhout 1831* (RM 169949!); mountains E of North Park, along state road, *George E. Osterhout 2241* (RM 169951!, RM 312684!); Rocky Mountain Natl. Park, Specimen Mountain, alt. 11450 ft, *Dale W. McNeal Jr. 170* (RM 276537!); Head of Poudre Canyon at Cameron Pass in the Rocky Mts., c. 70 mi due W of Fort Collins, 10300 ft elev., *E. Neese 16149* (BRY 275157!); mountains of Cameron Pass, *George E. Osterhout 268* (RM 169948!); Cameron Pass, *George E. Osterhout 7256* (RM

169861!); Cameron Pass, *George E. Osterhout 4982* (RM 169950!); Cameron Pass, *George E. Osterhout 3860* (RM 169954!); Chamber's Lake, *George E. Osterhout 3671* (RM 169961!). **Jackson Co.**, 9 mi E of Gould, *T. Mosquin & J.M. Gillett 5345* (UC M-287589!); W of Walden, *Earl L. Johnston 317* (RM 117558!). **Routt Co.**, summit of North Park Range, meadows & flats, *Leslie N. Goodding 1814* (CAN 441747!, BRY 193071!, RM 52145!, SASK 67099!). **Boulder Co.**, Fourth of July Canyon, above Eldora, along N Fork of Middle Boulder Creek, alt. c. 9500 ft, *George Neville Jones 34049* (UC M-290000!); peat bog N of Niwot Ridge, subalpine forest, *Lee Snyder 11091* (WS 288145!); Silver Lake, near Boulder, 3150 m alt., *Francis Ramaley 762* (RM 31281!). **Grand Co.**, Lulu Pass, openings in woods, alt. 3275 m, *I.W. Clokey 4381* (ND 011154!, PH 591420!, RM 90104!, UC 892169!); Berthoud Pass, 11000-12000 ft elev., *Frank Tweedy 5814* (RM 47938!); Berthoud Pass, near Idaho Springs, open alpine slope, *Otto Degener & Leroy Peiler 16782* (RM 193990!). **Gilpin Co.**, Tolland, *Francis Ramaley 9385* (RM 74031!); a small lake 1/4 mi below Tolland, alt. c. 8800 ft, *Francis Ramaley & W.W. Robbins 3464* (RM 61543!); Teller Lake, in low swale, *H.M. Hall 10478* (UC 204736!, UC 217424!). **Clear Creek Co.**, Pike Forest, Geneva Creek, 10% slope, S exposure, alt. 11500 ft, *Ralph K. Gierisch 2665* (RM 471043!); high mountains about Gray's Peak, near timberline, mountains about the headwaters of Clear Creek, alt. 10000-12000 ft, *H.N. Patterson 78* (UC 193547!); Gray's Peak, 4 mi below the summit by the trail, *Geo. Smith 155* (PH 709116!); Gray's Peak above timber, *Benj. H. Smith s.n.* (PH s.n.!); mountains about the headwaters of Clear Creek, Bard Creek Valley, near Empire, alt. 8500-9000 ft, *H.N. Patterson s.n.* (RM 234336!). **Lake Co.**, Lake Creek, moist woods, 10500 ft elev., *I.W. Clokey 3502* (CAN 191137!, RM 93422!, UC 892192!, WS 36477!); 1/2 mi E of Independence Post, found at timberline, 11500 ft elev., *Bassett Maguire, George Piranian & B.L. Richards Jr. 12740* (CAN 191123!); 3 mi E of the top of Independence Pass, "meadow", elev. bet. 11000 & 12000 ft, *U.T. Waterfall 11562* (BRY 142219!, UC 994001!). **Mesa Co.**, Grand Mesa, moist meadow above Mesa Lake, alt. 10100 ft, *C.L. Porter 6545* (RM 241785!, UC M-009893!). **Chaffee Co.**, Monassas Creek, open wet woods, 11000 ft elev., *I.W. Clokey 3453* (UC 892191!). **Gunnison Co.**, Queen's Basin, along edge of igneous talus, alt. 11000-12500 ft, *Jean H. Langenheim 3909* (RM 257011!, UC M-086617!); moist thickets in woods on W bank of East River opposite Gothic, 8 mi N of Crested Butte, *Edgar T. Wherry C3733* (PH/PENN s.n.!); Gunnison Watershed, mountains above Ouray, elev. 11000 ft, *C.F. Baker 760* (UC 29654!, WS 26556!). **Montrose Co.**, Uncompahgre Forest, 10% NE slope, 9300 ft alt., *Lancaster, Doran & Bunderson 48* (RM 471039!). **Custer Co.**, Sangre de Cristo Range, W of Westcliffe, trail to Lakes of the Clouds, 10500 ft alt., *W.A. Weber 5824* (BRY 142224!). **Hinsdale Co.**, Uncompahgre Forest, near head of Big Blue Creek, gentle NE slope, alt. 12000 ft, *Jacob J. Jauch J-10* (RM 471040!). **Ouray Co.**, Ouray, Yankee Boy Basin, *George E. Osterhout 5340* (RM 169853!). **San Miguel Co.**, about 1 mi W of Red Mt. Pass, on alpine NE slope, 11800 ft elev., *T. Mosquin & J.M. Gillett 5406* (UC M-287591!). **Rio Grande Co.**, Hayden's Survey, 1875, *T.S. Brandegee s.n.* (UC 178526!). **San Juan Co.**, San Juan Forest, Creek Basin, 15% W slope, alpine grassland, alt. 12400 ft, *Gasper A. Loughridge 339* (RM 471041!); San Juan Natl. Forest, Kite Lake, E of Continental Divide, wet subalpine meadow, 11200 ft elev., *INSTARR San Juan Project 297*, University of Colorado, Boulder (SASK 48449!); Rocky Mountain Natl. Park, Trail Ridge, 10000 ft alt., *E.C. Smith 59* (UC 892233!); Rocky Mountain Flora, Lat. 40, subalpine, 1862, *E. Hall s.n.* (PH 709127! *p.p. mag.*); Rocky Mountain Flora, Lat. 39 -41 , 1862, *E. Hall & J.P. Harbour s.n.* (PH s.n.!); Rocky Mountain Alpine Flora, Lat. 39 - 41 , 1862, *E. Hall & J.P. Harbour 335* (PH 001148!); Rocky Moutain Flora, Lat. 39 -41 , alpine & subalpine, 1862, *C.C. Parry 54* (CAN 191125!); Sierra Madre, Hayden's U.S. Geological Survey, elev. 11000 ft, *J.M. Coulter s.n.* (PH s.n.!, *p.p.*); Sierra Madre, Hayden's U.S. Geological Survey, elev. 11000 ft, *J.M. Coulter s.n.* (PH 709113!); Galena Mt., elev. 10500-12000 ft, *Sam Fleak 438* (BRY 100843!); Vasquez, Idlewild Ranger Station, national-road, *Johnston & Hedgack 329* (RM 87559!).

IDAHO. Lemhi Co., spring near Long Tom Lookout, *Ray J. Davis 1439* (UC 892187!, WS 99854!); meadow on S Fork Camas Creek near Sleeping Deer Mt., 40 mi NW of Challis, *C.L. Hitchcock & C.V. Muhlick 11332* (RM 198577!, UC 96819!, WS 155970!); Salmon Forest, Allan Lake Meadow, SW slope, alt. 9000 ft, *Allen N. Wheeler 77* (RM

471024!). **Clearwater Co.**, Clearwater Forest, elev. 6000 ft, *J.E. Kirkwood 1993* (RM 130547!). **Valley Co.**, Payette Forest, vicinity of Cloochman Creek, with junction of Trail Creek, c. 1 mi NE of Squaw Meadows, 20 mi NNE of McCall, alt. 5000 ft, 10-20% slope, SW exposure, *Peter F. Stickney 2139* (RM 471034!). **Fremont Co.**, N face of Mt. Jefferson, W of Henry's Lake, alt. 9000 ft, *Arthur Cronquist 1875* (ND 011140!); Upper Snake River Area, North Snake drainage, boat landing 1 mi downstream from Big Spring, alt. 6400 ft, *D.W. Lindsay 1783* (BRY 109273!). **Custer Co.**, Sawtooth Mts., 1/4 mi W of Toxaway Lake, c. 10 mi WSW of Obsidian, elev. c. 8700 ft, *C.L. Hitchcock & J.S. Martin 5750* (UC 722604!, WS 95702!); Lost River Mts., Leatherman Pass, head of W Fork Pahsimeroi River, limestone pile in meadow at 10000 ft elev., *C.L. Hitchcock & C.V. Muhlick 11195* (UC 968680!, WS 155978!); near Cape Horn, wet marshy hillside, alt. 6400 ft, *J.F. Macbride & Edwin B. Payson 3600* (RM 86109!, UC 256368!); Challis Forest, head of Casino Creek, alt. 8000 ft, 40% S slope, *M.G. Markle 84* (RM 471031!); Mackay, moist bottom swales, alt. 5887 ft, *Aven Nelson & J.F. Macbride 1577* (WS 44747!); Sawtooth Mts., Challis Natl. Forest, along streams near Stanley Lake, elev. 6500 ft, J. William Thompson 13958 (CAN 191133!, PH 768290!, UC 609842!); Sawtooth Range, Stanley Lake, near Lake III, alt. 8000 ft, *C.L. Worley & L.K. Mann 36-214 p.p.* (WS 76064!). **Bonneville Co.**, Caribou Mountain, swampy places, 5800 ft, *Edwin B. Payson & George M. Armstrong 3594* (RM 98208!, PH 617124!). **Blaine Co.**, Sawtooth Natl. Forest, Boulder Mts., 13.25 mi N of Ketchum, head of Trail Creek, 9650 ft elev., *D. Atwood & S. Goodrich 8490* (BRY 231250!); Sawtooth Primitive Area, Alpine Creek, NW of Alturas Lake, meadowland just below lowermost of lakes at head of creek, *C.L. Hitchcock & C.V. Muhlick 10458* (UC 968700!, WS 155907!); Smoky Mts., moist slide-rock hillside, alt. 9000 ft, *J.F. Macbride & Edwin B. Payson 3750* (RM 86113!); Sawtooth Range, alpine slopes at base of Devil's Bedstead, 8000 ft elev., *J. William Thompson 13569* (PH 756787!, WS 79705!). **Elmore Co.**, Trinity Lake Region, stream banks, alt. 8000 ft, *J. Francis Macbride 674* (RM 67444!); meadow on S slope of Trinity Mt., 2 mi S of Trinity Lake, c. 10 mi W of Featherville, *C.L. Hitchcock & C.V. Muhlick 10394* (CAN 191118!, RM 198578!, UC 968613!); 20 mi N of Pine, on talus slopes above Big Roaring River Lake, elev. 8000 ft, 23 August 1947, *Fred G. Meyer & Lillian E. Meyer 2270* (UC 758442!). **Cassia County**, Albion Mts., Sawtooth Natl. Forest, T13S R24E NE1/4 Sec. 9, Mount Harrison just east of lookout tower, 7 mi SW of Albion, cirque basin on quartzite rock, 9200 ft elev., 14 August 1981, *D. Atwood & S. Goodrich 8359* (BRY 229786!). **Twin Falls Co.**, Magic Mountain Ski Area, South Hills, Fourth Fork Rock Creek, 21 (17 airline) mi S of Rock Creek, common in wet meadow along stream, elev. 6700 ft, *Noel H. Holmgren 6180* (BRY 167064!). **Owyhee Co.**, Silver City, wet grassy inclines, alt. 7000 ft, *J. Francis Macbride 441* (RM 67431!, UC 160091!, WS 26555!); Silver City Mts., bet. War Eagle Mountain & Silver City, *Bassett Maguire & Arthur H. Holmgren 26666* (CAN 191139!, PH 824341!, UC 739047!, WS 169996!). **Franklin Co.**, 3 mi from head of Hillyard Canyon, *Ray J. Davis 3993* (WS 127283!). **County not stated**: Payette Forest, alt. 5800 ft, *Bryant S. Martineau & W.N. Sparhawk 153* (RM 470606!); Coeur D' Alene Mountains, ridges N from Carbon, open mountain summits, alt. 1500 m, *J.B. Leiberg 1512* (UC 154463!); Minidoka Forest, E slope, alt. 8500 ft, *H.L. Smith 3* (RM 471025!); Cache Forest, Cub River, alt. 6500 ft, *Selas S. Hutchings 54* (BRY 15874!).

MONTANA. **Glacier Co.**, Glacier Natl. Park, Logan Pass, moist turf, *F.H. Sargent s.n.* (BRY 142218!); Glacier Natl. Park, vicinity of Piegan Pass, alt. 7500 ft, *Bassette Maguire 1093* (RM 131268!); Glacier Natl. Park, Logan Pass, alpine meadow, alt. 6650 ft, *H.T. Rogers & J.M. Rogers 1269* (WS 125756!). **Flathead Co.**, Swan Range, c. 6 mi NE of Echo Lake, Jewel Basin, along creek, alt. c. 6500 ft, *H.T. Rogers & J.M. Rogers Q72* (WS 125757!). **Stillwater Co.**, Absaroka Natl. Forest, head of Boulder Creek, sandy moist meadow at Independence, elev. c. 8000 ft, *C.L. Hitchcock & C.V. Muhlick 13345* (CAN 191112!, PH 837708!, RM 202866!, UC 757607!, WS 158775!). **Park Co.**, 2 mi SE of Cooke City, meadowland, *C.L. Hitchcock & C.L. Muhlick 13609* (PH 837707!, RM 202868!, WS 158777!, UC 757605!); Beartooth Mts., Absaroka Natl. Forest, 3-5 mi E of Cooke City, alt. 8000 ft, *Louis O. Williams & Rua P. Williams 3780* (ND 011144!); Cooke City, grassy hillside, alt. 7600 ft, *E. & D. Pearson 146* (RM 104458!); vicinity of Cooke City, second swamp beyond

Kersey Lake on the trail to the Crazy Lakes, Trail 20P, *Jean G. Witt 1278* (WS 184746!); Absaroka Forest, Head Copper Creek, N slope, alt. 8500 ft, *C.A. Butler 41* RM 470668!). **Madison Co.**, Tobacco Root Mts., just below Lower Brandon Lakes, *C.L. Hitchcock 16955* (UC 798454!). **Carbon Co.**, 23 mi SW of Red Lodge, atop the Beartooth Mts., moist soil along Quad Creek, elev. c. 10000 ft, *Arthur Cronquist 8074* (WS 216348!). **Beaverhead Co.**, in rock crevices in meadow bordering Lake Waukena, *C.L. Hitchcock & C.V. Muhlick 13106* (RM 202757!); Beaverhead Forest, head of Doolittle Creek, western slope, alt. 6500 ft, *H.W. Elofson 38* (RM 471045!). **Lewis & Clark Co.**: (?), Lewis & Clark Forest, Sun River, mountain slopes beneath fir & pine, alt. 5500 ft, *A.A. Saunders 222* (RM 470607!); Red Mt., alt. 7000 ft, *E.N. Brandegee s.n.* (UC 91133!); Beartooth Forest, *A.M. Baum 420* (RM 471038!); Elk Summit, E along creek, elev. 5700 ft, *J.E. Kirkwood 1682* (RM 130665!); Central Montana, Little Belt Mountains, Long Baldy, alt. 7000-8000 ft, *J.H. Flodman 893* (NDG 062593/HG 46800!).

NEVADA. **Elko Co.**, Ruby Mts., Humbold Natl. Forest, Seitz Lake, 8900 ft elev., edge of lake, *S. Goodrich, F. Smith & J.C. Tuhy 20164* (BRY 257965!); East Humboldt or Ruby Mts., canyon at the head of S Fork of the Humboldt, elev. 9800 ft, *A.A. Heller 9402* (UC 196039!); Jarbidge Mts., Coon Creek, N exposure, elev. 9000 ft, *A.H. Holmgren 1637* (UC 675899!); Jarbidge Mts., head of Coon Creek, vicinity of Coon Creek Snow Cabin, open wet areas along stream, *Bassett Maguire & Arthur H. Holmgren 22390* (BRY 18864!, CAN 191132!); 10 mi SE of Jarbidge, Humboldt Forest, alt. 7000 ft, 20% E slope, *Jack Martin M-27* (RM 471027!); Jarbidge Mts. at Coon Creek Ranger Station, Coon Creek, headwaters, creek banks, *Percy Train 670* (ND 011145!, PH 798389!); Jack Creek (Humboldt Forest), alt. 7500 ft, W exposure, streamside, *A.H. Holmgren 679* (BRY 28189!, RM 186673!); Jack Creek (Humboldt Forest), 7500 ft elev., *A.H. Holmgren 679A* (WS 109877!); Jarbidge Mts., Humboldt Natl. Forest, trail S of Emerald Lake, alt. 10000 ft, scree slope, *Mont E. Lewis & Ron Walters 4560* (BRY 163509!); Jarbidge, moist woods, alt. 7000 ft, *Aven Nelson & J. Francis Macbride 1966* (RM 75324!); Ruby Range, above the loop in Lamoille Canyon, 9000 ft alt., *Bassett Maguire & Arthur H. Holmgren 22093* (PH 813508!, PH 824363!, UC 711478!); Ruby Range, rocky places on ridge S of basin above Island Lake, elev. 10800 ft, *Bassett Maguire & Arthur H. Holmgren 22581* (PH 813509!); Ruby Range, slopes N of Island Lake, slide rock between cliffs & ridge, 10700 ft elev., *Bassett Maguire & Arthur H. Holmgren 22646* (CAN 191115!); Humboldt Forest, W Jarbidge River, alt. 8500 ft, 60% N slope, *Dale H. Kinnaman D.K.51* (RM 471026!); Independence Mts., Hayes Creek, headwaters of Jack Creek, *Bassett Maguire & A.H. Holmgren 22467* (UC 711479!); Independence Mts., McAfee Peak Area, alt. 10000 ft, on steep loose talus slopes, *Arnold Tiehm 6315* (RM 336984!). **Humboldt Co.**, meadow near Alder Creek Lakes, alt. 7800 ft, *W.P. Taylor & C.H. Richardson Jr. 11* (UC 195012!). **Washoe Co.**, Oplin Creek, *C.L. Brown s.n.* (UC 196178!); Mt. Rose, alpine & subalpine, elev. 9700 ft; *A.A. Heller s.n.* (UC 194717!); 1 1/2 mi SW of Mt. Rose, near head of Galena Creek, elev. c. 9500 ft, *C.L. Hitchcock & J.S. Martin 5508* (UC 722580!, WS 95717!); Mt. Rose, by Camp, 9000-10000 ft elev., *P.B. Kennedy 990* (UC 75833!, UC 129587!); E slope of Mt. Rose on Jones Creek trail to peak, head of south fork of White Creek, elev. 10000 ft, *Percy Train 4402* (UC 892179!). **Lander Co.**, Toyabe Range, Toiyabe Natl. Forest, Stewart Creek, 20.5 mi, 305 degrees from town of Round Mt., 9000 ft elev., wet areas around a spring & along a stream, *S. Goodrich 13455* (BRY 209928!, RM 329884!). **White Pine Co.**, Snake Range, Humboldt Natl. Forest, Snake Creek drainage, just below Johnson Lake, elev. c. 10760 ft, *Noel H. Holmgren & James L. Reveal 1615* (BRY 48941!, RM 278160!); 12 mi SW of Baker, Snake Range, Humboldt Natl. Forest, N side of Mt. Washington, 11400 ft elev., rocky (limestone) alpine area, *S. Goodrich, F. Smith & J.S. Tuhy 20052* (BRY 257854!); below Lake Theresa, below Mt. Wheeler, 10000-10200 ft alt., meadow, *F.W. Pennell & R.L. Schaeffer Jr. 23148* (PH 854343!); Snake Range, Nevada Natl. Forest, Wheeler Peak Quadrangle in spruce-fir or aspen forest along Lehman Trail from Forest Camp, *Jean Langenheim 38811* (UC M-213839! *p.p.min.*). **Nye Co.**, Toiyabe Range, Toiyabe Natl. Forest, Stewart Creek, 50 mi S of Austin, 9000 ft elev., riparian community, *J. Belnap 1527* (BRY 251525!); Toiyabe Range, Toiyabe Natl. Forest, Washington Creek, 30 mi S of Austin, 7600 ft elev., riparian community, *J.*

Belnap 1982 (BRY 251554!); Toiyabe Range, Toiyabe Natl. Forest, McLeod Creek, 20 mi, 196 degrees from Austin, 8600 ft elev., moist ground along drainage bottom, *S. Goodrich 13410* (BRY 209927!); Toquima Range, Toiyabe Natl. Forest, Pine Creek Canyon, wet grass thickets along stream, *Bassett Maguire & Arthur H. Holmgren 25863* (CAN 191111!, UC 701827!); WS 170028!); Toquima Range, Toiyabe Natl. Forest, near the head of Pine Creek Canyon, on a S-facing slope, alt. c. 8500 ft, *Gary J. Pierce 1891* (RM 293896!). **Esmeralda** Co., elev. 7000 ft, *W.H. Shockley 525* (JEPS 35890 *p.p.mag.*, NDG 062498/HG 45957!).

OREGON. Wallowa Co., Wallowa Mts., Lake Basin, below Mirror Lake, alt. 7400 ft, *L. Constance & C.D. Jacobs 1350* (WS 69125!); Wallowa Mts., meadow about shallow lakes in Eagle Cap Peak Basin, *Bassett Maguire & Arthur H. Holmgren 27094* (UC 739039!); Wallowa Mts., E end of Ice Lake, c. 8 mi SW of Wallowa Lake, elev. c. 8000 ft, sandy soil on a high cliff, *Georgia Mason 9065* (WS 276804!); Pacific Northwest Experiment Station, Wallowa Natl. Forest, N Fork Imnaha River, 8000 ft, *Elbert H. Reid 814* (RM 471096!); cliffs on north slopes of the highest Wallowa Mts., *Wm.C. Cusick 2096* (NDG 062422/HG 46837!, UC 29593!, UC 91136!, WS 26650!); Wallowa Forest, alt. 6000 ft, *Joseph A. Harris 23* (RM 470603!); Powder River Mountains, near spring at Head of Aneroid Lake, alt. 7500 ft, *Roxana S. Ferris & Rena Duthie 1154* (RM 103010!); head of Wallowa River, 9000 ft alt., *Wm.C. Cusick 2489* (JEPS 20960!, NDG 062548/HG 45920!, RM 31433!, UC 29652!, WS 26638!); head of Wallowa River, 9000 ft alt., *Wm.C. Cusick 2491* (JEPS 20961!, NDG 062549/HG 45919!, RM 31434!, UC 29651!, WS 26637!). Blue Mts., Whitman Natl. Forest, meadows about lower lake 1/2 mi below Anthony Lake Elkhorn Ridge, *Bassett Maguire & Arthur H. Holmgren 27016* (UC 739043!). **Grant Co.**, South Blue Mts., Strawberry Mt., margin of swamp, 2600 m alt., *Wm.C. Cusick 3557* (RM 72466!, WS 26554!, WS 69974!); **Harney Co.**, Steen Mts. Region, Little Blitzen Gorge, 15 1/2 mi E & 10 1/4 mi S of Frenchglen, elev. 7400 ft, *Albert N. Steward 6821 & Chas. G. Hansen* (WS 221124!). **Klamath** Co., Crater Lake Natl. Park, Pole Bridge Creek, edge of stream, *William H. Baker 7187* (WS 219921!); Crater Lake Natl. Park, above the engineers camp, elev. 6000 ft, *A.A. Heller 12959* (PH/PENN 71200!, PH 645743!, UC 201310!, UC 892174!); Crater Lake Natl. Park, in woods below Administration Building, *W.C. McCalla 6393* (ALTA 68808!); Lake-Klamath Co. line, base of Gearhart Mt., swamp near Corral Creek, *May Loveless 360* (PH 684416!). **Deschutes** Co., head of Brown's Creek, stream bank, *Morton E. Peck 16905* (ND 011141!); along creek at Tumalo Ranger Station, also higher & lower in mts., *Kirk Whited 768* (WS 79730!). **Crook** Co., Deschutes Forest, alt. 5900 ft, SE slope, along creek, *W.J. Sproat 162* (RM 471050!). **Clackamas Co.**, SW slope of Mt. Hood, along Timberline Trail on SE slope of Zigzag Canyon, alt. bet. 5000 & 5300 ft, *H.A. & J.H. Thomas 343* (UC M-009353!); Mt. Hood, Paradise Park, moist meadows, 6000 ft alt., *C.S. English Jr. 749* (WS 43238!); Mt. Hood, borders of Elk Meadows, *J.W. Thompson 3255* (PH 663873!). **Wasco Co.**, Mt. Hood Natl. Forest, Fifteen Mile Meadow, elev. 4500 ft, *G.N. Jones 4125* (UC 538240!). **Linn Co.**, Jefferson Park, stream bank, *Morton E. Peck 18843* (UC 892164!); Santiam Forest, Whitewater Creek near Jefferson Park, alt. 5000 ft, S slope, *Chas. H. Flory 56* (RM 471091!). Minam Forest, alt. 6?00 ft, *C.E. Fleming 168* (RM 470615!); Wet thicket near Breitenbush Lake, 1935, *Morton E. Peck 18766* (UC 892165!); Ochoco Forest, Trail Station, alt. 5400 ft, *Douglas C. Ingram B-540* (RM 471085!); Highest Mountains, 1885, *Wm.C. Cusick 1286=1288* (PH 709106!); Cascade Mts., Dead Indian Road, Butte Creek, *Wm. C. Cusick 2960* (UC 53801!). Oregon or California (?), head of Davis Creek, *Mrs. R.M. Austin & Bruce 2183* (UC 29591!).

UTAH. Cache Co., Cache Forest, Branch of Saddle Creek, E slope, *Grazing Reconnaissance 102* (RM 471072!); 2-3 mi N of trail from Tony Grove Lake to White Pine Lake, 8400-8800 ft elev., *K. Thorne 2908* (BRY 254414!). **Box Elder Co.**, Raft River Mts., Sawtooth Natl. Forest, 7 1/2 mi SE of Yost, 8800 ft elev., along Clear Creek *D. Atwood & S. Goodrich 8281* (BRY 229709!); Raft River Mts., SW of Strevell, Clear Creek Campground, damp creek bottoms, elev. 6400 ft, *K.S. Erdman 2392* (BRY 76069!). **Daggett Co.**, Uinta Mts., N 1.5 airline mi from Leidy Peak, 10300 ft elev., *J.E. Wilson s.n.* (BRY 238473!). **Summit Co.**, Beaver Creek, lodgepole pine association, *Cottam 3592* (BRY 15891!); Lost

Lake, alt. 10500 ft, along streams, *Cottam 3864* (BRY 15862!); Provo River Falls, alt. 7500 ft, meadow, among Engelmann association, *Cottam 3897* (BRY 15868!); Uinta Mts., Wasatch Natl. Forest, N side of Bald Mt., 9.75 mi NW (314 degrees) of Kings Peak, 11200 ft elev., *S. Goodrich 16257* (BRY 227251!); Uinta Mts., Wasatch Natl. Forest, 9 mi NW of Kings Peak, E side of Bald Mt., head of Smiths Fork, 11050 ft elev., *S. Goodrich 16268* (BRY 227262!); Uinta Mts., 1/2 mi E of Star Lake, elev. 10600 ft, *B.F. Harrison 10752* (BRY 18836!, UC 712064!); Uinta Mts., Sulfer Camp, 0.5 mi N of entrance on dirt road within camp, *R.B. Jeppsen 338B* (BRY 279660!); NE of road from Meeks Cabin Res. to Mirror Lake Road (Hwy 150), E of Elizabeth Pass, *R.B. Jeppsen & S. Goodrich 322* (BRY 279643!); Uinta Mts., Kings Peaks-Gilbert Peak Region, Henrys Forks Basin, alt. 11600 ft, *Bassett Maguire, Dean A. Hobson & Ruth R. Maguire 14438* (CAN 191135!, PH 781089!); W end of Uinta Mts., c. 3 mi N of Trial Lake Campground, summit slopes of Notch Mt., 11000 ft elev., *E. Neese 10861* (BRY 225781!); W end of Uinta Mts., c. 2 mi of Trial Lake, S side of Notch Mt., near Twin Lakes, 10400 ft elevation, *E. Neese 10880* (BRY 225801!); Uinta Mts., lodge pole pine woods at Trial Lake, 10000 ft elev., *Bassett Maguire & George Piranian 12541* (UC 604327!); Uinta Mts., Henry's Fork drainage, vicinity of foot bridge across river c. 6 mi SW of Henry's Fork Campground, 10000 ft elev., *E. Neese & J. Neese 15369* (BRY 260162!); Elizabeth Ridge, 3 mi S of Elizabeth Pass, *K. Ostler 701* (BRY 183681!); E fork of Blacksfork River, 9000 ft elev., meadow community, *K. Ostler 793* (BRY 183754!); woods along Provo River, 3 mi E of Soapstone Junction, in sandy duff, on gentle S-facing slope in lodgepole pine forest, *S.L. Welsh 1629* (BRY 30833!, BRY 142223!); in Bald Mt. Pass, quartzite outcrops, 10600 ft elev., in open Engelmann spruce woods, *S.L. Welsh & G. Moore 6657* (BRY 63626!). **Uintah Co.**, Uinta Mts., Ashley Natl. Forest, 23 mi NW, 323 degrees of Vernal, near Ashley Twin Lakes, 10250 ft elev., Engelmann spruce community, *S. Goodrich 17665* (BRY 240937!); Uinta Basin, Ashley Natl. Forest, 8.6 km NW of Red Cloud Loop Road on Leidy Peak Road, 3200 m alt., *J. Scott Peterson & Elizabeth Neese 1306* (BRY 229247!, BRY 229167!); Uinta Mts., Ashley Natl. Forest, Hacking Lake, 11000 ft elev., Douglas fir community, *E. Neese & J.S. Peterson 6376* (BRY 191889!); Vernal District, Ashley Natl. Forest, Sims Peak, 10000 ft elev., *S. Goodrich 4787* (BRY 163911!); 5.4 mi NW of Red Cloud Loop Road, on road to Leidy Peak, 10500 ft elev., spruce-lodgepole pine community, boggy area, *E. Neese & J.S. Peterson 6339* (BRY 191853!); E end of Uinta Mts., E slope of Leidy Peak, 11000 ft elev., wet meadow in spruce krummholz zone, *E. Neese 15122* (BRY 259905!). **Duchesne Co.**, Uinta Mts., Primitive Area, Big Meadows, 9750 ft elev., *D. Atwood & S. Goodrich 7744* (BRY 219208!); Uinta Mts., head of Duchesne River, near Mirror Lake, 20.5 mi, 80 degrees from Kamas, 10600 ft elev., Engelmann spruce forest openings, *S. Goodrich 14710* (BRY 216575!); Uinta Mts., head of Duchesne River, near Mirror Lake, 20.5 mi, 80 degrees from Kamas, 11000 ft elev., steep E exposure, adjacent to quartzite cliffs, *S. Goodrich 14754* (BRY 216668!); Uinta Mts., head of Duchesne River, near Mirror Lake, 22 mi, 78 degrees from Kamas, 11200 ft elev., Engelmann spruce *S. Goodrich 14796* (BRY 216711!); along Mirror Lake Creek, in spruce & lodgepole pine, elev. 10300 ft, *Bassett Maguire, A.G. Richards & Ruth Maguire 4311* (RM 140647!, UC 533006!); Atwood Lake Basin, Lake Atwood, 11050 ft elev., Engelmann spruce community, *S. Welsh, E. Neese & D. Atwood 18989* (BRY 198351!, RM 318158!); Uinta Mts., N end of Atwood Lake, alt. 11100 ft, *B.F. Harrison, R. Liechty & N. Allen 10089* (BRY 15887!); Bald Mt. Pass, rocky meadow at about 10300 ft elev., *S.L. Welsh & G. Moore 6666* (BRY 63667!, UC M-315211!); Slate Creek, trail to Brown Duck Lake, c. 1.7 mi W of Moon Lake, 9200 ft elev., lodgepole pine-Engelmann spruce woods, *S.L. Welsh & E. Neese 19806* (BRY 213783!); Uinta Mts., Brown Duck Lake, 10200 ft elev., lodgepole pine forest-montane wet meadow, Pre-Cambrian quartzite, *E. Neese & S.L. Welsh 9338* (BRY 213680!); Chepeta Lake vicinity, White Rocks River Drainage, c. 10600 ft elev., spruce-lodgepole pine forest & wet meadow, *E. Neese & S.L. Welsh 9465* (BRY 214056!); Uinta Mts., Yellowstone Canyon, Milk Lake, 11000 ft elev., spruce-firmontane wet meadow community, Pre-Cambrian quartzite, *S.L. Welsh & E. Neese 19934* (BRY 213918!); Uinta Mts., Yellowstone Drainage, Bluebell Pass, 11620 ft elev., alpine tundra, rock stripes, fell fields, Pre-Cambrian quartzite, *S.L. Welsh & E. Neese 19973* (BRY 213959!); High Uinta Mts., Grandaddy Lakes Basin, beside bogs under conifers E of Thesis pond, in forest floor, alt. 10000 ft, *Howard Stutz 2045* (BRY 21373!); Wolf Creek

Pass, grassy slope in spruce-fir forest, alt. 9475 ft, *B.F. Harrison 9695* (BRY 15888!). **Wasatch Co.**, 1/10 mi E from Wolf Creek Pass, alt. 9900 ft, springy soil at foot of mountain, *A.O. Garrett 8342* (UC 710636!); Uinta Natl. Forest, head of Vat Creek, 20 mi E (108 degrees) of Heber City, 9800 ft alt., small openings in Engelmann spruce-subalpine fir forest, *S. Goodrich 16015* (BRY 227098!); Uinta Mts., Uinta Natl. Forest, Silver Meadow, 21 mi due E of Heber City, 9300 ft elev., in shade of spruce-fir forest at the edge of a wet meadow, *S. Goodrich 17486* (BRY 240758!); Uinta Mts., Uinta Natl. Forest, Phelps Brook drainage, 22.25 mi E of Heber City, 9650 ft elev., dry meadow in spruce-fir forest, *S. Goodrich 17495* (BRY 240767!, RM 343247!). **Salt Lake Co.**, Mt. Millecent, Big Cottonwood Canyon, *A.O. Garrett 1524* (RM 52715!); Big Cottonwood Canyon, *A.O. Garrett 1645a* (RM 54077!); Wasatch Mts., Big Cottonwood Canyon, in shady places along streams, alt. 8900 ft, *A.O. Garrett 1647* (PH 524304!, RM 52684!); Big Cottonwood Canyon, *A.O. Garrett 1974* (RM 56654!); Wasatch Range, White Pine Canyon, Little Cottonwood, along stream, elev. 8500 ft, *W.P. Cottam, John Allan, F.C. Rolland & R.K. Johnson 16987* (BRY 33298!); Wasatch Range, bet. Alta & Twin Lake, 4 mi SW of Brighton, ridge about snowbank, alt. 10500 ft, *Bassett Maguire 17379* (UC 738648!); Alta, alt. 9000 ft, *W.S. Cooper 840* (RM 57911!); Alta, Wasatch Mts., Bald Mt., *Marcus E. Jones 1238* (MO 145907!); Wasatch Mts., Alta, *Marcus E. Jones s.n.* (UC 373326!); Wasatch Range, 4 mi SW of Brighton, stony meadows S of Alta Pass & W slopes, *Bassett Maguire 17452* (CAN 191110!, UC 738892!, WS 170192!); 3 mi S of Brighton, W shore of Lake Catherine, alt. 10000 ft, under thickets, *Bassett Maguire 17425* (UC 738651!); Wasatch Range, 1 mi SE of Brighton, woodlands along trail to Lake Mory, *Bassett Maguire 17399* (UC 738890!); Wasatch Range, Big Cottonwood Canyon from Catherine Pass up over Mt. Tuscorora & up to Mt. Wolverine, elev. 10231-10795 ft, *Fred Rowland 16961* (BRY 31558!). **Utah Co.**, Mt. Timpanogos, *Del Wiens 1980* (BRY 222067!). **Sanpete Co.**, Manti-Lasal Natl. Forest, head of Black Canyon, alt. 10100 ft, *Mont E. Lewis 5151* (BRY 179153!); Manti-Lasal Natl. Forest, Upper Woodward Cane, Sec. alt. 8500 ft, streamside, *Mont E. Lewis 6603* (BRY 220895!). **Juab Co.**, head of Birch Creek, c. 8 mi NW of Trout Creek, edge of subalpine meadow, 8800 ft elev., *R. Foster & J. Henriod 7080* (BRY 186786!, RM 314822!); N slope of Granite Canyon, Trout Creek, alt. 7800 ft, *Bassett Maguire & R.J. Becraft 2852* (UC 520761!); Deep Creek Mts., 16.5 km (261 degrees) W of Callao, N exposure above Toms Creek, 9400 ft elev., Engelmann spruce community, moist places along stream, *S. Goodrich 18963* (BRY 256313!); Deep Creek Range, Granite Creek, *Abies concolor* association, moist places about spring & streamside, 9000 ft elev., *Bassett Maguire & Arthur H. Holmgren 21883* (PH 813502!); Deep Creek Range, Hudsonian basin at the headwaters of Indian Farm Creek, alt. 11000 ft, *Bassett Maguire & Arthur H. Holmgren 21996* (PH 813496!). **Piute Co.**, Tushar Mts., Gold Mt., Fish Lake Natl. Forest, 11 mi W of Marysvale, spruce-fir community, *D. Atwood 8009* (BRY 231974!); Beaver District, Tushar Mts., c. 8 mi due WNW of Marysvale, white fir-aspen community, 9600 ft elev., *S. Welsh, M. Welsh & J. Henriod 17740* (BRY 186502!, RM 314449!). **Beaver Co.**, Fish Lake Natl. Forest, S Fork of Bullion Canyon, meadow area in spruce-fir community, *D. Atwood 8202* (BRY 234012!); Tushar Range, Bear Canyon, basal talus slopes, 8500 ft elev., *Bassett Maguire 17602* (WS 170198! *p.p.min.*); Tushar Range, Beaver River headwaters, W Fork, vicinity Big John Flats, along stream course under spruce, 9,000-10000 ft elev., *Bassett Maguire 19839* (UC 738814!, WS 170199!); Tushar Mts., Lake Stream, S base of Mt. Holly, streamside, 10600 ft elev., *A. Taye 3122* (BRY 276425!). **Garfield Co.**, c. 22 mi SW of Panguitch Lake in Lowder Creek, peat bog, spruce-fir community, 10400 ft elev., *D. Atwood 6980* (BRY 186971!). **Kane Co.**, Dixie Natl. Forest, Billingsley Creek, 5 mi W of Long Valley junction along Hwy 14, ponderosa pine community, *D. Atwood 7419* (BRY 207562! *p. p. min.*). **Washington Co.**, Pine Valley Mts., Furtherwater Canyon, c. 9 mi S of Pine Valley, alt. 10000 ft, abundant along stream in large meadow, *Frank W. Gould 1984* (ND 011137!, PH 824732!, RM 196910!, UC 892188!). Counties not stated: Utah, Uintah Mountains, *Thos. C. Porter s.n.* (PH 709114!). Utah, Uintah Mts., Dryer Mine, spring borders, *Leslie N. Goodding 1351* (RM 41755!). Utah, Stillwater Fork-La Motte Peak, along stream, *E.B. & L.B. Payson 5057* (PH 659989!, RM 115279!, UC 395913!, WS 52392!).

WASHINGTON. Okanogan Co., N Fork of Bridge Creek, on grassy banks of brooks that come down the mountains flanks, alt. 6000 ft, *A.D.E. Elmer 653* (WS 26653!); Rock Mt., c. 19 mi NE of Winthrop, on rocky alpine ridge, SW aspect, elev. 7700 ft, 1972, *G.W. & G.G. Douglas 4713* (BRY 207895!); Mutton Ridge, W of Salmon Meadows, wet ground around springs, *Chas. B. Fiker 1092* (WS 76412!); head of Lone Frank Creek, in wet bog, elev. 6800 ft, *Chas. B. Fiker 2258* (WS 78329!); along trail to Slate Pass, *Chas. B. Fiker 2526* (WS 87825!); Chopaka Mt., c. 11 1/2 mi NW of Loomis, in boggy subalpine meadow, aspect NNW, elev. 6400 ft, *G.W. & G.G. Douglas 4505* (ALTA 53602!). **Chelan Co.**, Wenatchee Forest, Plateau camp, 10% E slope, meadow, alt. 6000 ft, 14 September 1935, *Douglas Hole H-76* (RM 471093!); South Navarre Peak, elev. 6700 ft, *Marvin Kelly 015* (WS 69667!); Mt. Stuart, base of dripping cliffs, alt. 7500 ft, *J. William Thompson 5845* (PH 674635!); crevices of rocks high on Mt. Stuart, alt. 8000 ft, *J. William Thompson 7784* (PH 691876!); N side of Lake Chelan, W slope of head of Falls Creek, wet meadows, elev. 6000 ft, *George H. Ward 2* (WS 179149!); Chelan Forest, W.M. Miners Basin, steep SW slope, *George R. Wright 10* (RM 471087!). **Jefferson Co.**, on W side of Constance Pass, arctic-alpine zone, elev. 5400 ft, *F.G. Meyer 1563* (UC 719036!, WS 122671!). **Kittitas Co.**, Cascades, Mt. Stuart, *A.D.E. Elmer 1164* (WS 26652!); Wenatchee Forest, Naneum Meadows, alt. 6000 ft, *Douglas Hole H-10* (RM 471095!); Mt. Stuart region, head of Beverly Creek, dry meadows, alt. 5000 ft, *J. William Thompson 7754* (PH 693060!); Kittitas, Cheland & King Cos., in & near Cascade Mountains of these counties, *G.R. Vasey 379* (WS 26609!). **Pierce Co.**, Mt. Rainier Natl. Park, Elysian Fields, along small stream, *F.A. Warren 1441* (WS 61594!); Mt. Rainier Natl. Park, Indian Henrys, bank of little stream, *W.C. McCalla 5159* (ALTA 68814!); Mt. Rainier Natl. Park, N side of Mt. Rainier, *G.N. Jones 133* (WS 42818!); Mt. Rainier, dry slopes, 6500 ft alt., *C.V. Piper 2139* (WS 26647!); E side of Mt. Rainier, moist places near little streams that wander through meadow at Berkeley Park, *W.C. McCalla 5230* (ALTA 68809!); Mt. Rainier, Glacier Basin, 5500 ft elev., *J.M. Grant s.n.* (PH 628745!); Mt. Rainier Natl. Park, Glacier root, *J.M. Grant s.n.* (RM 102836!); Mt. Rainier Natl. Park, *J.M. Grant s.n.* (RM 102829!); Cascade Mts., Mt. Rainier, steep declivity irrigated by a rivulet, alt. 6500 ft, *O.D. Allen 285* (UC 91135!, WS 26648!). **Yakima Co.**, Snoqualmie Forest, wet meadow, alt. 5500 ft, *Elbert H. Reid 11* (RM 471084!); Signal Peak, 4000 ft elev., moist streambanks, *V. Neidenreich 203* (WS 60776!); Mt. Adams, *L.F. Henderson s.n.* (WS 26645!); Mt. Adams, *T.J. Howell s.n.* (PH *s.n.*); Mt. Paddo (Adams), cold springs, 6000-7000 ft alt., (Mt. Adams NW side), *Wilhelm N. Suksdorf 773* (WS 79736!); Mt. Paddo (E side of Mt. Adams), *Wilhelm N. Suksdorf 4234* (WS 79737!); Mt. Paddo, 2000 m alt., *Wilhelm N. Suksdorf 6362* (UC 892050!); Mt. Paddo, *Wilhelm N. Suksdorf 11927* (UC 892043!); Mt. Paddo (SE side of Mt. Adams), on Bird Creek, *Wilhelm N. Suksdorf 12905* (WS 79733!); Mt. Paddo, S side (Mt. Adams, SW), *Wilhelm N. Suksdorf 12945* (WS 79778!); Mt. Paddo, Wodan Valley, (Mt. Adams, E side), *Wilhelm N. Suksdorf 12892* (WS 79735!); Mt. Paddo (SE side of Mt. Adams), on Bird Creek, *Wilhelm N. Suksdorf 12906* (WS 79734!); Mt. Paddo, Wodan Valley, (E side, Mt. Adams), *Wilhelm N. Suksdorf 12920* (WS 79739!); Mt. Paddo, Wodan Valley, (SE side of Mt. Adams), *Wilhelm N. Suksdorf 12921* (WS 79732!); Mt. Paddo (Adams), cold springs, 6000-7000 ft alt., *W.N. Suksdorf s.n.* (CAN 191124! *p.p. mag.*); Cascade Mts., alpine slopes near Dewey Lake, 5000 ft elev., *J. William Thompson 15160* (CAN 191134!, PH 832663!, UC 749601!, WS 152674!). Yakima Co., Yakima Region, Northern Transcontinental Survey 1884, *T.S. Brandegee 912* (UC 91153! *p.p. min.*). **Skamania Co.**, Chiquash Mts., *Wilhelm N. Suksdorf 12937* (WS 79779!). **Pend Oreille Co.**, Bunchgrass meadow, spruce/fir forest edges, 5000 ft alt., *Earle F. Layser 345* (WS 262885!). Cascade Mts., Stevens Pass, 3800 ft elev., *J.H. Sandberg & J.B. Leiberg 725* (UC 167601!, WS 26649!). Wenatchee Forest, Ewing basin, alt. 5200 ft, 0% slope, moist alluvial wash, meadow, *Frank B. Lenzie 46* (RM 471080!). Mt. Olympus Natl. Monument, Marmot Lake, subalpine meadow, elev. 4000 ft, *Floyd L. Dickinson 78* (WS 69272!).

WYOMING. Sheridan Co., Big Horn Mts., c. 5 air mi SE of Burgess Junction, c. 24 air mi WNW of Big Horn on Woodrock Road, moist lodgepole pine woods, elev. 8400 ft, *B.E. Nelson 4330* (RM 347744!); Big Horn Mts., c. 17 air mi SE of Burgess Junction, c. 14 air mi WSW of Big Horn on Woodrock Road along Ranger Creek, boggy area along small stream, elev. 8100 ft, *B.E. Nelson 4470* (RM 347743!); Big Horn Mts., South Tongue River near mouth of Marcum Creek, moist ground among willows, alt. 8000 ft, *L. .is O. Williams & Rua Williams 3237* (RM 177452!, WS 78910!). **Big Horn Co.**, Ten Sleep Lakes, moist hillsides, *Leslie N. Goodding 410* (RM 37031!, UC 51065!); Doyle Creek, in woods along a stream, *Leslie N. Goodding 391* (RM 37033!, UC 892189!); Rocky Mt. Forest & Range Experiment Station, Big Horn Natl. Forest, meadow by 1953 burn on Granite Creek, Paintrock District, alt. 8700 ft, 10% E slope, meadow in lodgepole pine forest, *Richard M. Hurd 340* (RM 244421!, RM 402835!); Cliff Lake-Cloud Peak Area, meadow on E upper side of Lower Crater Lake, alt. 10400 ft, *Lawrence Lofgren 90* (RM 248691!); Big Horn Mts., c. 37.5 air mi E of Greybull, c. 21 air mi NE of Hyattville in the vicinity of Edelman Pass & Emerald Lake at the headwaters of Shell Creek, meadows, elev. 10400 ft, *B.E. Nelson 5021* (RM 347773!); Big Horn Mts., c. 37.5 air mi E of Greybull, c. 21 air mi NE of Hyattville in the vicinity of Edelman Pass & Emerald Lake at the headwaters of Shell Creek, wet meadows & along streamlets, elev. 10400 ft, *B.E. Nelson 5005* (RM 347774!); Big Horn Mts., c. 30 air mi E of Greybull, c. 17 air mi NNE of Hyattville along South Trapper Creek, stream bank, elev. 8600 ft, *B.E. Nelson 3359* (RM 347747!); Big Horn Mts., c. 33.5 air mi ESE of Greybull, c. 11.5 air mi NE of Hyattville, S of Paint Rock Lakes, spring & surrounding wet meadow, elev. 8600 ft, *B.E. Nelson 4920* (RM 347741!); Big Horn Mts., c. 24 air mi E of Lovell, c. 20.5 air mi WNW of Burgess Junction, off Devil Canyon Road above Little Tepee Creek, moist to wet meadow, elev. 8300 ft, *B.E. Nelson 3624* (RM 347745!); Big Horn Mts., Tillets Hole, c. 1.5 air mi NW of Medicine Wheel Archeological site, c. 22.5 air mi E of Lovell, moist meadows, elev. 8700 ft, *B.E. Nelson 6273* (RM 347777!); Big Horn Natl. Forest, Wyoming Gul., alt. 9300 ft, 5% N slope, meadow, *R.K. Gierisch 1788* (RM 402834!); Big Horn Mountains, Middle Paint Rock Creek, c. 20 air mi NNE of Ten Sleep, creekside, elev. 8900 ft, 19 August 1980, *Gael Fonken 716 & B.E. Nelson* (RM 347775!); Big Horn County (?), eastern slope of the Big Horn Mountains, headwaters of Clear Creek & Crazy Woman River, elev. 7000-9000 ft, 20 July-15 August 1900, *Frank Tweedy 3020* (RM 38407!, WS 26651!); Big Horn County (?), vicinity of Big Horn Mountains, July-August *F.A. Williams s.n.* (RM 35333!); vicinity of Big Horn Mts., *F.A. Williams s.n.* (RM 35348!); Big Horn Mts., *Vie Willits 603* (RM 69046!); Big Horn Mts., prefers wet site, elev. 9500 ft, *E.C. Moran 1428-M* (BRY 23053!). **Park Co.**, Hughes Creek, subalpine meadow, elev. 10000 ft, *R.D. Dorn 3365* (RM 319678!); Northern Rocky Mountains, subalpine meadow along road to Clay Butte Look-out Station, elev. 8900 ft, *P.A. Robertson 693* (RM 330752!). **Yellowstone Natl. Park Co.**, Yellowstone Natl. Park, Obsidian Creek, in a bog, *Aven Nelson & Elias Nelson 6109* (BRY 193204!, RM 20766!, RM 20767!, RM 169963!, UC 34252!, UC 892218!, WS 26512!); Yellowstone Natl. Park, moist woods along E side of Sylvan Lake at Sylvan Pass, elev. 8541 ft, *Thomas W. Nelson, Jane P. Nelson, James L. Nelson & Kathy M. Nelson 3217* (RM 354746!); Yellowstone, Mt. Washburn, moist hillside, alt. 9000 ft, *D.D. Condon 5699* (BRY 15325!); Yellowstone Natl. Park, Beartooth Forest, Goose Lake, *H.S. Conard 1934* (RM 105178!); Yellowstone Natl. Park, Spring creek near canyon, *W.W. Jones s.n.* (UC 166420!); Yellowstone Natl. Park, Dunraven Pass, grassy seepage slope, *F.H. Sargent s.n.* (BRY 142220!); Yellowstone Natl. Park, wet sub-alpine meadow & stream on hillside at Dunraven Pass, elev. 8859 ft, *J. Stuart Lassetter 1453* (BRY 120233!); Yellowstone Natl. Park, bet. Old Faithful & West Thumb, alt. 8000 ft, *Bassett Maguire & Ruth Maguire 1250* (UC 501139!). **Johnson Co.**, Big Horn Mts., c. 23 air mi SW of Buffalo, c. 21 air mi NNW of Mayoworth, E of Hazelton Peak along Middle Fork Crazy Woman Creek, stream bank, elev. 8200 ft, *B.E. Nelson 3572* (RM 347746!); Big Horn Mts., c. 32.5 air mi NW of Buffalo, c. 20.5 air mi WSW of Story, bet. Geddes Lake & Elk Pass, meadows, elev. 9400-10000 ft, *B.E. Nelson 4758* (RM 347742!); Big Horn Mts., Tensleep Creek just below Lost Twin Lakes, c. 7 air mi SSE of Cloud Peak, c. 22 air mi WSW of Buffalo, riparian meadow, elev. 10100 ft, *Gael Fonken 863* (RM 347776!); Big Horn Mts., along Merle Creek S of Sheep Mt., c. 19 air mi SW of Buffalo, wet stream bottom, elev. 9000 ft, *B.E. Nelson 6117* (RM 347772!); Big Horn Mts., along Merle Creek, c. 0.7 air mi WSW of Sheep Mt. Look-out, c. 4.7 air mi NE of Powder River Pass, c. 19 air mi SW of Buffalo, open spruce forest in creek bottom, elev. 9100 ft, *B.E. Nelson 7179 & Gael Fonken* (RM 347771!). **Teton Co.**, Targhee Natl. Forest, Alaska Basin due SW of Grand Teton Mt., elev. c. 9500 ft, *James K. Bissell s.n.* (BRY

191025!); Targhee Forest, alt. 8700 ft, *Claud C. Shannon 2, Targhee no. 313* (RM 402832!); Grand Teton Natl. Park, Cascade Canyon, elev. 9000 ft, *Marion Ownbey 970* (RM 143278!); Teton Forest, nead head of Phillips Canyon, alt. 9500 ft, 20 degrees SE slope, *C.H. McDonald 883* (RM 402833!); Continental Divide, Two-Gwo-Tee Pass, moist meadows, elev. 9500 ft, *Louis Williams 1358* (RM 135281!, RM 142436!); Grand Teton Natl. Park, head of Indian Paintbrush Canyon, alpine area on rocky talus slope, alt. 10000 ft, *Harold E. Bailey 308* (UC I-339856!); Teton Forest Reservation, *T.S. Brandegee s.n.* (UC 91134!); Grand Teton Natl. Park, Teton Range, Holly Lake & Mt. Woodring Area, W of Jenny Lake, 940? ft elev., *John Merkle 63-18* (RM 273967!); Grand Teton Natl. Park, Teton Range, Holly Lake & Mt. Woodring Area, W of Jenny Lake, alt. 6450 ft, *John Merkle 63-55* (RM 273968!); Grand Teton Natl. Park, bog W of Taggart Lake, elev. 7500 ft, *Louis Williams 1191* (RM 135279!, RM 142441!); Teton Peaks, *Aven Nelson 933* (NDG 062565/HG 45935!); Jackson's Hole, *Aven Nelson 933* (UC 91138!); Teton Mountains, damp soil, *Elmer d. Merrill & E.N. Wilcox 1029* (RM 32324!). **Fremont Co.**, Shoshone Natl. Forest, Togwotee Pass, under willows in a wet morass, 9658 ft elev., *John F. & Mildred S. Reed 2908* (RM 220028!, WS 194615!); Wind River Range, W of Lander, rock slide at NW side of Grave Lake, elev. 10000 ft, *T.A. Bell s.n.* (RM 74358-s!); Wind River Range, Gannett Peak area, 1 mi NE of Gannett Glacier, elev. 10000 ft, *Francis X. Jozwik 496* (RM 273338!). **Sublette Co.**, western slope of Wind River Range, SE of Pinedale, vicinity of Horseshoe Lake, moist meadows, elev. 9000 ft, *C.L. Porter & B.F. Miller 6121* (RM 229656!, UC 984202!); Surveyor Park, Fremont Lake, wet shaded meadow, *Edwin B. Payson & Lois B. Payson 2819* (PH 602585!, RM 93866!, UC 279560!); Bridger Forest, basin N of Hat Pass-Wind River Mts., 15% W dry slope, subalpine, alt. 10000 ft, *Mont E. Lewis 952* (RM 471033! *p. p.*). **Lincoln Co.**, Greys River Valley bet. Salt River & Wyoming Ranges, along Greys River at Poison Meadow, c. 18.5 air mi SE of Afton, in patches at edge of a meadow, elev. 8450 ft, *Orval C. Harrison 332* (RM 343284!); Grand Teton, Jackson's Hole, stream bank, alt. 8000 ft, *Edwin B. Payson & Lois B. Payson 2234* (RM 88561!); mountains near Cottonwood Lake, E of Smoot, dry slopes, alt. 9400 ft, *Edwin B. Payson & George M. Armstrong 3808* (RM 98202!, RM 169891!). **Albany Co.**, Snowy Range, below Sugar Loaf, high alpine on a dry slope, 10900 ft elev., *L.C. Bliss 538* (RM 253984!); Medicine Bow Mts., Snowy Range, 1/2 mi below University of Wyoming Summer Camp, moist meadow, *Ray J. Davis 369-W* (UC 892162!, WS 110577!); Medicine Bow Natl. Forest, vicinity of Brooklyn Lodge, around bogs & meadows at Spruce, *Bassett Maguire & A. Nelson 13350* (PH 781090!); Medicine Bow Mts., in wet subalpine meadows bet. Little & Big Brooklyn Lakes, *Aven & Ruth Nelson 5779* (RM 209648!); Medicine Bow Mountains; bet. Little & Big Brooklyn Lakes, *Aven Nelson & Ruth Nelson 5779* (BRY 203396!); Brooklyn Lake District, *Aven Nelson 9241* (RM 123977!, UC 467232!); Medicine Bow Mts., semi-boggy places, *Aven Nelson 11014* (RM 138812!); Nash's Fork, on the boulders of mt. streams, *Aven Nelson 7776* (RM 28794!); Medicine Bow Mts., moist subalpine slopes, *Aven Nelson 7848* (UC 892190!); Medicine Bow Mts., 2.6 mi W of Albany on Albany-Keystone Road then 1.9 mi NW on road to Cinnabar Park, in peaty loam of a wet meadow, elev. 8800 ft, *B.E. Nelson & Linda Nelson 824* (RM 296366!); Medicine Bow Mts., trails divide, *Aven Nelson & Ruth A. Nelson 978* (RM 138049!); Medicine Bow Mts., moist creek bank near University of Wyoming Summer Camp, *Marion Ownbey 137* (WS 110557!); Medicine Bow Mts., Nash's Fork below University of Wyoming Summer Camp, *W.G. Solheim 308* (RM 311430!); Medicine Bow Mts., near University Camp, in wet swales, open woods, *Aven Nelson & Ruth A. Nelson 1118* (RM 146953!); Medicine Bow Forest, Elk Creek study bog, 3-4% slope, S exposure, well-developed around bog's perimeter, alt. 9700 ft, *David Sturges 163* (RM 272470!); Elk Range Forest & Experimental area, Nelson Park, 5% slope, E exposure, alt. 10200 ft, *A. Lorin Ward 19* (RM 283898!); Laramie, along moist sunny creek bank, *Ray J. Davis 101W* (UC M-244659!); La Plata Mines, in a glade, *Elias Nelson 5113* (RM 310375!). **Carbon Co.**, Medicine Bow Natl. Forest, slopes S of Mirror Lake, moist meadow in sparse pine woods, elev. c. 10400 ft, common on dry open slopes, *Charles Feddema 3308* (RM 402837!); Bridger Peak, wet creek banks, *Leslie N. Goodding 1962* (RM 52142!); Sierra Madre Mts., moist meadow at 8320 ft, *R.N. Holmes 367* (RM 330855!); near Sand Lake, alt. 10100 ft, *Allen Morton 9* (RM 293986!); Medicine Bow Mts., 1.3 mi from North Brush Creek Road on the road to Kennaday Peak, common in a wet meadow, elev.

8500 ft, *B.E. Nelson 905* (RM 296364!); Medicine Bow Mts., 21.7 mi W of Centennial on Wyoming Hwy. 130 at the junction with North French Creek Road, common in wet clay of a springy area in a small clearing among spruce-lodgepole pine, elev. 9500 ft, *B.E. Nelson 912* (RM 296363!); Medicine Bow Mts., on the ridge W of Lake Marie on the trail to Medicine Bow Peak, abundant in a moist meadow, elev. 10900 ft, *B.E. Nelson 1055* (RM 296365!); Sierra Madre Mts., c. 14 air mi SW of Encampment, c. 29 air mi ENE of Dixon, along Solomon Creek, along stream & wet areas, elev. 9100 ft, *B.E. Nelson 4037 & William Blunt* (RM 329349!); Medicine Bow Mts., near Silver Lake, growing singly in moist meadows, *Marion Ownbey 330* (WS 110536!); Snowy Range Area, 2 mi E from intersection of North French Creek Road & Hwy. 130 on Hwy 130, located in *Picea engelmannii* stand 316, 10150 ft elev., *John M. Wirsing 110* (WS 272125! *p.p.mag.*); Medicine Bow Range, bet. Lake Marie & Silver Lake, subalpine slopes at timberline, alt. 10400 ft, places; *C.L. Porter & Marjorie W. Porter 10274* (CAN 305082!, RM 280948!, UC M-312265!); Counties not stated: Union Peak, *Aven Nelson 995* [Lectotype of *Arnica subplumosa* Greene (here designated) - NDG 062566/HG 45934!; Isolectotype (here designated) - RM 3572!)]. Little Goose Canyon, wet banks, *Aven Nelson 8503* (RM 37032!); Little Goose Canyon, spring bog, *Aven Nelson 8519* (RM 37034!). La Plata Mines, *Elias Nelson 5080* (RM 12657!). Battle Lake Mt., *Aven Nelson 4218* (RM 10608!); Battle Lake Mt., *Aven Nelson 4218a* (RM 12896!).

Maguire (1943) has considerably expanded the circumscription of *A. mollis* W.J. Hook. by the inclusion of a number of taxa in the synonymy which exhibits only but superficial morphological similarity to *A. mollis* (*sensu* Hooker 1834). Careful study of type material and a fairly large assemblage of specimens show that the following taxa should be uprooted from Maguire's list of synonyms, namely: 1) *Arnica coloradensis* Rydb. - this is treated as a new synonym of *Arnica rydbergii* Greene (*vide infra*); 2) *Arnica ovata* Greene - this is the correct name for plants previously known as *Arnica diversifolia* Greene (see discussion under *Arnica ovata* Greene); 3) *Arnica silvatica* Greene (= *Arnica subplumosa* Greene var. *silvatica* (Greene) A. Nelson) - this taxon is considered in this study as a new synonym of *Arnica ovata* Greene (see discussion under the latter name), and 4) *Arnica arachnoidea* Rydb., a taxon which in all likelihood is a new synonym of *Arnica parryi* A. Gray (see discussion under the latter name).

In view of the above exclusion of a number of taxa, *A. mollis* now becomes a more clearly delimited taxon which is primarily distinguished from *A. ovata* Greene by the following set of diagnostic characters: a) distinctively large broad hemispheric to campanulate capitula, b) consistently tawny to deep brown plumose (very rarely subplumose) pappus with its deep amber-like deposits inside setae, c) sessile cauline leaves or with lowermost pair infrequently subsessile or with extremely short broad-winged base, d) narrowly to broadly lanceolate, lance-elliptic, entire to scantily and irregularly denticulate cauline leaves, and e) oblanceolate basal leaves, as well as those arising from innovations.

ARNICA SUBPLUMOSA GREENE

Arnica subplumosa Greene was described in 1896 without any specimen cited as type. Maguire (1943) lectotypified the taxon with *C.F. Baker 760*, a collection from Ouray, Colorado obtained on August 10, 1901 - *i.e. c.* 5 years after the taxon was formally described. A meticulous search through the computerized registry of *Arnica* material in the Greene Herbarium (NDG/HG) combined with a thorough examination of a number of collections from the same herbarium reveals that there are only 5 collections that were determined by E.L. Greene (in his own hand) as *Arnica subplumosa*. These collections are as follows:

1) Wyoming, Union Peak, 13 August 1894, *Aven Nelson 995* (NDG 062566/HG 45934!);
2) Wyoming, Teton Peaks, 21 August 1894, *Aven Nelson 933* (NDG 062565/HG 45935!);
3) Colorado, Andrews Shetland Ranch, 8000 ft alt., 12 July 1896, *Carl F. Baker 51* (NDG 062516/HG 45982!);
4) Colorado, Divide between Ouray and Telluride, above timber, common on rich slopes, stems clustered, 10 August 1901, *C.F. Baker 760* (NDG 062564/HG 45936!), and
5) California, E. Fork Kaweah River, 8500 ft alt., 29 August 1904, *Culbertson 4521* (NDG 062567/HG 45933!).

Of these collections, only three (nos. 1, 2 & 3 above) actually predated the publication date of November 16, 1896 of *Arnica subplumosa* Greene. For obvious reasons, the material (*C.F. Baker 760*) selected by Maguire (1943) as the lectotype is here rejected; although this is one of the 2 collections that were obtained from Colorado which may qualify well to the habitat description of "subalpine woods of the Colorado Mountains" given by Greene (1896, p. 104). The other collection, *Carl F. Baker 51* (no. 3 above) is the holotype of *Arnica macilenta* Greene and was earlier doubtfully determined by Greene (*in sched.*) as *A. subplumosa* Greene, a fact explicitly expressed in a brief discussion accompanying the original description of *A. macilenta* (Greene 1900, p. 162).

On the basis of the original specimen in the Rocky Mountain Herbarium (RM) Wyoming, *Aven Nelson 933* was used as one of the original material from which the description of *Arnica chamissonis* Less. var. *longinodosa* A. Nelson was drawn. This collection therefore, is one of the paratypes of the latter taxon and as clearly shown here, the same collection is also one of the *bona fide* syntypes of *A. subplumosa* Greene, together with *Aven Nelson 995* (no. 1 above).

Careful analysis of the protologue of *Arnica subplumosa* Greene indicates that *Aven Nelson 995* is the only material that best qualifies as the lectotype. The selection is based on the fact that this is the only collection that was originally identified as *Arnica chamissonis* Less., hence Greene (1896) referred to it clearly as being "passed partly for *A. chamissonis* and partly for *A. longifolia*". On the other hand, *Aven Nelson 933* was originally identified as *Arnica amplexicaulis* Nutt., although the cauline leaves of this collection are slightly longer and narrower than those of *Aven Nelson 995*.

In the present study, *Aven Nelson 995* (duplicate in RM, no. 3572!), *Aven Nelson 933* (original in RM, no. 3571!); duplicate in UC, no. 91138!) and *C.F. Baker 760* are undoubtedly typical *Arnica mollis* W.J. Hook. On the otherhand, *Carl F. Baker 51* is definitely *Arnica chamissonis* Less. while *Culbertson 4521* (duplicate in UC, no. 130793!) belongs to *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo. The highly superficial resemblance in leaf morphology of these latter collections with those of the previous ones has led E.L. Greene to identify them as *Arnica subplumosa*.

Finally, *Aven Nelson 995* is here designated as the lectotype of *Arnica subplumosa* Greene to replace the earlier lectotype (*C.F. Baker 760*) assigned by Maguire (1943).

ARNICA CONFINIS GREENE

Maguire had at least examined 2 isotypes of *A. confinis* Greene. One of these isotypes (CAN 109755!) was annotated by Maguire as *A. mollis* Hook. (*in sched.*, dated November 24,

1938) while the other isotype (GH *s.n.*!) was determined by him as *A. diversifolia* Greene in *sched.*, no date on annotation label). In his monograph (Maguire 1943), *A. confinis* Greene was treated as synonym of *A. mollis* Hook. Careful study shows that the latter isotype consists of 2 quite obviously different plant individuals, one of which is *A. mollis* Hook. while the other is an extreme ecological variant of *A. ovata* Greene, the correct name for plants previously recognized in the literature as *A. diversifolia* Greene (*vide supra*).

Maguire was unable to examine the holotype (*J. Macoun Geol. Surv. Can. 26933*!) at the Greene Herbarium, University of Notre Dame (NDG 062426/HG 46834!). The holotype is composed of 5 plant individuals of which one belongs to *A. ovata* Greene while the remainder are *A. mollis* Hook. and are identical to those found in CAN and to the only other plant mounted on the same herbarium sheet at GH. The type description states that the "lowest leaves obovate to oblanceolate, an inch long or more and petiolate,..." (Greene 1902, p. 281). As far as the holotype is concerned, the obovate and petiolate description refers to a couple of innovations present on the only plant being referred here to *A. ovata* Greene. The lowest leaves of the other plants are entirely oblanceolate and ±sessile or subsessile. A pair of very small, ±obovate, short-petiolate lowest leaves is present on the other plant of the isotype at GH here referred to *A. ovata* Greene.

In as much as the holotype of *A. confinis* Greene is a mixed collection consisting largely of plants belonging to *A. mollis* Hook., and minimally to that of *A. ovata* Greene, as well one of the isotypes has similar condition, *A. confinis* Greene is therefore treated in this study as synomym of *A. mollis* Hook. and *A. ovata* Greene with respect to the larger and smaller portions of its types and original circumscription, respectively.

ARNICA OVALIS RYDB.

Arnica ovalis Rydb. is a taxon of special interest in that this has been recently treated as synonym of *Arnica mollis* W.J. Hook. (Wolf 1981, Wolf & Denford 1984c, p. 306) and of *Arnica rydbergii* Greene (Downie 1987, Downie & Denford 1988 in press). Incidentally, this taxon was inadvertently overlooked by Maguire (1943) as well as subsequent workers (*e.g.* Ediger & Barkley 1978, *etc.*).

My examination of the holotype [*J.M. Macoun Geol. Surv. Can. 72719* (CAN 109254!)] shows the presence of white barbellate pappus and densely hirsutulous achenes, in addition to a pair of small oval basal leaves and relatively narrow elliptic-lanceolate cauline leaves. Superficially, this collection resembles a miniature plant of *Arnica ovata* Greene (= *Arnica diversifolia* Greene), particularly as to leaf and capitulum morphology. It is however, definitely not assignable to this taxon nor to that of *Arnica mollis* W.J. Hook. as interpreted by Wolf (1981) and Wolf & Denford (1984c). It is not *Arnica ovata* Greene as this taxon is mainly characterized by slightly angular scantily hispidulous achenes and distinctly stramineous to tawny, subplumose pappus. *Arnica mollis* W.J. Hook. on the other hand, has distinctly tawny plumose (rarely subplumose) pappus and usually large broadly hemispheric capitula. I conform to Downie's (1987) treatment of *A. ovalis* Rydb. as a minor variant of *Arnica rydbergii* Greene due to the following characters, namely: a) ±turbinate capitula, b) sessile cauline leaves, c) entire to slightly denticulate ligule apex, and d) densely hirsutulous achenes.

ARNICA COLORADENSIS RYDB.

Since P.A. Rydberg (1905) first described *Arnica coloradensis* based on a single collection by C.C. Parry in 1882 from the alpine area of the Rocky Mountains in Colorado, this taxon has apparently become obscure. For lack of additional material previously identified as *A. coloradensis* Rydb., Maguire (1943) simply dismissed the type collection [*C.C. Parry s.n.* (Holotype, NY *s.n.*!; Isotype, NY *s.n.*!)] as "merely a reduced alpine ecotype of *A. mollis*". Subsequent workers, *e.g.* Ediger & Barkley (1978), accepted Maguire's treatment and similarly failed to see the morphological connection between the types of *A. coloradensis* Rydb. and *A. rydbergii* Greene. Except for the confusion that arose from the seemingly "brownish" color of the pappus which is due to combined effect of pigment extracted from the ligules and disc florets, preservative treatment (clearly visible from the blot marks on the mounting papers!) and possibly age, the type of *A. coloradensis* Rydb. is well within the morphological variability of *A. rydbergii* Greene.

Noteworthy is the fact that a number of collections from Colorado, *e.g. Frank Tweedy 5817* (RM 47875!) from Berthoud Pass (Grand Co.), *Kenneth K. Mackenzie 310* (RM 30567!) from Breckenridge (Summit Co.), *I.W. Clokey 3615* (UC 892196!) from Monassos Creek (Chaffee Co.) were all identified by Maguire (*in sched.*) as *Arnica mollis* Hook. (subsp. *genuina* Maguire). I have examined the type of *Arnica rydbergii* Greene (J.H. Flodman 891) from Central Montana (Little Belt Mts., near the Pass, 10 August 1896) growing at an altitude of 7,000 ft. The type of *A. coloradensis* Rydb., together with the above-cited collections have been thoroughly studied and compared with the type of *A. rydbergii* Greene and other representative specimens in ALTA. All these collections are unquestionably, typical *A. rydbergii* Greene, a taxon which is easily distinguished from *A. mollis* W.J. Hook. by its small, turbinate capitula, white barbellate pappus and densely strigulous to hirsutulous brown to waxy black achenes. Additionally, the leaves though slightly similar in outline to those of *A. mollis* W.J. Hook., have 5 distinctly arcuate major veins (range is 3 to 5 in *A. rydbergii* Greene), a character noted by Rydberg (1905) in his original description of *A. coloradensis*. Downie (1987) & Downie & Denford (1988, in press) list additional diagnostic characters for *A. rydbergii* , namely: a) clustered stems, b) frequently sessile lower cauline leaves, c) small narrow capitula, d) entire to minutely denticulate ligule apex, and e) few narrowly tubular disc florets. The latter condition consequently results to the formation of distinctly turbinate capitula.

Arnica coloradensis Rydb. therefore must be excluded from the synonymy of *Arnica mollis* W.J. Hook. and henceforth, is best treated as a synonym of *A. rydbergii* Greene. A formal taxonomic treatment of this case is as follows:

Arnica rydbergii Greene, Pittonia 4: 37, 1899.
TYPE: Central Montana, Little Belt Mountains near the Pass, 10 August 1896, *J.H. Flodman 891* (HOLOTYPE, NDG 062553/HG 45923!; ISOTYPES, US 290296!, NY (2

specimens), PHOTO CAN [*fide* Downie (1987), Downie & Denford (1988, in press)].

Arnica coloradensis Rydb., Bull. Torrey Bot. Club 32: 131, 1905. *syn. nov.* TYPE: Colorado, Alpine Flora of Rocky Mountains, 1872, *C.C. Parry s.n.* (HOLOTYPE, NY *s.n.*!; ISOTYPE, NY *s.n.*!).

For a complete list of synonyms for *Arnica rydbergii* Greene, see Downie (1987) and Downie & Denford (1988, in press).

ARNICA GRANULIFERA RYDB.

Arnica granulifera Rydb. was originally treated by Maguire (1943) as a synonym of *Arnica latifolia* Bong. Recent study by Wolf (1981) and Wolf & Denford (1984c) lead to the transfer of this taxon in synonymy with *Arnica mollis* W.J. Hook. My examination of the holotype, *J.H. Flodman s.n.* (NY *s.n.*!), collected from Central Montana [Little Belt Mountains, Long Baldy, alt. 7000-8000 ft, 19 August 1896] clearly shows a set of characters referrable to *Arnica latifolia* Bong. and contrary to Wolf's interpretation (1981, p. 188) as *Arnica mollis* W.J. Hook. and "can be recognized by its broad heads with broad phyllaries and dark, plumose pappus". The following characters are exhibited by the holotype of *A. granulifera* : a) narrowly campanulate to nearly turbinate capitula, the 2 younger heads show more of the capitulum shape better than the strongly compressed more matured central capitulum; b) 3 pairs of irregularly serrate-dentate, sessile cauline leaves; c) narrow (13 x 2-2.5 mm), nearly glabrous or sparsely hirsutulous involucral bracts, and d) definitely barbellate dirty-white pappus - a character mentioned by Rydberg (1927) in his original description. The slightly brownish yellow hue of the pappus notably near the base is mainly due to the pigments extracted from disk florets and possibly ligulate florets during the time of pressing and drying. Additionally, the achenes although relatively immature are nearly glabrous to "sparsely short stipitate glandular with few duplex hairs" (Wolf 1981, p. 181; Wolf & Denford 1984c, p. 284) - characters that are definitely those of *A. latifolia* Bong. Incidentally, Wolf did not affix an annotation label on the holotype of *A. granulifera* Rydb. For the diagnostic characters of *Arnica mollis* W.J. Hook. (see discussion under the taxon).

4. **Arnica chamissonis** Less. Linnaea 6: 238, 1831; F.V. Coville, Contrib. U.S. Nat. Herb. 4: 139, 1893; T. Howell, Fl. NW Amer. 1: 373, 1897; H.M. Hall & C.C. Hall, A Yosemite Flora, p. 264, 1912, *pro nomen*; A.W. Sharples, Alaska Wild Flowers, p. 7, 1938; E. Hultén, Flora of Alaska & Yukon, p. 1590, 1950; A. Cronquist *in* R.J. Davis, Flora of Idaho, p. 688, 1952; A. Cronquist, Vasc. Pl. Pac. NW 5: 48, 1955; J.P. Anderson, Flora of Alaska & adjacent parts of Canada, p. 495, fig. 1051, 1959; E. Hultén, Flora of Aleutian Island, 2nd ed. (revised), p. 356, 1960; A.C. Budd & K.F. Best, Wild Plants of Canadian Prairies, Publ. 983, p. 432, 1964; H.D. Harrington, Man. Pl. Colorado, p. 617, 1964; E. Hultén, Flora of Alaska & neighboring territories, p. 920, 1968; W.A. Weber, Rocky Mt. Flora, 4th ed. (revised), p. 115, 1972; S.L. Welsh, Anderson's Flora of Alaska, p. 119, 1974; R.D. Dorn, Man. Vasc. Pl. Wyoming 1: 296, 1977; R.I. Ediger & T.M. Barkley, N. Amer. Fl. ser. 2, pt. 10, 20, 1978; H.J. Scoggan, Fl. Canada, pt. 4, p. 1474, 1979; J.G. Packer, Moss's Flora of Alberta, 2nd ed. (revised), p. 537, map 1012, 1983; S.L. Welsh *et al.*, A Utah Flora, p. 143, 1987. *Arnica chamissonis* Less. subsp. *genuina* Maguire, Brittonia 4(3): 461, 1943. **TYPE** (here designated): Alaska, Unalaschka, Eschscholtz, *non datum*, *Ad. von Chamisso s.n.* (HOLOTYPE, LE *s.n.*!; ISOTYPE ("no. 306" *fide* Herder, *in sched.*), LE *s.n.*!). **TYPE** (here designated): Alaska, Unalaska, *non datum*, *Choris s.n.* (TOPOTYPE, LE *s.n.*!) and *Choris et Langsdorff s.n.* (TOPOTYPE, LE *s.n.*!). (Fig. 24; Generalized illustration, Fig. 25).

Arnica foliosa Nutt., Trans. Amer. Phil. Soc. II, 7: 407, 1841 *syn. nov.*; A. Gray, Syn. Fl. N. Amer. I: 382, 1884; T. Howell, Fl. NW Amer. 1: 374, 1897; P.A. Rydberg, Flora of Colorado, Colo. Agric. Bull. 100: 389, 1906; A. Nelson, New Man. Rocky Mt. Bot. p. 573, *pro parte*, 1909; S.F. Blake *in* I. Tidestrom, Contrib. U.S. Nat. Mus. 25: 607, 1925; P.A. Rydberg, N. Amer. Fl. 34: 347, *pro parte*, 1927. = *Arnica chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire, Rhodora 41: 508, 1939; H.M. Raup, Sargentia 6: 252, 1947; B. Maguire, Brittonia 4(3): 463, 1943; E. Hultén, Flora of Alaska & Yukon, p. 1591, 1950; A. Cronquist *in* R.J. Davis, Flora of Idaho, p. 687-688, 1952; A. Cronquist, Vasc. Pl. Pac. NW 5: 48, 1955; A. Dutilly, E. Lepage & M. Duman, Contrib. Arct. Inst. Cat. Univ. Amer. 9F: 163, 1958; E.H. Moss, Flora of Alberta, ed. 1, p. 447, 1959; A. Cronquist *in* R. Ferris, Illus. Fl. Pac. States 4: 420, 1959; P.A. Munz, Calif. Mt. Wildflowers, p. 109, fig. 175, 1963; E. Hultén, Flora of Alaska and neighboring territories, p. 921, 1968; P.A. Munz, Calif. Fl. p. 1240, 1968; A. Cronquist *in* C.L. Hitchcock, A. Cronquist, M. Ownbey & J.W. Thompson, Fl. Pac. NW, p. 483, 1973; R.M. Lloyd & R.S. Mitchell, Fl. of White Mts., Calif. & Nevada, p. 165, 1973; S.L. Welsh, Anderson's Flora of Alaska, p. 119, 1974; H.J. Scoggan, Fl. Canada pt. 4, p. 1475, 1979; L. Arnow *et al.*, Fl. Central Wasatch Front, Utah, p. 101, 1980; A.E. Porsild & W.J. Cody, Vasc. Pl. Cont. NWT, Canada, p. 574, fig. 905, map 1047, 1980; J.G.

Packer, Moss's Flora of Alberta, 2nd ed. (revised), p. 537, map 1012, 1983.
TYPE (here designated): "Rocky & Blue Mts.", Nuttall *s.n.* (HOLOTY. E, BM *s.n.*! *pro parte mag.*; ISOTYPES, GH *s.n.*![14], GH *s.n.*![15].

Arnica foliosa Nutt. var. *andina* Nutt., Trans. Amer. Phil. Soc. II, 7: 407, 1841, *syn. nov.*; = *A. chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley, N. Amer. Fl. ser. II, pt. 10, p. 21, 1978.
TYPE (here designated): "Rocky & Blue Mts.", Nuttall *s.n.* (GH *s.n.*! *pro parte min.*).

Arnica foliosa Nutt. var. *incana* A. Gray, Amer. Nat. 8: 213, 1874 *syn. nov.*; A. Gray, Bot. Calif. 1: 416, 1876; F.V. Coville, Contrib. U.S. Nat. Herb. 4: 139, 1893; H.M. Hall & C.C. Hall, A Yosemite Flora, p. 264, 1912; F.J. Smiley, Univ. Calif. Publ. Bot. 9: 385, 1921; S.F. Blake *in* I. Tidestrom, Contrib. U.S. Nat. Mus. 25: 607, 1925; W.L. Jepson, Man. Calif. Fl. Pl. p. 1157, 1925. = *A. incana* (A. Gray) Greene, Pittonia 4: 169, 1900 *non* Pers. (1807); *A. cana* Greene, Ottawa N[illegible]6: 282, 1902 - *nom. nov. vice A. incana* (A. Gray) Greene; C.V. Piper, Contrib. U.S. [illegible]. Herb. 11: 593, 1906; = *Arnica chamissonis* Less. subsp. *incana* (A. Gray) Maguire, Brittonia 4(3): 466, 1943; A. Cronquist *in* R.J. Davis, Flora of Idaho, p. 688, 1952; A.E. Porsild & W.J. Cody, Vasc. Pl. Cont. NWT, Canada, p. 574, map 1048, 1980. = *Arnica chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire var. *incana* (A. Gray) Hultén, Flora of Alaska & Yukon, p. 1591, 1950; E. Hultén, Flora of Alaska & neighboring territories, p. 921, 1968; E. Hultén, Lunds. Univ. Arrskr. II, sect. 2 46(1): 1591, 1950; A. Cronquist, Vasc. Pl. Pac. NW 5: 48, 1955; A. Cronquist, *in* R. Ferris, Illus. Fl. Pac. States 4: 420, 1959; P.A. Munz, Calif. Fl. p. 1241, 1968; A. Cronquist *in* C.L. Hitchcock, A. Cronquist, M. Ownbey & J.W. Thompson, Fl. Pac. NW p. 483, 1973; S.L. Welsh, Anderson's Flora of Alaska & adjacent parts of Canada, p. 119, 1974; R.I. Ediger & T.M. Barkley, N. Amer. Fl. ser. II, pt. 10, p. 22, 1978. H.J. Scoggan, Fl. Canada pt. 4, p. 1475, 1979. = *Arnica chamissonis* Less. var. *incana* (A. Gray) Welsh, Great Basin Nat. 28(3): 149, 1968.
TYPE: CALIFORNIA, Sierra Nevada, "in deep water strange to say but true", 1872, *H.N. Bolander, Kellogg & Keller s.n.* (HOLOTYPE, GH s.n.!).

Arnica montana angustifolia Hook., Fl. Bor. Amer. 1: 330, *pro parte*, 1834.

Arnica chamissonis Less. var. *typica* Regel, Suppl. ad Ind. sem. h.b. Petrop. p. 16, 1864; Herder, Bull. Soc. Nat. Mosc. 4: 425, 1867; Maguire, Brittonia 4(3): 461, 1943. TYPE: *non vidi*.

Arnica chamissonis Less. var. *angustifolia* Herder, Bull. Soc. Imp. Nat. Soc. 4: 425, 1867. TYPE: SASKATCHEWAN, "Palliser's Brit. N. Am. Expl. Expedition, 1857-8", *E. Bourgeau s.n.* (ISOTYPE, GH *s.n.*!).
TYPE: SASKATCHEWAN, "Palliser's Brit. N. Am. Expl. Expedition, 1857-9", *E. Bourgeau s.n.*! (PARATYPE, NY *s.n.*!).

Arnica denudata Greene, Pittonia 3: 105, 1896. TYPE: NEVADA, Deeth, 14 July 1896, *Edw. L. Greene s.n.* (ISOTYPE, UC 193550!).

Arnica denudata Greene var. *canescens* Greene, Pittonia 3: 105, 1896. TYPE: *non vidi*.

Arnica columbiana Greene, Pittonia 4: 159, Dec. 1900. *non A. columbiana* A. Nelson, Bot. Gaz. 30: 200, Sept. 1900. = *Arnica greenei* A. Nelson, Bot. Gaz. 31: 406, 1901.

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[14] Mounted on the same herbarium sheet with *Aven Nelson 766* [(GH *s.n.*!): Wyoming, Upper Wind River, 10 August 1894]- ISOTYPE of *A. ocreata* A. Nelson.
[15] Mounted on the same herbarium sheet with *Rev. Mr. Spalding s.n.* [(GH *s.n.*!): Oregon, Clear Water, no coll. date]. The latter is here determined as *Arnica fulgens* Pursh.

TYPE: BRITISH COLUMBIA, McLennan River, headwaters of Columbia River, 27 July 1898, *W. Spreadborough Geol. Surv. Can. 19646* (ISOTYPE, CAN 109586!).

Arnica macilenta Greene, Pittonia 4: 161, 1900. P.A. Rydberg, Flora of Colorado, Colo. Agric. Bull 100: 389, 1906. = *Arnica subplumosa* Greene var. *macilenta* (Greene) A. Nelson, Man. Bot. Rocky Mts., p. 573, 1909.
TYPE: COLORADO, Larimer County, Andrew's Shetland Ranch, alt. 8000 ft, 12 July 1896, *Carl F. Baker 51* (HOLOTYPE, NDG 062516/HG 45982!; ISOTYPE, POM 53698!).

Arnica bernardina Greene, Pittonia 4: 170, 1900. = *Arnica foliosa* Nutt. var. *bernardina* (Greene) Jepson, Man. Fl. Pl. Calif. p. 1157, 1925. = *Arnica chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire var. *bernardina* (Greene) Maguire, Amer. Midl. Nat. 37: 140, 1947; A. Cronquist *in* R. Ferris, Illus. Fl. Pac. States 4: 420, 1950; R.I. Ediger & T.M. Barkley, N. Amer. Fl., ser. II, pt. 10, p. 22, 1978.
TYPE: CALIFORNIA, San Bernardino Mts., Bear Valley, moist meadows and even in water, 1 August 1882, *S.B. & W.F. Parish 1448* (ISOTYPE, GH *s.n.*!).

Arnica ocreata A. Nelson, Bot. Gaz. 30: 201, 1900.
TYPE: WYOMING, Upper Wind River, 10 August 1894, *Aven Nelson 766* [HOLOTYPE, RM 2979!; ISOTYPES, CU *s.n.*! (Dubois!), GH *s.n.*!, NDG 062471/HG 46790!, WS 26632! (Dubois!).
TYPE: WYOMING, Wind River meadow, 10 August 1894, *Aven Nelson 1195* (PARATYPES, NDG 062471/HG 46789!, RM 2882!).
TYPE: WYOMING, Yellowstone Park, Shoshone Lake, alt. 7500 ft, 1 August 1897, *P.A. Rydberg & Ernst A. Bessey 5224* (PARATYPE, RM 21636!).
TYPE: WYOMING, Yellowstone National Park, Snake River, in the edge of thickets on the bottoms, 12 August 1899, *Aven Nelson & Elias Nelson 6403* (PARATYPE, RM 20768!).

Arnica exigua A. Nelson, Bot. Gaz. 30: 202, 1900.
TYPE: WYOMING, Yellowstone National Park, Yellowstone Lake, on dry sandy banks, 24 August 1899, *Aven Nelson & Elias Nelson 6940* (HOLOTYPE, RM 20772!).
Arnica tomentulosa Rydb., Bull. Torrey Club 28: 20, 1901.
TYPE: WYOMING (northwestern), Buffalo Fork, 9000 ft, August 1897, *F. Tweedy 523* (HOLOTYPE, NY *s.n.*!).

Arnica stricta A. Nelson, Bot. Gaz. 31: 407, 1901. *non A. stricta* Greene, Ottawa Nat. 23: 214, 1910.
TYPE: WYOMING, Loveland, 2 July 1893, *J.D. Parker s.n.* (HOLOTYPE, RM 1850!).

Arnica celsa A. Nelson, Bot. Gaz. 31: 408, 1901. P.A. Ryberg, Flora of Colorado, Colo. Agric. Bull. 100: 389, 1906.
TYPE: WYOMING, Albany Co., Tie City, in a wet native meadow, growing in great profusion, 20 July 1900, *Aven Nelson 7643* (HOLOTYPE, RM 28788!).

Arnica rhizomata A. Nelson, Bot. Gaz. 31: 409, 1901. P.A. Rydberg, Flora of Colorado, Colo. Agric. Bull. 100: 388, 1906.
TYPE: WYOMING, Albany Co., Lincoln Gulch, in open, grassy subalpine parks, 8 August 1900, *Aven Nelson 8012* (HOLOTYPE, RM 28787!; ISOTYPE, GH *s.n.*!).
TYPE: WYOMING, Pine Creek, 11 July 1892, *B.C. Buffum s.n.* (PARATYPE, RM 1417!).
TYPE: WYOMING, Green Mountain, 6 July 1896, *Aven Nelson s.n.* (PARATYPE, RM 7630!).
TYPE: WYOMING, North Vermillion Creek, 17 July 1897, *Aven Nelson 3587* (PARATYPE, RM 10610!).

Arnica kodiakensis Rydb., N. Amer. Fl. 34: 353, 1927. A.W. Sharples, Alaska Wild Flowers p. 17, 1938.
TYPE: ALASKA, Kodiak, 1910, *Miss Ruth Mylroie 30* (HOLOTYPE, NY *s.n.*!).

Arnica elongata Greene *in* Tatewaki *et* Kobayashi, J. Fac. Agr. Hokkaido Imp. Univ. 36: 85, 1934, *pro spec.*

Arnica lanulosa Greene, Pl. Baker. 3: 26, 1901.
TYPE: COLORADO (west central), Region of the Gunnison Watershed, Crested Butte, alt. 8875 ft, 6 July 1901, *C.F. Baker 336* (ISOTYPES, GH *s.n.*!, POM 53719!, POM 53721!, RM 33186!, RM 169907!, US 411995!). TYPE: COLORADO, Region of the Gunnison Watershed, Marshall Pass, small colonies on shelving banks, 20 August 1901, *C.F. Baker 881* (PARATYPES, NDG 062488/HG 45953!, POM 53775!, POM 53777!).

Arnica rubricaulis Greene, Ottawa Nat. 33: 213, 1910.
TYPE: BRITISH COLUMBIA, Trail, in a large clump by a brook, 22 June 1902, *J. M. Macoun Geol. Surv. Can. 64985* (HOLOTYPE, NDG 062552/HG 45922!; ISOTYPES, CAN 109619!, GH *s.n.*!, NY *s.n.*!, WS 26616!).

Arnica foliosa Nutt. var. *sonnei* (Greene) Jepson, Man. Fl. Pl. Calif. p. 1157, 1925, *pro quoad spec.*

Arnica bruceae Rydb., N. Amer. Fl. 34: 347, 1927.
TYPE: CALIFORNIA, Modoc County, Lake Annie, June 1898, *Mrs. C.C. Bruce 2174* (HOLOTYPE, NY *s.n.*!).

Arnica maguirei A. Nelson, Amer. J. Bot. *21*: 58, 1934. *Arnica chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire var. maguirei (A. Nelson) Maguire, Rhodora 41: 508, 1939. A. Cronquist, Vasc. Pl. Pac. NW 5: 48, 1955. A. Cronquist *in* C.L. Hitchcock, A. Cronquist, M. Ownbey & J.W. Thompson, Fl. Pac. NW, p. 483, 1973. R.I. Ediger & T.M. Barkley, N. Amer. Fl. ser. II, pt. 10, p. 22, 1978.
TYPE: MONTANA, Glacier National Park, Lower St. Mary Lake, near pond north of outlet, alt. 4460 ft, in low-lying open woodland of willow and cottonwood, 4 August 1932, *Bassett Maguire 1098* (HOLOTYPE, RM 135044!; ISOTYPE, GH *s.n.*!).
TYPE: MONTANA, about outlet to Lower St. Mary's Lake, moist rich loam under aspen & willows, associated with *Epilobium angustifolium, Calamagrostis canadensis*, & *Heracleum lanatum*, 11 July 1934, *Bassett Maguire, Ruth Maguire & C.B. Maguire 15356* (TOPOTYPES, CAN 190981!, PH 871081!).

Arnica chamissonis Less. subsp. *chamissonis* var. *interior* Maguire, Madrono 6: 154, 1942. A. Cronquist *in* R. Ferris, Illus. Fl. Pac. States 4: 419, fig. 5719, 1959. A. Cronquist *in* C.L. Hitchcock, A.Conquist, M. Ownbey & J.W. Thompson, Fl. Pac. NW, p. 483, 1973.
TYPE: BRITISH COLUMBIA, Palliser, *S. Brown 770, non vidi.*

Arnica chamissonis Less. subsp. *foliosa* (Nutt.) Maguire var. *jepsoniana* Maguire, Amer. Midl. Nat. *37*: 140, 1947.
TYPE: NEVADA, Esmeralda County, White Mountains, Chiatovitch Creek, in scattered dense patches in damp soil, on sheltered meadowland near streams, alt. 2440 m, 6 July 1931, *Victor Duran 3100* (ISOTYPES, RM 129120!, UC 477355!).

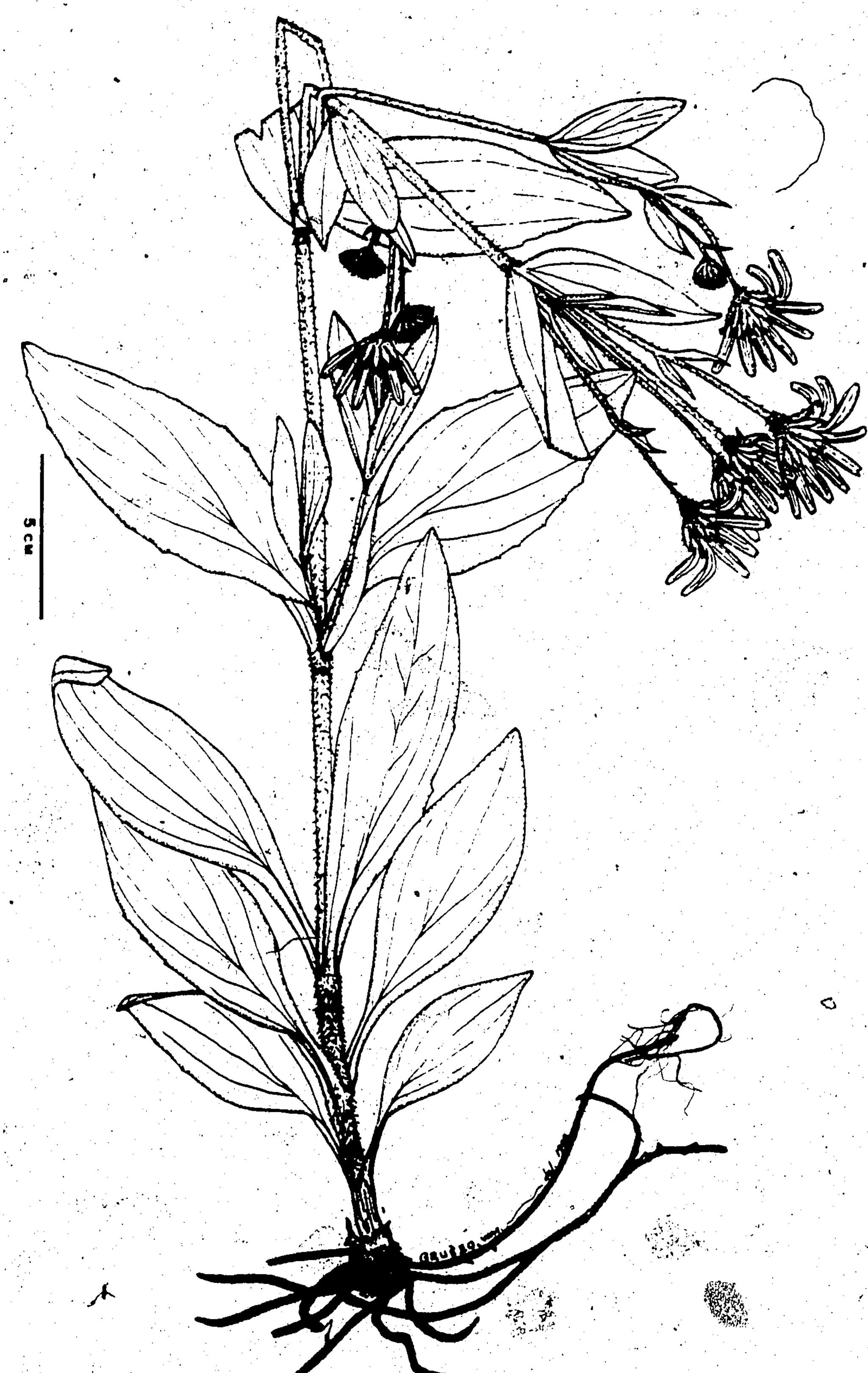
Plants (2-)3-8 (-15) dm tall, arising from long, soft, nearly naked, rhizomes with conspicuous nodal scales; *stems* solitary, erect or ascending, simple or more commonly branched above midsection, slender to stout, nearly glabrous or sparsely tomentulose to densely white tomentose or villous pubescent with short or long, soft, woolly multiseptate hairs, usually scantily glandular above; *basal leaves* 1-2 pairs, 4-8 (-10) cm long x 2-3 cm wide, narrow- to broad-lanceolate-elliptic, subsessile to short-petiolate, sometimes slightly withered at anthesis, entire to irregularly denticulate, nearly glabrous or sparingly tomentose to densely pilose; *cauline leaves* (4-) 6-8 (-10) pairs, not much reduced upwards, (5-) 6-12 (-20) cm long x (2-) 4-6 (-8) cm wide, all sessile to subsessile or the lowermost ones usually with narrow- or broad-winged, short-petioles, often with membranous connate-sheathing bases, the upper sessile, lanceolate-elliptic to oblong or broadly oblanceolate with 3-5 main veins, entire or remotely denticulate to prominently dentate, nearly glabrous or puberulent to sparsely or densely white tomentose-pilose; *capitula* (1-) 3-10 (-16), campanulate to seldom hemispheric, (10-) 12-16 (-18) mm high; *periclinium* short, narrow, scarcely to densely villous with whitish hairs intermixed with short- or long-stipitate glands; *involucral bracts* (8-) 13-18 (-23), nearly linear to narrow-lanceolate, (4-) 6-10 (-12) mm long x (1-) 2-3 mm wide, with acute to slightly acuminate or seldom obtuse apex, inside portion of apex with conspicuous tuft of white hairs, the latter sparse or negligible in plants of dry habitats, sparingly pubescent and with few, short-stipitate glands or densely pilose-tomentose; *ligulate florets* (8-) 10-16 (-20), pale to bright yellow, (8-) 10-18 (-20) mm long x 2-4 mm wide, narrow- or broad- lanceolate to oblong, its apex shallowly and unevenly tridentate; *disc florets* (40-) 50-120 (-145), light to bright yellow, narrow-tubular to funnel-shaped, (4-) 6-10 (-12) mm long, nearly glabrous or slightly pubescent with short stiff hairs to densely short villous and with short-stipitate glands; *achenes* (50-) 60-130 (-155), narrow-cylindrical to fusiform, (3-) 4-6 (-8) mm long, cream to dark brown, subglabrous to sparsely hirsutulous and short-stipitate glandular; *pappus* of (24-) 28-32 (-36) bristles, usually stramineous and barbellate to tawny and slightly subplumose. *Chromosome number*, 2n = 38, 57, 76.

ECOLOGY AND DISTRIBUTION. *Arnica chamissonis* Less. is the most widely distributed member of subgenus *Chamissonis*, with populations recorded as far west as Umnak Island of the Aleutian Island-group. It is also found on some of the member-islands of this

Figure 24. Holotype of *Arnica chamissonis* C.F. Less. [Alaska, Unalaska Island, *Chamisso s.n.* (LE *s.n.*!)].


HOLOTYPE
Arnica chamissonis Less.
PHOTO: WILLIAM SM. GRUEZO
LABEL INTERPRETATION
William Sm. Gruezo

Figure 25. Habit and morphology of *Arnica chamissonis* C.F. Less. [Alaska, Glenn Hwy (Hwy 1 S), c. 1 km N of Mile post 49, en route to Seward, 30 July 1986, *Wm. & Aida Gruezo WM11923* (ALTA 92006!)].

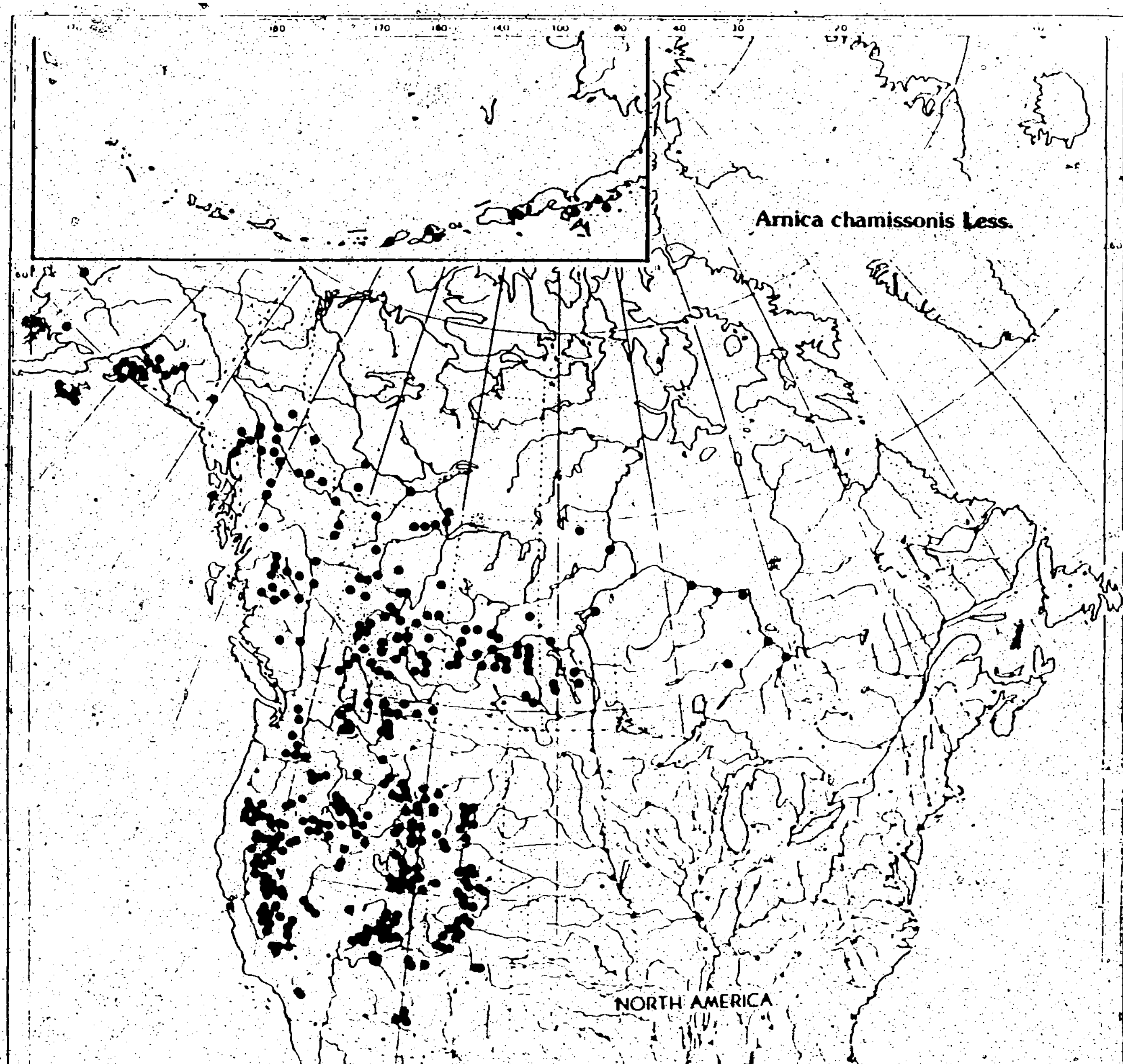

5 CM

chain, on Kodiak Island, and up to the coastal and inland portions of southern Alaska. It is a very common element of roadside vegetation in central and southern Yukon Territory and British Columbia. In Alberta, this species is luxuriantly growing in the Front Ranges of the Rocky Mountains, specially in the Mountain Park region close to the Cardinal Divide. Few, small populations were found in central and northern portions of this province. A number of widely separated populations were recorded from Saskatchewan, Manitoba, Ontario, with the easternmost station situated in the delta of Eastmain River (78°, 12-14' W), Québec. Its northernmost site is in the vicinity of Anvik River (62°, 58' N) Alaska with numerous populations elsewhere in northwestern U.S.A. A high mountain pass between Eagar and McNary (33°, 33'N), Arizona harbors the southernmost population of *A. chamissonis* Less. (Fig. 26).

Throughout its geographic range, *A. chamissonis* Less. occupies remarkably diverse habitats ranging from nearly or seasonally hydric to marginally xeric. At low to medium altitudes, it is regularly found in low-lying moist meadows, in open grassy slopes, periphery of marshes, swamps or bogs and lakes, along streambanks and gravel bars adjacent to hotsprings pools, river deltas and outwash plains of intermittent creeks and snow-melt waters, shallow drainage canals and culvert outlets, *etc.* Dense clonal populations of *A. chamissonis* Less. greatly abound on narrow shoulders of highways and gravel roads whereas small, isolated or highly localized patches are sometimes present in grassland or prairie ecotones and gaps in aspen, willow and other woodland communities. It is one of 3 species in subgenus *Chamissonis* that thrives well from sea level to an altitude of 3,505 m. Its flowering season extends from middle of April to late September.

SPECIMENS EXAMINED. CANADA. ALBERTA: 5 miles N of Fort Fitzgerald, *W.J. Cody & C.C. Loan 4717* (ALTA 16875!). **Wood Buffalo Park**, Caribou Hills, Margare Lake, common on open sand beach, *J.S. Rowe 1099* (CAN 375400!); Mackenzie Basin, Peace Point, margin of Sink hole slough, *Hugh M. Raup 3378* (CAN 109614!); Mackenzie Basin, base of eastern slope of Caribou Mts., prairie, *Hugh M. Raup 3379* (ALTA 16878!, PH/PENN *s.n.!*); Mackenzie Basin, base of eastern slope of Caribou Mts., margin of prairie, *Hugh M. Raup 3380* (CAN 109612!); Mackenzie Basin, base of eastern slope of Caribou Mts., W, margin of prairie, *Hugh M. Raup 3382* (ALTA 16879!, CAN 109613!); Mackenzie Basin, base of eastern slope of Caribou Mts., margin of prairie, *Hugh M. Raup 3381* (CAN 109611!); Caribou Mts., lakeshore, *P. Lee 214* (ALTA 84778!). **Hay River** watershed, site 17:

Figure 26. Geographical range of *Arnica chamissonis* C.F. Less.


Arnica chamissonis Less.
NORTH AMERICA

6 km SSW of Zama City, in *Populus tremuloides* woods, elev. 381 m, *James W. Case 5923* (ALTA 76191!); High Level, c. 5 km N of High Level & c. 1.8 km S of High Level airport, west side of Hwy 35 near swampy/boggy area on edge of *Populus tremuloides* forest, alt. c. 320 m, *William Sm. Gruezo & Aida BG. Gruezo WM11723* (ALTA!, WGRZ!). **Keg River**, disturbed soil, *E.H. Moss 8280* (ALTA 16883!); Keg River, native grassland, *E.H. Moss 8946* (ALTA 16882!). **Red Earth-Wabasca River** area, north central Alberta, 12 mi N of Trout Mt. fire tower, where road meets Wabasca River, grassy clearing near Wabasca River, *L. Abele 30 & W. Peterson* (ALTA 74096!). 2 1/2 mi S of **Gregoire Lake**, in lush forbs meadow on old floodplain of Surmount Creek, occasional hay harvest site, elev. 488 m, *John Corbin & Peter van Eck 11320* (ALTA 90143!). **Peace River**, W bank of Wentzel River where road crosses it, approx. 15 km N of Little Red River, riverbank, *C. Bradley s.n.* (ALTA 84108!); N of Peace River, Dunvegan, *J.M. Macoun Geol. Surv. Can. 59982* (CAN 109583!). On Highway 2, c. 20 km S of Peace River, east side of road to Peace River, grassy roadside meadow & margins of small patch of *Populus tremuloides* forest as well as wheat fields, alt. c. 750 m, slide photo of habitat taken & on collector's file with same coll. number (WM11722), *William Sm. Gruezo & Aida BG. Gruezo WM11722* (ALTA!, WGRZ!). SE of **Codesa**, grassy area, *E.H. Moss 7634* (ALTA 16884!). near **Spirit River**, open, partly burned willow clumps, *E.H. Moss 7558* (ALTA 16885!). **Lesser Slave Provl. Park**, lake-facing side of beach dune ridge, steep slope facing W, sandy soil-open mixed wood dominated by *Populus balsamifera & Picea glauca*, *C. Bradley 3-1* (ALTA 84199!); near Slave Lake, roadside, *E.H. Moss 2219* (ALTA 16887!); near Slave Lake, depressions with willows & tall grasses, *E.H. Moss 6053* (ALTA 16886!). **Lily Lake**, Graminetum part of a low moor, *E.H. Moss 670* (ALTA 16888!). **Spring Creek Basin**, SW of Valleyview, station 3, River, near banks, *Olaf I. Ronning A-47* (ALTA 40990!). **Beaverlodge**, W of Grand Prairie, *M.O. Malte 58* (CAN 212281!); c. 2 1/2 mi E of Beaverlodge Research Station, Mt. Trail Breaking Project, side of dirt track, *B. Heywood 116* (ALTA 39330!). **Loon Lake**, 2 mi W of Wolf Lake & 36 mi ESE of Lac La Biche, study area 2, mixed wood zone-boreal forest, elev. 2000 ft (615 m), *C.D. Bird & K.E. Hinkes 34745* (CAN 453154!). Freeman Creek at bridge, SW of **Swan Hills**, low grassy roadside, *M.G. Dumais 4088 & K. Anderson* (ALTA 39977!, CAN 369177!); Goose Mountain, mesic herb meadow along Goose River, *C. Bradley & M. Fairbarns 643a* (ALTA s.n.!). **Pimple Tower**, 20 mi S of Swan Hills, *M.G. Dumais 4088 & K. Anderson* (ALTA 39977!). 4-5 mi W of Whitecourt, W of Athabasca River, edge of road by aspen woods, *M.G. Dumais 5535* (ALTA 40711!). low ground north of **Barrhead**, *W.C. McCalla 10116* (ALTA 68731!); swampy ground E of Barrhead, fairly abundant here, usually scattered or in small groups, *W.C. McCalla 10132* (ALTA 68732!). 20 miles NW of **Edson**, cleard area, *Ian Corns 144* (ALTA 57103!); W of Edson, moist place, *W.P. Fraser 99* (SASK 22234!). Lower Rock Creek Valley area, near E boundary of **Willmore Wilderness Park**, edge of creek in *Salix* community, *Glenn Brown 77* (ALTA 56642!). **Sheep Creek**, along Continental Divide, *H.F. Lambert 119* (CAN 109571!). **Jasper Natl. Park**, near Pyramid Lake, along the trail, *J.M. Macoun Geol. Surv. Can. 96063* (CAN 109575!); near Pyramid Lake, along trail, *J.M. Macoun Geol. Surv. Can. 96062* (CAN 109573!); vicinity of Jasper town, river banks, *A.E. Porsild & A.J. Breitung 14447* (CAN 109617!, CAN 109618!); vicinity of Jasper, along Cottonwood Trail, (plant no. 26), elev. c. 3500 ft, *A.E. Porsild 22587* (CAN 266359!); Jasper, *M.O. Malte s.n.* (CAN 197184!); Jasper, *M.O. Malte s.n.* (CAN 221915!); wet ground near Athabasca River, *W.C. McCalla 2679* (ALTA 68746!). **Banff Natl. Park**, junction of North Saskatchewan & Alexandra Rivers, in a floodplain meadow, *A.E. Porsild & A.J. Breitung 16049* (CAN 109616!); Spray River: river flats bet. Mt. Turbulent & Goat Range, elev. 5500 ft, *A.E. Porsild & A.J. Breitung 15538* (CAN 109615!); **Rocky Mts. Foothills**, Bow River Forest Reserve, N of Red Deer Crossing, small *Picea mariana* bog, *A.E. Porsild 20425* (CAN 290382!); Rocky Mts., (Herb. Dr. Richardson), date unknown, *Drummond s.n. ex herb. Musei Britannici 14742* (CAN 109576!). **Mercoal**, *E.J. Woollven 6* (ALTA 16869!); Mercoal, *E.J. Woollven 14* (ALTA 16870!); 3 mi SW of Mercoal, edge of spruce-cottonwoods on mossy bank of McCleod River, alt. c. 4500 ft, *F.J. Hermann 13441* (ALTA 16839!); Mercoal, SW of Coalspur, *M.O. Malte & W.R. Watson 1843* (RM 280381!, UC M-309731!); Mercoal, SW of Coalspur, *M.O. Malte & W.R. Watson 1844* (CAN 291685!). moist C.N.R. roadside ditch, 1/2 mi or so E of Fort Saskatchewan, *G.H. Turner 958* (ALTA 65853!); moist

C.N.R. roadside ditch, 1/2 mi or so E of Fort Saskatchewan, *G.H. Turner 959* (ALTA 65856!); C.N.R. ditch at Staflu Farm, 1 mi E of Fort Saskatchewan, *G.H. Turner 5758* (ALTA 65854!). **Thomas Lake**, collected along the line of the Grand Trunk Pacific Railway, *John Macoun & William Herriot Geol. Surv. Can. 72820* (CAN 109578!). collected in the vicinity of **Edmonton**, usually in low ground, *W.C. McCalla 2511* (ALTA 68747!, CAN 109582!); collected in the vicinity of Edmonton, wet spots in meadows & field, *W.C. McCalla 3107* (ALTA 68748!). **Leduc**, *T.N. Willing s.n.* (SASK 22244!). roadside near Mulhurst, *G.H. Turner 6752* (ALTA 65855!). 4 mi E of Buck Lake, SE of Drayton Valley, dry rocky hillside, *M.G. Dumais 2787a & K. Anderson* (ALTA 26489!, CAN 334505!); Buck Lake, SE end of lake, edge of woods in border of lake within 5 mi from campsite, *M.G. Dumais 1811 & C. Watson* (ALTA 23592!); low ground at W end of Ma-Me-O Beach, *G.H. Turner 6757* (CAN 196366!). **Stettler District**, N of Halkirk, Painters Creek (= Paintearth Creek), stubble, *A.H. Brinkman 2427* (ALTA 16871!); Stettler District, S of Castor, low spots, grainfield, *A.H. Brinkman 2401* (PH/PENN *s.n.*!), **Lacombe**, moist prairie, *J.L. Bolton s.n.* (SASK 33917!); Lacombe, open places, *J.L. Bolton s.n.* (SASK 33918!). **Red Deer, prairies**, *H.H. Gaetz Geol. Surv. Can. 11600* (CAN 109579!). Hwy 11 c. 8 mi E of **Nordegg**, damp bank of a little stream, at edge of woods, *W.C. McCalla 11788* (ALTA 68745!); Nordegg, near Golf Course, *M.O. Malte & W.R. Watson 1426* (CAN 291682!); 3 mi S of South Ram River on Forestry Road Nordegg-Calgary, low grassy flat by edge of woods, *M.G. Dumais 4868* (ALTA 25309!). Rocky Mts. Foothills of west-central Alberta, near Mountain Park, on Townsite coal mine, in coal spoils on abandoned coal mine, subalpine zone, elev. 1780 m, *W.B. Russel s.n.* (ALTA 84823!); Mountain Park, back of "Miner's Roof", *M.O. Malte & W.R. Watson 1940* (CAN 291684!); Mountain Park, *E. Woollven 16* (ALTA 16900!). D'Acadia District, **Handhills**, 10 milles au sud de Delia, depression marecageuse, *Bernard Boivin & J.-M. Perron 12398* (ALTA 73351!, RM 305718!, SASK 64478!). Craigmyle district, E of 17 32 16 W 4, low ground near creek, *A.H. Brinkman 592* (ALTA 16872!). Buffalo Prairie, low ground by a brook, *J.M. Macoun Geol. Surv. Can. 96058* (CAN 109577!). NW of **Calgary, low meadow with sedge & grass**, *W.C. McCalla 10185* (ALTA 68744!); a few mi NW of Calgary, at edge of pool in heavy shade of willow thickets, *W.C. McCalla 12039* (ALTA 68743!); vicinity of Fish Creek near Calgary, *Macoun Geol. Surv. Can. 22813* (CAN 109580!); low grassland S of Banff Hwy, 8 mi W of Calgary, *W.C. McCalla 8844* (ALTA 68741!); low wet ground S of Banff Hwy, 8 mi W of Calgary, *W.C. McCalla 9672* (ALTA 68742!); low meadow along Banff Hwy, 10 mi W of Calgary, *W.C. McCalla 6689* (ALTA 68740!). **Cypress Hills**, Spring Creek Ranger Station, depression on plateau, 4700 ft elev., *A.J. Breitung 5638* (RM 213920!); Cypress Hills, Elkwater Lake, in forest, uncommon, *A.J. Breitung 5564* (ALTA 16873!). Rocky Mts., Crowsnest Pass, border of a dry pond near "Gap", *Macoun Geol. Surv. Can. 22814* (CAN 109570!); St. Mary Coulee near St. Mary Reservoir & Dam, N of Hwy 5, SW of Magrath, grassy riverbank, flat above river opposite campsite, *M.G. Dumais 5873a* (ALTA 45309!). 3 mi SW of Twin Butte (north of Waterton Lakes Park), in sedgy prairie among scattered willows in Rocky Mts. Foothills Parkland, *W.G. Dore 12235* (RM 221060!). Aspen parkland near Yarrow Creek, N of Waterton Park, elev. 4300 ft, *Keith Shaw 2589* (BRY 126403!). **Milk River Ridge**, prairies, *Macoun Geol. Surv. Can. 11601* (CAN 109581!). Lethbridge district, Milk River Ridge, 40 mi S of Lethbridge, abundant in low meadow in the natural grassland hills at elevation of 4200 ft, *W.G. Dore & A.J. Breitung 11701* (ALTA 16877!). **Police Outpost Provl. Park**, rich soil in aspen grove, edge of Police Lake, *Keith Shaw 2601* (ALTA 75261!). near **Waterton Lakes Natl. Park**, roadside, *Lloyd H. Shinners/Survey 565* (ALTA 16880!); low damp ground, *R.H. Dixon 918* (ALTA 16881!); near Belly River campground, open aspen forest, SW aspect, alt. 1375 m (= 4500 ft), *P. Kuchar 2773* (ALTA 46077!); Waterton Lakes Natl. Park, E end of Maskinonge Lake, aspen woods, elev. 4200 ft, *A.J. Breitung 17747* (ALTA 16874!); Stoney Creek, aspen grove, alt. 4300 ft, *J. Nagy 2937* (CAN 340740!); moist meadow near aspen grove along Waterton River, elev. 4200 ft, *August J. Breitung 16315* (UC 985841!); Waterton Lakes Natl. Park, Indian Springs Pond, pond shore of sand & fine gravel in prairies, alt. 4500 ft, *W. Blais 1684* (CAN 340743!); along Hwy to Glacier Park, *A.E. Porsild & A.J. Breitung 15138* (CAN 217148!); Waterton Lakes Natl. Park, *M.O. Malte s.n.* (CAN 206184!). **Cardston Gate**, moist grassy poplar grove near small lake, alt. 4200 ft, *J. Nagy 3752* (CAN 346902!); 2 mi from Montana border, Blood

Indian Timber Limit, in pine forest at edge of Belly River, elev. 4500 ft, *Keith Shaw 2283* (BRY 126824!). Alberta, near gate along North Fork Trail, *B.J. Golberg 356* (ALTA 72324!). 1.5 mi W of Craigend P.O., rare in cultivated field, *W.J. Cody & R.L. Gutteridge 7194* (ALTA 16876!).

BRITISH COLUMBIA. Cassiar Highway (Hwy 37), c. 1 km from Natadesleen Lake, corner of access road to lake, right side of highway en route to Stewart Junction, growing on partially moist sandy loam soil in grassy road shoulder, alt. c. 1100 m, *William Sm. Gruezo & Aida BG. Gruezo WM11981* (ALTA!, WGRZ!); Cassiar Highway (Hwy 37), c. 50 m S of Cranberry River bridge, both sides of road, in low-lying grass-sedge meadow, growing on fairly moist sandy-gravelly soil in densely grass-covered meadow, alt. c. 1100 m, *William Sm. Gruezo & Aida BG. Gruezo WM11982* (ALTA!, WGRZ!). Yellowhead Trail (Hwy 16), Moricetown proper, corner of highway and access road to town church or opposite parking area where Moricetown Canyon marker is laid, growing on dry sandy-gravelly soil in thickly grass-covered roadside depressions, alt. c. 850 m, *William Sm. Gruezo & Aida BG. Gruezo WM11983* (ALTA!, WGRZ!); Yellowhead Trail (Hwy 16), corner of highway & Loiseau Road, c. 22 km W of Houston, also opposite access road to Grouse Mt., edge of small intermittent creek and in sedge-grass meadow, growing on stony-rocky soil in low-lying meadow & nearly dried up shallow creek, alt. c. 900 m, *William Sm. Gruezo & Aida BG. Gruezo WM11986* (ALTA!, WGRZ!); Yellowhead Trail (Hwy 16), c. 17 km NW of Ross Lake or c. 41 km NW of Burns Lake, right side of road en route to Burns Lake, in road shoulder meadow, growing on relatively dry sandy-gravelly soil in densely grass-covered roadside meadow, alt. c. 800 m, *William Sm. Gruezo & Aida BG. Gruezo WM11987* (ALTA!, WGRZ!); Yellowhead Trail (Hwy 16), Fraser Lake proper, c. 150 m before the Ministry of Highway & Public Works Maintenance yard, right side of road en route to Fraser Lake town center, roadside shallow ditch, alt. c. 700 m, growing on nearly dry gravelly-sandy soil in shallow intermittent road ditch, *William Sm. Gruezo & Aida BG. Gruezo WM11988* (ALTA!, WGRZ!); Yellowhead Trail (Hwy 16), c. 21.2 km W of Prince George, intersection of Domano Boulevard & Yellowhead Trail, right side of road en route to Prince George, roadside meadow, alt. c. 700 m, growing on partly dry gravelly-sandy soil in grassy meadow, alt. c. 700 m, *William Sm. Gruezo & Aida BG. Gruezo WM11989* (ALTA!, WGRZ!). Liard Hot Springs, *J.P. Anderson & R.G. Brown 10375* (CAN 109585!); Blanchard River, Mile 84 Haines Road, 0% slope, on gravel bar along river, *G.W. & G.G. Douglas 9162* (BRY 153067!); Haines Road, Mile 46, damp roadside, alt. 200 m, *T.M.C. Taylor, A. Szczawinski & M. Bell 1414* (CAN 257550!); Head of Dease Lake, in lush herbage at margin of muskeg pond in *Picea* woods, semi-open, *T.T. McCabe 8816* (UC 662024!); Wolverine Lake E of Manson Creek N of Fort St. James, sandy-gravelly area at edge of deciduous thickets by lake, *J.A. Calder, D.B.O. Savile & J.M. Ferguson 13637* (RM 257954!); 2 mi NW of Ootsa Lake village near Ootsa Lake, occasional at edge of Aspen woods, *J.A. Calder, D.B.O. Savile & J.M. Ferguson 13476* (UC M-090702!, WS 235370!); Fort George, *W.B. Anderson 6252 = Geol. Surv. Can. 105961* (CAN 109658!); Williams Lake, Hwy 97, gravel bank, 17 August 1964, *H.J. Scoggan 16373* (ALTA 43432!, CAN 307503!); Kleena Kleene P.O., on One Eye Lake on road bet. Anahim Lake & Williams Lake, occasional in grassy meadow back from lake margin, *J.A. Calder, J.A. Parmelee & R.L. Taylor 19094* (SASK 22246!); Vicinity of Buckinghorse River, sand bars along river, *H.M. Raup & D.S. Correll 11580* (CAN 278903!); Pine River Pass, R.M. (= ? Rocky Mt.), damp grassy thickets, *Dawson Geol. Surv. Can. s.n.* (CAN 109572!); Houston, gravelly edge of Buck River, *J.W. Eastham 12102* (CAN 109753!); Plentiful in sunny meadow near Farrel Creek, alt. 2700 ft, *Mrs. J. Norman Henry 655* (PH 698372!); S shore of Francois Lake, near ferry landing, *J.W. Eastham 11911* (CAN 109584!); Near Shusuah Lake, *E. Wilson 515 = Geol. Surv. Can. 67795* (CAN 109587!); 3 mi E of New Hazelton, old burns, *T.T. McCabe 8116* (UC 649303!); Hazelton, Skeena River, *J.M. Macoun Geol. Surv. Can. 96060* (CAN 109593!); Hazelton, Skeena River, *J.M. Macoun Geol. Surv. Can. 96059* (CAN 109592!); Yoho Natl. Park, low ground on bank of Kicking Horse River near bridge leading to Yoho Valley, *W.C. McCalla 7690* (ALTA 68733!); Yoho Natl. Park, flat ground now rather dry bank of Kicking Horse River below Mt. Stephen, *W.C. McCalla 7756* (ALTA 68734!); Cranbrook, abundant on vacan lot in Cranbrook town, *J.W. Eastham*

11025 (WS 163765!); Canadian Rockies, Valley of the Lower Kicking Horse River, Palliser to Glenogle, alt. 2900-3200 ft, *Stewardson Brown 770* (PH 529825!); Eu-ta-a-kwe-ti-chick Lake, dry soil, *G.M. Dawson 14739* (CAN 109590!, NDG 062626!); Guichon Creek, *Dawson Geol. Surv. Can. 14741* (CAN 109595!); Glacier, *C.S. Williamson s.n.* (PH *s.n.*!); Silkirk, mouth of Illecillewaet, alt. 1600 ft, *Chas. H. Shaw 870* (PH 526536!); Revelstoke, woods, *Macoun Geol. Surv. Can. 14738* (CAN 109594!); Sproat, woods, *Macoun Geol. Surv. Can. 14737* (CAN 109589!); Sproat, Columbia River, *John Macoun Geol. Surv. Can. s.n.* (CAN 109588!).

MANITOBA. Churchill River below Missi Falls, *C.E. Cairnes Geol. Surv. Can. 89714* (CAN 109602!); Riding Mts., Norgate Road, by roadside, second growth, wet sandy shallow muskeg, *W.E.D. Halliday 131-1932* (CAN 206551!); Riding Mts., *W.E.D. Halliday 122468* (CAN 109603!); The Pas, 30 mi N of Rocky Lake, *W.W. Krivda 1253* (CAN 233746!); 45 mi N of Lake Winnipeg, Cross Lake, road through spruce forest, Whiskey-jack portage, *H.J. Scoggan 3652* (ALTA 16889!, CAN 114790!); 100 mi NW of Winnipeg, Ashern, dry sandy clearing, *H.J. Scoggan 9277* (CAN 210448!); 120 mi NW of Winnipeg, Grahamdale, clearing on clay soil, *H.J. Scoggan 9316* (CAN 210449!); Riding Mt. Natl. Park, roadside gravel 7 mi N of south entrance, *H.J. Scoggan 11337* (CAN 224156!); Bank of Nelson River, junction of Limestone River & Nelson River, sandy clay, *R.M. Tryon Jr. & A. Orville Dahl 210* (RM 287989!).

NORTHWEST TERRITORIES. S of Fort Smith, small patch in sand in hay field, rare, *W.J. Cody & C.C. Loan 4208* (RM 233194!, WS 215755!); Fort Providence, Blue Fish meadows (dry), *University of Alberta Range Herbarium no. 27* (ALTA 86504!); Logan Mountains, Flat River Valley, c. 2 km S of Tungsten (= Cantung) proper (mining townsite), 61! 58' N 128! 17' W, border of black spruce-fir forest & vicinity of hot springs pools, alt. c. 1500 m, growing on moist dark loam soil along rim of hot springs pools & within 50-100 m perimeter, common & abundant, slide photos (6) on collectors' file bearing same collection number (WM11795), *William Sm. Gruezo & Aida BG. Gruezo WM11795* (ALTA!, WGRZ!); Logan Mountains, Flat River Valley, c. 2 km S of Tungsten (= Cantung) proper (mining townsite), 61! 58' N 128! 17' W, border of black spruce-fir forest & vicinity of hot springs pools, alt. c. 1500 m, growing on gravelly-sandy soil near the outhouse, scattered individually, quite abundant & common, *William Sm. Gruezo & Aida BG. Gruezo WM11799* (ALTA!, WGRZ!); Logan Mts., Flat River Valley, c. 2 km S of Tungsten, edge of spruce-fir forest along hot springs pools, dark moist loamy soil, elev. 1500 m, *J.G. Harris 1527* (ALTA 88332!, BRY 236438!); Flat River, 134 mi N of Watson Lake, open valley, wet area near hot-springs, elev. 4000 ft, *P.M. Youngman & G. Tessier 428* (CAN 279605!); Mackenzie Mts., hot spring meadow, elev. 4000 ft, *E.W. Arnold 81* (CAN 264976!); Mackenzie District, Fort Simpson, forming large patch in old field behind Hudson Bay Company, *W.J. Cody & J.M. Matte 8759* (RM 276906!, SASK 24348!, SASK 282801!, WS 259086!).

ONTARIO. Cochrane District, Ogoki, on Albany River N of Ogoki, Hudson Bay Lowlands, river shore, *W.K.W. Baldwin & A.E. Porsild et al. 6728* (CAN 413462!); Kenora District, Hudson Bay Lowlands, Winisk, clearing on riverbank at Settlement, *W.K.W. Baldwin 8060* (CAN 414797!); James Bay, Moose Factory, *W. Spreadborough Geol. Surv. Can. 62530* (CAN 109599!); James Bay, mouth of Albany River, *W. Spreadborough Geol. Surv. Can. 62531* (CAN 109600!); vicinity of mouth of Severn River, crest of river bank along E channel c. 1 mi S of coast, occasional, *D.R. Moir 1434* (CAN 261278!); vicinity of mouth of Goose Creek, crevices in boulder pavement along river, c. 4 mi S of coast, occasional, *D.R. Moir 1603* (CAN 261277!); Polar Bear Provl. Park, Brant River, island near mouth of W branch, sandy clay humus, *F.N. Cowell 1077* (CAN 320596!).

SASKATCHEWAN. Beyond Sutherland, *Alice Winifred Anderson s.n.* (CAN 387402!); 0.6 mi NW of Hwy 120 at mile 35, damp depression in abandoned roadway in mixed wood forest, 4-5 individuals seen, *H.G. Anderson 1246* (SASK 441141!); Hansen Lake Road, Ballantyne River, *Alnus incana*, *Salix pellita*, *Poa* spp. thicket, moist streamside vegetation, *George W. Argus & John J. Hudson 4627* (RM 277602!, SASK 24987!); Glaslyn, road to Turtle Lake, ditch through Trembling Aspen & Jack Pine, *W.K.W. Baldwin & J. Macpherson 10583* (CAN 437583!); District of Kindersley, Leipzig, depression entre les trembles, *Bernard Boivin et D. Dunbar 10427* (RM 305717!, SASK 64477!); District of Melfort, Carrot River, remblai de la route, *Bernard Boivin et T. Mosquin 10830* (SASK 64476!); 3 3/4 mi W & 1/4 mi N of McKague, occasional in low semi-open prairie, *A.J. Breitung 1212* (UC 892051!); 7 mi SW of Tisdale, occasional in semi-open prairie or woodland, *August J. Breitung 1753* (CAN 204201!, RM 233250!); Meadow Lake, occasional in rich moist soil, *A.J. Breitung 8238* (SASK 22232!); Saskatoon, *W.H. Cameron s.n.* (SASK 22242!); Brightsand Lake, woods near lake shore, *Robert Connell s.n.* (SASK 26612!); Lake Waskesiu, *W.P. Fraser s.n.* (SASK 22240!); Whitefox, open woods, *W.P. Fraser & G.F. Ledingham s.n.* (SASK 22236!); Humboldt, moist ground, *W.P. Fraser & G.F. Ledingham 100* (SASK 22239!, SASK 22243!); Prairie River, R/Y bank, *W.E.D. Halliday 148* (CAN 206552!); 2 mi S of Green Lake Village near O'Brien's Fishing Lodge, along W shore of Green Lake, *Picea glauca/Populus balsamifera/P. tremuloides* dominated woods along lake shore, *Vernon L. Harms 16800* (SASK 42718!); Opawikusehikan Narrows area, 3 mi S of Pelican Narrows, open area, *Vernon L. Harms 20183* (SASK 47965!); McDonald Creek of Reindeer River, creek banks, less 5% cover, *J. & J. Heilman 2350* (SASK 55730!); Luseland, damp places, *Huldo Hoining s.n.* (SASK 22235!); 2 mi E & 2 mi N of Mayfair, roadside, near low spot, *B.H. Hood 146* (SASK 26898!); Floral, in sedge sod of moist meadow by pool on R.R. right-of-way, two large patches with *Carex praegracilis, C. sartwellii, C. lanuginosa*, *J.H. Hudson 2524* (SASK 34813!); Fusilier, margin of shallow freshwater slough on prairie, now almost dry, occasional with *Ranunculus flammula, Helenium*, *John H. Hudson 3192* (SASK 60874!); Pasquia Hills, 16.2 mi up Fir River road from Hwy 3, wet earthy roadside, a few plants with *Phleum pratense, Deschampsia caespitosa*, *John H. Hudson 4406* (SASK 78828!); S of Nipawin, edge of grain field, *G.F. Ledingham s.n.* (SASK 22245!); Streets of Prince Albert, in ditches, *Macoun Geol. Surv. Can. 12762* (CAN 109607!); Eagle Creek, prairies & open plains, *Macoun Geol. Surv. Can 14740* (CAN 109609!); Bredenbury, along line of the Grand Trunk Pacific Railway, *John Macoun & William Herriot Geol. Surv. Can. 72819* (CAN 109608!); Yorkton, *John Macoun & William Herriot Geol. Surv. Can. 72818* (CAN 109608!); Scott, *M.O. Malte s.n.* (CAN 197189!); P.A.N.P., roadside, *E.G. Reeder s.n.* (SASK 22238!); St. Gregor, wet ground near willows, *R.C. Russell S52085* (SASK 22233!); 5 mi W of Endeavour, edge of a slough, cattails & *Glyceria grandis* present, *Robert A. Wright 43A* (SASK 69549!).

YUKON. Coal River Springs & adjacent areas, river bank communities & associated white spruce-balsam poplar forest, 650-750 m alt, *George W. Scotter 24549 & Teuvo Ahti* (ALTA 82902!); Larsen Creek Hot Springs, gravel bar bet. hot spring terrace & creek, 760 m alt., *George W. Scotter 24637* (ALTA 82901!); Nahanni Range Road (Hwy 10), c. 89 km S of Tungsten (= Cantung) and c. 1 km before Km post 102, border of sparse *Picea glauca* (White Spruce) forest, alt. c. 1000 m, growing on moist sandy-gravelly soil in grassy road shoulders, slide photos(3) on collectors' file bearing same coll. number (WM11788), *William Sm. Gruezo & Aida BG. Gruezo WM11788* (ALTA!, WGRZ!); **Canol Road**, E slope of Rose River valley near pump station no. 10 at Mile 77, pine & spruce bogs, elev. 3000 ft, *A.E. Porsild & A.J. Breitung 10321* (CAN 109565!); Canol Road, Mile 95, Upper Rose River valley, floodplain meadows, elev. 3600 ft, *A.E. Porsild & A.J. Breitung 10424* (CAN 109566!); Canol Road, Mile 102, Rose-Lapie River Pass, meadows & grassy slopes near headwaters of Lapie River, subalpine meadows, elev. 3600 ft, *A.E. Porsild & A.J. Breitung 10632* (CAN 109567!); Canol Road, Mile 36-42, river banks & alluvial flats along W banks of Nisutlin River, elev. 2750 ft, *A.E. Porsild & A.J. Breitung 10872* (ALA 40954!, KLUANE!, UC 994969!); Canol Road, NE spur of Mt. Sheldon, near road, opposite Mile 226-227, subalpine meadows, in deep rich loam, elev. 3400 ft, *A.E. Porsild & A.J. Breitung 11494* (CAN 109568!, UC 994968!); Canol Road, E spur of Mt. Sheldon, subalpine meadows near road, opposite Mile 226-227, in deep rich loamy soil, elev. 3400 ft, *A.E. Porsild & A.J. Breitung 11495* (ALTA 29668!, CAN 109569!, UC 994967!); Alaska Highway (Hwy 1), c. 1.5 km W of Km post 1930 or c. 3 km S of Beaver Creek, border of sparse stunted Picea-Salix forest, left side of road en route to Koidern, growing on relatively dry sandy-gravelly soil in road shoulders, alt. c. 900 m, ***William Sm. Gruezo & Aida BG. Gruezo WM11953*** (ALTA!, WGRZ!); Klondike Highway (Hwy 2), c. 1.6 km S of Km post 460 & c. 4.6 km S of Pelly Crossing, right side of road by edge of Salix thickets, alt. c. 1000 m, ***William Sm. Gruezo & Aida BG. Gruezo WM11822*** (ALTA!, WGRZ!); c. 4.8 km S of Beaver Creek, Mile 1201 Alaska Hwy, along roadside in dry gravelly area, elev. 700 m, ***G.G. Douglas & V.L. Tait 10498*** (ALA 76683!, BRY 178137!, KLUANE!); Vicinity of Mackintosh (Mile 1022, Alaska Hwy), bet. Bear Creek & Pine Creek, mainly along pipeline clearing cut through spruce forest, ***W.B. Schofield & H.A. Crum 7627*** (CAN 269449!); Vicinity of Pine Creek, near Mile 1019, prairie, ***H.M. & L.G. Raup 12074*** (ALA 20289!, KLUANE!, RM 271861!, SASK 22230!); Bear Creek (near Lake Desert D'Asch), ***Adolf Muller s.n.*** (PH 638771!) Bear Creek (near Lake Desert D'Asch), ***Adolf Muller s.n.*** (PH 639023!); Pine Creek Station, ***J.P. Anderson & T.G. Brown 10323*** (CAN 109622!); Takhanne River, 56 mi from Haines Junction on road to Haines, gravel river bank at edge of woods, common, alt. 2200 ft, ***J.A. Calder & I. Kukkonen 28188*** (UC M-235124!); 2 mi N of Haines Junction on Alaska Hwy, locally common along roadside at edge of woods, alt. 2000 ft, ***J.A. Calder & I. Kukkonen 28111*** (UC M-235125!); Kluane Natl. Park, Mile 138 Haines Hwy, roadside, elev. 2450 ft, ***G.W. & G.G. Douglas 5954*** (CAN 463335!); Kluane Natl. Park, Mile 1017 Alaska Hwy, in old field along highway, elev. 2000 ft, 1973, ***G.W. & G.G. Douglas 6901*** (CAN 463330!); Kluane Natl. Park, Mile 135 Haines Road, along highway, in gravel, elev. 745 m, ***G.W. & G.G. Douglas 9188*** (BRY 153070!, KLUANE!); Alaska Highway (Hwy 1), c. 1 km N of Haines Junction proper & c. 0.5 km S of Kluane National Park Wardens Office; right side of road en route to Haines Junction, vicinity of Rest Stop area, meadows along margin of Populus tremuloides forest, alt. c. 900 m, ***William Sm. Gruezo & Aida BG. Gruezo WM11961*** (ALTA!, WGRZ!); Haines Road (Hwy 3), c. 2 km from Haines Junction en route to Dezadeash, along both sides of road, margins of spruce (Picea) forest, growing on sandy-stony soil in clearings along road shoulders, alt. c. 950 m, ***William Sm. Gruezo & Aida BG. Gruezo WM11962*** (ALTA!, WGRZ!); Haines Road (Hwy 3), c. 0.5 km S of Km post 240, right side of road en route to Dezadeash, along margins of poplar(Populus)-spruce (Picea) forest, relatively sloping road shoulders, also numerous near Kathleen Lake Lodge, alt. c. 950 m, ***William Sm. Gruezo & Aida BG. Gruezo WM11964*** (ALTA!, WGRZ!); Haines Road (Hwy 3), c. 20 m before Dezadeash Lodge, right side of road en route to Haines, border of sparse poplar (Populus) forest, growing on moist sandy-gravelly soil in sparse thickets by roadside, alt. c. 960 m, ***William Sm. Gruezo & Aida BG. Gruezo WM11965*** (ALTA!, WGRZ!); Haines Road (Hwy 3), c. 0.6 km S of Km post 222, right side of road en route to Haines Junction, border of spruce (Picea)- poplar (Populus) forest, growing on moist sandy-gravelly soil in grassy road shoulders, alt. c. 950 m, ***William Sm. Gruezo & Aida BG. Gruezo WM11967*** (ALTA!, WGRZ!); Km post 224, both sides of road, in relatively broad meadows at margins of spruce(Picea) forest, growing on sandy-gravelly soil in low-lying meadows road margins as well as edge of small creek, slide photos (2) on collectors' file bearing same collection number (WM11968), alt. c. 950 m, ***William Sm. Gruezo & Aida BG. Gruezo WM11968*** (ALTA!, WGRZ!); Haines Road (Hwy 3), vicinity of Km post 230, c. 50 m before Kathleen Lake Lodge & Chevron Gas Station, right side of road en route to Haines Junction, border of spruce (Picea) forest, growing on moist sandy-stony soil in grassy road shoulder meadow, alt. c. 950 m, ***William Sm. Gruezo & Aida BG. Gruezo WM11970*** (ALTA!, WGRZ!); Alaska Hwy, opposite Canadian Experimental Station, near Haines Junction, ***Maxcine Williams 1373*** (BRY 49390!); Haines Hwy, few mi from Haines Junction, roadside grass, ***Maxcine Williams 1381*** (BRY 49345!); Alaska Hwy, Mile 1017, c. 1 mi W of Haines Junction, sandy gravel, at edge of Aspen woods, ***S.L. Welsh & G. Moore 6068*** (BRY 59135!, BRY 142203!); Alaska Hwy, in burned over woodland at Milepost 944, grassy meadows, surrounded by willows, ***S.L. Welsh & G. Moore 7769*** (ALA 37466!, BRY 71181!, BRY 142201!, KLUANE!); Alaska Hwy, c. 1 km W of Mile 1021, on recent Lake Alsek beach ridge, elev. 760 m, ***G.W. & G.G. Douglas 9299*** (BRY 153068!, KLUANE!); c. 1 mi E of Haines Road junction, valley of Alsek River, prairie, ***H.M. & L.G. Raup 12952*** (ALA 20290!, CAN 278899!, KLUANE!, RM 271862!, SASK 22231!, WS 250483!); Alaska Hwy, Junction of Haines Road, in a natural prairie, ***C.H.D. Clarke 357*** (CAN 109621!); Shakwak Valley, 1/2 mi E from Mile 1018, CDA Experiment Farm near Haines Junction, mesic prairie surrounded by aspen & cottonwoods, *James A. Neilson 1233* (CAN 312200!); Mush Lake, c. 19 km WSW of Dezadeash Lodge, *L. Freese 132* (KLUANE 573!); Alaska Highway (Hwy 1), c. 150 m E of K... post 1590 (between Haines Junction & Whitehorse), meadow opening in poplar (*Populus*)- spruce (*Picea*) forest, growing on relatively dry sandy soil in grassy flat meadow, alt. c. 950 m, *William Sm. Gruezo & Aida BG. Gruezo WM11971* (ALTA!, WGRZ!); Johnson Crossing, along SE bank of Teslin River, intermittent mudflats near main posts of bridge at vicinity of boat launch, alt. c. 700 m, growing on wet or boggy sandy-silty soil in sparsely grass-covered mudflats c. 5 m from river waterline, alt. c. 700 m, *William Sm. Gruezo & Aida BG. Gruezo WM11972* (ALTA!, WGRZ!); Johnson Crossing, riverbanks, common, *A.E. Porsild 18416* (ALA 41220!, ALTA 30020!, CAN 208743!); c. 17 mi E of Carcross, on floodplain of Tagish River, willow-spruce community, *S. Welsh & G. Moore 7686* (ALA 37479!, BRY 71053!, KLUANE!); Richthofen Creek on west shore of Lake Laberge, along meadows banks of creek, *R.T. Porsild 1950* (CAN 462527!); Teslin & environs, on meadows along river, alt. c. 2300 ft, *Morten P. Porsild 761* (CAN 109620!); Teslin Lake Government Public Campground area, Mile 813 Alaska Hwy, 6 mi NW of Teslin Village, among wet decaying driftwood in *Salix* covered area along inlet creek to lake, *Vernon L. Harms 17266* (Gs.n.!); Alaska Highway, c. 7.5 km NW of Teslin proper, vicinity of Mile post 813, inside the compound of Teslin Lake Campground, c. 5 m from shore of lake, growing on moist sandy soil among decaying driftwoods at margins of dense Salix thickets, fairly abundant but not common in this site, alt. c. 700 m, 07 August 1986, *William Sm. Gruezo & Aida BG. Gruezo WM11973* (ALTA!, WGRZ!); Alaska Highway (Hwy 1), c. 1.2 km E of Km post 1130, west of Rancheria, right side of road en route to Watson Lake, roadside meadow, growing on moist sandy-gravelly soil near small galvanized iron culvert, alt. c. 800 m, 08 August 1986, *William Sm. Gruezo & Aida BG. Gruezo WM11977* (ALTA!, WGRZ!); Alaska Highway (Hwy 1), vicinity of Km post 1082, E of Little Rancheria Creek, edge of pine forest, on both sides of road, alt. c. 1000 m, 08 August 1986, growing on moist sandy-gravelly soil in grassy roadside meadow, alt. c. 1000 m, 08 August 1986, *William Sm. Gruezo & Aida BG. Gruezo WM11980* (ALTA!, WGRZ!); SASK 42995!); Vicinity of Liard River, c. 6 mi SE of Watson Lake, poplar-willow woods, *H.M. Raup & D.S. Correll 10959* (ALA 20288!, CAN 278898!, KLUANE!, RM 271863!, SASK 22237!, WS 250501!); Haines Hwy, near Yukon Territory-B.C. border, roadside grass, abundant, *Maxcine Williams 1379* (BRY 49374!); Alaska Highway, c. 3 km after Iron Creek, cut-side (right side) of a sharp road bend bordering a poplar forest, alt. c. 950 m, growing on wet sandy-gravelly soil, slide photos (3) bearing same coll. number (WM11774) on collectors' file, *William Sm. Gruezo & Aida BG. Gruezo WM11774* (ALTA!, WGRZ!).

U.S.A. ALASKA. **Richardson Hwy**, mile 62.5, *Aline Strutz 1249* (BRY 61349!); Richardson Hwy just before Gulkana River, large patch along roadside before descending the hill, *Maxcine Williams 1883* (BRY 61327!); Richardson Highway (Hwy 4), c. 1.1 km south of Mile post 69 (= vicinity of Mile post 70), edge of spruce-poplar forest, right side of road en route to Valdez, growing on sandy-gravelly soil in road shoulders, slide photos (3) on collectors' file bearing same collection number (WM11881), alt. c. 1300 m, *William Sm. Gruezo & Aida BG. Gruezo WM11881* (ALTA!, WGRZ!); Richardson Highway (Hwy 4), c. 100 m before Ernestine Station & 125 m S of Mile post 62, right side of road en route to Valdez, margin of spruce-poplar forest, growing on sandy soil in road shoulders by edge of intermittent shallow canal, alt. c. 1300 m, *William Sm. Gruezo & Aida BG. Gruezo WM11883* (ALTA!, WGRZ!); c. 5 mi NE of Palmer, along Wolverine Creek, *S.L. Welsh 4669* (BRY 142202!); Glenn Highway (Hwy 1), Mile post 59, left side of road en route to Anchorage, c. 80 m from Hilltop Cafe & Tesoro Gas Station, growing on stony-sandy grassy soil in road shoulders, alt. c. 1000 m, *William Sm. Gruezo & Aida BG. Gruezo WM11914* (ALTA!, WGRZ!); Glenn Highway (Highway 1), vicinity of Mile post 59.8, left side of road en route to Anchorage, c. 75 m from Hilltop Cafe & Tesoro Gas Station, growing on moist stony-sandy soil along edge of grassy shallow intermittent canal near garbage dumpsite; plants are remarkably tall (up to c. 1.5 m) & robust, color photos (2) on collectors' file bearing same collection number (WM11915), alt. c. 1000 m, *William Sm. Gruezo & Aida BG. Gruezo WM11915* (ALTA!, WGRZ!); Glenn Highway (Hwy 1, SE), Turnagain Arm area, vicinity of

Mile post 94.3, left side of road en route to Girdwood, growing on moist sandy loam soil along edge of shallow road ditch where snowmelt waters from mountain slopes are being drained, slide photos (2) on collectors' file bearing same collection number (WM11916), alt. c. 10 m, *William Sm. Gruezo & Aida BG. Gruezo WM11916* (ALTA!, WGRZ!); Glenn Highway (Hwy 1, SE), Turnagain Arm area, c. 2 km E of Girdwood & c. 0.5 km before railroad crossing, road shoulders c. 10 m from railroad tract & c. 30 m from shoreline, growing on dry sandy soil near road sign (Curve, 35mph), slide photos (2) on collectors' file bearing same coll. number (WM11918), alt. c. 10 m, *William Sm. Gruezo & Aida BG. Gruezo WM11918* (ALTA!, WGRZ!); Girdwood proper, in front of Double Musky Inn, along edge of road canal & lawn of Double Musky Inn where it is maintained as ornamental plant, growing on sandy loam soil in grassy margin of road canal and front lawn, slide photos (4) on collectors' file bearing same collection number (WM11919), alt. c. 10 m, 29 July 1986, *William Sm. Gruezo & Aida BG. Gruezo WM11919* (ALTA!, WGRZ!); Girdwood proper, along Alyeska Highway, c. 0.8 km from junction of Glenn Highway (Hwy 1, SE) & Alyeska Hwy, road depressions between main road & bike pathway, growing on sandy loam soil in grassy road shoulder depression, alt. c. 10 m, *William Sm. Gruezo & Aida BG. Gruezo WM11920* (ALTA!, WGRZ!); Glenn Highway (Hwy 1), c. 66 miles N of Seward, right side of road en route to Seward, broad tract of meadows near base of mountain range, growing on moist sandy loam soil in low-lying meadows near cement bridge, slide photos (3) on collectors' file bearing same coll. number (WM11921), alt. c. 300 m, *William Sm. Gruezo & Aida BG. Gruezo WM11921* (ALTA!, WGRZ!); Glenn Highway (Hwy 1, S), vicinity of entrance road to Chugach National Forest Campground, Granite Creek, left side of road en route to Seward, c. 1.5 km S of Mile post 62, growing on sandy loam soil along road shoulders, alt. c. 500 m, *William Sm. Gruezo & Aida BG. Gruezo WM11922* (ALTA!, WGRZ!); Glenn Highway (Hwy 1, S), c. 1 km N of Mile post 49, right side of road en route to Seward, growing on sandy-stony grassy hillslope near road canal, between Mile posts 42 & 43 as well as 47 & 48, alt. c. 500 m, *William Sm. Gruezo & Aida BG. Gruezo WM11923* (ALTA!, WGRZ!); Highway 9, Moose Pass proper, behind garage of Chevron Gas Station, boggy site with continuous seepage flow, growing on ever-wet mucky soil in margin of *Betula* forest, fairly abundant and distinctly robust plants, alt. c. 700 m, *William Sm. Gruezo & Aida BG. Gruezo WM11925* (ALTA!, WGRZ!); Seward proper, vicinity of Peninsula Ford dealer & Free Mason cemetery, grassy margins and open field, growing on sandy-stony soil in margins and vacant field, also found growing on graveyards of Heroes Cemetery just adjacent to this site, alt. c. 5 m, *William Sm. Gruezo & Aida BG. Gruezo WM11926* (ALTA!, WGRZ!); Seward proper, inside the compound of Heroes Cemetery with entrance gate bearing the following inscription- 'Eternal Rest Unto God', adjacent to Free Mason Cemetery & across Peninsula Ford dealer, growing on sandy loam soil in graveyards, slide photos (2) on collectors' file bearing same collection number (WM11927), alt. c. 5 m *William Sm. Gruezo & Aida BG. Gruezo WM11927* (ALTA!, WGRZ!); Seward Township, Highway 9, c. 6 miles N of Seward proper, right side of road en route to Seward, road shoulders, growing on sandy loam soil in grassy road margins, alt. c. 10 m, *William Sm. Gruezo & Aida BG. Gruezo WM11928* (ALTA!, WGRZ!); Glenn Highway (Hwy 1, E), c. 0.5 km E of Mile post 93 or 0.5 km before Eagles Nest Bed & Breakfast Lodge or c. 2.3 miles E of Soldotna, road shoulders, left side of road en route to Kenai, growing on moist gravelly soil by edge of road, alt. c. 750 m, *William Sm. Gruezo & Aida BG. Gruezo WM11931* (ALTA!, WGRZ!); Kenai Township, Highway 1, c. 2 miles before Kenai proper, corner of Hwy 1 & McCollum Drive, open field and waste place along road, growing on sandy loam soil in vacant subdivision lot, alt. c. 300 m, *William Sm. Gruezo & Aida BG. Gruezo WM11932* (ALTA!, WGRZ!); Highway 1 (South), c. 4 miles N of Kasilof, vicinity of Mile post 103, border of spruce(Picea)-birch(Betula) forest, on both sides of road, open grassy fields, growing on moist sandy-stony soil in grassy road shoulders, alt. c. 100 m, *William Sm. Gruezo & Aida BG. Gruezo WM11934* (ALTA!, WGRZ!); Highway 1 (South), Ninilchik proper, right side of road to town center & opposite Hylen's camper park signpost/access road, c. 1 km before the townhall, growing on stony soil along edge of road ditch, alt. c. 100 m, *William Sm. Gruezo & Aida BG. Gruezo WM11935* (ALTA!, WGRZ!); Sterling Highway (Hyw 1, S), c. 0.8 km N of Mile post 154 & c. 3.2 km S of Anchor Point, left side of road en route to

Homer, road shoulders, growing on sandy-stony soil in grassy road margins, alt. c. 100 m, *William Sm. Gruezo & Aida BG. Gruezo WM11936* (ALTA!, WGRZ!); Sterling Highway (Hwy 1, S), c. 1 km S of Mile post 168 & c. 0.2 km from corner of Green Timber Road & Sterling Hwy, right side of road en route to Homer, edge of road by the ditch, growing on wet sandy-silt soil in road margins & edge of ditch, alt. c. 100 m, *William Sm. Gruezo & Aida BG. Gruezo WM11937* (ALTA!, WGRZ!); Sterling Highway (Hwy 1, S), c. 2.5 km before Homer proper, left side of road en route to Homer, c. 1.9 km S of Mile post 171, growing on sandy-gravelly soil in broad road depressions, alt. c. 100 m, *William Sm. Gruezo & Aida BG. Gruezo WM11939* (ALTA!, WGRZ!); Sterling Highway (Hwy 1, S), c. 1 km S of Mile post 169, cut-side of road opposite parking area of Homer View Point, growing on sandy-stony soil along edge of road ditch, slide photos (2) on collectors' file with no. WM11940, alt. c. 100 m, *William Sm. Gruezo & Aida BG. Gruezo WM11940* (ALTA!, WGRZ!); Ninilchik proper, corner of Sterling Highway (Hwy 1) & Oilwell Road & beside the Calvary Baptist Church & Christian School, growing on sandy soil in open field and waste site along road, alt. c. 50 m, *William Sm. Gruezo & Aida BG. Gruezo WM11941* (ALTA!, WGRZ!). **Anchorage Municipality**, Chugach State Park, Eklutna Valley, along roadside under scrub poplar & alder, gravelly soil, Quaternary surface deposit, 880 ft elev., *LuDean Marvin 1650* (BRY 274727!); **Seward Hwy**, c. 16 mi S of Anchorage, *Aline Strutz 522* (BRY 61341!); **Division 1**, near the Tongass Forest, mile 39, Haines Road, meadow, common, alt. 200 ft, *Ray F. Taylor T-60* (RM 470602!). Holy Cross Quad, Anvik River, 62° 58' N 160° 43' W, growing on rocky beach, *Bob Karlen 31* (ALA V75284!); Bristol Bay area, Cabin Bay, Lake Nerka, 59° 35' N 158° 45' W, beach gravel, *K. Roberson 137* (ALA 38333!); Kenai Peninsula, *L.J. Palmer 106* (ALA 6484!, ALA 25546!, ALA 25549!); Seward Quad, Kenai Lake, Ptarmigan Creek Trail (to Ptarmigan Lake from campground), 60° 25' N 149° 20' W, *J.W. Smith 78-28* (ALA 83833!); Seward Hwy, picnic site overlooking Turnagain Arm, c. 30 mi from Anchorage, roadside, *Maxcine Williams & Aline Strutz 752* (ALA 25233!).

Admiralty Island, Mole Harbor, *Maxcine Williams s.n.* (BRY 61322!, CAN 109665!). **Baranof Island**, Sitka, near lake, *L.G. Smith 13* (BRY 88448!). **Kodiak Group**, Raspberry Island, Raspberry Strait, Port Vita, in a meadow, *W.J. Eyerdam 3980* (CAN 109563!, UC 921389!, WS 161068!); Kodiak Islands, Raspberry Island, Port Vita, in damp meadow, 9 m alt., *Walter J. Eyerdam 3210* (CAN 109596!, UC 750768!, WS 127711!, WS 224324!); Kodiak, road to airport, outwash from creek, mostly sand, *Maxcine Williams 2563* (BRY 94059!); Kodiak Quad, Sitkalidak Island, Ocean Bay, 57° 05' N 153° 12' W, meadow habitat, *M.A. Hatch 481* (ALA 95656!); Kodiak Quad, Sitkalidak Island, Ocean Bay, 57° 05' N 153° 12' W, common, *M.A. Hatch 497* (ALA 95788!); Kodiak Island, vicinity of Old Harbour, 57° 13' N 153° 18' W, *Frank Brooks 54* (ALA *s.n.*!); Karluk Quad, Akalura River Field Station & vicinity, 57° 12' N 154° 32' W, dry soil along stream bank, *Jeff Barnhart 49* (ALA 94305!); Sutwik Island Quad, Ugaiushak Island, 56° 47' N 156° 41' W, growing in moist upland meadows, *Brian Lawhead 108* (ALA 95042!); Chignik Quad, Chignik River Field Station & vicinity, 56° 16' N 158° 42' W, sandy beach on riverbank, *G. Weiler 35* (ALA 83911!); Cold Bay, Russell Creek, 55° 15' N 162° 30' W, level, fairly well-drained open areas in association with *Poa, Carex & Salix*, *Samuel J. Harbo 3* (ALA 24780!). Kodiak Island, growing in lowland meadow marsh at Kalsin Bay, *Catherine H. Ellis s.n.* (BRY 85551!); Kodiak Island, Olga Bay, Cannery Station, moist places in valley, *Ethel H. Looff & Henry B. Looff 539* (ND 011127!); Kodiak Island, Olga Bay, Cannery Station, *Ethel H. Looff & Henry B. Looff 1176* (RM 184148!); Kodiak, *Coville & Kearney s.n.* (NDG 062420/HG 46843!); Kodiak Island, Alitak, Valleys, *Ethel H. Looff s.n.* (UC 581608!); **Shumagin Islands**, Popof Island, collector unknown, (NDG 062420/HG 46841!); Shumagin Islands, Popof Island, *Kincaid s.n.* (NDG 062423/HG 46844!); Shumagin Islands, Popof Island, *J. Kincaid s.n.* (NDG 062420/HG 46840!); **Aleutian Islands**, Unimak Island, False Pass, *W.J. Eyerdam 2074* (UC M-094249!); **Unalaska**, Iliuliuk, *W.L. Jepson 283* (UC M-086188!); Unalaska, Aleutian Islands, Iliuliuk, *W.L. Jepson 234* (UC M-086187!); Unalaska Island, sea level, *H.M. Laing 404* (CAN 109598!); Unalaska Quad, Unalaska Island, 53° 52' N 166° 34' W, on gravel with cow parsnip, *B.F. Friedman 80-195* (ALA V75240!); Unalaska Quad, Unalaska Island, 53° 52' N 166° 34' W, Captain's Bay, growing in small small stream bed on moss, *B.F. Friedman*

81-81 (ALA V74649!); Umnak Island, moist sandy soil near beach, associated plants = *Elymus-Calamagrostis*, *Aconitum*, *W.B. Miller 1694* (ALA 1834!, ALA 2686!. Unalaska, *Coville & Kearney s.n.* (NDG 062420/HG 46839!). **Kakuk Bay**, *Kincaid s.n.* (NDG 062423/HG 46845!). Alaska, *X.M. Bennet & Henry C. Cowles 957* (UC 892055!). Alaska, exact locality not stated, mounted together with 4 other specimens(i.e.HG 46839, HG 46840, HG 46841, & HG 46843) on the same herbarium sheet (NDG 062420), *Fisher s.n.* (NDG 062420/HG 46842!).

ARIZONA.**Apache Co.**, Mt. Pass bet. Eagar & McNary, 10200 ft elev. in a meadow, grass-sedge community, *Larry C. Higgins 7821* (BRY 121801!); near Big Lake on Big Lake-Alpine Road, *P.D. Keener s.n.* (UC M-280074!); White Mts., Apache Natl. Forest, Winn Campground Bog, several patches around periphery of bog, *T.R. Van Devender & F.W. Reichenbacher s.n.* (UC 1488870!); Luka-Chukai Mts., in shallow water of lake, elev. 2760 m, *George J. Goodman & Lois Butler Payson 2937* (UC 892097!). V.T. Ranch, Kaibak or Karlak (?) Forest, muddy places around pond, *Cottam 2681* (BRY 15864!).

CALIFORNIA. **Modoc Co.**, Eight Mile Creek, NE corner of county, meadows near willows, alt. 5750 ft, *Annie M. Alexander & Louise Kellogg 4926* (UC 748078!); Cowhead Lake, in meadow, *Annie M. Alexander & Louise Kellogg 4990* (UC 748079!); Egg Lake, in water 6-18 inches deep, *Milo S. Baker s.n.* (UC 29627!); Egg Lake, in water 6-18 inches deep, *Milo S. Baker s.n.* (UC 29628!); Egg Lake, in shallow water 6-18 inches deep, *Milo S. Baker s.n.* (JEPS 20957!); Modoc Natl. Forest, Warner Mts., East Creek c. 1 mi E of Patterson Ranger Station, open sage brush, *Roxana S. Ferris & Laura Lorraine 10570* (UC 711923!); Warner Mts., S & E of Alturas, Parker Creek, stream edge in gravel, *Frances D. Payne s.n.* (JEPS 5916!); Warner Mts., S & E of Alturas, Parker Creek, elev. 5200 ft, *Frances D. Payne 204* (JEPS 35869!); Warner Mts., E slope of Warren Peak, S slope of Owl Creek, elev. 7500 ft, *Frances D. Payne 293* (JEPS 35870!); Warner Mts., E of Warren Peak, Owl Creek, elev. 7000 ft, *Frances D. Payne 295* (JEPS 35871!); Modoc Forest, Blue Lake, wet shore of lake, flat slope, alt. 6150 ft, *L.S. Smith 1007* (RM 471056!); Warner Mts., head N Fork Parker Creek, very common on meadow, alt. 7300 ft, *W.P. Taylor & H.C. Bryant s.n.* (UC 468971!). **Siskiyou Co.**, 20 mi NE of Weed, on route between Weed & Klamath Falls, extensive & prominent colonies in standing water (6-8 inches deep) of Grass Lake, elev. 5068 ft, *Rimo Bacigalupi 5974 & S. Galen Smith* (JEPS 19744!); Grass Lake Station, on U.S. Hwy 97, common in wetter areas, elev. 5100 ft, *Roxana S. Ferris & Laura Lorraine 10499* (RM 193522!, UC 711894!, WS 172103!); in a standing water in pools in a meadow 1 mi S of Bray, elev. 4600 ft, *A.A. Heller 15270* (JEPS 22842!, UC 892107!); very common at Grass Lake on U.S. Hwy 97, elev. 5122 ft, *A.A. Heller 15757* (UC 726140!, WS 150237!); Grass Lake, Marsh Plant Survey of California, *Herbert L. Mason 13608* (UC M-192153!); Grass Lake, Hwy 97, Marsh Plant Survey of California, *Calvin McMillan & Malcolm A. Nobs 797* (UC M-192152!); Grass Lake, Hwy 97, *Calvin McMillan & Malcolm A. Nobs 798* (UC M-192167!); Antelope Creek near Tennant, alt. 4800 ft, *Leo Whitney 1836* (UC M-037313!). **Lassen Co.**, Modoc Natl. Forest, southern end of Warner Mts., along Mosquito Creek in Corporation Meadow, elev. 6700 ft, *Rimo Bacigalupi 5414 & G.T. Robbins* (JEPS 17745!); on plain 6.1 mi S of Madeline, marshy land, in wet soil, *Rimo Bacigalupi 6005 & S. Galen Smith* (JEPS 19757!); *M.S. Baker & Frank Nutting s.n.* (UC 29631!); Amedee, Honey Lake Valley, *J. Burtt Davy s.n.* (UC 73900!); Martin Springs, Eagle Lake, *Brown & Wieslander 26* (JEPS 35887!); Lassen Forest, Dry Lake, Grass Valley, flat slope, meadow, alt. 5560 ft, *George A. Fischer & Irwin H. Johnson F-194* (UC 507003!, UC M-136826!); Lassen Natl. Forest, Little Harvey Valley, meadow, alt. 5500 ft, *A.L. Hormay 8* (RM 470722!, UC M- 142923!); low, wet ground near Westwood, alt. 5100 ft, *W.C. McCalla 6283* (ALTA 68739!); Feather Lake, in wet muck in a rush association, elev. 5700 ft, *C.S. Robinson 77* (JEPS 35877!); southern end of Warner Range, Modoc Natl. Forest, on wet shore of Blue Lake, above Blue Lake Ranch, elev. 6150 ft, *Leland S. Smith 1007* (CAN 325204!, JEPS 35881!); Cleghorn Reservoir, muddy flat, alt. c. 6000 ft (1820 m), *G.L. Stebbins Jr. & G.A. Jenkins 2343* (UC 584281!). **Shasta Co.**, eastern Shasta Co., near Great Spring on Hat Creek, *H.M. Hall & E.B. Babcock 4270* (UC 53881!). **Plumas Co.**, Prattville, *D. Cleveland s.n.* (UC 134177!); Red

Clover Valley, *A.A. Heller & P.B. Kennedy 8750* (UC 196038!); near Prattville, Lake Almanor, *Thomas H. Kearney 166* (UC 710419!); Last Chance Creek, c. 2 mi N of Lake Almanor, near Chester, Marsh Plant Survey of California, *Malcolm A. Nobs & S. Galen Smith 1396* (UC M-192155!); wet place NW of Almanor, *C.R. Quick 52-514* (BRY 142200!); 1 mi W of Chases, alt. 5500 ft, *E. Sawyer 272* (UC 579430!). **Sierra Co.**, Sierra Valley, under Jeffrey pines near Calpine, elev. 4900 ft, *Rimo Bacigalupi 4267, H.L. Mason & J.R. Sweeney* (JEPS 16713!); Sierraville, Transition zone, alt. 5000 ft, *H.M. Hall & E.B. Babcock 4472* (UC 53876!); Sierra Co., *J.G. Lemmon 157* (UC 178531!); Quadrangle Sierraville, 1 mi SE of Sawmill, elev. 5800 ft, *G.T. Nordstrom 947* (UC 119291!). **Butte Co.**, Colby, *Mrs. R.M. Austin 553* (UC 91142!). **Nevada Co.**, Donner Lake, *Harriet A. Walker 2143* (UC 159287!); lower end of Donner Lakes, *A.A. Heller 6932* (RM 46721!, UC 57895!); Independence Lake, E slope of Sierra Nevada, elev. 6600 ft, *W.L. Jepson 8070* (JEPS 35888!); plants in wet meadow at edge of Sagehen Creek, *R. Ornduff 4221* (UC M-169384!); Sierra Nevada Mts., above Donner Lake, meadow, *C.F. Sonne s.n.* (UC 134178!); meadow near Donner Lake, *C.F. Sonne s.n.* (UC 193590!); Sierra Nevada Mts., Donner Lake, *C.F. Sonne 189* (PH 548780!). **Placer Co.**, N end of Lake Tahoe, marsh bet. Sandy Beach & Agate Bay, Marsh Plant Survey of California, *Malcolm A. Nobs & S. Galen Smith 1514* (UC M-192154!); Tahoe Natl. Forest, 2 mi SW of Martis Peak, meadow, alt. 7500 ft, *Harry S. Yates 5991* (RM 470717!, UC M-119288!). **El Dorado Co.**, Tahoe Meadows, open sandy flat c. 6240 ft elev., common, *E.B. Babcock 420* (UC 530010!); in formerly wet "meadow" along State Hwy 89, just NW of Tallac Village, near southern end of Lake Tahoe, elev. 6240 ft, *Rimo Bacigalupi 8913 & Tsan Iang Chuang* (JEPS 34437!); Lake Valley, *M.S. Baker s.n.* (UC 62955!); Lake Valley, *Katharine Brandegee s.n.* (UC 467702!); Emerald Bay, *Helen D. Geis 78* (UC 468972!); in 2-8 feet standing water of flooded meadow, E of Camp Richardson, Lake Tahoe, 6200 ft elev., *Verne Grant & Alva Grant 7771* (UC M-213880!); Meek's Bay, Lake Tahoe, elev. 6100 ft, *A.A. Heller 13343* (PH 645513!); road bet. Fallen Leaf Lake & Lake Tahoe, large colony at edge of meadow, *Peter H. Raven 21441* (WS 288932!); Old sawmill, State Hwy 89 (Upper Truckee River), 4 mi S of Meyers Post Office, shady stream bank, elev. c. 6400 ft, *Helen-Mar Wheeler 417* (JEPS 20974!); Pyramid Peak, Sales Flat, elev. 6600 ft, *H.S. Yates 5968* (UC M-119290!). **Alpine Co.**, Toiyabe Natl. Forest, W Carson Sorensens, alt. 7000 ft, *Elmer P. Boyle EPB-43* (RM 470629!); Toiyabe Natl. Forest, Wolf Creek Meadow, deep sand, meadow, elev. 7500 ft, Joe C. Johnson JJ-144 (RM 470628!, WS 198457!). **Mono Co.**, Bridgeport Meadow, in rank growth of grasses, edge of road, alt. 6400 ft, *Annie M. Alexander & Louise Kellogg 4500* (UC 736124!); Bridgeport Meadows, common, alt. 6473 ft, 1945, *Annie M. Alexander & Louise Kellog 4593* (UC 736132!); drier upper parts of meadow in "delta" of Hilton Creek, immediately E of U.S. Hwy 395, elev. 6800 ft, *Rimo Bacigalupi 3787 & Lincoln Constance* (JEPS 13864!); White Mts., canyon of N Fork Crooked Creek, 1.4 mi below & E of Naval High Altitude Research Station, streamside below stony slope with bristlecone & limber pines, elev. c. 9800 ft, *Rimo Bacigalupi 8092, P.C. Hutchison & L. Heckard* (JEPS 28220!); White Mts., Crooked Creek Laboratory, moist meadow with seep spring & small lake, elev. 10150 ft, *E.R. Blakley & K.K. Muller 3551* (JEPS 32943!); near Lake Mono, wet meadows, *Chesnut & E.R. Drew s.n.* (UC 34556!); Leavitt's Meadows, Bridgeport & Sonora Road, *J.W. Congdon s.n.* (WS 227047!); wet meadow at S end of Long Valley near Hilton Creek, growing in shallow water with *Iris missouriensis & Carex*, 7300 ft alt., *L. Constance 2437* (RM 179112!, UC 614637!, WS 101061); 2.2 mi SW of Masonic, Mono Natl. Forest, alt. 7950 ft, *G.A. Graham 176* (UC 577677!); White Mts., N Fork Crooked Creek, alt. 10100 ft, *W.L. Jepson 7265* (JEPS 35901!, WS 264615!); White Mts., subalpine area in the immediate vicinity of Crooked Creek Cave, Crooked Creek Canyon, very rare, alt. 10000 ft, *Robert M. Lloyd 3088* (UC M-311786!); White Mts., Crooked Creek Canyon, common plant along stream, subalpine, elev. 9900 ft, *Robert M. Lloyd 3271* (UC M-300146!); White Mts., Inyo Natl. Forest, 1 mi below meadow & corral at head of Crooked Creek, moist loam soil along stream, 11500 ft elev., *Bassett Maguire & Arthur H. Holmgren 26057* (WS 169596!); Leevining Creek, eastern slope of Sierra Nevada, *Alice Ottley 1095* (JEPS 35876!); on moraine ridge along Parker Creek drainage in a small dry meadow area at end of road toward the Mt. Dana-Minaret Wild Area, elev. 8800 ft, *James L. Reveal & Jack L. Reveal 446* (RM 301445!), UC 1338630!); Bridgeport, alt. 6465 ft, *Lewis S. Rose 50150*

(UC 942913!); 3 mi W of Leevining, meadow, alt. 7700 ft, *Lewis S. Rose 50194* (BRY 142199!). **Tuolumne Co.**, Meadow View Camp, elev. c. 5950 ft, *V.F. Hesse 2264* (JEPS 18837!); Sawmill Meadow below Long Barn, *R.F. Hoover 2526* (JEPS 20968!); Kennedy Meadows, *R.F. Hoover 3685* (JEPS 20966!, UC 767461!); Trail to Ireland Lake from Tuolumne Meadows, Lyell Fork, in *Pinus murrayana* belt, grassy meadows, *Edward Lee 2374* (JEPS 79453!); Stanislaus Natl. Forest, W end of Leland Meadow, 2-3 mi N of Strawberry Lake, occasional on dryish edges of meadow, alt. c. 6500 ft, *Clarence R. Quick s.n.* (UC 650302!); foot of "The Iceberg", on Clark Fork of the Stanislaus River, *Ira L. Wiggins 9509* (CAN 190982!, RM 189729!). **Mariposa Co.**, Bridalveil Creek, canyon above the falls, *R.F. Hoover 3769* (UC 767466!). **Inyo Co.**, S Fork of Big Pine Creek, in meadow near stream, alt. 8000 ft, *Annie M. Alexander & Louise Kellogg 2560* (UC 669913!); Cottonwood Lakes, SW of Lone Pine, in meadow, alt. 11000 ft, *Annie M. Alexander & Louise Kellogg 3311* (RM 200906!, UC 703945!, WS 163753!); Upper Bishop Creek, Andrews Camp, *Katharine Brandegee s.n.* (UC 220233!); Andrews Camp, *Katharine Brandegee s.n.* (UC 220238!); Bishop Creek, Andrews Camp, *A. Davidson 2572* (UC 159909!); White Mts., Inyo Natl. Forest, upper basin N Fork of Crooked Creek, moist sandy soil in meadow along stream, alt. 10500 ft, *Bassett Maguire & Arthur H. Holmgren 26149* (BRY 20117!, CAN 190991!, PH 810077!, RM 200523!, WS 169595!); Bishop Creek, Andrews Camp, alt. 9000 ft, *Peter H. Raven & G.L. Stebbins Jr. 160* (UC 914596!). **Fresno Co.**, Mono Hot Springs, S Fork of San Joaquin River, elev. 7000 ft, *Elizabeth Ferguson 428* (JEPS 35882!); Sierra Natl. Forest, Dinkey Grove of Big Trees (also known as the McKinley Grove), elev. 6250 ft, *Adele Lewis Grant 1203* (JEPS 35879!); Bench Meadow, on N slope of Kaiser Ridge, above Camp 62, elev. 8300 ft, *W.L. Jepson 13233* (JEPS 35873!); S Fork of San Joaquin River, dry river flats at Jackass Meadow, elev. 7250 ft, *W.L. Jepson 16056* (CAN 325203!, JEPS 35885!); Sierra Natl. Forest, open lodgepole meadows just below Florence Lake at Jackass Meadow Forest Camp, 7500 ft elev., *A.R. Kruckeberg 3433* (WS 236262!). **San Bernardino Co.**, Cienega near Bluff Lake, *LeRoy Abrams 2880* (PH 534342!); San Bernardino Mts., in meadow below & W of Bluff Lake, alt. 7300 ft, *Robert T. Clausen & Harold Trapido 4788* (UC 1505648!); Bluff Lake, moist meadow, alt. 2200 m, *Ira W. Clokey 5312* (WS 80108!); San Bernardino Mts., Bluff lake, frequent in wet meadow, 7400 ft elev., *Joseph Andorfer Ewan 1366* (RM 119165!); San Bernardino Mts., Dry Lake, wet meadow, *P.A. Munz 6195* (JEPS 22840!, RM 92082!); San Bernardino Mts., San Gorgonio Mt., Dry Lake, alt. 9100 ft, *H.M. Hall 7614* (PH 556696!). **Tulare Co.**, Southern Sierra Nevada Mts., Basin of Upper Kern River, Volcano Creek, alt. 7500 ft, *H.M. Hall & H.D. Babcock 5453* (UC 63528!); eastern Tulare Co., Crabtree Meadows, alt. 10350 ft alt., *H.M. & G.R. Hall 8451* (UC 126621!); Kern River Canyon, at mouth of Whitney Creek, 2 mi S of Junction Meadow, alt. 7800 ft, *W.L. Jepson 5013* (JEPS 35891!); Sierra Nevada, Whitney Meadows, common locally in sun or rather dry gravelly flat in meadow, alt. 9750 ft, 27 July 1949, *Philip A. Munz 14271* (RM 216133!, UC 809676!); Sierra Nevada, Whitney Creek, on a dried lake bed, alt. 10800 ft, *Peter Raven & G. Thomas Robbins 7582* (RM 261076!); Sequoia Natl. Park, edge of small lake along John Muir Trail about 2 mi N of Crabtree Meadows, elev. c. 11000 ft, *G. Thomas Robbins 3635 & Peter H. Raven* (JEPS 7971!); Sierra Nevada, Kern Plateau, Big Meadow, occasional in wet soil in a broad meadow in a Jeffrey pine forest, elev. 7800 ft, *Ernest C. Twisselmann 7522* (JEPS 31282!); Sierra Nevada, Kern Plateau, Cannell Meadow, occasional in wet soil in a broad sunny meadow, Jeffrey pine association, elev. 7400 ft, *Ernest C. Twisselmann 9898* (JEPS 36191!); Sierra Nevada, Kern Plateau, in coarse wet sand & mud around a very rapidly drying small lake, lodgepole pine association, scarce, elev. 7700 ft, *Ernest C. Twisselmann 9915* (JEPS 36192!); Sierra Nevada, Kern Plateau, Rattlesnake Meadow, colonies occasional in shade in loam around borders of a sunny meadow, meadow in a Jeffrey pine forest, elev. 7100 ft, *Ernest C. Twisselman 11291* (JEPS 52044!); Sierra Nevada, Kern Plateau, lake on ridge bet. Rattlesnake Meadow & Long Meadow, lodgepole pine association, small colony growing in moist soil in semi-shade, elev. 7600 ft, *Ernest C. Twisselmann 11313* (JEPS 52040!); Sierra Nevada, Kern Plateau, Cannell Meadow, occasional in wet soil in a broad sunny meadow in a Jeffrey pine forest, elev. 7450 ft, *Ernest C. Twisselmann 11349* (JEPS 51997!); Sierra Nevada, Kern Plateau, Cannell Meadow, occasional in recently dried soil in south-central part of the meadow, early growth apparently made in standing water, long sunny meadow in a yellow pine forest, elev. 7200 ft, *Ernest C. Twisselmann 13621* (JEPS 54460!); Kern Plateau, Paloma Meadow, occasional in wet soil in a sunny meadow in a red fir forest, elev. 8100 ft, *Ernest C. Twisselmann 13880* (JEPS 54425!); Kern Plateau, [illegible] Meadow, occasional about a broad very long meadow in a Jeffrey pine forest, growing [illegible] dry gravelly soil, elev. 8000 ft, *Ernest C. Twisselmann, Eben McMillan & John Nicoll 14799* (JEPS [illegible]4!); Sierra Nevada, Kern Plateau, NW arm of Manter Meadow, small dense colony gro[illegible] in a wet soil in a broad sunny meadow in a Jeffrey pine forest, elev. 7150 ft, *Ernest C. Twisselmann 16739* (JEPS 64610!); Sierra Nevada, Kern Plateau, Tunnel Meadow, common in colonies in wet sunny soil in a meadow in a lodgepole & foxtail pine forest, elev. 9100 ft, *Ernest C. Twisselmann, Donald J. Bedell, Eben McMillan & Liberto R. Nathan 16980* (JEPS 64693!); Sierra Nevada, Kern Plateau, Ramshaw Meadow, occasional in small colonies in moist to wet soil along S Fork of Kern River, broad meadow in a foxtail pine forest, *Ernest C. Twisselmann, Donald J. Bedell, Eben McMillan & Liberto R. Nathan 17304* (JEPS 64626!). **Counties not specified**: Lassen Forest, Harvey Valley, level to south, lava to meadow heavy soil, sage-weed vegetation, alt. 5500 ft, *Parkinson 36* (RM 470726!); Lassen Forest, Bogard Ranger Station, flat slope, alt. 5630 ft, *Lassen 1927 G.S. Crew 41* (RM 470724!); Lassen Natl. Forest, Feather Lake, 0 % slope, wet muck soil, alt. 5700 ft, *Lassen 1927 G.S. Crew 77* (RM 470723!). Sierra Valley, *C.G. Lemmon s.n.* (UC 337195!); Sierra Valley, *C.G. Lemmon s.n.* (UC 337196! *p.p.*). Sequoia Forest, Beach Meadow Ranger Station, flat S slope, alt. 8000 ft, *C.S. Robinson R-50* (RM 470720!). Near Lake Tahoe, margin of swamp, part of it in water, alt. 6300-6400 ft, *W.H. Brewer 2148* (UC 29588!, UC 29626!). Lake Tahoe, Cascade, *Chestnut & E.R. Drew s.n.* (UC 53991!); Sierra Nevada Mts., collected at Lake Tahoe, Tahoe Tavern, alt. 6200 ft, *Geo. B. Grant 58* (UC 166727!); Lake Tahoe, Camp Richardson, in 2-8 ft standing water along outer edge of flooded meadow, growing with *Juncus nevadensis, Carex & Polygonum amphibium*, forming densely intewoven system of rhizomes, alt. 6200 ft, "Marsh Plant Survey of California", *Verne Grant & Alva Grant 7771* (UC M-192193!); Tahoe City, *M.E. Parboue s.n.* (UC 882062!); Vicinity of Lake Tahoe, Rubicon Park, alt. 6225-9000 ft, *W.A. Setchell & C.C. Dobie s.n.* (UC 75909!); Tahoe Forest, Sardine Valley, 0% slope, S exposure, alt. 6000 ft, *Leland S. Smith 2090* (RM 470718!). California, no locality data on label, *W.H. Brewer 2148* (UC 29623!); California, no locality data on label, *Mrs. R.M. Austin 92* (UC 91143!); California, wet meadows, *Mrs. R.M. Austin 148* (UC 134168!); California, Upper Owens River, *Katharine Brandegee s.n.* (UC 220234!); California, Susanville, *T.S. Brandegee s.n.* (UC 91141!); Sierra Nevada Mts., Yosemite Natl. Park, Lyell Fork, Tuolumne Meadows, S side near Elizabeth Lake Trail with R-329, *H.M. Hall 11839* (UC 221357!); California, vicinity of Hog Ranch, meadows of the Transition alt. 4700 ft, *H.M. Hall & E.B. Babcock 3319* (UC 34609!); Sierra Nevada, Kings River Canyon & Kearsarge Pass, near S Fork of Bubb's Creek, alt. 9000 ft, *W.L. Jepson 811* (JEPS 35889!); Sierra Nevadas, Mulkey Meadow to Three Rivers, Volcano Creek, alt. 8500 ft, *W.L. Jepson 947A* (JEPS 35911!); mts. of Eastern California, no additional data on label, *Chas. Shaffer s.n.* (PH *s.n.*); meadow along Truckee River, 1 1/2 mi from town, *C.F. Sonne s.n.* (UC 197278!); Truckee, *C.F. Sonne s.n.* (UC 193591!); Truckee, near S.P.R.R., *Harriet A. Walker 2134* (UC 159246!); Truckee, *C.S. Williamson s.n.* (PH *s.n.*).

COLORADO. Larimer Co., Estes Park, alt. 9000 ft, *W.S. Cooper 240* (RM 48434!); Grizzley Creek, meadows, *Leslie N. Goodding 1863* (BRY 193196!, CAN 441751!, PH 523770!, RM 52150!, RM 169839!, UC 69439!); near Cameron Pass, *G.E. Osterhout 269* (RM 169852!); Estes Park, moraine, *G.E. Osterhout 1373* (RM 169851!). **Jackson Co.**, Arapaho Natl. Forest, at Denver Creek Campground, on Hwy 125, lodgepole pine zone, willow-sagebrush-grass meadow, 8300 ft alt., *C.L. Porter & Marjorie W. Porter 9154* (RM 268341!, SASK 19458!, UC M-246693!). **Moffat Co.**, NW Moffat Co., Cold Spring Mt., in a wet grassy meadow, elev. 7800 ft, *C.L. Porter 3926* (RM 203995!). **Grand Co.**, Arapaho Natl. Forest, near Trail Creek Campground, near State Hwy 125, in short grass edges of willow shrub thicket along Willow Creek, elev. c. 8700 ft, *W.J. Dress 9103* (UC I-377768!); Troublesome, *G.E. Osterhout 3017* (RM 169842!); Sulphur Springs, *G.E. Osterhout 3597* (RM 169840!); Sulphur Springs, *G.E. Osterhout 3598* (RM 169627!). **Summit Co.**, Breckenridge, *T.S. Brandegee 202* (UC 177080!); collected near Breckenridge, alt. 9700 ft, *Kenneth K.*

Mackenzie 214 (RM 30565!). **Park Co.**, Colorado Front Ranges, meadows along highway near Jefferson, wet meadow, elev. 9900 ft, *A.E. Porsild 22967 & William A. Weber* (CAN 266752!). **Lake Co.**, 3 mi S of Fremont Pass, disturbed gravels at margin of creek & on first creek terrace, *T. Mosquin & J.M. Gillette 5364* (UC M-287586!). **Gunnison Co.**, Region of Gunnison Watershed, Iola, 7480 ft alt., *C.F. Baker 665* (RM 33184!, RM 169848!, UC 29622!, WS 26626!); 3rd Kettle Pond margin, elev. 9500 ft, *D.B. Dunn 15220* (BRY 101101!); Kettle Ponds, 1 1/2 mi SE of Gothic, marshy area with *Carex & Typha*, *Larry C. Higgins 2311* (BRY 80864!); 1 mi in on way to Castle Park, W of Ohio Creek, road from Gunnison; damp area along roadside, *Jean H. Langenheim 4469* (UC M-212594!, WS 248666!); Lola, vicinity of Columbine Ranch, abundant in meadows, *Bassett Maguire & George Piranian E 354-16* (UC 553659!); Powderhorn School, 2.2 mi SE of Hwy 149, 17 mi south of Hwy 50, wet meadow, floodplain of Cebolla Creek, 8140 ft elev., *E. Neese 15864* (BRY 274600!); Parlin, wet meadows at 8000 ft, *Benjamin H. Smith 124* (PH *s.n.*). **Mineral Co.**, Rio Grande Natl. Forest, Goose Creek, meadow, elev. 8900 ft, *John Murdoch Jr. 4779* (UC 892057!). **Counties not specified on labels:** Loveland, *B.C. Buffum s.n.* (RM 311720!); Twin Lakes, *Fred Clements 374* (CAN 190988!); Silverton, alt. 9500 ft, *C.S. Crandall s.n.* (RM 13208!); Rocky Mt. Alpine Flora, Lat. 39 -41 , *E. Hall & J.P. Harbour 335* (PH *s.n.*); North Park, wet woods, *Earl L. Johnston 308* (RM 117556!); Walden, W of town, *Johnston & Hedgack 317* (RM 87560!); Park Range District, Routt Forest, Grazing Experimental Plot no. 5, Newcomb Creek, meadow, alt. 8700 ft, *Arthur L. Nelson N-8 (4PR)* (RM 470662!); Willow Creek Pass, head of Willow Creek, meadows, *Aven Nelson & Ruth A. Nelson 2218* (RM 178127!, UC 614075!); Moraine, *G.E. Osterhout s.n.* (RM 312969!); North Park, *G.E. Osterhout s.n.* (RM 312039!); mountains about head waters of Clear Creek, in the valley near Empire, alt. 8500 ft, *H.N. Patterson s.n.* (PH 569276!); Tabeguache Basin, dense clump on gravel bar, alt. 8000 ft, *Edwin Payson 579* (RM 80653!, WS 71444!); Routt Forest, alt. 7000 ft, *Ray Peck 56* (RM 471074!); Pine Glade Lake, 8 mi E of Tolland, *Francis Ramaley 9407* (RM 76082!); Middle Park, near Hot Sulphur Springs, alt. c. 7600 ft, *Francis Ramaley & W.W. Robbins 3637* (RM 61580!); Middle Park, near Hot Sulphur Springs, alt. c. 7600 ft, *Francis Ramaley & W.W. Robbins 3661* (RM 61542!); Tolland, *Ramaley & Robbins 6838* (RM 64590!); Tolland, *W.W. Robbins 10254* (RM 81414!); near Leadville, *L.M. & N.T. Schedin 514* (RM 97899!); near Leadville, *L.M. & N.T. Schedin 548* (RM 97697!); Wagon Wheel Gap, *Benj. H. Smith s.n.* (PH *s.n.*). Sapinero, *H.N. Wheeler 451* (RM 31280!); Sapinero, *H.N. Wheeler 551* (RM 31293!); Twin Lakes, Lt. Wheeler's Expedition, *John Wolf & J.T. Rothrock 568* (PH *s.n.*).

IDAHO. Bonner Co., 2 mi S of Nordman, Hager Pond area, NW corner of Hager fen, alt. 2800 ft, *John H. Rumely 215* (WS 219414!). **Idaho Co.**, meadow on stream terrace-grazed near Red River Ranger Station, *R.F. Daubenmire 46353* (WS 177080!); Warren Meadows, *Ray J. Davis 2586* (WS 109414!). **Valley Co.**, McCall, bet. two arms of Payette Lake, shallow water of open bog in *Pinus-Larix* woods, alt. 5000 ft, *L. Constance 1948* (CAN 190983!, RM 180177!, UC 572871!, UC 604329!, WS 80454!); McCall, bet. two arms of Payette Lake, shallow water of open bog in *Pinus-Larix* woods, alt. 5000 ft, *L. Constance s.n.* (RM 180176!); Sawtooth Mts., Payette Natl. Forest, mt. meadow S of Warm Lake, alt. 6500 ft, *J. William Thompson 13897* (RM 181978!, UC 609872!). **Adams Co.**, 3 mi N of New Meadows, E fork of Goose Creek, *J.H. Christ 11218* (WS 261722!); New Meadows, *Ray J. Davis 897* (UC 892052!; WS 100148!). **Fremont Co.**, Targhee Forest, Guild Scaler's Cabin, alt. 6500 ft, *A.P. Balch APB-10* (RM 470631!). **Custer Co.**, Challis Forest, near Boyle's Ranch, moist meadows, alt. 5700 ft, *Arthur Buckingham 134* (RM 470658!); Mackay, moist granite banks, alt. 5887 ft, *Aven Nelson & J.F. Macbride 1535* (RM 71131!). Mackay, ditch banks, alt. 5887 ft, *Aven Nelson & J.F. Macbride 1572* (RM 71132!); Mackay, moist bottom swales, alt. 5887 ft, *Aven Nelson & J.F. Macbride 1577* (CAN 190971!, RM 71130!, RM 169916!, UC 165240!); Sawtooth Mts., Challis Natl. Forest, open meadow near Stanley Lake, alt. 6500 ft, *J. William Thompson 13960* (CAN 190986!, UC 609612!); Sawtooth Range, on delta of Fishhook Creek, Redfish Lake, alt. 6550 ft., *Clair L. Worley & L.K. Mann 36-250* (WS 76070!). **Boise Co.**, Placerville, in willow flats along creek, *J.H. Christ 16848* (WS 261714!). **Blaine Co.**, Camas Prairie, Corral, moist meadow, *J.F. Macbride & E.B. Payson*

29[?]2 (RM 86357!, RM 92888!, UC 256388!); Alturas Lake, dry meadow, alt. 6400 ft, *J.F. Macbride & Edwin B. Payson 3730* (RM 86108!, UC 256369!); 11.5 mi NW ... Ketchum, on S side of road along Big Wood River, meadow, *T. Mosquin & J.M. Gillett 5441* (UC M-287585!). **Elmore Co.**, Bascom's Ranch, loam bottom lands, alt. 4500 ft, *J. Francis Macbride 624 (RM 67122!, UC 160494!, WS 44715!).* **Twin Falls Co.**, Minidoka Natl. Forest, meadow, clay loam soil, common, alt. 6100 ft, *Ralph K. Gierisch RG-715* (RM 470648!). **Owyhee Co.**, Riddle, *Ray J. Davis 863* (WS 100159!); 3 mi E of Oregon, Cow Creek, meadow, *Ray J. Davis 2125* (WS 109445!); 4 mi S of Riddle, Idaho Hwy 51, locally common along edge of marsh, elev. 5300 ft, *Noel H. Holmgren 5855 & Patricia K. Holmgren* (BRY 167126!); House Creek, around willow clumps, *Aven Nelson & J. Francis Macbride 1804* (RM 75464!). **Counties not specified on labels:** Payette Forest, near stream, moist sandy loam soil, alt. 5900 ft, *Bryant S. Martineau & W.N. Sparhawk 152* (RM 470641!); Payette Forest, sand rocky soil, moist below H.W. (= ? high water) mark, alt. 4100 ft, *Lee O. Miles 203* (RM 72807!); Payette Forest, Deadwood Basin, flat slope, moist clayey soil, open meadow, alt. 5200 ft, *W.N. Sparhawk 133* (RM 470642!); Priest Lake, thorofare & shore, sandy shore, alt. 660 m, *D.T. MacDougal 301* (CAN 190984!); near shore of Priest Lake, among willows, *Aven Nelson & Ruth A. Nelson 3048* (RM 177972!); Priest Lake, *C.V. Piper 3741* (PH 507724!); Priest Lake, *C.V. Piper 4119* (WS 25910!); Trail River Mts., *J.M. Coulter s.n.* (PH 709052!); Snake River, Henry's Fork, *J.M. Coulter s.n.* (PH 709119!); St. Anthony, dry river banks, *Elmer D. Merrill & E.N. Wilcox 854* (RM 32327!).

MONTANA. Glacier Co., Glacier Natl. Park, Bearing Falls, open slopes, *Bassett Maguire 1097* (RM 135048!); Marias Pass, vicinity of Divide Lake, along water course under willows, alt. 5215 ft, *Bassett Maguire & George Piranian 15353* (PH 781079!); Glacier Co., 4 mi S of Babb, rich moist soil along stream under willows, alt. 4480 ft, *Bassett Maguire, Ruth Maguire & C.B. Maguire 15354* (PH 781080!, UC 604319!); Marias Pass, vicinity of Divide Lake, along water course, alt. 5215 ft, *Bassett Maguire & George Piranian 15355* (PH 781078!, UC 604318!); Glacier Park, E entrance, *G.E. Osterhout 8011* (RM 169974!). **Flathead Co., c. 3 mi SW of Belton, damp ground at W end of Lake Five,** *H.T. Rogers & J.M. Rogers 1222* (WS 125809!); Flathead Lake & vicinity, Big Fork, *Mrs. Joseph Clemens s.n.* (PH 557883!). **Park Co.**, above Wilsall, Shields River, *Wilhelm N. Suksdorf 595* (WS 79837!); NW side of Kersey Lake, vicinity of Cooke City, swampy meadow near an old deserted cabin at end of wagon road, *Jean G. Witt 1393* (WS 184744!); c. 4 mi E of Cooke City, Chief Joseph campground, meadow, *Jean G. Witt 1898* (WS 228473!); Little Falls of Yellowstone, *Hayden s.n.* (PH 709053!); Yellowstone Park, Hot Sulphur Springs, *Hayden s.n.* (PH 709143!). **Gallatin Co.**, Spanish Basin, alt. 6500 ft, *P.A. Rydberg & Ernst A. Bessey 5225* (PH 709101!); Gallatin Canyon, alt. 5500 ft, *J.W. Blankinship 307* (PH 519481); West Gallatin River, Shed's Bridge, *W.W. Jones s.n.* (UC 166688!). **Madison Co.**, Madison Range, margin of Ulrey Lake, *C.L. Hitchcock 16800* (WS 175070!); Northern Rocky Mt. Forest & Experiment Station, Beaverhead Natl. Forest, head of Lazyman Creek, alt. 8500 ft, *Jack E. Schmautz JES-6* (RM 470667!). **Beaverhead Co.**, W side of Big Hole River c. 6 mi N of Wisdom, moist ground, *C.L. Hitchcock & C.V. Muhlick 12589* (CAN 190977!, PH 837718!, RM 202875!, UC 757603!, WS 158767!); drying meadow 4 mi above Brown's Lake along Rock Creek, *C.L. Hitchcock & C.V. Muhlick 13114* (PH 837710!, RM 202871!). **Counties not specified on labels:** Flathead Natl. Forest, Danaher Ranch, elev. 5100 ft, *J.E. Kirkwood 2398* (PH 696210!, RM 112377!, RM 130518!, UC 352479!); Missoula, Seeley Lake, forest edge, alt. 4000 ft, *J.E. Kirkwood 2117* (UC 892059!); Bozeman, *W.W. Jones s.n.* (UC 166625!); Bozeman, *Wyatt N. W. Jones s.n.* (RM 73880!); Midvale, *L.M. Umbach s.n.* (RM 122340!); near Red Lodge, *J.N. Rose 47* (RM 68741!); Deerlodge Forest, in meadow areas, alt. 6550 ft, *C.E. Fleming 103* (RM 470666!); Helena Forest, near Little Blackfoot Creek, along creek bottom, alt. 6000 ft, *J.T. Jardine 580 (31)* (RM 470664!); Jefferson Forest, Spring Creek, SW slope, alt. 5400 ft, *Barry C. Park 44* (RM 470663!); Henry's Foot of Snake River, Hayden Survey 1872, *J.M. Coulter s.n.* (PH 709112!); marsh foot of Kuotenai Mts., Big Fork, *L.M. Umbach s.n.* (PH 769903!).

NEVADA. **Elko Co.**, Deeth, in meadows, elev. 5340 ft, *A.A. Heller 9017* (PH 536937!); East Humboldt or Ruby Mts., Wm. Smiley's Ranch near Deeth, elev. 5800 ft, *A.A. Heller 9080* (PH 536855!); W Stampede, Little Lake Canyon, *P.B. Kennedy 555* (RM 39633!, UC 65512!); Maggie Creek, *P.B. Kennedy 632* (RM 39657!); Ruby Range, Lamoille Canyon, drier meadow 1/2 mi above Terrace Ranger Station, alt. 8500 ft, *Bassett Maguire & Arthur H. Holmgren 22627* (PH 813418!, UC 711481!); Humboldt Forest, Indian Johnie Creek, E slope, alt. 6000 ft, *B. Leonard BL-68* (RM 470652!); Bull Run Mts., Bull Run Creek just W of Bull Run Reservoir, in meadow areas along creek, alt. 5900 ft, *Arnold Tiehm 9048 & Barbara Ertter* (BRY 280556!); Prunty Ranch meadows, headwaters of Bruneau River, *Percy Train 587* (UC 892101!); Jarbidge Mountains, Coon Creek Ranger Station, dry meadow, elev. 8500 ft, *Percy Train 745* (UC 892103!, UC 892104!). **Humboldt Co.**, Black Rock Range, Mahogany Canyon, Stanley Camp, 0.8 mi E of Summit Lake Indian Reservation boundary, in meadow, elev. 6400 ft, *Noel H. Holmgren 4612 & Patricia K. Holmgren* (BRY 106776!, UC I-381428!); Pine Forest Range, Leonard Creek drainage, growing with graminoids along stream, elev. c. 7000 ft, *Noel H. Holmgren & James L. Reveal 1197* (BRY 48929!); Virgin Valley, *L. Kellogg s.n.* (UC 468970!); White Pine, Stella Lake below Wheeler Peak, edge in lake, elev. 10000 ft, *Mont E. Lewis 6365* (BRY 220965!); Pine Forest Mts., near Alder Creek Lake, elev. 7600 ft, *W.P. Taylor & C.H. Richardson Jr. 12* (UC 195013!). **Washoe Co.**, frequent in open wet meadows along Franktown Creek in Little Valley, 17 air mi SSW of Reno, elev. 6500 ft, *Loran C. Anderson 3712* (BRY 193481!); Sierra Nevada Range, near headwaters of Thomas Creek, in meadow, elev. 7500-8000 ft, *W. Andrew Archer 6618* (UC 892105!); Little Valley, elev. 2000-2155 m, *C.F. Baker 1354* (CAN 190993!, RM 44161!, RM 169849!, UC 75359!); Washoe, *C.L. Brown s.n.* (UC 196030!); Toiyabe Natl. Forest, Carson Range (andesite with basalt flows locally), meadow about Hunter Lake, elev. 8230 ft, *Kenneth R. Genz 8595* (BRY 210345!); Granite Range, upper meadows of S fork of Rock Creek, c. 1.6 km (1 mi) E of Granite Peak, 16 km (10 mi) airline distance NNW of Gerlach, common in moist meadow, elev. 2470 m (8100 ft), *Noel H. Holmgren 9670 & Patricia K. Holmgren* (BRY 283374!); Lake Tahoe, Incline, meadow, alt. 6250 ft, *Lewis S. Rose 35519* (UC 8[illegible]099!); Washoe Valley, Mrs. Rob Sewers s.n. (PH *s.n.*). **White Pine Co.**, Mt. Wheeler, Lehman Creek, dry loamy soil along creek, alt. 7500 ft, *Cottam 3292* (BRY 15863!, BRY 15866!); Snake Range, Nevada Natl. Forest, Wheeler Peak Quadrangle in spruce-fir or open aspen forests along Lehman Trail from Forest Camp, common in damp areas in spruce-fir understory, *Jean Langenheim 3811* (UC M-213839! *p.p,mag.*); Humboldt Natl. Forest, trail above Lehman Campground, riparian community CELE type, stream edge, occasional, alt. 7100 ft, *Mont E. Lewis 1741* (RM 470651!); Snake Range, Lehman Creek Basin, thickets along Lehman Creek, vicinity of Forest Camp, frequent, 7500 ft elev., *Bassett Maguire 21203* (UC 738897!). **Nye Co.**, Upper Reese River Canyon Road, c. 9 mi S of Dieringer, damp sandy loam, *F.S. Goodner & W.H. Henning 713* (UC 901176!); Toiyabe Natl. Forest, Monitor Range, Barley Creek drainage, moist to wet soil along drainage bottom, 9000-9200 ft elev., *Sherel Goodrich 10561* (BRY 181481!); Toiyabe Natl. Forest, Monitor Range, Left Fork of Danville Canyon, wet ground along stream & around springs, aspen & willows, 8300 ft elev., *Sherel Goodrich 12096 p.p.* (BRY 196314!); Toiyabe Range, Toiyabe Natl. Forest, Mohawk Pasture, 6 mi E of Reese River Ranger Station, wet meadow, frequent, *Bassett Maguire & Arthur H. Holmgren 25892* (CAN 190973!, PH 810078!, UC 701769!); Indian Valley, Reese River, vicinity of Reese River Ranger Station, heavy clay soil bordering grassy willow thickets, frequent, *Bassett Maguire & Arthur H. Holmgren 25893* (UC 701768!, WS 169598!); Toiyabe Range, Toiyabe Natl. Forest, drying meadow on Upper Stewart Creek, frequent, *Bassett Maguire & Arthur H. Holmgren 26010* (CAN 190974!, UC 701855!, WS 169597!); Toiyabe Natl. Forest, Mud Springs A-S, gentle N slope, distributed in moist sites, alt. 7000 ft, *Basil K. Crane BC-256* (RM 470630!); Fenced Meadow, Forks of San Juan Creek, W slope of Toiyabe Range, moist creek bottom meadow, *Percy Train 3315* (UC 892102!). **Mineral Co.**, Wassuk Range, Lapon Meadows, elev. 9000 ft, *W. Adrew Archer 7077* (UC 901177!); Toiyabe Natl. Forest, Little Walker River drainage SSW of Fales Hot Springs, Long Valley, meadow, glacial deposits, elev. 8200 ft, *Kenneth R. Genz 8821* (BRY 210312!). **Douglas Co.**, Lake Tahoe, Nevada Farm Bureau Camp, 1 mi N of State Line, wet meadow, elev. 6300 ft, *Laura E. Mills & Kay H. Beach 1167* (UC M-047755!); Pine Nut Mountains, ephemeral lake 2.3 air mi NE of Mt. Siegel Peak, at the edge of wet areas, 7050 ft elev., *Arnold Tiehm 8912 & Barbara Ertter* (BRY 280661!). **Esmeralda Co.**, White Mts., grassland, damp to drained in open meadows, *Victor Duran 2499* (UC M- 297656!); D. Davis Ranch, elev. 7000 ft, *W.H. Shockley 525* (JEPS 35890! *p.p.min.*, NDG 062498/HG 45957!); White Mts., Summit, *W.H. Shockley 545* (JEPS 35902!). **Ormsby Co.**, Eagle Valley, alt. 1446 m, *C.F. Baker 1089* (UC 134176!). **Counties not specified on labels:** Clover Valley, *I.E. Diehl s.n.* (PH 672762!); Clover Valley, *I.E. Diehl s.n.* (UC 373464!); 5 mi SE of San Jacinto, marshes along Little Salmon River, *Bassett Maguire 17024* (UC 738650!). Nevada Forest, Dog Spring Meadow, 5% N slope, 9000 ft elev., *Geo. C. Larson 154* (RM 470646!); Nevada (Toiyabe) Forest, Silver Creek, S slope, gravel soil, alt. 9600 ft, *W.B. Hamlin H-7* (RM 470645!).

NEW MEXICO. Colfax Co., Philmont Scout Ranch near Cimarron, near Agua Fria Camp, common in wooded area along stream, 8700 ft elev., *Ronald L. Hartman 2350* (RM 298230!); Philmont Scout Ranch near Cimarron, junction of Apache Creek & Rayado Creek, occasional in meadow, 8900 ft elev., *Ronald L. Hartman 2595* (RM 298201!); Chuska Mts., Lake D., SE side Dead Man Lake with *Helenium;* crest of mts. W of Toadlena, 3 mi W of Toadlena, 9100 ft elev., *Herbert E. Wright s.n.* (BRY 78102!).

OREGON. Union Co., fields along Grande Ronde River & route 244, approx. 10 mi W of La Grande, elev. c. 3000 ft, *Charles Feddema 3417* (RM 470605!); fields along Grande Ronde River & route 244, approx. 10 mi W of La Grande, elev. c. 3000 ft, occasional, *Charles Feddema 3433* (RM 470604!); Starkey Forest & Experiment Station, Starkey Headquarters, 3.5 mi NNW, on damp alluvial soil beside creek, alt. 3750 ft, *Dorothy & Ralph Naas 3073* (RM 470706!). **Umatilla Co.**, Blue Mts., Meacham, *M.E. Peck 4987* (WS 79712!). **Columbia Co.**, Umatilla Forest, Ukiah District, E side of Sheep Creek, gradual W slope, rocky coarse soil, alt. 4500 ft, *Bernard Lee 10* (RM 470708!). **Grant Co.**, Prairie City, John Day River, river bank, *Roxana S. Ferris & Rena Duthie 725* (RM 103025!); Pacific Northwest Forest & Experiment Station, Whitman Natl. Forest, Bull Run Creek, flat slope, disturbed loam soil, meadow, alt. 5200 ft, *R.M. Porter 1020* (RM 470707!). **Malheur Co.**, Crowfoot Ranger Station, level slope, rich moist bottom loam soil under willow shade, along streams, alt. 5100 ft, *Douglas C. Ingram B733* (RM 471070!); 16 mi N of Jordan Valley, moist soil in meadow along Sucker Creek, locally common, *Bassett Maguire & Arthur H. Holmgren 26389* (CAN 190992!, PH 824339!, UC 739046!). **Harney Co.**, along a secondary road, 10.3 mi due N of roadstation of Wagontire & a few miles SE of Wagontire Mt., with grasses in meadow (which in normally wet years shows evidence of being quite wet), elev. 4800 ft, *Rimo Bacigalupi 7968, L. Heckard & J. Weiler* (JEPS 29981!); Harney Valley, wet meadow of Catlow Valley, *W.C. Cusick 2595a* (WS 26625!); Steens Mt., moist soil in meadow bet. Lily Lake & Fish Lake, *Bassett Maguire & Arthur H. Holmgren 26759* (UC 739040!, WS 170008!); 8 mi S of Burns, wet meadow, *Morton E. Peck 13928* (PH 663879!). **Crook Co.**, Ochoco Mts. bet. Prineville & Michell, wet swales in Big Summit Prairie, elev. c. 5000 ft, *Arthur Cronquist 7464* (RM 240393!, UC M-000112!, WS 210459!); in wet meadow of Ochoco Creek, common, *Wm.C. Cusick 2638* (RM 35167!, UC 34394!); 5 mi W of Prineville, moist meadow, *Morton E. Peck 15970* (PH 663877!). **Deschutes Co.**, Deschutes Forest, E shore of Sparks Lake, level slope, moist mud flats, meadow, alt. 5475 ft, *John C. Kuhns 421* (RM 470714!); Deschutes Forest, Davis Lake Ranger Station, wet pumice & ash soil, alt. 4760 ft, *Frank B. Lenzie 766* (RM 470713!). **Lake Co.**, Silver Lake, growing in a creek, *L. Constance 9458* (PH 684749!); moist meadow of Silver Creek, *Wm.C. Cusick 2730* (RM 35168!, UC 34395!, WS 26548!); Paulina Marsh, 4.1 mi N on road to Fort Rock from Silver Lake, elev. 4300 ft, *Barbara Ertter 3871 & Jeffrey Strachan* (BRY 229583!); Expedition to Fossil Lake, Silver Lake to Fort Klamath, *H.W. Furlong, W.B. Greeley, Mary Wilson & Anna Alexander s.n.* (UC 467704!); bet. Paisley & Lakeview, *L.F. Henderson 9390* (WS 68078!); 3 mi NE of Silver Lake, at Paulina Marsh, standing in water in meadow, *David D. Keck & J. Clausen 3695* (UC 579804!); Fremont Natl. Forest, Willow Creek Meadow, 0% slope, deep silt loam soil, meadow, alt. 5000 ft, *Max R. King MK-32* (RM 470711!); in water near Button Springs, growing in vernal swamps which later in the season become muddy places, *J.B. Leiberg s.n.*

(WS 26508!); hills east of Crooked Creek Valley, *May Loveless 259* (PH 684426!); Quartz Pass, mt. meadow in water, alt. 5500 ft, *J. William Thompson 12183* (UC 578861!, UC 892109!). **Klamath Co.**, 24 mi S of Crescent, Beaver Marsh, *L.R. Abrams 9655* (RM 101147!); Cascade Mts., Bear Wallow, above Wokas Lake, shallow water of pond in yellow pine forest, *Elmer I. Applegate 4426* (UC 563095!); Rouge River (Crater) Forest, Anna Creek, alt. 5000 ft, *Lee P. Brown 40* (RM 470709!); High Cascade Mts., Lake-of-the-Woods, waterform, *L. Constance s.n.* (UC 533947!); in water of Sycan Marsh, *W.C. Cusick 2753a* (WS 26607!); Chiloquin, edge of a mud-hole, *Anna Evans 183* (PH 684425!); Lake-of-the-Woods, waterform, *L.F. Henderson 9453* (WS 68077!); marshy places on E side of Swan Lake, *Bassett Maguire & Arthur H. Holmgren 26573* (CAN 190990!, CAN 453251!, PH 824340!, UC 739048!, WS 170007!); Keno, damp ground, *Morton E. Peck 9345* (PH 663880!); W side of Upper Klamath Lake; damp thicket near Rock Creek bridge, *Morton D. Peck 9469* (PH 663872!, WS 79709!); 11 mi E of Beattie, wet thicket, *Morton E. Peck 15211* (UC 892108!); Fremont Forest, above sawmill field, S slope, clay soil, meadow, alt. 5000 ft, *Kenneth F. Richardson R-* (RM 470712!); Davis Lake, scattered on lake margin with *Juncus*, shallow water & mud, elev. 4350 ft, *Albert N. Steward 7247 & S.C. Head* (WS 241627!); sagebrush slopes 10 mi W of Beattie, *J. William Thompson 13183* (PH 756527!, WS 79707!). **Douglas Co.**, Diamond Lake, grassy slopes & open woods, *A. Seaman 5910* (WS 79720!). **Counties not specified on labels:** Crater Forest, Trout River, flat slope, moist volcanic loam soil, alt. 4600 ft, *Lee P. Brown & R.F. Murray 145* (RM 470715!); Ochoco Forest, Derr Meadow Station in meadow, level slope, alt. 5200 ft, *Douglas C. Ingram B-871* (RM 470710!); 4 km N of Button Springs, alt. 1470 m, *J.B. Leiberg 372* (UC 179704!); Farewell Bend, alt. 1170 m, *J.B. Leiberg 430* (UC 179705!); Anderson Valley, Adobe flats, alt. 1500 m, *J.b. Leiberg 2389* (UC 179196!); Shirk, margins of springs, alt. 1500 m, *J.B. Leiberg 2570* (UC 179576!); Shirk, alt. 1500 m, *J.B. Leiberg 2571* (UC 179112!); Beatty's Butte, alt. 1830 m, *J.B. Leiberg 2608* (UC 179884!); Powder River Mts., *C.V. Piper 2492* (WS 26631!); Crater Forest, meadows N of Pelican Ranger Station, level slope, deep black loam soil, alt. 4200 ft, *E.J. Rogers R-65* (RM 470716!).

UTAH. **Rich Co.**, gravel road 3 mi NE of Woodruff, marsh & wetlands, 6300 ft elev., *E. Neese, R. Henson & J. Harrington 14569* (BRY 258338!); **Cache Co.**, Logan Canyon, Red Banks, found under willow & *Alnus* thickets, *Bassett Maguire & Ruth R. Maguire 12339* (CAN 190979!, CAN 190980!, PH 781083!, UC 604323!); Bear River Range, 2 mi North of Beaver Creek Junction, about spring along Logan River, *Bassett Maguire 21609* (UC 738891!); Logan Canyon, c. 5 mi up Hwy 89, sagebrush & aspen, some Douglas fir, open meadows & creekside community, 8000 ft elev., *K. Thorne & V. Hugie 1424* (BRY 226116!). **Daggett Co.**, 11 air mi SSW of Manila, margin of small pond north side of Hwy 44, lodgepole-aspen community, 2400 m elev., *E. Neese 14520* (BRY 258250!); 9 air mi SW of Manila at Half-Moon Park, wet meadow opening in lodgepole pine forest, 2540 m elev., *E. Neese 14751* (BRY 260441!); c. 2 mi S of Sheep Creek Lake, 10 air mi SW of Manila, drying meadow in lodgepole forest, 2600 m elev., *E. Neese 14773* (BRY 260462!); Ashley Natl. Forest, Uinta Mts., 12.6 km (196 degrees) S of Manila, near summit springs, growing in water of a small pond, 8250 ft elev., *S. Goodrich 19597* (BRY 257599!); Ashley Natl. Forest, Uinta Mts., Meadow Park, 10.5 mi SE (150 degrees) of Manila, wet meadow in aspen-ponderosa pine zone with *Calamagrostis, Agrostis, etc.*, 7600 ft elev., *S. Goodrich & R. Jepson 15958* (BRY 226952!). **Summit Co.**, China Meadow, *A.O. Garrett 7950* (UC 892098!); mouth of Hayden's Fork, damp grassy ground, alt. 8800 ft, *George J. Goodman 288* (RM 113905!); Uinta Mts., Wasatch Forest, Hewinta Cabins, rocky stream bottom, *Dean A. Hobson 136* (WS 170227!); Uinta Mts., Blacksfork River, 2 mi from turnoff to Hewinta, 9500 ft elev., *K. Ostler 552* (BRY 183587!); Uinta Mts., Stillwater Fork, dry meadow, elev. 8800 ft, *E.B. & L.B. Payson 4973* (PH 659954!, RM 115230!, UC 395861!, WS 52356!); Uinta Mts., Blacks Fork, immediately N of bridge on road to guard station, N slope, *S.L. Welsh, G. Moore & E. Matthews 9181* (BRY 83688!). **Uintah Co.**, Reservoir at end of Pothole road, c. 20 mi N of Vernal, drying ground of sagebrush-grassland meadow, *E. Neese 14932* (BRY 260625!). **Duchesne Co.**, Uinta Primitive Area, Big Meadows, 9750 ft elev., *D. Atwood & S. Goodrich 7722* (BRY 219186!); 1 mi N of Mountain Home, ditchbank, fenceline-roadside &

pasture, *S. Goodrich 21119* (BRY 271363!); Ashley Forest, Moon Lake, dry rocky hillside, alt. 8100 ft, *B.F. Harrison 7707* (BRY 15867!, UC 913881!); Uintah Mts., Ashley Natl. Forest, vicinity of Moon Lake, around edge of willow thicket, 8090 ft elev., *Bassett Maguire & George Piranian 12527* (UC 604322!). **Wasatch Co.**, Current Creek just below Current Creek Dam, 17 mi (260 degrees) from Tabiona, riparian-aspen-willow-silver sagebrush community, disturbance from dam construction, 7600 ft elev., *S. Goodrich 14503* (BRY 216365!); Uinta Natl. Forest, Mill Hollow near Mill Hollow Reservoir, 16.5 mi E (94 degrees) of Heber City, streamside community with willows, grasses, & sedges at edge/within spruce-fir forest, 7800 ft elev., *S. Goodrich 16067* (BRY 227060!); Wasatch Mts., *O. Howard s.n.* (BRY 38702!); W side of Strawberry Reservoir, at Bryants Fork, wet meadow-sagebrush-grassland community, 7600 ft elev., *E. Neese 8058* (BRY 199761!); c. 2 mi below Currant Creek Dam, rocky slope & adjacent lowland with *Populus angustifolia* & oak-sagebrush, c. 8000 ft elev., *E. Neese 14359* (BRY 258096!); Berg Ranch, 2 mi E of Murdock Station, N of Heber City, among sedges, wet soil, alt. 7000 ft, *E. Reimschiissed 79* (BRY 50602!). **Salt Lake Co.**, Silver Lake, Big Cottonwood Canyon, alt. 8735 ft, *A.O. Garrett 1528* (PH 524302!, RM 52704!); Wasatch Range, Brighton, meadows by Silver Lake, 8750 ft elev., *Bassett Maguire 17447* (UC 738808!). **Sanpete Co.**, Manti-Lasal Forest, near junction-Miller's Flat-Seely Creek roads, 5% slope, NE exposure, dry forb-grass opening, alt. 8500 ft, *Mont E. Lewis 1001* (RM 470975!); Manti-Lasal Natl. Forest, near Mary's Lake, SW of Joe's Val. Res., mountain sagebrush vegetation type, occasional, alt. 7600 ft, *Mont E. Lewis 4934b* (BRY 178972!); Fairfield Lake, c. 13 mi from Fairfield, *Salix*-wet meadowconifer-aspen community, 8800 ft elev., *K. Thorne & V. Hugie 696* (BRY 201290!). **Emery Co.**, Manti-Lasal Natl. Forest, junction Mine Road Hwy 93, riparian, occasional, alt. 8400 ft, *Mont E. & Ethel T. Lewis 7222* (BRY 281011!); CC Price-Ferron, 11 mi due NW of Ferron, aspen-sagebrush community, 8200 ft elev., *S. Welsh & S. Clark 15433* (BRY 171512!); CC Price-Ferron, c. 10.5 mi ENE of Fairview, grass-sedge streamside community, 8600 ft elev., *S. Welsh & S. Clark 15453* (BRY 171532!). **Sevier Co.**, southern end of Wasatch Plateau, c. 27 mi E of Salina, Acord Lake, heavily vegetated dry part of lake with *Carex athrostachya, Carex simulata*, elev. 7950 ft, *B. Albee 4674* (UC 1484829!); southern end of Wasatch Plateau, c. 27 mi E of Salina, Acord Lake, heavily vegetated dry part of lake with *Carex athrostachya, Carex simulata*, elev. 7950 ft, *B. Albee 4774* (BRY 221968!); Fishlake Natl. Forest, Fishlake, Pelican Point, wet meadows, *N. Duane Atwood 10577 & S. Goodrich* (BRY 273374!); Fishlake Natl. Forest, dry meadow, alt. 8700 ft, *Helen Dixon 575* (RM 134817!); Fishlake Forest, Big Lake, 2% NW slope, deep black peat soil, distributed on lake bottoms, elev. 9600 ft, *Milo T. Dyches 75* (RM 470656!); Fishlake Forest, U.M. Pass, slope 60%, alt. 10000 ft, *Wilson C. Gutzman G-7* (RM 471028!); CC Fremont, NW side of Fish Lake, spruce-fir-*Populus-Salix* community, sandy to bog soils, 9000 ft elev., *L. Higgins 10650* (BRY 174205!); Fish Lake, *Marcus E. Jones 5757* (UC 159398!); Fish Lake, alt. 9000 ft, *Marcus E. Jones 5758* (RM 64001!); Fishlake Forest, near Magleby Reservoir, W slope, deep loam soil, willow vegetation type, alt. 9000 ft, *Boyd Leonard BL-134* (RM 470653!); Sevier Forest, West Hunt Creek, moderate E slope, sandy alluvial soil, alt. 8500 ft, *T. Lommasson 213* (RM 470632!, RM 470633!); Fish Lake Natl. Forest, Old Reservoir site below Lost Lake, 20 mi E of Salina, *Bassett Maguire 19974* (UC 738811!); Sevier Forest, *T.B.N. 166* (RM 470634!); Fishlake Forest, edge of Annabell Lake, deep organic loam soil, rare, alt. 8500 ft, *W.L. Robinette LR-15* (RM 470654!); S end of Fish Lake, *P.A. Rydberg & E.C. Carlton 7512* (RM 59923!); S end of Fish Lake, *P.A. Rydberg & E.C. Carlton 7648* (CAN 190994!); junction of Gooseberry Creek & Hwy 31, open meadow along Gooseberry Creek, *S.L. Welsh & G. Moore 3530* (BRY 42791!); Richfield District, Monroe Mt., Hunters Flat, 6.5 mi due SSE of Glenwood, aspen-spruce woods, 9400 ft elev., *S. Welsh, E. Welsh & J. Henriod 17566* (BRY 185948!). **Wayne Co.**, Dixie Forest, area of Snow Lake, Aquarius Plateau, FEOV community, 1100 ft elev., *Mont E. Lewis 6631* (BRY 220859!); Fishlake Forest, Grassy Lake, E side of Thousand Lake Mt., flat slope, swamp, edge of lake, alt. 10500 ft, *H.M. Peterson P-121* (RM 470655!). **Beaver Co.**, Tushar Mts., South Creek at Coxs Ranch, *Populus angustifolia-Salix-Thermopsis-Carex* riparian community, 6840 ft elev., *A. Taye 2276* (BRY 276854!); Tushar Mts., N Fork Three Creeks, near Three Creeks Reservoir, wet meadow with *Salix, Cardamine*, in spruce-fir-aspen community, 8700 ft elev., *A. Taye*

2871 (BRY 277581!); Tushar Mts., Upper Kents Lake, wet meadow adjacent to aspen-spruce-fir stands, 8980 ft. elev., *A. Taye 2906* (BRY 277618!). **Garfield Co.**, Dixie Natl. Forest, Aquarius Plateau, Cyclone Lake, N of Escalante & c. 5 mi N of Posy Lake, *D. Atwood 8159* (BRY 232218!, RM 337145!); Boulder Mts., 19.5 mi SSW of Bicknell, Dixie Natl. Forest, Dog Lake exclosure, *D. Atwood & B. Thompson 7653* (BRY 219113!); Boulder Mts., margin of lakes, elev. 8900 ft, *D.E. Beck 8277* (BRY 15865!); Boulder Mts., around lake, some in lake, aspen association, 8900 ft elev., *Beck & Tanner s.n.* (BRY 15869!); Boulder Mts., almost pure aspen near lake, some in the lake, elev. 8900 ft, *Beck & Tanner 8277* (BRY 15870!); Powell Forest, Steep Creek along Boulder Road, 35% S slope, alt. 8700 ft, *Wilford Bentley 157* (RM 470639!); Intermountain Forest & Range Experiment Station, Powell Natl. Forest, Cook Pasture, Aquarius Plateau, hydrophyte growing at edge of lake, 10500 ft alt., *W.P. Cottam & Lincoln Ellison CE-1* (RM 470636!); Intermountain Forest & Experiment Station, Powell Natl. Forest, Aquarius Plateau near Donkey Meadow, 11000 ft elev., *W.P. Cottam & Lincoln Ellison CE-2* (RM 470635!); Intermountain Forest & Experiment Station, Powell Natl. Forest, W edge of Boulder Top, level, *Festuca ovina* grassland in small basin, alt. 11000 ft, *Lincoln Ellison 842-47* (RM 470637!); Panguitch Lake, 17 mi W of Panguitch, lake shore, elev. 5300 ft, *R. Erdman 494* (BRY 40843!); SC Paunsaugunt-Sevier, Tropic Reservoir road, 2 mi S of Hwy 12, 7650 ft elev., *R. Foster & D. Foster 4388* (BRY 170615!); Powell Forest, Pleasant Creek, alt. 9000 ft, *Walter E. Hanks 22* (RM 470640!); Dixie Natl. Forest, Aquarius Plateau, Cyclone Lake, 19 mi N of Escalante, dominant plant in seepage area at S end of lake, elev. 10000 ft, *Noel H. Holmgren 2441, James L. Reveal & Charles LaFrance* (BRY 56860!; UC M-310154!); Dixie Forest, Big Lake, Bicknell-Escalante Road, lake edge, 9100 ft elev., *Mont E. Lewis 6115* (BRY 205962!); S end of Panguitch Lake, dry gravelly shore, 8100 ft elev., *Bassett Maguire 18961* (CAN 190976!, PH 810061!, UC 738810!, WS 170226!); SC Plateau, Griffin Top, subalpine meadow community, 10400 ft elev., *E. Neese & S. White 3874A* (BRY 172903!, RM 471030!); SC Aquarius, 2 mi due N of Jacobs Resevoir, subalpine-*Deschampsia* community, 10200 ft elev., *E. Neese & S. White 3888* (BRY 172917!). **Iron Co.**, SC Markagunt, 2 mi W of Little Creek Peak, W slope, open sage community, 8000 ft elev., *R. Foster & D. Foster 4727* (BRY 172034!); SC Markagunt, 7 mi SE of Panguitch Lake, spruce-fir community, 9000 ft elev., *L. Higgins 10882* (BRY 174556!); Dixie Natl. Forest, Red Creek Reservoir, 0% slope, reservoir bank, near water, alt. 7800 ft, *Irwin H. Johnson J-52* (RM 470657!); 7 mi SW of Panguitch Lake, Castle Valley, along stream, 9400 ft alt., *Bassett Maguire 19010* (UC 738809!). **Kane Co.**, SC Paunsaugunt-Sevier, 5 mi NE of Elton, S slope, mountain brush community, Wasatch form, 7850 ft elev., *R. Foster & D. Foster 4481* (BRY 170825!); Dixie Natl. Forest, Duck Creek Lake, 8500 ft elev., *Bassett Maguire 19577* (UC 738812!). **Washington Co.**, Kolob Terrace, Lava Point Overlook, ponderosa-aspen-spruce community, 7900 ft elev., *S.L. Welsh 20712* (BRY 224749!). Utah, 10500 ft elev., *Ward s.n.* (PH *s.n.*).

WASHINGTON. Pend Oreille Co., Ione, marsh, 2100 ft elev., *Earle F. Layser 945* (WS 264191!). **Skagit Co.**, Skagit Pass, Lake Hull, *Anon. 736* (WS 26644!). **Snohomish Co.**, Cascade Mts., Transcontinental Survey, *Brandegee 139* (WS 26630!). **Pierce Co.**, Mt. Rainier, St. Andrews Park, 5000 ft elev., *W.T. Shaw s.n.* (WS 62959!). **Spokane Co.**, Newman Lake, *Wilhelm N. Suksdorf 8790* (WS 79771!); Newman Lake, *G.W. Turesson s.n.* (RM 76316!); Newman Lake, *G.W. Turesson 6* (RM 76630!). **Yakima Co.**, Yakima Region, Cascade Mts., Northern Transcontinental Survey, *T.S. Brandegee 109* (UC 178400!). **Klickitat Co.**, c. 5 mi S of Glenwood, in very wet low meadows, *F.G. Meyer 1498* (UC 719034!, WS 122669!); Falcon Valley, wet meadow & in water, *W.N. Suksdorf s.n.* (PH *s.n.*); Falcon Valley, wet meadows & in water, *W.N. Suksdorf 372* (WS 79772!); Falcon Valley, *Wilhelm N. Suksdorf 6283* (WS 79770!); Falcon Valley, Comboy Lake, in shallow water, *Wilhelm Suksdorf 7338* (PH 654767!, UC 348991!, WS 79773!); on Holmes Creek, *Wilhelm N. Suksdorf 7345* (WS 79766!); Falcon Valley, *Wilhelm N. Suksdorf 10142* (UC 892049!, WS 79774!); Falcon Valley, wet meadows & in water, *W.N. Suksdorf 38348* (CAN 190987!). **Skamania Co.**, South Prairie, *Wilhelm N. Suksdorf 3686* (WS 79769!).

WYOMING. Sheridan Co., Bighorn, Arrowhead Lodge, U.S. 14, 2% E slope, lodgepole pine openings, alt. 7700 ft, growing on disturbed soil, *Richard M. Hurd 308* (RM 236761!, RM 402978!); Little Goose Canyon, dry benches, *Aven Nels[illegible]527* (RM 37040!); Big Horn Mts., c. 8.5 air mi WSW of Dayton, ca 6.5 air mi NE of [illegible]unction, along Sheep Creek, SSE of Freeze Out Point, meadow along creek, elev. 7[illegible].*E. Nelson 3785 & Keith H. Dueholm* (RM 347690!). **Big Horn Co.**, Big Horn Mts., be[illegible]aby Wagon & Virginia Creeks, c. 18 air mi NE of Tensleep, along Baby Wagon Creek, elev. 9400 ft, *Gael Fonken 643 & B.E. Nelson (RM 347680!); Doyle Creek, subalpine meadows, Leslie N. Goodding 357* (RM 37035!, UC 51066!); Big Horn Mts., dry bench lands, *Aven Nelson 8527* (UC 892060!). **Park Co.**, Absaroka Mts., N Fork Shoshone River Drainage, Mooncrest Ranch along Rattlesnake Creek, c. 9 mi N of US Hwy 14, 16 & 20, aspen woods with *Habenaria, Senecio & Triglochin*, elev. 7000 ft, *E.F. Evert 2977* (RM 341673!); Absaroka Range, S Absaroka Wilderness, Fishhawk Creek, 0.5-1 mi SSW of Confluence with N Fork Shoshone River, open & shaded slopes along creek, elev. 6500 ft, *Ronald L. Hartman 8349* (RM 338319!). **Yellowstone Natl. Park Co.**, Yellowstone Natl. Park, Swan Lake Valley, alt. 7200 ft, *F.H. Kunweson 38352* (CAN 190989!); Yellowstone Park, *Geo W. Letterman 26* (PH 709132!); Yellowstone Natl. Park, Gibbon Meadow, in moist ground, *Aven Nelson & Elias Nelson 6740* (RM 20771!); Yellowstone Park, Shoshone, alt. 7500 ft, *P.A. Rydberg & Ernst a. Bessey 5224* (CAN 190985!). **Johnson Co.**, Big Horn Mts., along North Clear Creek, just W of Hunter Ranger Station, c. 11 air mi WSW of Buffalo, moist meadow, elev. 7350 ft, *Gael Fonken 522 & B.E. Nelson* (RM 347681!); Big Horn Mts., bet. Baby Wagon & Virginia Creeks, c. 4 air mi NW of Powder River Pass, c. 24.5 air mi SW of Buffalo, meadow around vernal pool, elev. 9400 ft, *B.E. Nelson 7245 & Gael Fonken* (RM 347685!); Big Horn Mts., bet. Baby Wagon & Virginia Creeks, c. 4 air mi NW of Powder River Pass, c. 24.5 air mi SW of Buffalo, along Baby Wagon Creek, elev. 9400 ft, *B.E. Nelson 7256 & Gael Fonken* (RM 347684!); eastern slope of Big Horn Mts., headwaters of Clear Creek & Crazy Woman River, elev. 7000-9000 ft, *Frank Tweedy 3022* (RM 38401!, WS 26627!); eastern slope of Big Horn Mts., headwaters of Clear Creek & Crazy Woman River, elev. 7000-9000 ft, *Frank Tweedy 3024* (RM 38408!). **Washakie Co.**, Big Horn Mts., c. 27 air mi SE of Tensleep, c. 10 air mi ESE of Big Trails along Red Fork Powder River, river bank, elev. 7300 ft, *B.E. Nelson 3547* (RM 347691!); Big Horn Mts., along Middle Fork Powder River, c. 17 air mi SE of Big Trails, c. 28 air mi SE of Tensleep, along river, elev. 7300 ft, *B.E. Nelson 8192* (RM 347682!); Big Horn Mts., along Leigh Creek on an old section of U.S. 16, c. 4.5 air mi W of Powder River Pass, c. 17.5 air mi NE of Tensleep, along creek, elev. 9150 ft, *B.E. Nelson 7044 & Gael Fonken* (RM 347687!); Big Horn Mts., along Leigh Creek on an old section of U.S. 16, c. 4.5 air mi W of Powder River Pass, c. 17.5 air mi NE of Tensleep, stony grassy slope, elev. 9150 ft, *B.E. Nelson 7063 & Gael Fonken* (RM 347686!); Big Horn Mts., along Canyon Creek, c. 6.7 air mi W of Hazelton Pyramid, c. 15 air mi ENE of Tensleep, along stream, elev. 8000 ft, *B.E. Nelson 7279 & Gael Fonken* (RM 347683!); Big Horn Mts., near Welch's resort, grassy meadows, alt. 8400 ft, *C.L. Porter 4369* (RM 207424!). **Teton Co.**, Gros Ventre Mts., Upper Slide Lake, growing with *Achillea millefolium & Aster* sp., common on light soil on bank, elev. 7100 ft, *Robert Lichvar 854* (RM 315629!); Buffalo River at Government Bridge, *Elmer D. Merrill & E.N. Wilcox 1092* (RM 32326!); Grand Teton Natl. Park, Snake River bottom, moist places in timber, elev. 6700 ft, *Louis Williams & Rua Pierson 1332* (RM 135276!); Jackson Hole Wildlife Park, among willows on first terrace above Pacific Creek, 6750 ft elev., *John F. & Mildred S. Reed 892* (RM 208736!); Grand Teton Natl. Park, 9.2 mi N of junction at Jackson Lake Lodge, moist soil near willows, alt. 6850 ft, *W.G. & Ragnhild Solheim 4128* (RM 100322-S!); Grand Teton Natl. Park, University of Wyoming Biological Research Station, moist soil edge of river, elev. 6730 ft, *W.G. Solheim 4214* (RM 248567!, UC M-040090!). **Natrona Co.**, Big Horn Mts., c. 18.5 air mi N of Arminto, Middle Fork Buffalo Creek, spruce forest with stream beneath, elev. 8100 ft, *Ronald L. Hartman 10473* (RM 347678!). **Freemont Co.**, Shoshone Natl. Forest, near Gustav Lake, *A.A. Beetle 4971* (WS 188676!); Wind River Mts., Fiddlers Lake, 24 mi SW of Lander, lodgepole pine grove bordering sedge meadow, alt. 10000 ft, *F.J. Hermann 12277* (RM 248629!); Southern Wind River Range, E slope at Louise Lake, common on sandy lakeshore, 8800 ft elev., *C.L. Porter & Marjorie W. Porter 8426* (RM 263233!, UC

M-187496!); Wind River Range, Dickinson Creek, dry subalpine meadows, elev. 10000 ft, *Richard W. Scott 207* (274428!). **Sublette Co.**, Wyoming Forest, Head S [illegible] aver Creek, 2% S slope, meadow, alt. 8800 ft, *S.E. Cazier C-46* (RM 408643!); 27 mi S of Jackson, U.S. Hwy 187, on open *Artemisia* slopes in lodgepole pine, *Bassett Maguire, George Piranian & B.L. Richards Jr. 12589* (PH 781082!, UC 604321!); Kendall, banks of dry pond, *Edwin B. Payson & Lois B. Payson 2928* (PH 602531!, RM 93860!, UC 279562!); in the vicinity of Green River Lakes, alt. 8000 ft, *Edwin B. Payson & Lois B. Payson 4632* (RM 103897!). **Lincoln Co.**, junction of Box Canyon Creek & Grey's River, near stream, elev. 7800 ft, *Geo. J. Goodman 5130* (RM 215546!); Star Valley-Grays River in the Afton area, Smith Fork, 1/4 mi E of Smith Fork Guard Station, growing to 30 inches among willows with *Geranium* &2 Castilleja, 7420 ft elev., *Orval C. Harrison 139* (RM 297870!); Greys River Valley bet. Salt River & Wyoming Ranges, just S of the mouth of Marten Creek, c. 13.5 air mi E of Afton, growing in a meadow, elev. 7275 ft, *Orval C. Harrison 333* (RM 343268!); Bear Creek, c. 2 mi above Junction with Greys River, riparian-willow flat, elev. 7110 ft, *J.S. Tuhy 165* (BRY 284097!); Grand Canyon of Snake River, sandy bottoms, 5500 ft elev., *Louis Williams 818* (RM 129871!, RM 169922!). **Albany Co.**, Medicine Bow Forest, Evans Creek Excl., 2% E slope, meadow vegetation ty[illegible] alt. 9000 ft, *Ralph K. Gierisch 1994* (RM 402980!); Medicine Bow Mts., wet banks, *Aven Nelson & Ruth A. Nelson 969* (RM 138219!); Centennial, in margins of wet copses, *Aven Nelson 7731* (RM 52089!, UC 128260!); Centennial, moist river bank copses, *Aven Nelson 8826* (BRY 117127!, BRY 192944!, RM 41795!, RM 169846!, UC 51298!); Centennial, wet sandy stream banks, *Aven Nelson 8827* (NDG 062515/HG 45980!, UC 51251!, UC 892172!); Bacon's Ranch, open woods, *Aven Nelson 8918* (RM 52149!); Jelm, wet sandy banks, *Aven Nelson 9080* (RM 64954!); 4 1/2 mi NW of Centennial, 1/2 mi from Wyoming Hwy 130 on Sand Lake Road, frequent in loamy clay in a meadow with *Trifolium*, elev. 9000 ft, *B.E. Nelson 788* (RM 296362!); Medicine Bow Mountains, 4 mi NW of Centennial on Wyoming Hwy 130 then 1.5 mi N on Sand Lake Road then 1.3 mi NE on a logging road, frequent in loamy soil along a stream with *Salix, Pedicularis, & Gentiana*, elev. 9600 ft, *B.E. Nelson 997* (RM 296368!). **Carbon Co.**, 11.9 mi S of Wyoming Hwy 130, 0.8 mi W of Fox Park, Wyoming Hwy 130, French Creek Campground intersection, along S French Creek, common in loam in a meadow with grass, sedge & *Sidalcea*, elev. 8200 ft, *B.E. Nelson & Linda Nelson 952* (RM 296369!); Medicine Bow Forest, Sawmill Park, gentle N slope, distributed in open & sagebrush parks, alt. 9000 ft, *Bruce Torghy BC-164* (RM 402979!). **Sweetwater Co.**, N side of Little Mt., c. 34 air mi S of Rock Springs, loamy in wet *Carex* meadow with *Equisetum arvense*, 8840 ft elev., *Ann Aldrich 570* (RM 330360!). **Counties not indicated on labels:** Wyoming Natl. Forest, Dutch Joe Ranger Station, pasture, gentle S slope, meadow, alt. 8300 ft, *Ernest E. McKee 26* (RM 402977!); Fort Bridger, Hayden's U.S. Geological Survey, *Thos. C. Porter s.n.* (PH *s.n.*!); near Fork Bridger, *Thos. C. Porter s.n.* (PH 569275!); Fork Bridger, *Thos. C. Porter s.n.* (RM 248123!). Teton Forest Reservation, *T.S. Brandegee s.n.* (UC 91144!); Harris Fork, *I.E. Diehl D49* (BRY 16948!); Upper Wind Rivers, *Aven Nelson 766* (NDG 062471/HG 46790!); Wyoming, 1894, *Aven Nelson 1195* (NDG 062471/HG 46789!); South Wyoming, Hog Park, *G.E. Ostehout 35* (RM-169841!); Wyoming, at Evanston, *J.A. Sanford s.n.* (UC 29624!); Wyoming, *J.A. Sanford s.n.* (UC 29625!). Rocky Mt. Flora, Lat. 40°, South Park, *E. Hall s.n.* (PH 709133! *p.p.mag.*); Rocky Mt., Lat. 39-41, 1862, *E. Hall & J.P. Harbour 337* (PH *s.n.*); Aq. (= Aquarius) Plateau & its slope, U.S. Geological & Geographical Survey of the Territories, alt. 9500-10000 ft, *L.F. Ward 473 & 518* (PH *s.n.*).

Selection of types of Arnica chamissonis Less.

Four Unalaskan specimens of *Arnica chamissonis* Less. were obtained on loan from the Herbarium (LE) of the V.L. Komarov Botanical Institute, Academy of Sciences of the U.S.S.R., Leningrad. All material were undated, unnumbered or without original number and have scanty information on the labels. Two of these collections were gathered by Choris & Langsdorff, and Choris, and were originally deposited at Fischer Herbarium. The former collection has label prepared by Herder in his penmanship while the latter was annotated by Herder and also bears the standard annotation label of Bassett Maguire dated 1938. These collections are here designated as topotypes of *Arnica chamissonis* Less. One of the 2 remaining collections was also annotated by Herder as *Arnica chamissonis* Less. and at the same time, he wrote the number "306" on the top left corner of the label. This specimen was also examined by Maguire in 1938 (*in sched.*), but he did not assign any type status for it. There is only but one line that is clearly handwritten on its label, *i.e.* "Unalaschka Eschscholtz". The fourth collection was not seen by Herder nor Maguire but of considerable importance as its labels bears a handwritten determination ending with "*n.sp.*". On its label, there are 2 lines in which "Unalaschka" is one of the 2 words on the first line that is legible while the other word is apparently an abbreviation for "Eschscholtz". The second line has been also abbreviated, *i.e.* "ACham", which refers to Adelbertus von Chamisso, the collector of the original material cited by Lessing (1831). The presence of the word "Eschscholtz" on the labels of these 2 specimens indicates that they belong to the same collection as clearly evident from their morphological similarity. As to whether the word "Eschscholtz" refers to another collector, *i.e.* Johann Friedrich Eschscholtz who was the surgeon and naturalist on board the ship 'Rurik' (Hultén 1968) and companion of A. von Chamisso during their expedition, or to a locality on Unalaska Island named in honor of Eschscholtz by his companions could not be fully ascertained at the moment. Nonetheless, it is definitely shown here that the fourth specimen mentioned above is unequivocably the holotype of *Arnica chamissonis* Less. and designated here as such, whereas the one bearing the number "306" is here assigned as isotype. These designations are based upon careful study of the material against the original description and thorough comparison of handwritings on the labels with sets of authentic penmanships[16] of the following naturalists, namely: a) Christian Friedrich

[16]The sets of authentic handwritings were generously provided by Dr. F. Butzin *vice* Dr. H. W. Lack (Oberkustos), Botanischer Garten und Botanisches Museum Berlin-Dahlem (B), Berlin, Federal Republic of Germany, pers. comm. 12 January 1988 and Dr. D.V. Geltman, Herbarium (LE), Department of Higher Plants, V.L.

Lessing, b) Adelbertus von Chamisso, c) Diedrich F.L. von Schlechtendal, and d) Ferdinand G.T.M. von Herder. It appears also that these two specimens are the only extant material from Unalaska in what could be considered the original Chamisso Herbarium at LE. A meticulous search for similar material at the Berlin Herbarium (B) was done and accordingly, no extant material was found (Dr. H.W. Lack, pers. comm. 31 August 1987). The possibility of other duplicates to be at Berlin Herbarium is now therefore discounted and if there were indeed some type material there of *A. chamissonis* Less., then these were totally lost during World War II. Conclusively, the 2 specimens when evaluated together clearly fulfill and satisfy the type description of *A. chamissonis* Less.

[16](cont'd) Komarov Botanical Institute, U.S.S.R. Academy of Sciences, Leningrad: pers. comm. 17 April 1988.

5. **Arnica longifolia** D.C. Eaton *in* S. Wats. Bot. King's Expl. *5*: 186, 1871; T. Howell, Fl. NW Amer. 1: 374, 1897; P.A. Rydberg, Colorado Agric. Bull. 100: 389, 1906; A. Nels, New Manual Rocky Mt. Bot., in part, 1909; Rydberg, N. Amer. Fl. 34: 348. 1927; F.J. Smiley, Univ. Calif. Publ. Bot. 9: 385, 1921; W.L. Jepson, Man. Fl. Pl. Calif., p. 1157, 1925; S.F. Blake *in* I. Tidestrom, Contrib. U.S. Nat. Mus. 25: 606, 1925; E.H. Moss, Flora of Alberta, 1st ed., p. 448, 1959; A. Cronquist *in* C.L. Hitchcock & A. Cronquist, Fl. Pac. NW, p. 483, fig. 3a, 1973; R.D. Dorn, Man. Vasc. Pl. Wyoming 1: 297, 1977; R.I. Ediger & T.M. Barkley, N. Amer. Fl., ser. II, pt. 10, 22, 1978; H.J. Scoggan, Fl. Canada, pt. 4, p. 1476, 1979; L. Arnow *et al.*, Flora of Central Wasatch Front, Utah, p. 101, 1980; J.G. Packer, Moss's Flora of Alberta, 2nd ed.(revised), p. 538, map 1019, 1983; S.L. Welsh *et al.*, A Utah Flora, p. 144, 1987. *Arnica longifolia* D.C. Eaton subsp. *genuina* Maguire, Brittonia 4(3): 468, 1943, *nomen illegit.*; A. Cronquist *in* R.J. Davis, Flora of Idaho, p. 690, 1952.
TYPE: NEVADA, Clover Mountains, 9000 ft elev., September 1865, *Sereno Watson 655* (HOLOTYPE, US 46876!). (Fig. 27; Generalized illustration, Fig. 28).

Arnica polycephala A. Nels. Bot. Gaz. *30*: 202. 1900. TYPE: WYOMING, Yellowtone National Park, Snake River, among the rocks on a cliff, 12 August 1899, *Aven Nelson & Elias Nelson 6422* (HOLOTYPE, RM 20774!; ISOTYPE, NDG 062547/HG 45917!).

Arnica caudata Rydb. Bull. Torrey Bot. Club *37*: 463. 1910. TYPE: UTAH, Salt Lake Co.: Big Cottonwood Canyon, near Lake Catherine, alt. 9300 ft, 3 August 1905, *A.O. Garrett 1547* (HOLOTYPE, NY *s.n.*!; UC 658879! PHOTO 330 & 331 of NY; ISOTYPE, RM 52683!; UC 658879! PHOTO 332 of RM).

Arnica myriadenia Piper, Proc. Biol. Wash. *33*: 106. 1920. = *Arnica longifolia* D.C. Eaton subsp. *myriadenia* (Piper) Maguire, Brittonia *4*(3): 470, 1943. TYPE: WASHINGTON, Pierce Co.: Mt. Rainier National Park, Owyhigh, talus, 6000 ft alt., 8 August 1919, *J.B. Flett 3211* (HOLOTYPE, US 1241262; UC 658881! PHOTO of US 1241262; ISOTYPE, WS 69056!).

Arnica ciliaris Rydb. N. Amer. Fl. 34: 351. 1927, *syn. nov.* TYPE: CALIFORNIA, Placer Co.: R.R. Canyon (?) or Crossing on road to Tahoe, 2 August 1896, *C.F. Sonne s.n.* (HOLOTYPE, NY *s.n.*!; ISOTYPES, NDG 062504/HG 45978! as *C.F. Sonne 5*, UC 195680!).

Plants 3 to 6 (-11) dm tall, arising from short scaly thickened woody branching caudex, often in extensively large clonal patches consisting of both innovations and floriferous plants; *stems* numerous, in distinctly compact tufts, nearly glabrate-puberulent below to scabrid-glandular-viscid above, regularly profusely branched on top to below midstem; *basal leaves* 1-2 pairs, small, 2 cm long x 1-1.5 cm wide, elliptic to ±ovate, usually wilted before anthesis; *cauline leaves* (4-) 5-7 (-11) pairs, sessile or subsessile with lower ones distinctly connate-sheathing, lanceolate to narrowly elliptic, 5-13 cm long x 1-2 cm wide, acute or acuminate to distinctly caudate, entire or sparsely denticulate, nearly glabrous to viscid-glandular; *capitula* (1-) 3-7 (-20) in cymose, corymbose or paniculate arrangement, small to medium, ±turbinate to narrowly campanulate; *periclinium* short narrow, sparsely to moderately short-stipitate glandular, scantily to moderately pilose with white or translucent, short or long, multiseptate hairs; *involucral bracts* (9-) 10-19 (-25), nearly linear to narrowly or sometimes broadly lanceolate, 7-12 (-15) mm long x 1-2 (-3) mm wide, acute to acuminate, scantily puberulent with white or translucent, short multiseptate hairs and with many to numerous short-stipitate glands; *ligulate florets* (6-) 8-12 (-15), bright yellow, wide apart from one another, (7-) 11-20 (-22) mm long x (1.5-) 3-5 (-6) mm wide, its apex shallowly bi- or tridentate; *disc florets* narrowly tubular or funnelform, (6-) 7-9 (-11) mm long, sparsely to densely hirsutulous up to midway with white or translucent hairs, very scantily so on limbs, rarely with short-stipitate glands at lower part of tube; *achenes* (23-) 35-70 (-124), round or slightly angular-cylindric, rarely fusiform, cream-brown with uniform tiny brown spots to chestnut brown or waxy pit-black, (3-) 4-6 (-7) mm long, glabrous to very sparsely hirsutulous, usually with conspicuous uniformly short-stipitate glands; *pappus* of (18-) 25-30 (-33) bristles, stramineous to ±tawny or rarely deep brown, barbellate to slightly subplumose. *Chromosome number*, 2n = 57, 76.

ECOLOGY AND DISTRIBUTION. *Arnica longifolia* is one of the taxa in subgenus *Chamissonis* whose distribution range is largely confined to south of 49° latitude with very few localities in Alberta where Packer & Bradley (1984, map 317) recorded it as a rarity. In this province, it is restricted to the montane, subalpine and alpine slopes of the Rocky Mountains. Douglas (1982) included this taxon in his account of the Asteraceae of British Columbia in anticipation of its eventual location within the boundary of that province. A lone collection from Graham Reach, Swanson Bay, British Columbia [grass bogs at head of small lake above

Figure 27. Holotype of *Arnica longifolia* D.C. Eaton [Nevada, Clover Mountains, 9000 ft elev., September 1865, *Sereno Watson 655* (US 46876!)].


ANNOTATION LABEL
MONOGRAPH OF THE GENUS ARNICA
00028193
HOLOTYPE

Figure 28. Habit and morphology of *Arnica longifolia* D.C. Eaton. [Utah, Beaver Co., Tushar Mts., Lake Stream near Three Creeks Reservoir, 8700 ft elev., spruce-*Salix-Ribes-Potentilla-Arnica* riparian community, 15 July 1984, *A. Taye 2743* (BRY 277383!)].


5 cm

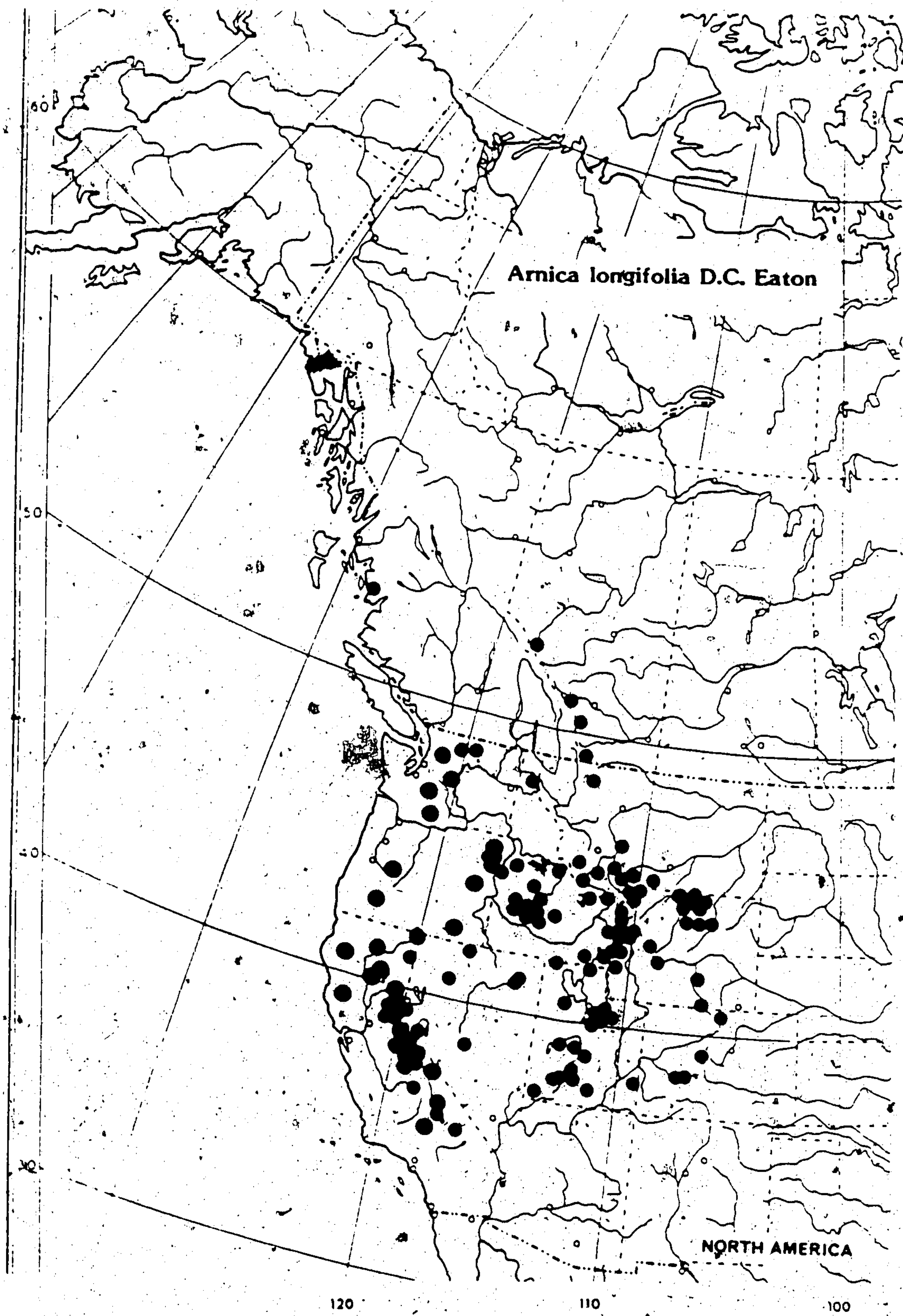
Yule Lake, 18 July 1936, *T.T. McCabe 3516* (UC 564337!)] is undoubtedly *A. longifolia* and hence, the first record of this taxon for this province. Below the 49° parallel, *A. longifolia* is quite widespread in Montana, Idaho, Wyoming, Utah, Colorado, Washington, Oregon, Nevada and California (Fig. 29).

Arnica longifolia has been given the common name 'Seep-spring Arnica' (Douglas 1982) mainly with reference to the most common site where extensive population growth of this species could be found. Evidently, all throughout its geographic range, this species attains its maximum prolific development in subalpine and alpine areas where there is an unobstructed water drainage in low-lying or sloping meadows about springs and seepage from snowmelt-waters of alpine glaciers. On this site in Wyoming as an example, *A. longifolia* is commonly the most dominant element of the vegetation [see below, *sub WM11396* (ALTA 91430!) for exact locality data] *vis-a-vis* an extensive growth of *Mertensia ciliata* (James) D. Don [*WM11392* (ALTA!)], together with *Arnica fulgens* Pursh [*WM11393* (ALTA!)], *A. mollis* W.J. Hook. [*WM11394* (ALTA!)], and species of *Taraxacum*, *Achillea*, *Castilleja*, *etc*. It is likewise common in similarly well-drained sites at the base of talus, bottoms of canyons and rockslides, between rocks and boulders above creek- or streambanks or in humus on rocks in the middle of cascading creeks, rock crevices of steep cliffs, lower edge of cirques between snowbeds, volcanic rubbles and lava boulders as well as crumbly granitic or limestone rock-outcrops.

The flowering season for *A. longifolia* begins around late June and is continuous through late September or early October, especially in the southern extremity of its distribution range. Altitudinally, it ranges from as low as 1372 m (4500 ft) to as high as 3658 m (12500 ft).

SPECIMENS EXAMINED. CANADA. ALBERTA. Jasper Natl. Park, below the moraine of Angel Glacier, *Aven Nelson & Ruth A. Nelson 4863* (RM 191982!). **Banff Natl. Park**, vicinity of Sunshine Lodge, south of Healy Creek, screes & cliffs along south & west base of Citadel Mountain, *A.E. Porsild & Johannes Lid 19571* (CAN 293158!); vicinity of Sunshine Ski Lodge, south of Healy Creek, *A.E. Porsild & A.J. Breitung 15971* (CAN 109812!); vicinity of Sunshine Ski Lodge, Citadel Peak, *A.E. Porsild & A.J. Breitung 14247* (CAN 109813!). Highwood Pass, Mile 92, Kananaskis Forestry road, west facing slope of

Figure 29. Geographical range of *Arnica longifolia* D.C. Eaton.


Arnica longifolia D.C. Eaton
60
50
40
30
NORTH AMERICA
120
110
100

Highwood Range, 5 mi NW of Mt. Head, *John G. Packer 1969-419* (ALTA 27081!). **Waterton Lakes Natl. Park**, near Waterton Lake, *Aven Nelson & Ruth A. Nelson 4757* (RM 191981!); c. 3 mi N of Waterton Townsite, on floodplain of Blakiston Creek, *G.W. & G.G. Douglas 7691* (BRY 153134!); Twin Lakes Trail, *J. Kuijt & W. Blais 2946* (CAN 340726! ex LEA); north shore of Crypt Lake, alt. 1980 m (= 6500 ft), *P. Kuchar 2935* (ALTA 46081!); Bertha Lake, meadow on west side of lake, *J. Kuijt & W. Blais 2218* (ALTA 82472!); shore of Bertha Lake, *August J. Breitung 17422* (ALTA 16938!, UC 985839!).

BRITISH COLUMBIA. Swanson Bay, Graham Reach, grass bogs at head of small lake above Yule Lake, *T.T. McCabe 3516* (UC 564337!) - *new* to British Columbia.

U.S.A. CALIFORNIA. Modoc Co., Canyons, *M.F. Gilman 519* (UC 468977!); Warner Mt. Range, Modoc Natl. Forest, Patterson Lake & Owl Creek, *L.S. Smith 1055* (JEPS 35892!, RM 471054!); Warner Mts., Eagle Peak, *W.L. Jepson 7974* (JEPS 35867!, JEPS 35868!); southern end of Eagle Peak Ridge above North Emerson Lake, *Leland S. Smith 1041* (JEPS 35880); Modoc Natl. Forest, *Leland S. Smith 1076* (JEPS 35884!); Warner Mts., head of Eagle Creek, *Annie M. Alexander & Louise Kellogg 5110* (UC 936275!); Warner Mts., Emerson Peak, NE, *Annie M. Alexander & Louise Kellogg 5057* (UC 936274!); Mt. Bidwell, *Mrs. M.H. Manning 343* (UC 71560!); Modoc Forest, Eagle Peak, ridge S above Emerson, *L.S. Smith 1041* (RM 471055!); **Siskiyou Co.**, E slope of Mt. Shasta, along Ash Creek, c. 1 mile N of Military Pass Road, *H.K. Wagnon 1713* (UC M-096783!); E slope of Mt. Shasta on Oak Creek, *M.S. Baker s.n.* (UC 76028!); Mount Shasta, along Squaw Valley Creek below the falls, *Wm. Bridge Cooke 15427* (ND 011130!); Mt. Shasta, along lower Panther Creek below the meadow, *William Bridge Cooke 17800* (WS 184302!); Mt. Shasta, in a spring along the wall of Mud Creek Canyon, *Wm. Bridge Cooke 13864* (ND 011134!, UC 642539!); **Shasta Co.**, Brokeoff Mountain, Summit Ridge, Lassen Volcanic Natl. Park, *John Thomas Howell 36187* (JEPS 28116!); in rock crevices of cliffs on west face of Helen Mt., facing the Lassen Peak trail & Lassen Peak Hwy, 200 yards below the parking area at summit of road, *George W. Gillett 485* (JEPS 12513!); **Trinity Co.**, Devil's Canyon Mts., cirque at head of White's Creek, *Joseph P. Tracy 14608* (JEPS 20980!); Devil's Canyon Mts., around White's Creek Lake, head of North Fork of White's Creek, *Joseph P. Tracy 14655* (UC 582486!); **Plumas Co.**, Plumas Forest, head of Nelson Creek, *Lloyd W. Swift 72* (RM 471053!); **Tehema Co.**, Brokeoff Mt. trail, 1/2 mile above Sulphur Works Checking Station, *George W. Gillett 1055* (JEPS 28760!); **Nevada Co.**, vicinity of Lake Spaulding on the South Fork Yuba River, NE of Emigrant Gap & in Nevada Co.), *A.M. Carpenter s.n.* (JEPS 35886!); Sierra Nevada Mts., on road from Webber Lake to Meadow Lake at Summit, *C.F. Sonne s.n.* (UC 91131!); Nevada Co.: alt. 7000 ft, *A.M. Carpenter s.n.* (UC 29629!); Truckee, *A. A. Heller 7191* (PH 507083!, RM 46659!, UC 57884!); below Water Tank at Truckee, *C.F. Sonne s.n.* (NDG 062506/HG 45976!); Sierra Nevada Mts., Frog Lake on Mt. Shawford (?), *C.F. Sonne 191* (PH 548682!). **Colusa Co.**, along edge of Dark Hollow Creek, on southern flank of Snow Mt. East, at lower edge of cirque bet. Snow Mt. West & Snow Mt. East, *G. Thomas Robbins 3712 & L.R. Heckard* (JEPS 15569!); Snow Mt., upper reaches of Dark Hollow Creek (south of East Peak), *L.R. Heckard 3889* (JEPS 75860!); **Lake Co.**, Snow Mt., *T.S. Brandegee s.n.* (UC 91146!); **Placer Co.**, mountains above Coldstream, *C.F. Sonne 191* (JEPS 20970!); Mt. Rose Country, Tahoe Forest, E slope, *L.S. Smith 2608* (JEPS 35909!); mountains above Coldstream, *C.F. Sonne s.n.* (UC 91127!); Sierra Nevada Mts., mountains above Coldstream, *C.F. Sonne s.n.* (UC 29640!); E slope of Anderson's Peak, N of Tinker's Knob, *C.F. Sonne s.n.* (UC 193595!); Mt. Anderson, *C.F. Sonne 3* (NDG 062509!/HG 45973!); Sierra Nevada Mts., E slope of Mt. Anderson, *C.F. Sonne s.n.* (UC 197284!); Mt. Rose Country, Tahoe Natl. Forest, *L.S. Smith 2608* (UC 477561!); Deer Park, *Miss Helen D. Geis 165* (UC 468976!); Deer Park, *Miss Helen D. Geis 43* (UC 468975!); on the edge of Bear Creek, near Deer Park, *Miss Harriet A. Walker 2165* (UC 159245); below Water Tank at Truckee, *C.F. Sonne s.n.* (NDG 062507!/HG 45975!); Truckee, wet place below Water Tank, *C.F. Sonne 14* (NDG 062512!/HG 45970!); Truckee, below & around Schafer's Reservoir, *C.F. Sonne s.n.* (UC 193465!); Truckee, *Katharine Brandegee 1913* (UC 220237!); Lake Tahoe Region, *W.C. Blasdale s.n.* (UC 467703!); on road to Tahoe at Crossing of R.R., *C.F. Sonne s.n.* (UC 195680!); **El Dorado Co.**, Summit area of Mt. Tallac, *Gladys L. Smith & Alasdair H. Neilson 2764* (JEPS 71780!); Mt. Tallac, above Lake Tahoe, *W.L. Jepson 8133* (JEPS 35878!); Summit of Mt. Tallac, *G. Thomas Robbins 1374* (UC 747188!); Tallac Peak, *Miss Helen D. Geis 77* (UC 468974!); Glen Alpine Region, Mt. Tallac, *Alice Eastwood 1171* (UC 892156!, UC 892157!); Sierra Nevada Mts., Glen Alpine Creek, *H.M. Hall 8815* (UC 148993!); Glen Alpine to Suzy Lake, *L.R. Abrams 12744* (WS 122494!); Sierra Nevada Mts., Glen Alpine Creek, *H.M. Hall s.n.* (RM 73167!); Sierra Nevada Mts., Heather Lake, *H.M. Hall 8825* (UC 148947!); **Alpine Co.**, Stanislaus Natl. Forest, 3/8 mile N of Highland Lake, Quadrangle Dardanelles (Alpine), *C.G. Albertus 328* (RM 470719!, UC M-119287!); along Ebbetts Pass Road (State Highway no. 4), on E side of grade below the pass, at the 8000-ft road marker, 2 mi E of pass-summit, *Rimo Bacigalupi 6052 & C. Fletcher Talbot* (JEPS 19839!); Sierra Nevada, Hope Valley, Summit Area of Stevens Peak, *Gladys L. Smith & Alasdair H. Neilson 2835* (JEPS 72231!); Sierra Nevada, Hope Valley, Summit Area of Stevens Peak, *Gladys L. Smith & Alasdair H. Neilson 2836* (JEPS 71779!); Toiyabe Natl. Forest, Wolf Creek drainage along Pacific Crest Trail near divide into Murray Canyon, *Kenneth R. Genz 8955* (BRY 210464!); Stanislaus Forest, Mrs. Adams' Pasture, S slope, *Thomas C. West W-36* (RM 471052!); **Mono Co.**, Sweetwater Mts., Sweetwater Canyon, edge of creek, *Annie M. Alexander & Louise Kellogg 3882* (JEPS 35875!, UC 703409!); Sweetwater Mts., Deep Creek, *Annie M. Alexander & Louise Kellogg 4059A* (UC 702122!); E slope of Sierra Nevada, Molybdenite Creek, *Annie M. Alexander & Louise Kellogg 4166* (JEPS 35893!); Sonora Pass, E slope of peak SW of Pass, *Annie M. Alexander & Louise Kellogg 4228* (JEPS 35874!, WS 256348!); Sierra Nevada, E of Mount Conness, Slate Creek Basin, *J. Clausen 984* (UC 556345!); Mono Natl. Forest, Bridgeport Quadrangle, 1 mile S of Moat Lake near Virginia Lakes, *T.M. Hendrix 568* (UC 577909!); Inyo Natl. Forest, H.M. Hall Natural Area, Slate Creek Valley, NE of Slate Creek on way to East Plateau, *A.R. Kruckeberg 3574* (RM 259292!, WS 235988!); White Mountains, in steep canyon on Lone Tree Creek, *Richard S. Mitchell 2254* (UC M-299868!); Sierra Nevada, Cabin Creek, N tributary of Slate Creek, *Philip A. Munz 20014* (RM 245268!); Bridgeport Quadrangle, *W.A. Peterson 559* (UC M-119297!); Sierra Nevada, E margin of Saddlebag Lake, base of Tioga Crest, *Carl W. Sharsmith 2788* (UC 712186!); **Tuolumne Co.**, Sierra Nevada, NW flank of Leavitt Peak, *Ernest C. Twisselmann 5730* (JEPS 27854!); on scree above road, 2.3 miles below & west of Sonora Pass, *Rimo Bacigalupi 8009, P.C. Hutchison & L. Heckard* (JEPS 28091!); Saddlebag Lake, *Mrs. H.P. Bracelin 33* (UC 419748!); Stanislaus River Region, above Relief Reservoir, *Frank W. Peirson 10398* (UC 501443!); Dardanelles Quandrangle, Stanislaus Natl. Forest, Sonora Pass, 5% W slope, *W.A. Peterson 487* (UC 580734!); Bridgeport, 1/2 mile SW of Summit Lake, W exposure, *W.D. Thomas 399* (UC M-119300!); **Madera Co.**, Dike Creek, *Peter H. Raven 3767* (BRY 142233!); **Inyo Co.**, Sierra Nevada, Owens Valley drainage, Shepherd Canyon, along trail below Anvil Camp, *Mary DeDecker 4875* (UC I-445380!); Sierra Nevada, Lone Pine Creek above Lone Pine Lake, *Ernest C. Twisselmann 5627* (JEPS 26386!); Panamint Mts., Death Valley Natl. Monument, stream near head of South Fork Hanaupah Canyon, *M. French Gilman s.n.* (JEPS 35872!); **Fresno Co.**, Sierra Nevada, Heart Lake, *Peter H. Raven 7900* (JEPS 12038!); 8750 ft West Lake, just N of lower end of ridge leading down W-NW from 9984 ft Red Mt., 3 1/2 map miles SE of Huntington Lake, *Chas. H. Quibell 1191* (UC M-043472!); **Tulare Co.**, southern Sierra Nevada Mts., Basin of Upper Kern, Jordan Hot Springs, Long Canyon, *H.M. Hall & H.D. Babcock 5302* (UC 63479!); wet places at Little Kern, *C.A. Purpus s.n.* (UC 134167!); Sierra Nevada, above Summit Valley, *C.G. Pringle s.n.* (PH *s.n.*!); Kaweah River Basin, Farewell Gap, *Ralph Hopping 181* (UC 467695!); Bludy (?) Canyon, *J.W. Congdon s.n.* (UC 91139!); Spur, Silver Lake, *Geo. Hansen s.n.* (NDG 062508!/HG 45974!); California, South Fork of Kevu River, *J.T. Rothroch 347* (PH 709184!).

COLORADO: Larimer Co., Ethel Peak, creek bottoms, *Leslie N. Goodding 1914* (PH 523769!, RM 52151!, RM 169628!); **Jackson Co.**, Routt Natl. Forest, Zirkel Wilderness, Grizzly-Helena trail & Ute Pass trail (Bear Creek), Boettcher Lake & Pitchpine Quadrangles, *W.A. Weber 15443 & R.C. Wittman* (BRY 206895!); **Gunnison Co.**, near Conundrum Pass, *Jean H. Langenheim 4045* (RM 257231!, UC M-080031!); trail along Copper Creek to summit of Conundrum Pass, Elk Mts., c. 10 mi NE of Gothic, *W.A. Weber & Sam Shushan 9380* (RM 248530!, UC M-049909!, WS 221896!); Copper Creek to Conundrum Pass, *D.B. Dunn 14748* (BRY 100989!); Gunnison Watershed, Keblar Pass, *C.F. Baker 726* (NDG 062481!/HG 45943!, RM 169626!, RM 33183!, UC 29638!, WS 26623!).

IDAHO. **Idaho Co.**, Seven Devils Mts., c. 11 miles SW of Riggins, & 1/4 mile down Bridge Creek from Mirror Lake outlet, formerly Nez Perce Natl. Forest, now Hells Canyon Natl. Recreation Area, *R.T. Bingham & C.J. Miller 35J* (WS 286806!); W side of Buffalo Hump, c. 10 mi SW of Orogrande, *C.L. Hitchcock 20376* (CAN 272664!, WS 230656!); Valley Co., 21 mi east of Stibnite, *J.H. Christ 14813* (WS 261717!); **Lemhi Co.**, Salmon Forest, Cathedral Meadows, *John N. Kinney 341* (RM 470971!); **Fremont Co.**, stream bottom at base of Mount Jefferson, 1 mi E of Red Rock Pass, W of Henry's Lake, *Arthur Cronquist 1863* (ND 011129!=ND 212435!); **Clark Co.**, Targhee Natl. Forest, Pleasant Valley, *Ray Pickett RP-88* (RM 471145!); **Custer Co.**, Wildhorse, *Ray J. Davis 1726* (WS 100032!); Bear Creek below Parker Mt., *J.F. Macbride & Edwin B. Payson 3278* (RM 86112!); Mackay (Bear Canyon), *Aven Nelson & J.F. Macbride 1443* (CAN 191099!, RM 71133!); Sawtooth Range, Stanley Lake, near lake III, *Clair L. Worley & L.K. Mann 36-214* (WS 76065!); Challis Forest, near Twin Peaks Ranger Station, *Frank M. Hurdle H-4* (RM 470978!); Challis Forest, near Twin Peaks Ranger Station, *Lewis B. Koch 12* (BRY 15883!, RM 470977!); Sawtooth Mts., Challis Natl. Forest, *J. William Thompson 13959* (PH 768291!, UC 609841!); Boulder Mts., Sawtooth Natl. Forest, in moist talus 2 mi SW of Ryan Peak, *C.L. Hitchcock & C.V. Muhlick 10663* (CAN 191102!, PH 838659!, RM 198595!, WS 155997!); Challis Forest, Beaver Creek, *Herman Work 461* (RM 470980!); Challis Forest, mouth of South Fork of Camas Creek, ric[illegible] *[illegible]rthur Buckingham 123* (RM 470659!); Challis Forest, Swamp Creek, [illegible] (RM 470979!); **Boise Co.**, Clear Creek, R8E T10N, *Ray J. Davis 2745* (BR[illegible]882!, U[illegible]659!, UC 892150!); **Blaine Co.**, Horse Creek, on Big Wood River above Ketchum, *Beverly Albee 30* (BRY 111196!); Ketchum, 15 July 1936, *Elizabeth Knox 21* (RM 146394!*p.p.*); Galena, 2 mi S of Sawtooth Natl. Forest, crumbly rock outcrop on US 93 along Big Wood River, *F.J. Hermann 20216* (RM 470981!); Sawtooth Natl. Forest, road turn-off on Hwy 75 to Alturas Lake, c. 200 m after access road to Alturas Lake Inlet Campground, edge of road, *William Sm. Gruezo WM11433* (ALTA 91433!); Sawtooth Natl. Forest, Hwy 75, c. 300 m N of mile post 154, along roadside bend, *William Sm. Gruezo WM11435* (ALTA 91434!); Blaine Co.: Sawtooth Natl. Forest, road turn-off on Hwy 75 leading to Alturas Lake, vicinity of Alpine Creek parking area, *William Sm. Gruezo WM11425* (ALTA 92178!); Blaine Co.: Sawtooth Natl. Forest, road turn-off on Hwy. 75 leading to Alturas Lake, vicinity of Alpine Creek parking area, c. 2 km past Alturas Lake, edge of an intermittent small slough, *William Sm. Gruezo WM11430* (ALTA 92177!); 7 mi E of Pole Creek Ranger Station, *C.L. Hitchcock & C.V. Muhlick 10739* (UC 968676!, WS 155975!); **Elmore Co.**, Atlanta, R11E T5N, *Ray J. Davis 2908* (UC 749698!, UC 892151!); Sawtooth Primitive Area, headwaters of Middle Fork Boise River above Atlanta, 1 mi S of Lower Spangle Lake, *C.L. Hitchcock & C.V. Muhlick 10113* (RM 197898!, UC 968526!); Boise Forest, Devil Creek, mouth, *R.B. Johnson RBJ-175* (RM 471037!); Trinity Lake Region, *J. Francis Macbride 699* (RM 67433!, WS 44689!); **Bear Lake Co.**, Bloomington Lake, *Ray J. Davis 1616* (WS 100109!); **Oneida Co.**, Bear River Range, SW corner of Franklin Basin, *Charles Piper Smith 2285* (RM 67767!); TO ASSIGN TO RESPECTIVE COUNTIES: • Open mt. summits Ridges N from Carbon, region of the Coeur d'Alene Mts., *John B. Leiberg 1512* (RM 66513!); Targhee Natl. Forest, *Dieffenbach, Glennon, Holte, Mel, Pearson & Vieth TNF 937* (RM 470970!); Idaho Co.: Seven Devils Mts., Nez Perce Natl. Forest, Dry Diggings Camp, *Aven Nelson & Ruth A. Nelson 2978* (RM 177932!, UC 614298!); Sawtooth Mts., Three Forks, *C.N. Woods & Ivar Tidestrom 2673* (BRY 300311!); **Bonneville Co.**, Palisade Natl. Forest, *Ray Pickett 91* (RM 82198!); Palisade Forest, Trail Creek, *F.J. Ryder 35* (RM 470974!); Palisade Natl. Forest, 1913, *F.J. Ryder 212* (RM 81399!); Palisade Forest, South Leigh Creek, *C.N. Woods 91* (RM 470973!); Salmon Forest, Baldy Mt. Camp, *Carl J. Kriley 85* (RM 470972!).

MONTANA. **Glacier Co.**, Glacier Natl. Park, near St. Mary's Lake *Bassett Maguire 1087* (RM 135052!); **Broadwater Co.: Helena Forest, E Fork of McClellan C. ek**, *D.C. Pashusta 86* (RM 470983!); **Deerlodge Co.**, Anaconda Pintlar Range, W above Storm Lake, *Klaus H. Lackschewitz 3926* (WS 287779!); Lake Hearst, Anaconda, *J.W. Blankinship 711* (CAN 191101!, RM 470992!); **Sweetgrass Co.**, Northern Rocky Mountain, Absaroka Natl. Forest; *G.N. Duvandack GHD-14* (RM 470992!); Absaroka Forest, Cottonwood Canyon, S slope, *C.H. Hurst 77* (RM 470990!); Absaroka Forest, Sec.11 T3N R11E, Rock Creek Lake, S slope, *Arthur D. Moir 19* (RM 470991!); **Stillwater Co.**, meadow at Independence, head of Boulder River, Absaroka Mts., *C.L. Hitchcock & C.V. Muhlick 13360* (CAN 191096!, PH 836534!, RM 203760!, UC 757571!, WS 159583!); **Carbon Co.**, Chrome Mine, NE end of Beartooth Plateau, 2 mi N of Wyoming-Montana state line, *Betsy Neely 1655 & Frank Smith* (BRY 300900!); Beartooth Forest, *C.E.G. Sewing 17* (RM 470993!); Beartooth Forest, Upper Lake Fork D-1, S slope, *L.H. McLean D1-8* (RM 470989!); Battle Lake Mt., *Aven Nelson 4219* (RM 10611!); **Park Co.**, shore of Rock Island Lake, c. 7 mi E of Cooke City, talus slope, *Jean G. Witt 1763* (WS 228545!); **Gallatin Co.**, Bridger Mts., *W.W. Jones s.n.* (UC 166627!); Gallatin Forest, 10% N slope, *Eric P. White 663* (RM 470665!); Gallatin Natl. Forest, head of Hyalite Creek, 40% E slope, *James C. Whitham 1707* (RM 470984!); **Madison Co.**, North Fork Mill Creek, Tobacco Root Mts., 2 mi SW of Brandon Lakes, *C.L. Hitchcock 16951* (CAN 191090!, WS 175076!); Gallatin Forest, Yellow Mule Ranger Station, 10% N slope, *James C. Whitham 1426* (RM 470985!); **Beaverhead Co.**, Northern Rocky Mountain, Beaverhead Natl. Forest, NW slope, *Lincoln Ellison & R.A. Robinson 3346* (RM 470986!); Beaverhead Forest, Sec. 32 T4S R11W, *D.C. Pashusta 80* (RM 470988!); Beaverhead Forest, Gold Creek, *Thomas D. Howe 54* (RM 470987!); Montana, Electric Peak, *P.A. Rydberg & Ernst A. Bessey 5226* (CAN 191100!; NDG 062511!/HG 45971!, PH 709100!, RM 21638!); Yogo Baldy, Little Belt Mountains, *J.H. Flodman 894* (NDG 062505!/HG 45977!); Montana, Midvale, along R.R., *L.M. Umbach 338* (RM 169976!); Northern Rocky Mountains, Lewis & Clark Forest, mouth of Ahorn Creek, *J.E. Kirkwood 2307* (UC 352430!, UC 892053!).

NEVADA. **Elko Co.**, summit of Ruby Mts., Robinson Lake shore, *Percy Train 4639* (UC 892149!); Ruby Mts., (S of Harrisson Pass), just below Pearl Lake, along upper Brown Creek, 67 km (42 mi) airline distance SSE (164 degrees) of Elko, *Noel H. Holmgren 10289, Patricia K. Holmgren & Sue Keller* (BRY 283370!); slopes N of Island Lake, *Bassett Maguire & Arthur H. Holmgren 22645* (CAN 191107!, PH 813419!); **Humboldt Co.**, Pine Forest Range, Leonard Creek drainage, 11 road mi N of Leonard Creek Ranch, *Noel H. Holmgren & James L. Reveal 1267* (BRY 48410!, UC M-305529!, WS 256049!); **Washoe Co.**, Mt. Rose, *A.A. Heller 9961* (JEPS 22843!, PH 537121!, UC 174558!); Tahoe Forest, along tract, N side, Sec. 14 T, E slope, *Leland S. Smith 2608* (RM 471051!); Mt. Rose, Tahoe Natl. Forest, SW of peak, *L.S. Smith 2527* (UC 477515!); **Pershing Co.**, West Humboldt Mts., Star Creek Canyon on E side of range, W of Silver State Mine, *Arnold Tiehm 9187* (BRY 280502!); **Lyon Co.**, Sweetwater Mt. near California-Nevada state line, Sweetwater Creek Canyon, E foothills, *Percy Train 4367* (UC 892100!); **Nye Co.**, Toiyabe Natl. Forest, Toquima Range, South Fork Shoshone Canyon, 4.5 mi & 135 degrees from town of Round Mountain, *S. Goodrich 13276* (BRY 209929!); Toquima Range; Toiyabe Natl. Forest, Pine Creek Canyon, *Bassett Maguire & Arthur H. Holmgren 25787* (CAN 190975!; UC 701826!); Nevada Forest, Sec.23 T16N R69E, Henry's Creek, 15% SE slope, *Frank E. Gray 335* (RM 470647!).

OREGON. **Wallowa Co.**, Wallowa Mts., Hurricane Creek Valley, head of Hurricane Creek, *L. Constance & C.D. Jacobs 1373* (WS 69148!); Aneroid Lake, 6 mi S of Wallowa Lake, *Lewis S. Rose 36527* (ND 011133!); Wallowa Mts., NW slope of Eagle Cap Peak, *C.W. Sharsmith 3892* (UC 604481!, WS 91104!); **Baker Co.**, rocky slopes of Wallowa Mts. near Cornucopia, *J. William Thompson 13368* (PH 757242!, UC 579004!, WS 79703!); **Grant Co.**, South Blue Mts., Strawberry Mt., *Wm. C. Cusick 3571a* (WS 79700!); Blue Mts., Strawberry Mt., head of Canyon Creek, *Bassett Maguire & Arthur H. Holmgren 26849* (CAN 191097!, UC 739042!, WS 170005!); **Harney Co.**, Steen Mts. Region, Little Blitzen Gorge, 15 1/2 mi E & 10 1/4 mi S of Frenchglen, *Albert N. Steward 6819 & Chas. G. Hansen* (WS 221116!); **Klamath Co.**, Crater Lake Natl. Park, on rock slides at Vidae Falls, *William H. Baker 6261*

(UC (922893!, WS 195255!, WS 195752!); Crater Lake Natl. Park, lava boulders W shoe of Wizard Island, *William H. Baker 6365* (UC 922892!); Crater Lake Natl. Park, lower Garfield Peak, *William H. Baker 7194* (WS 219856!); Crater Lake, W side of Wizard Island, *Elmer I. Applegate 9216* (UC 535800!); Crater Lake Natl. Park, N base of Garfield Peak, *Elmer I. Applegate 10163* (UC 563982!); Crater Lake Natl. Park, Garfield Peak, talus slopes, *William H. Baker 7202* (WS 219953!); Crater Lake Natl. Park, foot of trail near the edge of lake, *A.A. Heller 12621* (PH/PENN 68056!, PH 598789!, UC 726628!); Crater Lake Natl. Park, rim trail to Crater Lake Lodge, *L.R. Abrams 9827* (RM 100188!); Crater Lake Natl. Park, inside Crater Lake proper, on Rim Drive c. 100 m after Pinnalli Junction, fill-side of road, *William Sm. Gruezo WM11471* (ALTA 91435!); Crater Lake Natl. Park, inside Crater Lake proper, on R[illegible] 300 m from Crater Lake Lodge & Crater Lake Park Headquarters, on fill-si[illegible] *William Sm. Gruezo WM11475* (ALTA 91436!). **Wallowa Co.**, Minam Forest, [illegible]*ning 154* (RM 471048!, RM 471049!). **Deschutes Co.**, High Cascade Mts., W slope of [illegible] Sisters, Mesa Creek, *L.T. Henderson 14064* (PH 684766!). **Baker Co.**, Powder River Mts., [illegible] *Piper 2489* (WS 266024!). Oregon, in & along alpine streamlets, *Wm. C. Cusick 1774* (NDG 062510!/HG 45972!, UC 29639!, WS 266401!).

UTAH. **Cache Co.**, Wasatch Range, White Pine Lak[illegible]*ne 2894* (BRY 254398!); Wasatch Range, White Pine Lake, *K. Thorne 2894* [illegible] 254399!); Bear River Range, Mt. Naomi Region, N of Tony Grove Lake Basin, *Ba[illegible] Maguire, Dean A. Hobson & Ruth R. Maguire 14209* (CAN 191106!, PH 781119!, RM 1[illegible]49!); Bear River Range, rocky slope SE of White Pine Lake, *R.S. Snell 1017* (CAN 191093!, WS 170191!); trail to Mt. Naomi Peak, rocky ravine, *R.S. Snell s.n.* (BRY 310099!); Bear River Range, near summit of Mt. Naomi, *Bassett Maguire 16153* (CAN 191092!, PH 810064!); Bear River Range, 1 3/4 mi NW of Tony Grove Lake, along trail to Mt. Naomi, *Bassett Maguire 16135* (CAN 191095!, PH 810063!); cliff west of Tony Grove Lake, *John Thieret & Mildred Thieret 206* (UC M-010949!, WS 216257!); **Box Elder Co.**, Raft River Mts., Clear Creek Canyon, *R.B. Selander, R.K. Selander & S.J. Preece Jr. s.n.* (WS 285161!); Raft River Mts., Sawtooth Natl. Forest, Head of Lake Fork of Clear Creek above Bull Lake, 10 mi SE of Yost, *D. Atwood & S. Goodrich 8347* (BRY 229774!); Raft River Range, Dunn Canyon, Middle Fork, *Bassett Maguire & Arthur H. Holmgren 22187* (CAN 191098!, PH 813499!, PH 824361!, UC 711480!); **Summit Co.**, Ashley Forest, 65 % E slope, *Wallace M. Saling WMS-105* (RM 470982!); N slope of Uinta Mts., trail along Henry's Fork, S of Henry's Fork Campground, *E. Neese & J. Neese 15387* (BRY 260180!); Big Elk Lake, *B. Welsh & E. Neese 126* (BRY 199395!); **Salt Lake Co.**, Big Cottonwood Canyon, *A.O. Garrett 1505* (RM 52689!); **Tooele Co.**, Stansbury Mts., Big Creek Canyon, N-facing slope, *A. Taye & B. Wall 1172* (BRY 218650!); **Duchesne Co.**, Ashley Natl. Forest, Uinta Mts., Brown Duck Mt., 20 mi N (12 degrees) of Tabonia, 70 % S slope, *S. Goodrich & D. Atwood 16180* (BRY 227174!); **Wasatch Co.**, Wahsatch Mts., Alta, *Marcus E. Jones 13158 (= 1167)* (NDG 062513!/HG 45979!; PH s.n.!); Wasatch Co.: Wasatch Natl. Forest, Wasatch Mts., Hwy 152, vicinity of mile post 19, inside Redman Campground, *William Sm. Gruezo WM11444* (ALTA 92175!). **Utah Co.**, Aspen Grove, on trail to Mt. Timpanogos, *B. Welsh & S.L. Welsh 711* (BRY 221873! *p.p. mag.*); 1 mi above Little Basin, on trail Timpooneke Station to Mt. Timpanogos, *Bassett Maguire 17500* (WS 170193!); Mt. Timpanogos, *Fred Rowland 16973* (BRY 54921!); Mt. Timpanogos, below lower falls, *Decker 638* (BRY 15881!); Wasatch Mts., Mt. Timpanogos, *A.O. Garrett 5575* (BRY 15884!); Bridal Veil Falls, Provo Canyon, gravelly N-facing slope above the Falls, *S.L. Welsh 3393* (BRY 41762!); **Juab Co.**, c. 4 mi up Thomas Canyon, Basin Area, *R. Foster 6729* (BRY 185007!, RM 314437!); Upper Trout Creek Canyon, c. 3 mi W of BLM Register, *R. Foster 7360* (BRY 189076!); **Sanpete Co.**, Manti-La Sal Natl. Forest, Head of South Fork of Muddy Creek, *Mont E. Lewis 4396* (BRY 168735!); **Grand Co.**, La Sal Mts., *Edwin B. Payson & Lois B. Payson 4103* (RM 102250!, UC 275312!); **Sevier Co.**, Fishlake Natl. Forest, stream bank below Big Flat Ranger Station, *W. Leslie Robinette LR-112* (RM 470976!); **Wayne Co.**, Powell Forest, Aquarius Ranger Station, W of Boulder Top, *George W. Churchill C-9* (RM 470638!); **Piute Co.**, c. 4 mi W of Marysvale, *N.D. Atwood 3643* (BRY 102239!); Marysvale, *Marcus E. Jones 5900* (RM 14269!, RM 64002!); **Beaver Co.**, Fishlake Forest, Box Canyon below Tushar Ranger Station, W slope, *H.M.*

Christensen C-67 (RM 470614!); Tushar Mts., lake stream near Three Creeks Res., *A. Taye 2743* (BRY 277383!); Tushar Mts., Beaver River Canyon, *A. Taye 2694* (BRY 277307!); Tushar Range, Beaver Canyon, basalt talus slopes, *Bassett Maguire 17602* (CAN 191094!, PH 810065!, WS 170198! p.p. mag.); **Garfield Co.**, SC Boulder, 6 mi due N of Boulder, *E. Neese & S. White 3620* (BRY 172388!); SC Boulder, 10 mi due NNW of Boulder, *E. Neese & S. White 3372* (BRY 170227!); Uinta Forest, wash below Hub Ranger Station, easterly slope, *James A. Cahill 31* (RM 470969!). **Washington Co.**, Pine Valley Mts., Forsyth Creek, *Johnnie L. Gentry Jr. 2191 & Earl Jensen Jr.* (WS 268485!); Pine Valley Mts., Forsyth Canyon, 3 1/2 mi S of Pine Valley, *Frank W. Gould 1905* (ND 011135!, PH 824753!, RM 197008!, WS 156712!); Juab County, Mount Nebo, *P.A. Rydberg & C. Carlton 7736* (CAN 191105!, RM 59893!).

WASHINGTON. Okanogan Co., Okanogan Forest, Honeymoon Pass Area, 18 1/4 mi NE of Winthrop, *Ralph & Dorothy Naas 2546* (RM 470621!); Okanogan Forest, Washington Pass Area, 12 1/4 mi WSW of Mazama, *Ralph & Dorothy Naas 2736* (RM 470620!); **Snohomish Co.**, Cascade Mts., alpine slopes of Mt. Pugh, *J. William Thompson 14349* (ALTA 16939!, CAN 272383! *p.p.*, PH 832811! *p.p.*, UC 748824!, WS 152604!, WS 230550! *p.p. mag.*, CAN 191103! consists of *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, and so with the remainder of the specimens of those herbarium sheets marked with *pro parte/ pro parte magna*); **Kittitas Co.**, Cascades, Mt. Stuart, *A.D.E. Elmer 1194* (WS 26522!); **Pierce Co.**, Mt. Rainier Natl. Park, moist talus near Owyhigh Lakes, *J. William Thompson 8103* (PH 692754!, UC 470859!); **Yakima Co.**, Mt. Paddo, Wodan's Vale, SE side of Mt. Adams, *Wilhelm N. Suksdorf 6097* (WS 79775!); Mt. Paddo (Adams), *W.N. Suksdorf 38332* (CAN 191104!); Mt. Paddo (Adams), *W.N. Suksdorf 772* (WS 79776!).

WYOMING. Sheridan Co., Big Horn Mts., Little Goose Canyon, *Aven Nelson 8499* (RM 37039!); Big Horn Mts., Freeze Out Point, *Ronald L. Hartman 10256* (RM 347748!); Big Horn Mts., c. 5 air mi SE of Burgess Junction, c. 24 air mi WNW of Big Horn on Woodrock Road, *B.E. Nelson 4343* (RM 347754!); Sheridan Co.: Big Horn Mts. Natl. Forest, Hwy 14, c. 100 m W of mile post 66, *William Sm. Gruezo WM11380* (ALTA 91425!); Big Horn Mts. Natl. Forest, Hwy 14, on cut-side of road directly opposite Sibley Lake, *William Sm. Gruezo WM11385* (ALTA 91426!); Big Horn Mts., c. 36 air mi WNW of Ranchester, c. 24.5 air mi NW of Burgess Junction, just S of State line, *B.E. Nelson 4596* (RM 347753!); Big Horn Mts., c. 35 air mi W of Ranchester, c. 21.5 air mi NW of Burgess Junction, on NE side of Sheep Mt., *B.E. Nelson 4638* (RM 347752!); Big Horn Mts., c. 30 air mi W of Ranchester, c. 15.5 air mi NW of Burgess Junction on Boyd Ridge, *B.E. Nelson 4671* (RM 347751!); **Johnson Co.**, eastern slope of Big Horn Mts., headwaters of Clear Creek & Crazy Woman River, *Frank Tweedy 3023* (RM 38406!, WS 26639!); **Johnson Co.**, Big Horn Mts., c. 25 mi N of Lost Twin Lakes, c. 1.3 mi W of Darton Peak, c. 22 air mi WSW of Buffalo, *Gael Fonken 897* (RM 347749!); Johnson Co.: Big Horn Mts. Natl. Forest, Hwy 16, vicinity of mile post 44, c. 150 m from Deerhaven Lodge, *Picea* forest by roadside near creek, *William Sm. Gruezo WM 11373* (ALTA 91424!); **Big Horn Co.**, Doyle Creek, *Leslie N. Goodding 390* (RM 37041!, UC 892061!); Rocky Mt. Forest & Experiment Station, Big Horn Natl. Forest, Bear Creek, S & G, Bald Mt., 25% S slope, *Neland A. Kissinger Jr K-36* (RM 227284!, RM 402841!); Big Horn Natl. Forest, Hwy 14A, c. 2.7 km E of Pole Creek or c. 44 mi E of Lovell, *William Sm. Gruezo WM11391* (ALTA 91428!); Big Horn Natl. Forest, Hwy 14A, c. 2.7 km E of Pole Creek or c. 44 mi E of Lovell, *William Sm. Gruezo WM11395* (ALTA 91429!); Big Horn Natl. Forest, Hwy 14A, vicinity of mile post 38, N side of Observation Point (Scenic area), across road on alpine meadow, *William Sm. Gruezo WM11396* (ALTA 91430!); Big Horn Forest, along Bald Mt. road, W slope, *William J. Cochran C-142* (RM 402840!); Big Horn Mts., W slope of Baldy Pass, *J. Ewan 18708* (WS 192013!); Big Horn Mts., Middle Paint Rock Creek at timberline, c. 1.5 mi SW of Mistymoon Lake, c. 25 mi NNE of Ten Sleep, *Gael Fonken 1013* (RM 347679!); Big Horn Mts., c. 24.5 air mi NE of Lovell, c. 25 air mi NW of Burgess Junction, along Trout Creek in Cookstove Basin, *B.E. Nelson 4588* (RM 347689!); Big Horn Mts., Salt Creek just off US 14, c. 13 air mi ENE of Shell, c. 27.5 air mi ENE of Greybull, *B.E. Nelson 6536* (RM 347750!); Big Horn Mts., Salt

Creek just off U.S. 14; c. 13 air mi ENE of Shell, c. 27.5 air mi ENE of Greybull, *B.E. Nelson 6554* (RM 347688!); Big Horn Mts., moist swale S slope of Medicine Mt., *Louis O. Williams & Rua Williams 3256* (RM 177550!); in a wet meadow next to Ten Sleep Creek, *Thomas Nelson 141* (BRY 115135!); **Park Co.**, Beartooth Hwy, near Clay Butte Lookout, *Jean G. Witt 1389* (BRY 142234!, WS 184745!); near Lookout on Clay Butte, W of Beartooth Butte, *C.L. Porter & Marjorie N. Porter 5925* (PH 856801!, RM 222699!, UC 937427!); Beartooth Mts., Clarks Fork of Yellowstone River near mouth of Crazy Woman Creek, Shoshone Natl. Forest, *Louis O. Williams & Rua P. Williams 3676* (ND 011131!); **Yellowstone Natl. Park Co.**, Yellowstone Natl. Park, W side of Mt. Washburn, *A.A. Beetle 5183* (WS 188655!); Yellowstone, Mt. Washburn, dry hillside, *D.D. Condon 5698* (BRY 15893!); Yellowstone Natl. Park, Spring Creek, *Aven Nelson & Elias Nelson 6279* (RM 20773!, RM 169625!); Yellowstone Natl. Park, foot of Mt. Washburn, 2 mi above Dunraven Pass, *H.S. Conard 1583* (RM 101391!); Yellowstone Natl. Park, c. 5 mi W of East Gate Entrance, along sharp road bend; *William Sm. Gruezo WM11404* (ALTA 91427!); Yellowstone Natl. Park, c. 2 km N of Dunraven Pass peak, edge of road, *William Sm. Gruezo WM11408* (ALTA 91431!); Yellowstone Natl. Park, Mt. Washburn, dry hillside, *D.D. Condon 5711* (BRY 15892!); **Teton Co.**, Targhee Natl. Forest, 11 mi E of Driggs(Idaho), 1/2 mi S of Treasure Mt. Scout Camp, Teton Canyon, among boulders by slide below Medicine Falls, *Loran C. Anderson 576* (RM 254213!, UC M-249242!); Targhee Natl. Forest, 11 mi E of Driggs; Treasure Mt. Scout Camp, 6 mi up Teton Canyon from Idaho state boundary, open woods near Teton Creek, *Loran C. Anderson 560* (UC M-249244!); Targhee Forest, along dry gullies & water courses, *Claud C. Shannon 1* (RM 402981!); Gros Ventre Mts., Lower Slide Lake, *Robert Lichvar 574* (RM 315780!); Gros Ventre Mts., Granite Creek, *Robert Lichvar 591* (RM 315616!); Gros Ventre Mts., Sportsmans Ridge, open area above treeline, *Robert Lichvar 991* (RM 315627!); Gros Ventre Mts., Torquoise Lake, *Robert Lichvar 1196* (RM 315782!); Grand Teton Natl. Park, Teton Range, Holly Lake & Mt. Woodring area, W of Jenny Lake, *John Merkle 63-48* (RM 273966); W slope of Teton Range, in Alaska Basin, W- & N-facing slopes, *John Merkle 65-29* (RM 280106!); Bob Cat Ridge, *O.J. Munie 12* (RM 130057!); on Teton Mts., *Aven Nelson 957* (RM 4832!); rocky slope of Mt. St. John in Teton Natl. Park, *E. Perot Walker 2481* (PH/PENN s.n.!); Grand Teton Natl. Park, moraine of Teton Glacier, *Louis Williams 1022* (PH 682728!, RM 169923!); Grand Teton Natl. Park, moraine of Teton Glacier, *Louis Williams 1404* (RM 135278!, RM 142442!); Grand Teton Natl. Park, stream bank near Lake Solitude *Louis Williams 1705* (RM 169924!, WS 72560!); Teton Natl. Park, Cascade Canyon Trail, *Beryl O. Schreiber 1267* (UC 615412!); **Fremont Co.**, treeline S face of Pinacels on E side of Brook's Lake in northern Windrivers, *A.A. Beetle 11415* (WS 198795!); southern Wind River Mts., near Christina Lake, *C.L. Porter 5216* (RM 215261!); Wind River Range, subalpine on Two Ocean Mt., *John F. Reed, Beetle & Mildred S. Reed 2590* (RM 211626!); Continental Divide, rocky slope of Two Ocean Mt., *Louis Williams 1368* (RM 135277!); Wind River Range, Cony Mt., alpine tundra, *Richard W. Scott 327* (RM 275199!); **Sublette Co.**, Gros Ventre Mts., 15 mi NE of Bondurant, *Edwin B. Payson & Lois B. Payson 3018* (PH 602567!, RM 93862!); open sagebrush slopes, *Arthur H. Holmgren 16596* (RM 319218!); Wyoming Range, Bear Mt., 26 air mi WSW of Daniel, *John S. Shultz 374* (RM 313150!); **Carbon Co.**, Ferris Mts., second drainage W of Pete Creek, *Joseph Storto 302 & Thomas Wood* (RM 339690!); **Lincoln Co.**, Junction of Box Canyon Creek & Grey's River, *Geo. J. Goodman 5134* (RM 215556!); Wyoming Forest, Crow Creek, a fork of Greys River, S slope, *Schofield & Woods 206* (RM 402838!); Salt River Range, Smiths Fork Road at Switchback, above Smiths Fork River, *Orval C. Harrison 190* (RM 305058!); Tetons, Jackson's Hole, *Edwin B. Payson & Lois B. Payson 2301* (RM 88558!); Bridger Natl. Forest, S Fork of Swift Creek Canyon, 1/4 mi below Periodic Spring, 3 airline mi E of Afton, *Richard J. Shaw 3291* (BRY 261361!); Wyoming Forest, head N Fork Swift Creek, 20% S slope, *C.H. McDonald & A. Gardiner Mc & G-12* (RM 402839!). Wyoming, Little Goose Creek, *Aven Nelson 2356* (RM 7632!). **Ex hortus:** Collected in July 1964 from cultivated plants at the Botanical Garden, Copenhagen; these plants grown from seed sent in 1928 from Brno, Czechoslovakia. Voucher for count of 2n = 76 from root tips of seedlings of Copenhagen material. Counted by D. Kyhos & P. Raven. *R. Ornduff s.n.* (UC M-304163!).

Maguire studied the holotype of *Arnica ciliaris* Rydb. [*C.F. Sonne s.n.* (NY *s.n.*!)] and annotated it as a synonym of *Arnica chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire. However, this taxonomic judgment was not reflected in his revision (Maguire 1943) as *A. ciliaris* is not listed under *A. chamissonis* subsp. *foliosa* nor any of the other taxa recognized by him.

I have examined carefully the holotype and 2 'newly-discovered' isotypes of *A. ciliaris*, the latter sifted from the large material from the herbarium of the University of California (UC) and Notre Dame University (NDG/HG). Incidentally, one of the isotype specimens (*i.e.* UC 195680!) was overlooked by Maguire as type and considered only as ordinary material. Hence, this specimen was annotated by him as *A. longifolia* D.C. Eaton subsp. *myriadenia* (Piper) Maguire, quite contrary to his identification of the holotype (*vide supra*). The other isotype (NDG 062504/HG 45978!) which was unfortunately not examined by Maguire (as was the case for holotype material of arnicas described by E.L. Greene) bears the number "5" handwritten on an identical label as the one attached on the holotype sheet. Both specimens, however are genuinely identical to the holotype of *A. ciliaris*.

I completely disagree with Maguire's interpretation (*in sched.*) that *A. ciliaris* Rydb. is synonymous with *A. chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire. Apparently, Maguire's concept was adopted with minor modification by Ediger & Barkley (1978) when they treated *A. ciliaris* Rydb. as a synonym of *A. chamissonis* Less. subsp. *foliosa* (Nutt.) Maguire var. *andina* (Nutt.) Ediger & Barkley. The latter treatment is similarly erroneous.

In all likelihood, *A. ciliaris* Rydb. is none other than a robust ecotype of *A. longifolia* D.C. Eaton, and distinctly exhibits diagnostic characters of the latter, *e.g.* a) remarkably long, elliptic-lanceolate, acuminate leaves; b) subplumose tawny pappus; c) lanceolate and acuminate involucral bracts without any distint tuft of white hairs at inside apex; otherwise, a character clearly diagnostic of *A. chamissonis* , and d) presence of nearly membranous, long, sheath at bases of first and second lowermost cauline leaves.

Amongst the type material of taxa currently recognized in this study as synonyms of *A. longifolia*, the types of *A. ciliaris* are the ones that very closely resemble the holotype of *A. longifolia* (Fig. 27) as to over-all morphological appearance. The taller and more robust stature of the former suggests that the plants might have been growing in sufficiently moist, highly organic-rich and full-shaded habitat. Similar 'shade-form' collections are obtained from the Big Horn Mountain National Forest, Johnson County, Wyoming [*WM11373* (ALTA 91424!) and vicinity of Alpine Creek, Sawtooth National Forest, Blaine County, Idaho [*WM11425* (ALTA 92178!) + *WM 11430* (ALTA 92177!)]. In the former site, *A. longifolia* D.C. Eaton is found growing on loose loam soil thickly covered with decaying vegetative matters under the shade of *Picea* trees and in association with *Ribes* sp., *Mertensia ciliata* (James) G. Don [*WM11374* (ALTA!)], *Arnica cordifolia* W.J. Hook., *Rosa acicularis* [*WM11376* (ALTA!) and *Epilobium* sp., among others. In the latter locality, the plants were similarly growing on moist soil covered with decaying plant debris in *Pinus* forest floor as well as along edge of small, intermittent slough and grass-covered swamp in association with species of *Senecio triangularis* Hook. [*WM s.n.* (ALTA!)], *Carex* spp., *etc.* In those habitats, the thick and woody caudices typical of plants found in well-drained or drier, stonier sites are replaced with extensive rhizome formation reminiscent of those commonly present in *A. chamissonis* Less. Apparently, this reversal to rhizomatous condition indicates that *A. longifolia* D.C. Eaton is closely allied to *A. chamissonis* Less. and probably have been derived from the latter taxon.

An interesting collection, *WM11444* (ALTA 92175!), from Wasatch Mountains, Wasatch National Forest (inside Redman Campground) is evidently the first record for Wasatch County, Utah. For previous county records for Utah, see Welsh (1983) & Welsh *et al.* (1987).

Arnica arcana A. Nels. is a taxon that has been placed as synonym under 2 different species by Maguire (1943). Firstly, it was cited as a taxonomic synonym of *A. gracilis* Rydb. (Maguire 1943, p. 441). The holotype of *A. arcana* A. Nels. was assessed by Maguire (1943) as "a biotype of considerable distinction". He then alluded this variant as having superficial resemblance to *A. longifolia* D.C. Eaton as to its large size, but its sparse long-stipitate-glandular pubescence made Maguire (1943) to consider it as more closely resembling *A. mollis* Hook. He further hypothesized the possibility of natural hybridization between any of these 2 species with which *A. arcana* A. Nels. has resemblance. Secondly, *A. arcana* A. Nels. has been cited as synonym of *A. longifolia* D.C. Eaton subsp. *genuina* Maguire (Maguire 1943, p. 469). In this instance, no rationale for the treatment was given and there was no reference to his earlier discussion of the morphological variability of its holotype (*vide supra*). Cronquist (1955) also treated *A. arcana* A. Nels. as synonym of *A. longifolia* D.C. Eaton. On the other hand, Ediger & Barkley (1978) placed *A. arcana* A. Nels. under *A. lonchophylla* Greene. The latter taxon has been thoroughly studied by Downie (1987) and Downie & Denford (1988, in press) who, in contrast to Ediger & Barkley (1978) but which in agreement with Maguire (1943), recognize 2 subspecies, namely: *A. lonchophylla* Greene subsp. *lonchophylla* and *A. lonchophylla* Greene subsp. *arnoglossa* (Greene) Maguire. It is under the latter subspecies that Downie (1987) and Downie & Denford (1988, in press), unabled to examine any type specimens, doubtfully placed *A. arcana* A. Nels. as synonym following the treatment by Ediger & Barkley (1978). Despite of the fact that *A. arcana* A. Nels. was cited by Maguire (1943) as synonym of *A. gracilis* Rydb., Wolf (1981) and Wolf & Denford (1984c) made no mention of its taxonomic status or relationship with respect to *A. gracilis* Rydb., a taxon which they recognize as a natural hybrid (Wolf & Denford 1984b) worthy of species rank.

I have examined carefully the holotype of *A. arcana* A. Nels. [*Leslie N. Goodding 377* (RM 41751!), rock crevices of Doyle Creek, Big Horn Mountains, Wyoming] and consider this taxon as an ecotypic variant of *A. gracilis* Rydb. The relatively taller and more robust stature of the type material was due to the moister, possibly fertile and shaded site where it was growing, in contrast to the usual dry, exposed rocky alpine slope or ridge habitat (Maguire 1943, Wolf 1981, Wolf & Denford 1984). One additional character that seems to confuse proper taxonomic evaluation of this taxon is the presence of barbellate to subplumose stramineous pappus, a trait which was noted earlier by Rydberg (1927). In comparison, Wolf (1981) and Wolf & Denford (1984c) describe the pappus of both ray and disc florets of *A. gracilis* Rydb. as merely "white, barbellate", while Maguire (1943) states that it is "creamy-white, or occasionaly straw-colored, mostly shorter than the corolla, barbellate" (p. 442). There is no doubt, however that the holotype of *A. arcana* A. Nels. has barbellate to ±subplumose stramineous (light-brown or straw-colored) pappus. Additional collections that approach the morphology of this variant and likewise exhibit the same pappus character but unmistakably belong to *A. gracilis* Rydb. are as follows: a) *Richard J. Shaw 2363* (BRY 234322!) from Rimrock Lake, Prospector Mountain, Grand Teton National Park, Wyoming and b) *Betsy Neely 1645 & Frank Smith* (BRY 300901!) from McLaren Mine, 0.5 mile N of Daisy Pass, Montana. Incidentally, in *Arnica* subgenus *Austromontana*, there are 2 other species that exhibit similar pappus character, namely: *A. nevadensis* A. Gray (Maguire 1943, Wolf 1981, Wolf & Denford 1984c) and *A. viscosa* A. Gray (Wolf 1981, Wolf & Denford 1984c). *Arnica gracilis* Rydb. is therefore, the third species in this subgenus to have populations exhibiting stramineous ±subplumose pappus, in addition to the more common white barbellate type.

The holotype of *A. arcana* A. Nels. does not resemble in any way *A. longifolia* D.C. Eaton nor *A. mollis* Hook. However, it shows some morphological resemblance to *A. ovata* Greene, specifically the less dentate or nearly entire, more ovate-leaved populations (*cf.* holotype of *A. ovata* Greene, see Fig. 16).

6. **Arnica lanceolata** Nutt. subsp. **amplexicaulis** (Nutt.) Gruezo *comb. et stat. nov.* Basionym: *Arnica amplexicaulis* Nutt., Trans. Amer. Phil. Soc. II, 7: 408, 1841; T. Howell, Fl. NW Amer. 1: 373, 1900; H.M. Hall & C.C. Hall, A Yosemite Flora, p. 264, 1912; C.V. Piper & R.K. Beattie, Fl. NW Coast, p. 385, 1915; F.J. Smiley, Univ. Calif. Publ. Bot. 9: 386, 1921; S.F. Blake *in* I. Tidestrom, Contrib. U.S. Nat. Mus. 25: 606, 1925; G.N. Jones, Univ. Wash. Publ. Biol. 7: 166, 1938; E. Hulten, Lund Univ. Arsskr. N.F. Avd. II, 46: 1589, 1950; A. Cronquist *in* R.J. Davis, Flora of Idaho, p. 687, 1952; E.H. Moss, Flora of Alberta, 1st ed., p. 446, 1959; J.P. Anderson, Flora of Alaska & adjacent parts of Canada, p. 495, fig. 1052, 1959; A. Cronquist *in* R. Ferris, Illus. Fl. Pac. States 4: 420, fig. 5721, 1959; E. Hulten, Flora of Alaska & Neighboring Territories, p. 919, 1968; A. Cronquist *in* C.L. Hitchcock & A. Cronquist, Fl. Pac. NW, p. 484, fig. 3b, 1973; S.L. Welsh, Anderson's Flora of Alaska & adjacent parts of Canada, p. 118, 1974; W.J. Ferlatte, Flora of Trinity Alps N. Calif., p. 38, 1974; R.I. Ediger & T.M. Barkley, N. Am. Fl. ser. II, pt. 10, p. 23, 1978; H.J. Scoggan, Fl. Canada, pt. 4, p. 1474, 1979; H. Gilkey & L.R.J. Dennis, Handbook NW Plants, p. 451, 1980; J.G. Packer, Moss's Flora of Alberta, 2nd ed. (revised), p. 536, map 1010, 1983.

Arnica amplexifolia Rydb., Mem. N.Y. Bot. Gard. 1: 434, 15F, 1900. = *Arnica amplexifolia* Rydb. subsp. *genuina* Maguire, Madrono 6: 154, 1942 (*nomen illegit.*, ICBN 1983); = *Arnica amplexicaulis* Nutt. subsp. *genuina* (Maguire) Maguire, Brittonia 4(3): 472, 1943. **TYPE**: OREGON, on the rocks of the Wahlamet at the Falls, *Nuttall s.n.* (HOLOTYPE, BM *s.n.*!, UC 693864! PHOTO of BM; ISOTYPE, GH *s.n.*!, UC 658883! PHOTO 339 & 340 of GH). (Fig. 30; Generalized illustration, Fig. 31).

A. macounii Greene, Pittonia 4: 160, 8D, 1900; C.V. Piper & R.K. Beattie, Fl. NW Coast, p. 385, 1915; G.N. Jones, Univ. Wash. Publ. Biol. 7: 166, 1938. **TYPE**: BRITISH COLUMBIA, Vancouver Island, vicinity of Comax 1 July 1893, *J.M. Macoun Geol. Surv. Can. 478* (HOLOTYPE, NDG 062519/HG 45984!; ISOTYPES, CAN 109648!; UC 658884! PHOTO 344, 345 & 346 of CAN 109648, UC 658884! PHOTO 341, 342 & 343 of K).

Arnica amplexifolia Rydb. subsp. *prima* Maguire, Madrono 6: 154, 1942; = *Arnica amplexicaulis* Nutt. subsp. *prima* (Maguire) Maguire, Brittonia 4(3): 472, 1943. = *Arnica amplexicaulis* Nutt. var. *prima* (Maguire) Welsh, Great Basin Nat. 28(3): 149, 1968. **TYPE**: ALASKA, Kodiak, 28 August 1867, *A. Kellogg 231* (HOLOTYPE, PH, UC 658882! PHOTO 335 of PH; ISOTYPES, GH *s.n.*!, MO 145764!; UC 658882! PHOTO 336, 337 & 338 of GH s.n.).
TYPE: ALASKA, Kodiak, 27 August 1867, *A. Kellogg 290* (Paratype, MO 145763!):

Arnica aspera Greene, Ottawa Nat. 15: 281, 1902. C.V. Piper & R.K. Beattie, Fl. NW Coast, p. 386, 1915; G.N. Jones, Univ. Wash. Publ. Biol. 7: 166, 1938. = *Arnica macounii* Greene subsp. *aspera* (Greene) G.N. Jones, Univ. Wash. Publ. Biol. 5: 256, 1936. = *Arnica mollis* Hook. var. *aspera* (Greene) B. Boivin, Phytologia 23(1): 98, 1972. TYPE: WASHINGTON: Mt. Rainier, 19 Aug. 1889, *Edw. L. Greene s.n.* (HOLOTYPE, NDG 062408/HG 46821!, "fig. 2 is my type of *Arnica aspera* (E.L.G. 5 Sept. 1900); fig. 1 may perhaps be *A. amplexicaulis* Nutt. I doubt if it is with fig. 2"; ISOTYPES, US 42077!, UC 658885! PHOTO 347 of US 42077, UC 658885! PHOTO 348 & 349 of DS 72013).

Arnica hirticaulis Rydb., N. Amer. Fl. 34: 350, 1927. TYPE: WASHINGTON, Skamania County, Crooks, 9 July 1909, *Wilhelm N. Suksdorf 6648* (HOLOTYPE, NY *s.n.*!, UC 658862! PHOTO 350 of NY *s.n.*;ISOTYPE, WS 79759!, UC 658862! PHOTO 351 & 352 of WS 79759; UC 658862! PHOTO 353, 354 & 356 of UTC; UC 658862! PHOTO 357 of NY *s.n.*).

Arnica filipes Greene ex Rydb., N. Amer. Fl. 34: 350, 1927. TYPE: BRITISH [illegible]LUMBIA, Chilliwack River, Selese Creek, 4 August 1905, *W. Spreadborough Geol.* [illegible]*v. Canada 77025* (ISOTYPES, CAN 109650!, UC 658861! PHOTO 361, 362 & 363 of [illegible]N 109650; UC 658861! PHOTO 358, 359 & 360 of US 1240762).

[illegible]*a elongata* Rydb., N. Amer. Fl. 34: 350, 1927. TYPE: BRITISH COLUMBIA. [illegible]tains south of Chilliwack River, 25 July 1906 *W. Spreadborough Geol. Surv. Canada* [illegible] (HOLOTYPE, CAN 109657!; UC 658860! PHOTO 369, 370 & 371 of CAN 109657; [illegible]PE, WS 31387!; UC 658860! PHOTO 372, 373 & 374 of WS 31387).

[illegible]*alis* Rydb., N. Amer. Fl. 34: 351, 1927. = *Arnica amplexifolia* Rydb. subsp. [illegible]*guina* Maguire var. *borealis* (Rydb.) Maguire, Madrono 6: 154, 1942. TYPE: ALASKA, Juneau, 10 July 1917, *J.P. Anderson 614* (HOLOTYPE, NY *s.n.*!).

Arnica amplexicaulis Nutt. var. *piperi* St. John & Warren, Proc. Biol. Soc. Wash. 44: 36, 1931; A. Cronquist *in* C.L. Hitchcock & A. Cronquist, Fl. Pac. NW, p. 484, 1973. = *Arnica mollis* Hook. var. *piperi* (St. John & Warren) B. Boivin, Phytologia 23(1): 98, 1972. TYPE: WASHINGTON, Cape Horn, 26 June 1904, *C.V. Piper 4692* (HOLOTYPE, WS 26507!, UC 658886! PHOTO 368 of WS 26507; ISOTYPE, UC 658886! PHOTO 364, 365 & 366 of US 527543). TYPE: WASHINGTON, Cape Horn, *C.V. Piper 5009* (PARATYPE, UC 658886! PHOTO 367 of US 527617).

Arnica trina A. Nelson, Amer. J. Bot. 21: 581, 1934. = *Arnica amplexifolia* Rydb. var. *trina* (A. Nelson) Maguire, Rhodora 41: 507, 1939. TYPE: MONTANA, Glacier National Park, Lake Josephine, margin of woodland, alt. 4880 ft, 2 August 1932, *Bassett Maguire 1095* (HOLOTYPE, RM 135047!; UC 658859! PHOTO 378, 379 & 380 of RM). TYPE: MONTANA, Glacier National Park, Elrod Lake, occurring commonly, associated with *Tofieldia intermedia* Rydb., *Allium sibiricum* L., & *Habenaria dilatata* (Pursh) Hook. in meadow near shore, alt. 5300 ft, 28 July 1932, *Bassett Maguire 1094* (PARATYPES, GH *s.n.*!, RM 135046!).

Plants (2-) 3-6 (-8) dm high arising from coarse thick woody freely rooted caudices; *stems* few to many in loosely to tightly formed clumps or tufted, usually branched at midstem and inflorescence, nearly glabrous to sparsely or moderately pubescent with short or long white or translucent multiseptate hairs, often with many short- or long-stipitate glands; *basal* *leaves* 1-2 pairs, large, oblong to narrowly lanceolate or oblanceolate, rarely ovate, sessile or subsessile to long-petiolate, commonly withered at anthesis, subentire or sparsely denticulate to prominently dentate-serrate; *cauline leaves* (4-) 5-8 (-10) pairs, broadly ovate to narrowly or broadly lanceolate-elliptic, (4-) 5-10 (-12) cm long x (1-) 2-6 (-8) cm wide, sessile or with partly connate-sheathing base, subentire or distantly denticulate to conspicuously dentate-serrate, sparingly to densely pilose with short and long white or translucent multiseptate hairs, uppermost pairs slightly reduced; *capitula* (3-) 5-9 (-20), narrowly campanulate to often turbinate, (10-) 12-14 (-16) mm high; *periclinium* short, narrow, sparsely to moderately pilose with short and long white or translucent hairs mixed with short- or long- stipitate glands; *involucral bracts* (8-) 10-14 (-19), narrowly lanceolate, (8-) 10-12 (-14) mm long x 2-3 mm wide, acute to acuminate, sparingly to moderately pilose throughout with short or long translucent or white hairs, also with few to many short-stipitate glands; *ligulate florets* (5-) 7-12 (-17), usually lemon-yellow to pale yellow, broadly oblong-elliptic, (12-) 15-20 (-23) mm long x (4-) 6-7 mm wide, its apex mostly shallowly bidentate or unequally tridentate; *disc florets* (30-) 40-55 (-125), pale to deep yellow, narrowly tubular or funnelform to goblet-shaped, (5-) 7-9 (-11) mm long, lower part of tube scantily to moderately pilose with short simple white or translucent hairs, slightly constricted at midportion with distinct denser band of similar hairs; *achenes* (40-) 50-95 (-140), round- to slightly angular- cylindric, 4-5 (-6) mm long, light to chestnut brown, sparsely hirsutulous with simple or bifid brownish hairs or uniformly scantily short-stipitate glandular; *pappus* of (22-) 25-29 (-33) bristles, tawny to brown with deep amber-like deposits inside setae, distinctly subplumose, very rarely barbellate. *Chromosome number*, 2n = 38, 57, 76.

ECOLOGY AND DISTRIBUTION. The two geographic subspecies of *Arnica lanceolata* Nutt. have virtually similar ecological preferences. Both subspecies greatly abound where there is always a sufficient or a steady supply of moisture throughout the growing season. Specifically, *A. lanceolata* Nutt. is commonly abundant at lower elevations (0-2000 ft) on swampy or marshy grounds within high tide reach, alluvial shores, gravel bars and beaches, muskegs along river trail and along stream and river deltas. With increasing elevation

Figure 30. Holotype of *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo. [Oregon, on the rocks of the Wahlamet at the Falls, *Nuttall s.n.* (BM *s.n.*!)].

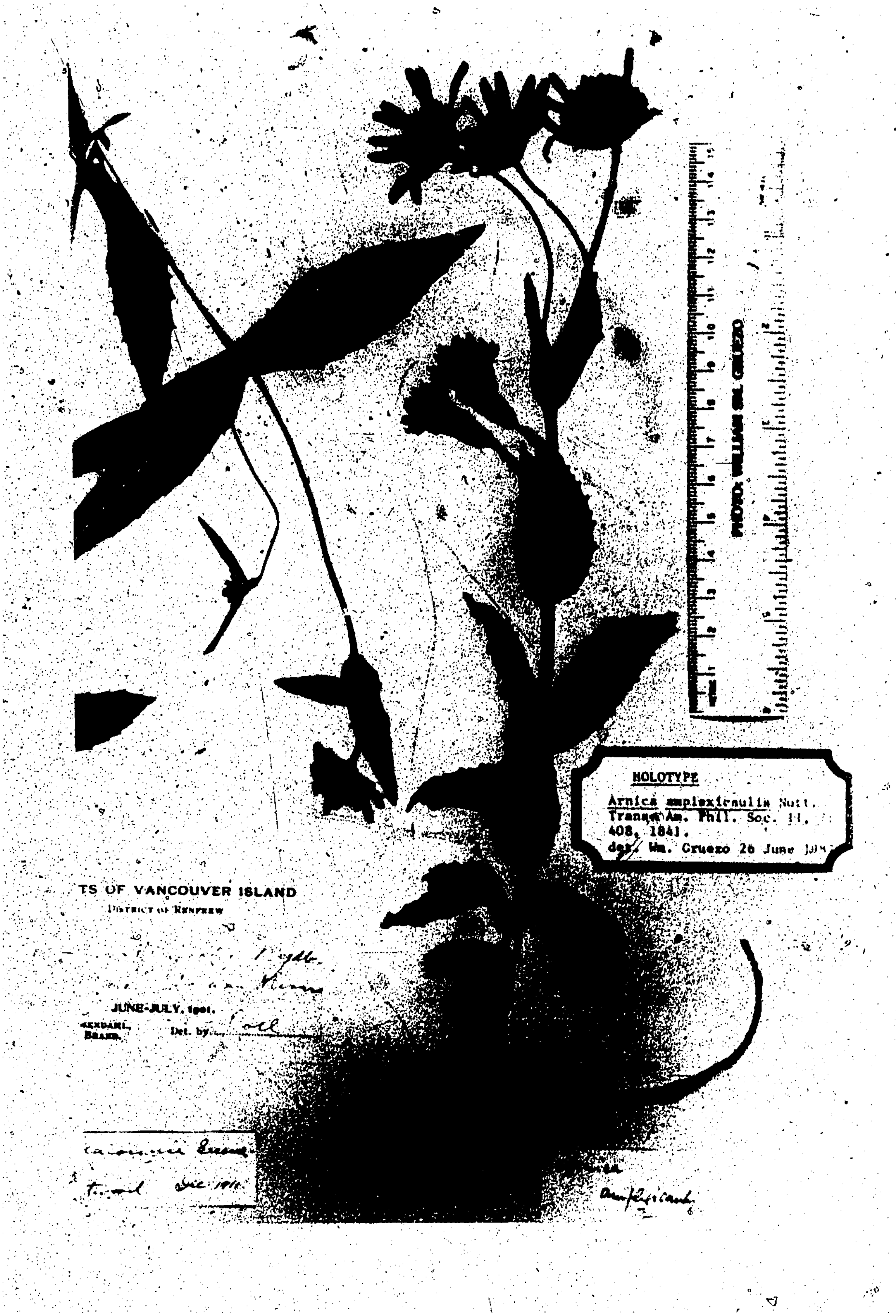
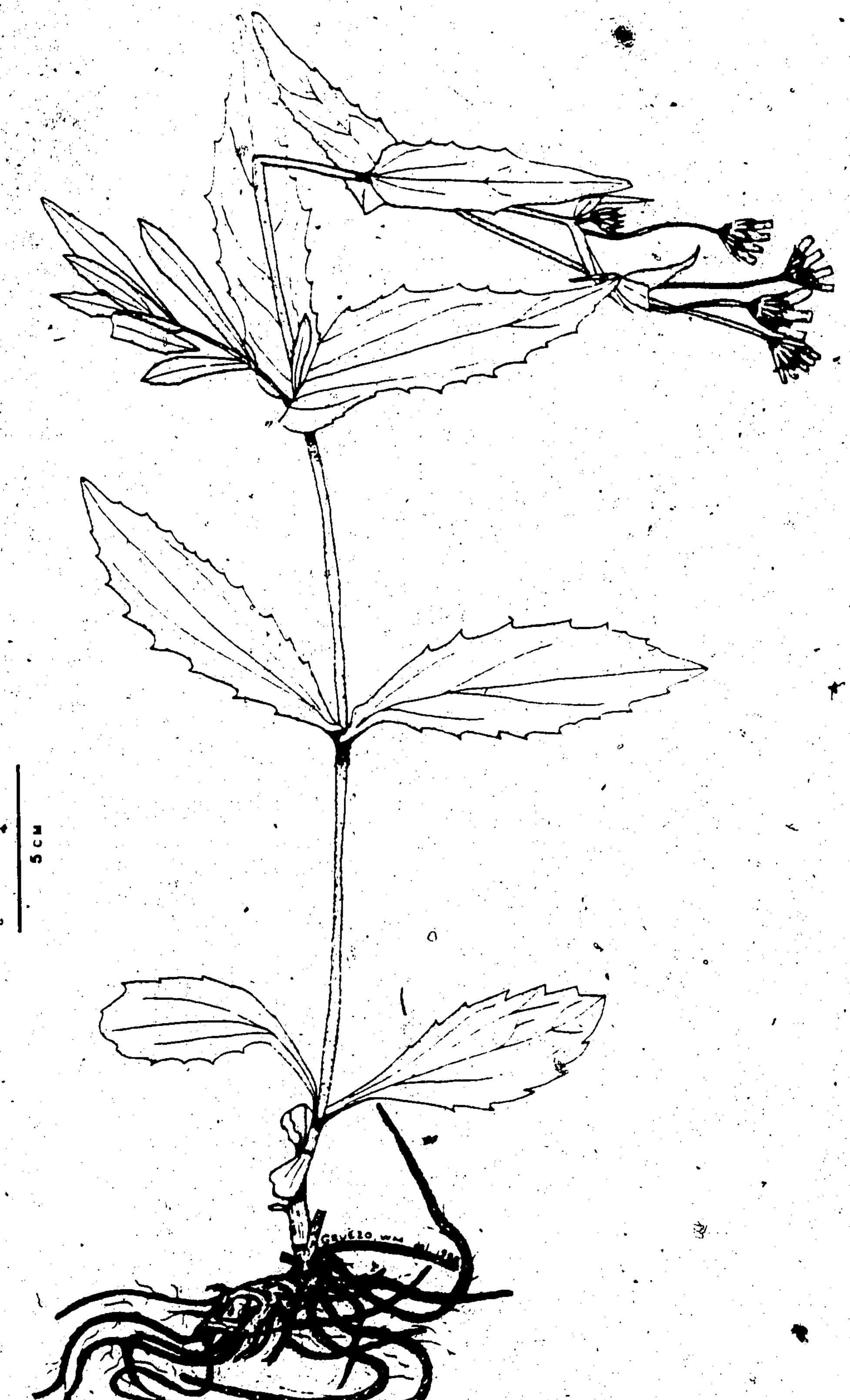

HOLOTYPE
Arnica amplexicaulis Nutt.
Trans. Am. Phil. Soc. II,
408, 1841.
TS OF VANCOUVER ISLAND
DISTRICT OF RENFREW
JUNE-JULY, 1901.
Det. by

Figure 31. Habit and morphology of *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo. [Alberta: Waterton Lakes National Park, vicinity of Cameron Lake, NW portion of lake, inside *Picea mariana* forest, on boggy soil and small stream, alt. 1676 m (= 5500 ft), 23 August 1985, *William Sm. Gruezo WM11616*. (ALTA!, WGRZ!)].


5 CM

(4000-10,200 ft), this taxon flourishes on moist rocky bottom of canyons and cliffs or headwalls of ravines, crevices of rocky cliffs and ledges within sprays of waterfalls, bogs and swamps in gaps of conifer (*e.g.* lodgepole pine-spruce) forests, and in moist mossy edges and sandy meadows of mountain lakes.

In subalpine and alpine zones, this species occupies snow-melt fed rock slides and talus slopes, spring draws, swampy meadows and slopes as well as among rocks below snowbeds and glaciers.

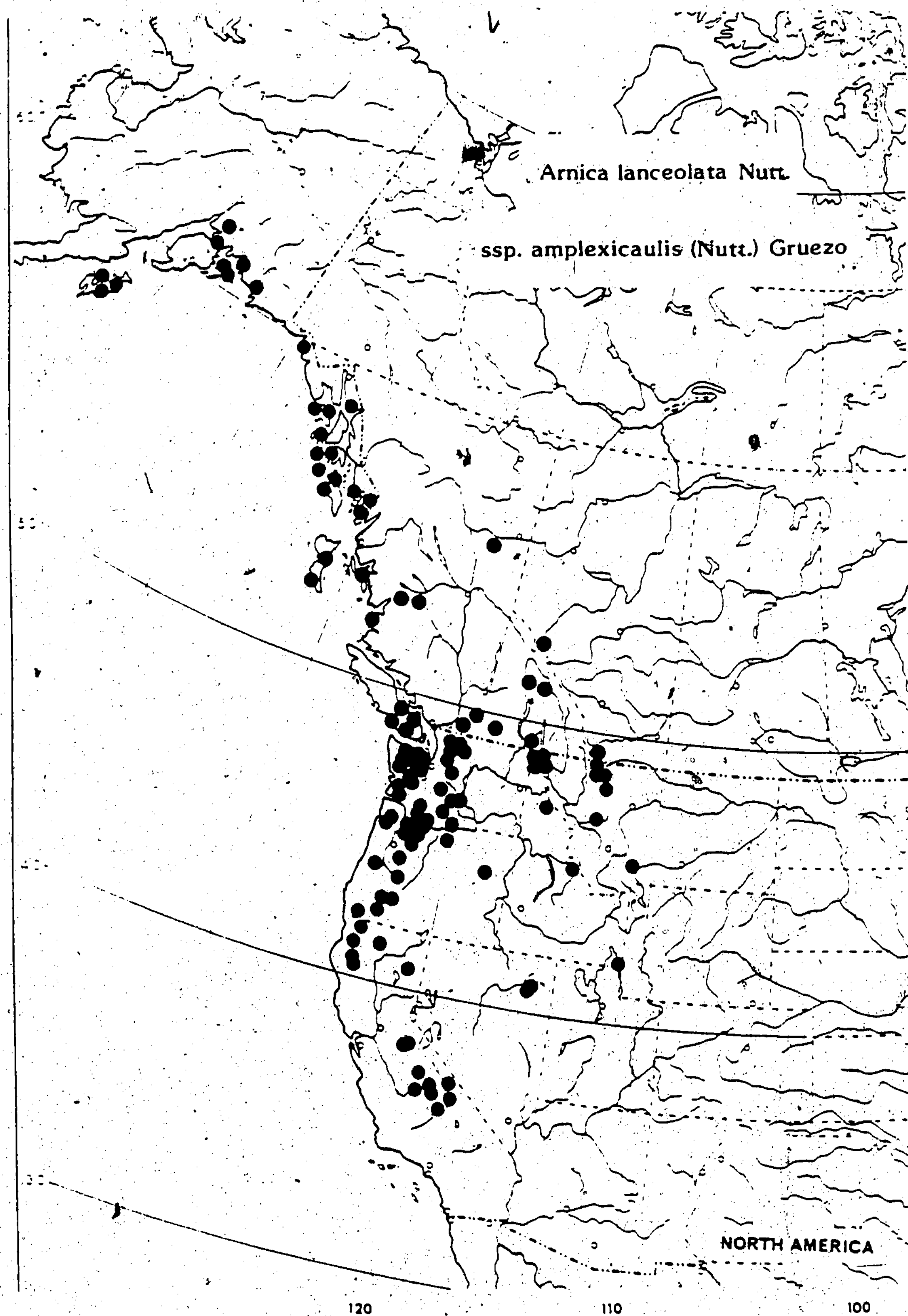
Persistently growing on protected and stable banks of watercourses (*e.g.* brooks, streams, rivers, *etc.*), it is one of the more remarkable components of riparian vegetation at both lower and higher altitudes, throughout its range (Fig. 32).

The flowering period of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo is from early May to late September. It thrives well from sea level to as high as 3,100 m.

SPECIMENS EXAMINED: CANADA. ALBERTA. Jasper National Park, Mt. Edith Cavell, snowbed slope *A.E. Porsild 21118* (CAN 288123!). **Waterton Lakes National Park**, *J. Nagy & W. Blais 2337* (ALTA 82479!); *G. Armstrong & J. Nagy 4542* (ALTA 82477!, CAN 346995!, WTON 3412!); *G. Armstrong & J. Nagy 5064* (CAN 346900!); *G. Armstrong & J. Nagy 5018* (CAN 346901!); *N.A. Skoglund s.n.* (SASK 38858!); es *August J. Breitung 16930* (ALTA 16835!); *J. Nagy & G. Armstrong 4746* (ALTA 82476!, CAN 346921!); *J. Nagy 2669* (ALTA 82439!, CAN 349727!); *R.M. Anderson s.n.* (CAN 109633!, UC 892034!); *S.S. Survey 1275* (ALTA 16840!); *W.C. McCalla 3695* (ALTA 68724!); *W.C. McCalla E3972* (ALTA 68723!); *W.C. McCalla 7177* (ALTA 68725!); *Keith Shaw 2335* (BRY 126802!); *E.H. Moss 3011* (ALTA 16836!); *S.S. Survey 491* (ALTA 16842!); *M.O. Malte & W.R. Watson 2667* (CAN 292628!); *J. Nagy 2805* (CAN 340725!); *E.H. Moss 12094* (ALTA 16838!); *R.H. Dixon s.n.* (ALTA 16844!); *S.S. Survey 325* (ALTA 16841!); *S.S. Survey 602* (ALTA 16843!). *Kananaskis*, *Macoun Geol. Surv. Canada 73014* (CAN 109625!); *Macoun Geol. Surv. Canada 65514* (CAN 109632!); *Macoun Geol. Surv. Canada 14715* (CAN 109627!).

BRITISH COLUMBIA. Queen Charlotte Islands, *Dawson Geol. Surv. Canada 14692* (CAN 109660!); Queen Charlotte Islands, Graham Island, *J.A. Calder & R.L. Taylor 36935* (WS 263713!); Queen Charlotte Islands, Moresby Island, *J.A. Calder & R.L. Taylor 23586* (UC 1332658!); *T.T. McCabe 3534* (UC 564326!); Fitzhugh Sound, *T.T. McCabe 3116* (UC 551016!) Rocky Mountains near Pine Pass, *H.J. Scoggan 16381* (CAN 307513!); Mt. Fougner at Bella Coola, *J.A. Calder, J.A. Parmelee & R.L. Taylor 20373A* (WS 234533!); *T.T. McCabe 1530* (UC 542868!); *Macoun Geol. Surv. Canada 14717* (CAN 109655!); Selkirk Glacier, *Stewardson Brown 645* (PH 529824!); Selkirk Mts., Asulcan Creek, *Macoun Geol. Surv. Canada 65516* (CAN 109652!); Eight miles north of Revelstoke, Silvertip Falls of 8-Mile Creek, *T.T. McCabe 5451* (UC 576251!); Mount Revelstoke National Park, between Millar Lake and Jade Lake, *J.H. Soper 12498, M.J. Shchepanek & A.F. Szczawinski* (CAN 342317!); Rocky Mountains, Kootanie (South) Pass, *Dawson Geol. Surv. Canada 14718* (CAN 109629!); Bald Mountain, Glacier Park, *John M. Fogg Jr. 1321* (PH *s.n.*!) Glacier,

Figure 32. Geographical range of *Arnica lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo.


Arnica lanceolata Nutt.
ssp. amplexicaulis (Nutt.) Gruezo
NORTH AMERICA
120
110
100

Edith M. Farr s.n. (PH 37780!, PH 37782!); Valley of the Lower Kicking Horse River, Palliser to Glenogle, *Stewardson Brown 783* (PH 529823!). **Vancouver Island**, Renfrew District, Mt. Edinburgh, *A.M. Johnson 1717* (UC 892038!); Vancouver Is., Comax District, Shaskeona Park, *W.B. Anderson 681* (WS 46314!); Vancouver Is., 4 miles NE of Sarita along Sarita River, 4 *J.A. Calder & K.T. MacKay 30362* (UC M-235063!); Vancouver Is., Lourchau Lake, *W. Spreadborough Geol. Surv. Canada 96038* (CAN 109662!); Vancouver Is., Mt. Mark, *Macoun Geol. Surv. Canada 14714* (CAN 109641!); Vancouver Is., Koksilah, *John Macoun Geol. Surv. Canada 88381* (CAN 109647!); Vancouver Is., Moat Lake, Forbidden Plateau, *J.A. Calder & K.T. Mackay 32286* (SASK 22217!); Vancouver Is., Albuni Canal, Chinaman's Creek, *Macoun Geol. Surv. Canada 14716* (CAN 109653!); Vancouver Is., Nanaimo & vicinity, *H.J. Scoggan 15306* (CAN 307125!); Vancouver Is., Mt. Arrowsmith, *J.H. Soper 12303, M.J. Shchepanek, A.F. Szczawinski & T.M.C. Taylor* (CAN 343483!); Vancouver Is., Renfrew District, Gordon River, *C.O. Rosendahl & Carl J. Brand 83* (CAN 109659!, RM 35259!, UC 34213!, UC 892039!); Chilliwack Lake, *W. Spreadborough Geol. Surv. Canada 77008* (CAN 109663!); Chilliwack Lake, *W. Spreadborough Geol. Surv. Canada 77026* (WS 31383!); Chilliwack Lake, *W. Spreadborough Geol. Surv. Canada 77027* (CAN 109644!); Chilliwack River, *J.M. Macoun Geol. Surv. Canada 26927* (CAN 109638!); Chilliwack River, *J.M. Macoun Geol. Surv. Canada 26930* (CAN 109640!); Chilliwack River, *W. Spreadborough Geol. Surv. Canada 77006* (CAN 109656!); Chilliwack River, *W. Spreadborough Geol. Surv. Canada 77010* (CAN 109634!, WS 31384!); mountains south of Chilliwack River, *W. Spreadborough Geol. Surv. Canada 77004* (CAN 109649!); mountains south of Chilliwack River, *W. Spreadborough 77009* (CAN 109637!); mountains south of Chilliwack River, *W. Spreadborough Geol. Surv. Canada 77028* (CAN 109646!, WS 31382!); mountains south of Chilliwack River, *W. Spreadborough Geol. Surv. Canada 77029* (CAN 109645!; WS 31381!); Chilliwack Valley, *J.M. Macoun Geol. Surv. Canada 26927* (NDG 062520/HG 45983!); Chilliwack Valley, *J.M. Macoun Geol. Surv. Canada 26928* (NDG 062518/HG 45985!); Chilliwack Valley, Middle Creek, *J.M. Macoun Geol. Surv. Canada 26929* (CAN 109654!, NDG 062517/ G 45986!); Chilliwack Valley, *J.M. Macoun Geol. Surv. Canada 26930* (NDG 062470/HG 46778!); Skagit Valley, *J.M. Macoun Geol. Surv. Canada 69319* (NDG 062599!); Skagit River, Lake House, *J.M. Macoun Geol. Surv. Canada 69319* (CAN 109651!); Skagit River, *J.M. Macoun Geol. Surv. Canada 69332* (CAN 109639!); Cascade Range, near head of McGillivray Creek, *J.M. Macoun Geol. Surv. Canada 96039* (CAN 109636!); Ymir District, Salmon River, *W.C. Sandercock Geol. Surv. Canada 89944* (CAN 109661!).

U.S.A. **ALASKA**. Gold Creek Canyon about half way to Perseverance, *Maxcine Williams 1934* (BRY 61340!); Copper River Delta, in muskeg along Eyak River Trail, *John H. Crow s.n.* (WS 271545!); Valdez Township, c. 4 miles from Valdez along Prince William Sound shore, near edge of Gold Creek River *Bee Cumby 271* (ALA V071842!); **Evans Is.**, Port San Juan, *W.J. Eyerdam 7337* (WS 224272!); Evans Is.(?), head of Port Nell (?) or San Juan (?), *Edmund Heller 49* (UC 146298!); **Kodiak Is.**, Three Saints Bay, *W.J. Eyerdam 366* (UC M-094251!); Kodiak Is., Old Harbour, *W.J. Eyerdam 637* (UC M-094250!); Mainland, Le Conte Bay, *Mr. & Mrs. Ernest P. Walker 880a* (RM 85634!); Yakutat area, *Rhoda Thomas 11* (ALA 28429!) Yakobi Is., W. Coast, Surge Bay Lake, *Mary Clay Muller 4957* (BRY 239675!) Chichagof Is.(NE part), Tongass National Forest, road from Hoonah north to White Alice, *Mary Clay Muller 3367* (ALA 87231!, BRY 217176!); Port Frederick, head of Neka Bay, *Mary Clay Muller 4854* (ALA V76076!); Tongass National Forest, Slocum Inlet near Khaz Island, *Jim Downs 129* (ALA V073013!) Juneau, mountainside, *J.P. Anderson 6400* (ALA 1824!, ALA 35176!, CAN 109666!, RM 190709!) Baranof Is.(south 1/3), Tongass National Forest, north end of Plotnikof Lake, *Mary Clay Muller 3141* (ALA 87575!) Sitka, *Barclay Geol. Surv. Canada 14693* (CAN 109667!); Sitka, Blue Lake Trail, *L.G. Smith 125* (BRY 88462!) Port Alexander Quad, Rezanof Lake, *R. Kacyon s.n.* (ALA 94428!) Kuiu Is., Washington Bay, *W.J. Eyerdam 8004* (WS 223839!) Kosciusko Is., South Tongass Forest, along Charley Creek near falls, *Wayne Robuck 1329* (RM 470613!) Prince of Wales Is., near gravel road to Thorne Bay, *Helen Schmuck 322* (BRY 263204!); Tongass, Prince of Wales Is., Control Lake Intersection toward Craig, *Linda Vorobik 98* (ALA 87801!) Wards Cove near

Ketchikan, *F.W. Went 143* (UC 533861!) Misty Fjords National Monument, north of Big Goat Lake, *Linda Vorobik 385, Ker Rice & Kathy Lucich* (ALA V072829!) Hyder, *T.T. McCabe 8493* (UC 662023!) Evans Is., Port San Juan, *W.J. Eyerdam 5983* (CAN 125364!, CAN 154963!, WS 223404!); Evans Is., Port San Juan, *W.J. Eyerdam 7119* (WS 224380!) Kodiak Is., Kodiak, *Maxcine Williams 2562* (BRY 94060!).

CALIFORNIA. Siskiyou Co., Klamath National Forest, Preston Peak, Rattlesnake Meadow, *C.A. Ground 804* (RM 470624!); south side of Mt. Shasta, *H.E. Brown 560* (UC 221562!); Klamath National Forest, El Capitan, *J.L. Kraemer 326* (RM 470725!); Shackleford Creek, *Geo. D. Butler 1656* (RM 73441!, UC 166160!); Salmon Mountains, High Lake Basins in the vicinity of English Peak, Marble Mountains Wilderness Area, south-southwest of Abbott's Lake, *Frederick W. Oettinger 648* (UCI 408756!); South Fork of Clear Creek near Doe Flat, *Ruby Van Deventer 1000* (JEPS 13128!); **Trinity Co.**: Trinity Alps, Boulder Creek basin, tributary to Canyon Creeks, *W.J. Ferlatte 464* (JEPS 74537!); *William J. Ferlatte 1284 & Alice Q. Howard* (JEPS 74635!); Trinity Alps, margin of Stony Creek near Granite Peak, *Milo S. Baker 211a-'26* (UC 297883!); **Mariposa Co.**, Yosemite National Park, Mirror Lake, *Beryl O. Schreiber 2348* (UC 608446!, UC M-119298!) Yosemite National Park, top of Vernal Falls, *E.B. Babcock 1132* (RM 106388!, UC 311621!); Yosemite, Vernal Falls, *Rhoda R. Reed s.n.* (UC 164638!); Yosemite Valley, *W.L. Jepson s.n.* (JEPS 35896!); **Plumas Co.**, Plumas National Forest, near Meadow Valley, Bidwell Bar, *Beryl O. Schreiber 2531* (RM 471089!, UC 608846!, UC M-119301!); **Tulare Co.**, Sequioa National Park, 0.5 mile above Mineral King P.O., *Roxana S. Ferris & Laura Lorraine 11193* (RM 210233!, UC 984834!); Mineral King, *Lewis S. Rose 51089A* (BRY 142204!, UC 942989!); Southern Sierra Nevada Mountains, vicinity of Mineral King, *H.M. Hall & H.D. Babcock 5673* (UC 63642!); Sequoia National Park, *W.T. Frost s.n.* (UC M-119295!); Coyote Creek, on the Coyote Pass trail, *W.L. Jepson 981* (JEPS 35912!); Sierra Nevada Mountains, south fork of San Joaquin River, *H.M. Hall & H.P. Chandler 649* (UC 63064!); East Fork Kaweah River, *Culberlson 4521* (NDG 062567/HG 45933!, UC 130793!) **Fresno Co.**, Lewis Creek, South Fork of King's River, *P.A. Munz 15942* (UC M-004857!); Mist Falls on south fork of King's River, *E.R. Blakley 5311* (UC 32985!); Sierra Nevada, King's Canyon National Park, Kings River, *Annie M. Alexander & Louise Kellogg 2627* (UC 669340!); south fork of Kings River, *Mrs. Joseph Clemens s.n.* (RM 96067!, UC 892037!); Sierra Nevada Mountains, Collins Meadow, Three Springs, *H.M. Hall & H.P. Chandler 446* (PH *s.n.*!, UC 29589!) **Inyo Co.**, Big Pine Creek, *Annie M. Alexander & Louise Kellogg 2568* (UC 67668!); west of Big Pine, Big Pine Creek, *C.W. Tilforth & Dorothy Tilforth 1182* (UCI 424949!); east slope of Sierra Nevada, Independence Creek, *Annie M. Alexander & Louise Kellogg 2976* (UC 694320!); Sierra Nevada, Loch Leven Fork of Bishop Creek above North Lake, *Roxana S. Ferris 8853* (UC 563037!); Buttermilk County west of Bishop, south of Grouse Mt., *Rimo Bacigalupi 3824 & Lincoln Constance* (JEPS 13955!) **Mt. Silliman**, *Katharine Brandegee s.n.* (UC 131580!); Mt. Silliman, *Katharine Brandegee s.n.* (UC 220239!); Mt. Whitney, Broder's Flat, Farewell Gap, *W.L. Jepson 1148* (JEPS 35910!); Kern River, Junction Meadow, *W.L. Jepson 5024* (JEPS 35863!); 5.5 miles up Tenaya Creek from Mirror Lake, *Robert J. Rodin 860* (UC 770955!).

IDAHO. Boundary Co., 9 miles north of Naples, on road to Leonia, 20-Mile Creek, *J.H. Christ 18131* (WS 178547!); SW slope of Mt. Roothaan, *R.F. Daubenmire 44417* (WS 260933!); **Rock Creek**, *F.A. Warren 305* (WS 38490!); **Bonner Co.**, Indian Creek, *R.F. Daubenmire 44346* (WS 260934!); Priest River Forest Reserve, *John B. Leiberg 182* (CAN 190968!); Priest Lake, *C.V. Piper 6074* (WS 79714!); Kaniksu Forest, Selkirk Mts., Pack River, *Peter F. Stickney 2486* (RM 470623!); **Shoshone Co.**, 9 miles above Avery on the North Fork of the St. Joe River, *C.B. Wilson 151* (UC 705438!, WS 126979!); **Lemhi Co.**, Lemhi Forest, Snowslide gulch head of Mahogany Creek, *Arthur M. Cusick 47* (RM 470650!); **Bear Lake Co.**, St. Charles Canyon, *Ray J. Davis 1656* (UC 892036!, WS 100189!).

MONTANA. Glacier Co., Glacier National Park, Lake Josephine, *Bassett Maguire 1090* (RM 131265!); Glacier National Park, vicinity of Logan Pass, , *Bassett Maguire & George Piranian 15335* (PH 781118!, UC 604306!); Glacier National Park, Marias Pass, Divide Lake, *Bassett Maguire & George Piranian 15337* (CAN 190963!, PH 781134!); Glacier National Park, Upper Park Creek, *Bassett Maguire & George Piranian 153_* (PH 781135!); Glacier National Park, Two Medicine Lake, *W.C. Muenscher 10040* (PH 781117!); Glacier National Park, edge of stream below Rainbow Falls, *W.C. McCalla E3971* (ALTA 68728!); Glacier National Park, trail to Grinnell Glacier, *Aven Nelson & Ruth A. Nelson 3130* (RM 177953!, UC 614297!); Glacier National Park, among rocks just below Grinnell Glacier, *Aven Nelson & Ruth A. Nelson 3136* (RM 177950!); Glacier National Park, along trail to Grinnell Glacier, *Aven Nelson & Ruth A. Nelson 3143* (RM 177951!, UC 614299!); Glacier National Park, between Logan Pass & Hidden Lake, *Aven Nelson & Ruth A. Nelson 3162* (RM 177970!, UC 614296!); Divide between McDonald & Camas Lake, *F.K. Vreeland 993* (CAN 190965!); **Missoula Co.**: Missoula, Rattlesnake Falls, *J.E. Kirkwood 2130* (PH 696212!, RM 130315!); **Gallatin Co.**: Bozeman & vicinity, Gallatin Basin, *J.W. Blankinship 306* (CAN 190962!, PH 519480!).

NEVADA. **Elko Co.**: Ruby Range, Lamoille Canyon, lower section Island Lake Creek, *Bassett Maguire & Arthur H. Holmgren 22628* (PH 813423!); Ruby Mts., overflow creek from Island Lake, *Percy Train 4551* (UC 892176!); Ruby Mts., Lamoille Canyon, Island Lake Creek, *Laura E. Mills & Kay H. Beach 1390* (UC M-035650!); Ruby Mts., upper Lamoille Canyon, Island Lake trail, *Noel H. Holmgren 10257, Patricia K. Holmgren & Sue Keller* (BRY 283364!); Ruby Range, moist places along cascades to Island Lake, *Bassett Maguire & Arthur H. Holmgren 22537* (PH 813504!); Ruby Range, Lamoille Canyon, lower section Island Lake Creek, *Bassett Maguire & Arthur H. Holmgren 22629b* (PH 813503!); Lamoille Canyon, Terrace Ranger Station, *A.H. Holmgren 1727* (BRY 28186!, UC 675876!); Ruby Mts., edge of Lamoille Creek 2 miles below Terrace Guard Station, *Laura E. Mills & Kay H. Beach 1471* (UC M-035599!); Ruby Range, Lamoille Canyon, vicinity of bridge on road to Boy Scout Camp, *Bassett Maguire & Arthur H. Holmgren 22044* (PH 813420!, UC 711477!); Lamoille Canyon, 0.5 mile below scout camp, *A.H. Holmgren 1548* (UC 675898!); 5 miles S in Lamoille Canyon, *N.E. Nichols & L. Lund 564* (UC 892180!); Lamoille Creek between Lamoille & the mountains, *A.A. Heller 9316* (UC 196040!); Lamoille Valley, near Soldier Creek, W of Fort Halleck site, *Margaret J. Williams 80-222-1 & Arnold Tiehm* (BRY 229013!) Ruby Mts., Lamoille Creek, *P.A. Munz 16205* (UC M-005138!).

OREGON. **Multnomah Co.**, beside trail to Larch Mountain, *J.W. Thompson 2739* (PH 663878!); 1 mile E of Multnomah Falls, 9 Aug. 1921, *J.C. Nelson 4126* (PH 592633!); wet rock under spray of Multnomah Falls, *J. William Thompson 11846* (PH 744705); Multnomah Falls, *Thomas Howell s.n.* (PH 12523!); high cliffs along the Columbia River at Multnomah Falls, *Joseph Howell s.n.* (PH 583283!); Eagle Creek, Columbia Gorge, *L.E. Detling 7174* (UC M-186005!); Eagle Creek, (Col. R.), *M.W. Gorman 7644* (UC 620438!); Eagle Creek, Skyline Trail, *LeRoy E. Detling 5354* (WS 276498!); near Warrendale, just above Elowah Falls of McCord Creek, *R. Ornduff 6258* (UC M-16936_); Gorge of Columbia River, in spray of Wahkeena Falls, *Bassett Maguire 17217* (PH 815006!, UC 632283!); Gorge of Columbia River, basin walls and banks of Multnomah Falls, *Bassett Maguire 17218* (BRY 15843!, CAN 190964!, PH 815007!, RM 180255!, UC 632282!, UC 892035!, WS 126367!); wet rock under spray of Multnomah Falls, *J. William Thompson 11846* (UC 892033!); Oneonta Gorge, *L.E. Detling 7115* (UC M-185994!); Bridal Veil, *Wilhelm N. Suksdorf 139* (WS 79760!); *Arthur Cronquist 6100* (WS 196726!); *Joseph Howell s.n.* (WS 79746!); *Joseph Howell s.n.* (WS 79745!) **Hood River Co.**, *Louis F. Henderson s.n.* (RM 13152!); *Wilhelm N. Suksdorf 228* (WS 79797!); *J.W. Thompson 3620* (PH 663871!); **Tillamook Co.**, *Thomas Howell s.n.* (PH 709115!); *J. William Thompson 12749* (PH 757109!, WS 79704!); **Clackamas Co.**, *J.C. Nelson 4094* (PH 592502!); *A.A. Heller 10055* (PH 537274!); *L.R. Abrams 8798* (RM 99919!); *W.J. Spillman s.n.* (WS 26530!). **Grant County**, *J. William Thompson 13310* (PH 757237!) **Marion County**, *J.W. Thompson 4979* (PH 661911!) **Linn County**, *L.F. Henderson 13680* (PH 684771!) **Benton County**, *Quentin D. Clarkson 21* (WS 221509!) **Lane County**, *L. Constance s.n.* (UC 576585!); Lane County, *J.F. Franklin & C.T. Dyrness 166* (RM 470617!); Lane County, *Wm. C. Cusick 4891* (UC 892175!, WS 79702!) **Klamath County**, *William H. Baker 7012* (WS 219918!) **Josephine County**, *R.H. Whittaker 13* (WS

197145!) Cascade Forest, below Salt Creek Falls, *Douglas C. Ingram 1661* (RM 470618!) Streambanks of West Oregon, *Wm. C. Cusick 1484* (NDG 062404/HG 46..7!) Popenoe, *Joseph Howell s.n.* (PH 608116!).

WASHINGTON. **Okanogan Co.**, *A.D.E. Elmer 672* (RM 12050!, WS 26524!); *C.L. Hitchcock 8067* (RM 195240!, UC 710911!); *Chas. B. Fiker 1338* (WS 75812!); *Chas. B. Fiker 2467 (WS 87527!)*; *G.W. & G.G. Douglas 4622* (ALTA 53601!). **Whatcom Co.**, *J. William Thompson 17196* (RM 269454!, RM 269460!); *J. William Thompson 8076* (PH 692755!, UC 470598!); *G.W. Turesson 20* (WS 66237!); *Edith Hardin 469* (WS 65687!); *H. St. John 8954* (WS 63178); *H. St. John 8982* (WS 63203!); *J.F.G. Clarke s.n.* (WS 67846!); **Clallam Co.**, *A.D.E. Elmer 2634* (WS 26605!); *C.V. Piper s.n.* (WS 26525!); *C.V. Piper 2204* (WS 26531!); *Harold St. John 5798* (WS 129492!); *J. William Thompson 7850 (PH 692786!)* **Snohomish Co.**, *J. William Thompson 14675* (CAN 190967!) **Chelan Co.**, *Ralph & Dorothy Naas 2696* (RM 470616!); *P.A. Munz 24244* (UC M-188071!); *J.H. Sandberg & J.B. Leiberg 633* (CAN 190966!, UC 167604!, WS 26526!); *J. William Thompson 7738* (NDG 011139/HG 2379!, PH 692784!, UC 471043!, WS 100602!); *G.N. Jones 114* (WS 42383!). **Kitsap Co.**, *F.A. Warren 83* (WS 39175!) **Jefferson Co.**, *Henry S. Conard 181* (PH 12522!, PH 510102!, WS 26611!); *Henry S. Conard 262* (PH 510101!); *R. Kent Beattie 3066* (PH 657519!, UC 892041!); *John E. Schwartz 175* (RM 470619!); *Fred Meyer 700* (WS 75973!). **Mason Co.**, *Fred G. Meyer & Lillian E. Meyer 2257 (UC 758420!)*; *Phillips B. Freer 329* (WS 197564!); *Fred G. Meyer 502* (WS 79836!); *Trevor Kincaid s.n.* (WS 26521). **Kittitas Co.**, *A.D.E. Elmer 1163* (CAN 190969!, WS 26523!). **Pierce Co.**, *J. William Thompson 7604* (PH 691949!); *W.C. McCalla 5196* (ALTA 68722!, ALTA 68730!); *O.D. Allen 138* (RM 10167!, UC 29633!, UC 91023!, WS 26588!). **Thurston Co.**, *Edward C. Townsend s.n.* (WS 107381!). **Grays Harbor Co.**, *J. William Thompson 7289* (PH 691869!, UC 470828!). **Lewis Co.**, *Jerry F. Franklin 596* (RM 471086!); *H. St. John 7957* (WS 61701!). **Yakima Co.**, *Wilhelm N. Suksdorf 7114* (WS 79807!); *Wilhelm N. Suksdorf 12917* (WS 79740!); *Wilhelm N. Suksdorf 12929* (WS 79790!); *Wilhelm N. Suksdorf 12932* (WS 79789!); *Wilhelm N. Suksdorf 6343* (WS 79805!); *J. William Thompson 15069* (WS 152631!); *Elias Nelson 1110* (WS 39312!); *Elias Nelson s.n.* (WS 79742!). **Klickitat Co.**, *W.N. Suksdorf s.n.* (CAN 190970!, PH s.n.!, UC 193549!, WS 79758!). **Cowlitz Co.**, *O.D. Allen 285a* (UC 134173!, WS 26529!). **Skamania Co.**, *Douglas C. Ingram 1887* (RM 471046!, WS 52237!); *Wilhelm N. Suksdorf 6648* (UC 892032!); *Douglas C. Ingram 1850* (RM 470622!, WS 52231!). Wason(?) City, *J.H. Sandberg & J.B. Leiberg s.n.* (RM 169772!) Quilcene, *S. Gardner s.n.* (UC 76479!) Mt. Hamilton, *M.W. Gorman 4670* (WS 79692!) Cape Horn, *C.V. Piper 5009* (WS 26618!).

WYOMING. County Unknown, Beaver Creek, Encampment, August 1912, *Aven Nelson s.n.* (RM 79441!) - *new* to Wyoming.

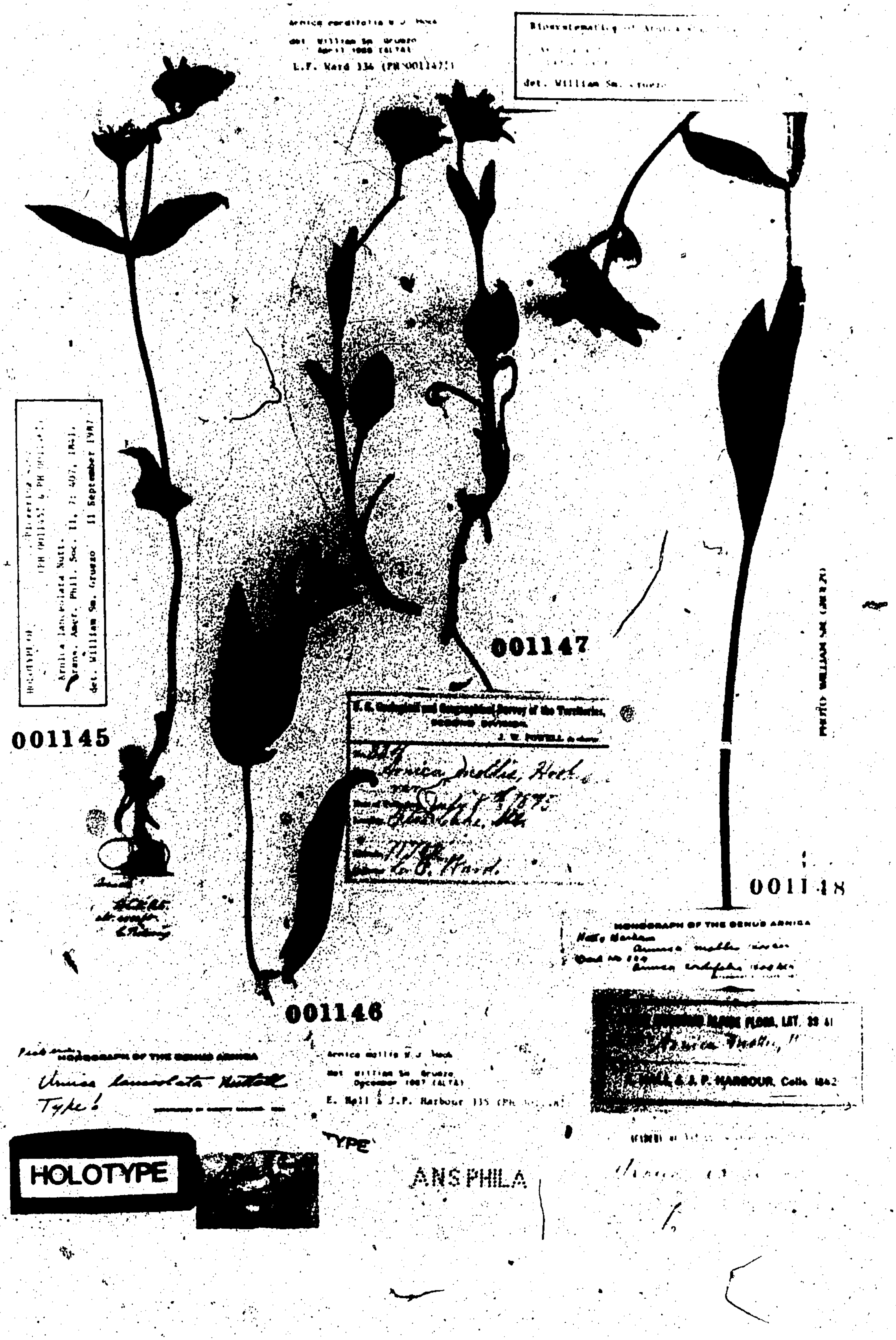
7. **Arnica lanceolata** Nutt. subsp. **lanceolata**, Trans. Amer. Phil. Soc. II, 7: 407, 1841; P.A. Rydberg, N. Amer. Fl. 34: 349, 1927; B. Maguire, Brittonia 4(3): 474, 1943. A.J. Cronquist *in* H.A. Gleason, Britton & Brown Illus. Fl. NE U.S. & adjacent Canada 3: 395, fig. *s.n.* p. 396 (center), 1952; R.I. Ediger & T.M. Barkley, N. Am. Fl. ser. II, pt. 10, p. 26, 1978. TYPE: NEW HAMPSHIRE, White Mountains, alt. 4500 ft, *C. Pickering s.n.* (HOLOTYPE, PH 001145! & PH 001146!, UC 658856! PHOTO 381 of PH 001145 & PH 001146). (Fig. 33; Generalized illustration, Fig. 34).

Arnica mollis Hook., *sensu* Torrey, Fl. N. Amer. 1: 403, 1843, *pro quoad spec.*
Arnica chamissonis Less., *sensu* A. Gray, Syn. Fl. N. Amer. 1: 382, 1884, *pro quoad spec.*
Arnica mollis Hook., *sensu* Fern., Rhodora 7: 149, 1905, *pro quoad spec.*; *sensu* Fr. Marie Victorin, Flore Laurentienne, p. 595, fig. 211, 1935, *pro quoad spec.*; *sensu* M.L. Fernald, Gray's Man. Bot., 8th ed., 1527, 1950, *pro quoad spec.* ;

Arnica mollis Hook. var. *petiolaris* Fern., Rhodora 7: 150, 1905; M.L. Fernald, Gray's Man. Bot., 8th ed., p. 1527, 1950. = *Arnica petiolaris* (Fern.) Rydb., N. Amer. Fl. 34: 352, 1927; H.J. Scoggan, Fl. Canada, pt. 4, p. 1477, 1979. TYPE: MAINE (N. Maine), Upper Kuwehee, Moxie Falls, in the spray, 1862, *G.L. Goodale s.n.* (HOLOTYPE, GH *s.n.*!; UC 658856! PHOTO 382 of GH). TYPE: MAINE, Rangeley, shady banks of a large brook, found growing at an altitude of 4000 ft, 28 July 1879, *Ralph W. Rounds s.n.* (PARATYPE, GH *s.n.*!; UC 658856! PHOTO 382 of GH).

Plants (0.5-) 2-5 (-7) dm tall arising from short thick branching freely rooted caudices, rarely from nearly naked rhizomes; *stems* few to many, somewhat solitary to loosely or compactly tufted, simple to branched at inflorescence rarely at midstem, subglabrous to sparsely or moderately pilose with soft long or short white or translucent multiseptate hairs and with short- or long- stipitate glands, the latter becoming denser above; *basal leaves* 1-2 pairs, large, elliptic-lanceolate or oblanceolate, evidently long-petiolate, nearly glabrous or sparsely pilose with long white or translucent multiseptate hairs, subentire to commonly denticulate-dentate-serrate; *cauline leaves* (3-) 4-6 (-7) pairs, all sessile except for lowermost pair, barely reduced upward, broadly obovate or oblancelate to narrowly or broadly lanceolate-elliptic, (6-) 8-12 (-20) cm long x (1-) 2-3 (-4) cm wide, subentire to irregularly denticulate-dentate-serrate, acute or rarely obtuse, nearly subglabrous to scantily pilose with similar hairs as those in basal leaves; *capitula* (1-) 3-7 (-10), small to medium, 10-15 (-18) mm high x 15-18 (-25) mm broad, narrowly campanulate or rarely ±turbinate; *periclinium*

Figure 33. Holotype of *Arnica lanceolata* Nutt. subsp. *lanceolata*. [New Hampshire, White Mountains, alt. 4500 ft, *C. Pickering s.n.* (PH 001145! + PH 001146!)].



Arnica cordifolia W.J. Hook
det. William Sm. Gruezo
det. William Sm. Gruezo
HOLOTYPE
Arnica lanceolata Nutt.
Trans. Amer. Phil. Soc. II, 7: 407, 1841.
det. William Sm. Gruezo 11 September 1987
001145
001146
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001148
U. S. Geological and Geographical Survey of the Territories,
J. W. POWELL in charge.
Arnica mollis, Hook.
L. F. Ward.
PHOTO WILLIAM SM. GRUEZO
MONOGRAPH OF THE GENUS ARNICA
MONOGRAPH OF THE GENUS ARNICA
Arnica lanceolata Nuttall
Type!
Arnica mollis W.J. Hook
det. William Sm. Gruezo
December 1987 (ALTA)
E. Hall & J.P. Harbour
E. HALL & J. P. HARBOUR, Colls. 1862
HOLOTYPE
TYPE
ANS PHILA

Figure 34. *Arnica lanceolata* Nutt. subsp. *lanceolata*. Habit and variation in gross morphology. A. *C.G. Pringle s.n.* (PENN 12529! *p.p.*), Brooks, White Mts., New Hampshire; B. *W.W. Eggleston & Alma L. Eggleston 22334* (PH 675161! *p.p.*), Tuckerman's Ravine Trail, Mt. Washington, Coos Co., New Hampshire; C. *J.A. Allen s.n.* (UC 29641! *p.p.*), Mt. Washington, New Hampshire; D. *F.H. Sargent s.n.* (BRY 142222! *p.p.*), Tuckerman's Ravine, by alpine brook, New Hampshire.

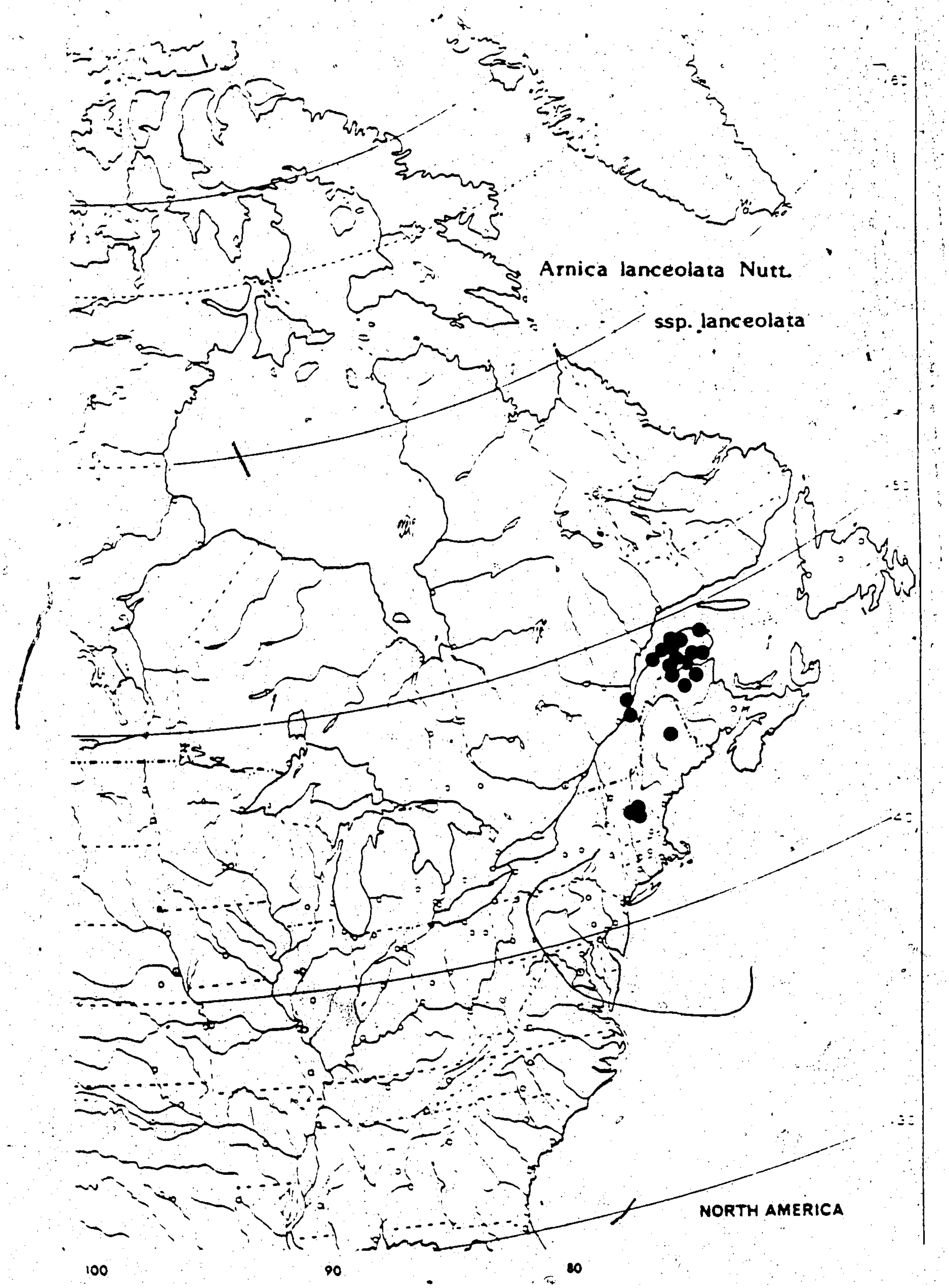

3 cm
A
B
C
D

short, narrow to broad, moderately pubescent with long multiseptate white or translucent hairs mixed with long-stipitate glands; *involucral bracts* (10-) 12-15 (-17), distinctly biseriate, narrowly to broadly lanceolate, acute to acuminate, (6-) 8-12 (-14) mm long x (1-) 2-3 mm wide, densely pilose toward periclinium with similar hairs as those of the latter; *ligulate florets* (8-) 10-15, bright yellow, oblong-elliptic, 10-17 (-20) mm long x (2-) 3-4 (-5) mm wide, its apex shallowly and bluntly tridentate or rarely subentire; *disc florets* pale yellow, broadly funnelform to ±goblet-shaped, 5-7 mm long, scantily to moderately hirsutulous toward base with white or translucent hairs or with slight constriction at middle visible due to presence of distinct bands of hairs; *achenes* 4-6 (-8) mm long, broadly round- to slightly angular-cylindric, sparsely hispidulous with brownish hairs or with few short-stipitate glands; *pappus* of (20-) 25-30 (-35) bristles, tawny to darker brown with amber-like deposits inside setae, subplumose (rarely subplumose). *Chromosome number*, 2n = 76.

ECOLOGY AND DISTRIBUTION. *Arnica lanceolata* Nutt. subsp. *lanceolata* is the only member of subgenus *Chamissonis* whose geographical range is quite restricted to a small region in eastern North America, particularly in the Gaspé Peninsula of Québec south-southwestward into the highlands of New Brunswick, Maine, New Hampshire and slightly impinging on the northern mountainous sector of New York. At sea level to lower elevation in the Gulf of St. Lawrence, it is prevalently growing on rocky-stony banks, gravel bars or beaches, alluvial flats or shores of large rivers as well as small streams. At higher altitudes, it is exceedingly luxuriant on wet hornblende schist at base of gullies, on moist cliffs near waterfalls or on headwalls of ravines and ultimately, in subalpine and alpine meadows where moisture is perpetually available all throughout the growing seasons (Fig. 35). It is purportedly recorded to be one of the acidophilic taxa in *Arnica* (Maguire 1943). The flowering season of *A. lanceolata* Nutt. subsp. *lanceolata* is from late June to middle of September. Elevational range is from sea level up to 1,100 m.

SPECIMENS EXAMINED. CANADA. NEW BRUNSWICK: Nespisiquit, Grand Falls, *J. Fowler s.n.* (PH 605618!); UC 892129!); St. John, Tobigue Narrows, *G.U. Hay s.n.* (PH 547980!).

Figure 35. Geographical range of *Arnica lanceolata* Nutt. subsp. *lanceolata*.


Arnica lanceolata Nutt.
ssp. lanceolata
NORTH AMERICA
100
90
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QUEBEC. **Matane Co.**, north slope of Mt. Logan, wet hornblende-schist at base of Nettle Gully, *M.L. Fernald & A.S. Pease 25336* (CAN 109673!); Matane Co., Mt. Logan, moist meadow near summit, common, *J.K. Morton NA4030* (ALTA 86187!, CAN 471348!); Matane Co., western slope of Mt. Logan, brooksides & subalpine meadows, *M.L. Fernald & L.B. Smith 26089* (CAN 109672!); Matane Co., western slope of Mt. Logan, meadows & brooksides, *C.W. Dodge, A.W. Pease & L.B. Smith 26086* (CAN 109671!); Matane Co., in Pease Basin, between Mts. Logan & Pembroke, alpine brooksides, *Ludlow Griscom & A.S. Pease 26092* (CAN 109670!). **Bonaventure Co.**, Grand Cascapedia River, alluvium, *E.F. Williams, J.F. Collins & M.L. Fernald 69113 (CAN 109677!); Bonaventure Co., Gaspé, Riviere Grande Cascapedia, au confluent de la Jonathan, rare, F. Marie-Victorin, F. Rolland-Germain & E. Jacques 33351* (QFA; RM 134609!); Bonaventure Co., Little Cascapedia River, alluvial thickets, *J.F. Collins & M.L. Fernald 146* (CAN 109679!; CAN 109682!, UC 147967!); Gaspé Peninsula, 10 mi up Bonaventure River, gravel beach, *H.J. Scoggan 2183* (CAN 109718!); Au pont en direction de St.-Elzear, cte Bonaventure, Bord rocheux de la riviere Hall, *Lionel Cinq-Mars L-48* (PH s.n.!; QFA). **Rimouski Co.**, Bic, rocks along Bic River, Edwin B. Bartram & Bayard Long 499 (PH 648526!; QFA); Bic, Bic river, riverbank, *Charles Williamson s.n.* (PENN 52110!); Bic, banks of Bic River, wet rocks, *C.S. Williamson 1417* (PH s.n.!). **Gaspé Co.**, subalpine area near summit of Mt. Albert, *Robert T. Clausen & Harold Trapido 2882* (UC 892166!); Gaspé Peninsula, Gaspé Co., Mt. Albert, swampy slope, north edge, H.J. Scoggan 1317 (CAN 109721!); Mont Albert, canton de Courcelette, comte de Gaspé-Nord, Terrain sourceux, Clairiere en foret de coniferes pres du "Camp du Sommet", *S. Brisson, R. Cayouette & L. Brassard 6059 (CAN 322960!); Gaspé Co., on gravel bed in Malbaie River, corner of the beach, L. McI. Terrill 4577* (CAN 339301!); Gaspé Co., southeastern face of Mt. Nicholabert, mossy border of mountain brook at 450-750 m alt, *M.L. Fernald & L.B. Smith 26093* (CAN 109668!); Gaspé Peninsula, Riviere Cap-Chat, comte de Gaspé, banc de sable sur la riviere, *F. Marie-Victorin & F. Rolland-Germain 49413* (PH 827936!, UC 740887!, WS 222566!); Au pied du mont Logan, avant de remonter vers la Passe Fernald, branche de la riviere Cap-Chat, Pere Louis-Marie & R. Cayouette 50344 (CAN 214994!); Gaspé Co., River Ste. Anne Des Monts, abundant on wet rocky or alluvial shores, *J.F. Collins & M.L. Fernald 69114* (CAN 109678!); Gaspé Peninsula, Gaspé Co., Tabletop Mt., alpine meadow, *H.J. Scoggan 1402* (CAN 109722!); Gaspé Peninsula, Gaspé Co., Tabletop Mt., alpine meadow, *H.J. Scoggan 1403* (CAN 109720!); Compte de Gaspé, Montagne de la Table, Botanist Dome, cirque nord-est, endroit humide, *J. Rousseau & L. Fortier 31505* (RM 134318!); Canons de la Riviere-aux-Renards, vers les sources, tres luxuriant sur les rochers au niveau de l'eau, *F. Marie-Victorin, F. Rolland-Germain, Jules B. Brunel & Z. Rousseau 17519* (PH 626854!; QFA); Gaspé, Riviere Grande Cascapedia, platieres a 14 milles de l' embouchure, *F. Marie-Victorin, F. Rolland-Germain & E. Jacques 33253* (PH 686037!, RM 134635!).

River Ste. Anne des Monts, gravel bars & subalpine mountain streams, *Macoun Geol. Surv. Canada 14719* (CAN 109680!); Le long de la Riviere Ste. Anne des Monts, sur les rochers bordant l'eau, *F. Marie-Victorin, F. Rolland-Germain, Jules B. Brunel & Z. Rousseau 17521* (PH 626853!); Gaspé Peninsula, Le long de la Riviere Ste. Anne des Monts, a dix milles de l' embouchure, *F. Marie-Victorin, F. Rolland-Germain, Jules B. Brunel & Z. Rousseau 17523* (PH 626852!); Parc Ste. Anne des Monts, cte Gaspé-Quest, 1 mille passe la barriere, bords sablonneux de la riviere Ste. Anne des Monts, *Lionel Cinq-Mars L-214* (PH *s.n.*!; QFA).

Trois-Pistoles Co., Riv.-du-Loup, Trois-Pistoles, entre les rangs 2 et 3, *Ernest Lepage 15267* (CAN 304535!; QFA). Québec-New Brunswick boundary, Patapedia River, 15 mi above Restigouche River, gravelly bank, *J. Rousseau 32470* (CAN 109681!); Québec-New Brunswiek boundary, Patapedia River, 15 mi above Restigouche River, slaty river, *J. Rousseau 32454* (CAN 109675!). Matapedia River, mill stream, gravelly flats, 1929, *J. Rousseau 32432* (CAN 109674!, PH 685909!, RM 134704!).

U.S.A. MAINE. **Piscataquis Co.**, Mt. Katahdin, bank of Katahdin Brook, *Hampton L. Carson Jr. s.n.* (PENN/PH s.n.!); Piscataquis Co., in moist cliff at fa.. on Katahdin Brook 2000 ft up Mt. Katahdin, *E. Perot Walker 49* (PENN/PH s.n.!). Piscataquis Co., Mount Katahdin, from damp rocky bed of a dry brook near west side of South Basin Pond, *Francis Harper s.n.* (PH 697005!); Aroostook Co., Valley of the St. John River, Township XII, Range 16, springy, schist outcrop at river bank, *Harold St. John & George E. Nichols 2509* (CAN 191121!); Aroostook Co., wet bank of St. John River, Allagash, *A.S. Pease & R.C. Bean 28999* (CAN 191122!).

NEW HAMPSHIRE. **Mt. Washington**, *J.A. Allen s.n.* (UC 29641!); Mt. Moosilauke, *Allen 1131* (PH 586725!); Mt. Washington, Tuckerman's Ravine, 27 Aug. 1898, *Allen 1131* (PH 586725!, on same herbarium sheet as Mt. Moosilauke's specimen (see previous entry); Mt. Washington, July 1885, *E. Facon s.n.* (WS 82048!); Mt. Washington, Tuckerman's Ravine, foot of Mt. Moosilauke, *Willard W. Eggleston s.n* (RM 15678!); White Mountains, Mt. Washington, Tuckerman's Ravine, *Willard W. Eggleston 1287* (RM 23411!); Coos Co., Mt. Washington, Tuckerman's Ravine Trail, *W.W. Eggleston & Alma L. Eggleston 22334* (PH 675161!); Tuckerman's Ravine, by an alpine brook, *F.H. Sargent s.n.* (BRY 142222!); Mt. Washington, Tuckerman's Ravine, upper trail, *Dorothy R. Wade 3140* (SASK 27615!); Coos Co., White Mountain National Forest, Alpine Garden, Mt. Washington, *William A. Dayton 1061* (RM 471079!); White Mountains, Mt. Monroe, *F.F. Forbes s.n.* (RM 50178!); White Mountains, Mt. Monroe, *F.F. Forbes s.n.* (UC 892182!); Mt. Washington, Oakes Gulf, *George Golding Kennedy s.n.* (PH 633706!); White Mountains, Tuckerman's Ravine, *Dana S. Carpenter 4* (PENN/PH s.n.!); Tuckerman's Ravine, *W.W. Eggleston 2373* (PH 586569!); White Mountains, Mt. Washington, alpine & subalpine, *Wm. F. Flint & J.H. Huntington s.n.* (UC 65609!); **Coos Co.**, Mt. Washington, Tuckerman's Ravine, moist cliffs, headwall, *John M. Fogg Jr. 5041* (PENN/PH s.n.!); Mt. Washington, in head of Tuckerman's Ravine, *J.W. Harshberger s.n.* (PENN 12527!, PENN 12528!, PENN 43570!); Coos Co., Mt. Washington, Tuckerman's Ravine, *B. Long & E.B. Bartram 47* (PH 648207!); Coos Co., Mt. Washington, headwall of Tuckerman's Ravine, *A.H. Moore 171* (PENN s.n.!, UC 159422!); Mt. Washington, Tuckerman's Ravine, damp cliff face, base of headwall, *H.T. Skinner s.n.* (PENN/PH s.n.!); Coos Co., Mt. Washington, Tuckerman's Ravine, mountain soil near stream, headwall, *Rodney H. True S14* (PENN/PH s.n.!); Mt. Washington, Tuckerman's Ravine, *Charles Williamson s.n.* (PENN 52338!); Mt. Washington, Tuckerman's Ravine, *C.S. Williamson 1417* (PH s.n.!); White Mountains, *J.W. Chickering Jr. 38328* (CAN 191114!); White Mountains, close to bridge below Crystal Cascade, *W.G. Farlow s.n.* (PENN/PH s.n.!); White Mountains, ravine of Mt. Monroe, *F.F. Forbes s.n.* (PH 769550!); White Mountains, Oakes Gulf, *George Golding Kennedy s.n.* (PH 633706!). White Mountains, Reliquiae Oakesianae, *Gul. Oakes s.n.* (PENN 12530!); White Mountains, Brooks, *C.G. Pringle s.n.* (UC 178527!); White Mountains, Brooks, *C.G. Pringle s.n.* (ND 011138!, NDG 062487/HG 45952!, PENN 12529!, PH 709126!); White Mountains, in alpinis Montium Alborum, *Oakes s.n.* (UC 380285!); Novae Angliae, in montibus albis, Tuckerman, *Anon. s.n.* (CAN 372717!); Novae Angliae, in mont. Albis, Tuckerman, *Anon. s.n.* (UC 380286!); Novae Angliae, Reliquiae Oakesianae, 1848, *Gul. Oakes 38327* (CAN 191113!); Locality Unknown, *Ezra Bramend & C.S. Williamson s.n* (PH s.n.!).

Long after Thomas Nuttall (1841) had described *Arnica amplexicaulis* and *A. lanceolata* as new species, the taxonomic history of these 2 taxa is one of the more chaotic cases in the genus *Arnica*.

Apparently, in the case of *A. lanceolata* subsp. *lanceolata*, the second report of this taxon after its formal description by Nuttall (1841) was by John Torrey (1843) who identified collections from the same area of occurrence as *Arnica mollis* W.J. Hook. Subsequently, Asa Gray in his 'Synantherae Flora of North America' (1884) reported the same population as *A. chamissonis* Less. F.L. Scribner (1892) in his vivid account of the environs and flora of Mt. Katahdin (= Kataadn, former spelling), Maine identified and reported collections of *A. lanceolata* Nutt. subsp. *lanceolata* as *A. mollis*. Nine months later (August 1892), F.P. Briggs in his report involving plants collected from the same mountain, identified his collections from virtually the same populations where Scribner obtained his material, as *A. chamissonis*. In 1901, M.L. Fernald after an extended exploration of same mountain and and vicinity, determined the same populations as *A. chamissonis*. This time he cited all previous collection sites which include those visited by Goodale, Scribner & Briggs. Evidently, Fernald's treatment of this taxon was strongly in adherence to his bicentric view of the distribution of *A. mollis* (Fernald 1905). This concept of *A. lanceolata* Nutt. subsp. *lanceolata* persisted well up to the 8th edition of *Gray's Manual of Botany* (Fernald 1950). Cronquist (1952) reinstated *A. lanceolata* Nutt. subsp. *lanceolata* to species rank only to be relegated again into synonymy of *A. mollis* by subsequent workers *e.g.* Boivin (1972), Kershaw *et al.* (1976 *fide* Hinds 1983) or more specifically, *A. mollis* Hook. var. *petiolaris* Fern. (Scoggan 1979; H. Hinds, pers. comm. 24 March 1987).

On the other hand, *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo typifies the commonest of botanical repertoire, *i.e.*, a taxon that possesses a long string of synonyms. This status is, barring human limitations, indicative somehow of the amplitude of morphological diversity that exists in extant populations all throughout its geographic range (Fig. 35). Incidentally, this situation was a natural outcome of the quick-paced botanical explorations that occurred by the turn of the 20th century. Thus, *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo to date has some 10 or more synonyms commencing with P.A. Rydberg's (1900) proposal of supplanting Nuttall's name *A. amplexicaulis* with his *A. amplexifolia* on the ground of homonymy. This case had been well-considered by Maguire (1943). In the same year (1900), E.L. Greene described *Arnica macounii* which is unquestionably a typical *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo. For a list of the other subsequently described taxa and currently considered as synonyms of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo, see above.

Further complication in the taxonomic history of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo and *A. lanceolata* Nutt. subsp. *lanceolata* comes in the work of Boivin (1972) in his treatment of the Compositae for the *Flora of the Prairie Provinces*. In this floristic study, Boivin resurrected Fernald's treatment of *A. lanceolata* Nutt. subsp. *lanceolata* as a synonym of *A. mollis* Hook. Additionally, he recognized 2 other varieties under the latter epithet, both of which were extracted from those taxa already treated as taxonomic synonyms of *A. amplexicaulis* Nutt. subsp. amplexicaulis (see Maguire 1943, *sub A. amplexicaulis* Nutt. subsp. *genuina* Maguire). These taxa are *A. aspera* Greene and *A. amplexicaulis* Nutt. var. *piperi* St. John & Warren. At the same time, he commented that this complex (which includes *A. mollis* Hook., A. amplexicaulis Nutt. and *A. lanceolata* Nutt. *sensu* Boivin 1972) is "one of the more remarkable cases of range disjunction in North American (*sic*), widely distributed in the Rockies and again in the Gulf of St. Lawrence" (Boivin 1972, p. 98). A taxonomic disparity, however, occurred in the treatment by Boivin in that he placed *A. amplexicaulis* Nutt. as a synonym of *A. aspera* Greene when the former name has publication priority (ICBN 1983, principle III) over the latter. Both taxa were originally described at the species level. Summarily, I entirely disagree with Boivin's treatment of both *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo and *A. lanceolata* Nutt. subsp. *lanceolata* as synonymous to *A. mollis* Hook.

Inter- and intra- populational assessment of morphological variation in the 2 subspecies of *A. amplexicaulis* Nutt. (*sensu* Maguire 1943) was undertaken by Calder and Taylor (1968) using material from 15 different stations on Vancouver Island, British Columbia supplemented with those originating from the Alaska-British Columbia coast. In their study, it was found that there is little correlation between the characters used to split *A. amplexicaulis* Nutt. into 2 subspecies as employed by Maguire (1943). Accordingly, Calder and Taylor (1968) rejected the existence of *A. amplexicaulis* Nutt. subsp. *prima* (Maguire)

Maguire. My examination of far more abundant material and growth room studies of re-established live plants obtained from the Alaskan coastlines and inland localities demonstrated that those differentiating characters really are highly unstable and are simply a plastic response to habitat ecologies. More interestingly is the fact that greenhouse propagated plants of *A. lanceolata* Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo are nearly identical to similarly propagated plants of *A. lanceolata* Nutt. subsp. *lanceolata* [*cf. J.K. Morton NA4030* (ALTA 86187!, CAN 471348!)]. This together with persistently higher ploidy level thus far reported for *A. lanceolata* Nutt. subsp. *lanceolata* [2n = 76 (Löve & Löve 1964 & 1968, Morton 1981, Wolf 1987)], similar overall habitat preferences (*vide supra*) and geographic separation as a consequence of Wisconsinan glaciation, is the main basis for the treatment of this complex to consist of two subspecies. A similar and comparable situation exists within *A. frigida* Meyer ex Iljin of subgenus *Arctica* (for details, see Downie & Denford 1986, Downie 1987, Downie & Denford 1988 in press).

References

Abrams, L. and R. Ferris. 1960. Illustrated flora of the Pacific States, Vol. 4. Stanford University Press, Stanford, California.

Afzelius, K. 1924. Embryologische und zytologische Studien in *Senecio* und verwandten Gattungen. Acta Horti Bergiani 8: 124-219.

Afzelius, K. 1936. Apomixis in der Gattung *Arnica*. Sv. Bot. Tidskr. 30: 572-579.

Alley, N.F. 1973. Glacial stratigraphy and the limits of Rocky Mountains and Laurentide Ice Sheets in southwestern Alberta, Canada. Can. Soc. Petroleum Geologists, Bulletin 21: 153-177.

Alston, R.E. 1967. Biochemical Systematics. *in* T. Dobzhansky, M.K. Hecht and W.C. Steere (eds.). Appleton-Century-Crofts, New York. Vol. 1, pp. 197-305.

Alston, R.E. and B.L. Turner. 1963. Biochemical Systematics. Prentice-Hall, Englewood Cliffs, New Jersey.

Argus, G.W. and D.J. White. 1978. The Rare Vascular Plants of Alberta. Syllogeus 17, National Museums of Canada, Ottawa, 46 p.

Averett, J.E. 1973. Biosystematic study of *Chamesaracha* (Solonaceae). Rhodora 75: 325-365.

Baagoe, J. 1977. Microcharacters in the ligules of the Compositae. *in* V.H. Heywood, J.B. Harborne and B.L. Turner (eds.). The Biology and Chemistry of the Compositae. Academic Press, London. Vol. 1, Chap. 7, pp. 119-139.

Barker, W.W. 1966. Apomixis in the genus *Arnica* (Compositae). Ph.D. dissertation, University of Washington, Seattle, 142 p.

Barker, W.W. 1967. I.O.P.B. Chromosome number reports. Taxon 16: 156-157.

Barkley, T.M. 1985. Generic boundaries in the Senecioneae. Taxon 34(1): 17-21.

Bate-Smith, E.C. 1962. The phenolic constituents of plants and their taxonomic significance. I. Dicotyledons. J. Linn. Soc. London Bot. 58: 95-173.

Bate-Smith, E.C., P.D. Sell and C. West. 1968. Chemistry and taxonomy of *Hieracium* L.

and *Pilosella* Hill. Phytochemistry 7: 1165-1169.

Battaglia, E. 1952. Ricerche embriologiche nel genere *Arnica* (Compositae). Att. Soc. Toscana Sci. Nat. Memb. B. 59: 210-216.

Belzer, N.F. and M. Ownbey. 1971. Chromatographic comparison of *Tragopogon* species and hybrids. Amer. J. Bot. 58: 697790.

Bentham, G. 1873a. Compositae. *In* G. Bentham and J.D. Hooker (eds.). Genera Plantarum 2: 163-533.

Bentham, G. 1873b. Notes on the classification, history, and geographical distribution of Compositae. J. Linn. Soc. Lond. 13: 335-577.

Bentley, R. and H. Trimen. 1880. Medicinal Plants, Vol. III. J. & A. Churchill, London. Reprinted 1983. Periodical Expert Book Agency, Delhi.

Böcher, T.W. and K. Larsen. 1950. Chromosome numbers of some arctic or boreal flowering plants. Medd. Groenl. 147: 1-32.

Böcher, T.W. and K. Larsen. 1955. Chromosome studies on some European flowering plants. Bot. Tidsskr. 52: 125-131.

Bohlmann, F. and C. Zdero. 1972. New thymol derivatives from *Arnica amplexicaulis*. Tetrahedron Lett. 2827-2828.

Bohm, B.A. and C.K. Wilkins. 1978. Chemotaxonomic studies in the Saxifragaceae s.l., 10. The flavonoids of *Heuchera cylindrica*. Can. J. Bot. 56: 1174-1176.

Boivin, B. 1972. Flora of the Prairie Provinces. Part III. Compositae. Phytologia 23(1): 1-140.

Borkowski, B., Z. Kowalewski and L. Skrzypczakowa. 1966. Chemical composition of inflorescence of some *Arnica* species. I. Analysis of flavonoid fractions. Diss. Pharm. Pharmacol. 18: 367-374.

Bouchard, A., D. Barabé, M. Dumais and S. Hay. 1983. The Rare Vascular Plants of Québec. Syllogeus 48. National Museums of Canada.

Brehm, B.G. and M. Ownbey. 1965. Variation in chromatographic patterns in the *Tragopogon dubius-pratensis-porrifolius* complex (Compositae). Amer. J. Bot. 52: 811-818.

Briggs, F.P. 1892. Plants collected at Mt. Ktaadn, Me., August 1892. Bull. Torrey Bot. Club 19: 333-336.

Brunner, H. 1969. Thin-layer chromatography for testing pharmaceuticals. I. *Arnica* roots. Dt. Apoth.-Ztg. 109: 1723-1726.

Calder, J.A. and R.L. Taylor. 1968. Flora of the Queen Charlotte Islands. Part I, Systematics of the Vascular Plants. Canada Department of Agriculture Monograph no. 4, part I. Queen's Printer, Ottawa, 659 p.

Candolle, A.P. de. 1836-1838. Prodromus systematis naturalis regni vegetabilis, Vols. 5-7. Paris.

Carmichael, J. W. 1983. The TAXMAP classification program. Version 5.2. The University of Alberta Computing Services R126.0384, 15 p., reprint, 2 December 1983.

Carmichael, J.W., J.A. George and R.S. Julius. 1968. Finding natural clusters. Syst. Zool. 17: 144-150.

Carmichael, J.W. and P.H.A. Sneath. 1969. Taxometric maps. Syst. Zool. 17: 144-150.

Cassini, H. 1826. Opuscules phytologiques, Vol. 1 and 2. Paris.

Cassini, H. 1829. Tableau synoptique des Synantherées. Ann. Sci. Nat. (Paris) 17: 387-423.

Cassini, H. 1834. Opuscules phytologiques, Vol. 3. Paris.

Chamisso, A. 1826. De Plantis in Expeditione Praefatur. Linnaea 1: 1-10.

Chuksanova, N.A. 1969. *in* A.A. Federov (ed.). Chromosome numbers of flowering plants. V.L. Komarov Bot. Inst., Acad. Sci. U.S.S.R., Leningrad.

Clark, L.J. 1973. Wild Flowers of British Columbia. Gray's Publ. Ltd., Sidney, B.C., 591 p.

Cooke, W.B. 1962. On the flora of the Cascade Mountains. Wasmann J. Biol. 20(1): 1-67.

Crawford, D.J. 1970. Systematic studies in Mexican *Coreopsis* (Compositae). *Coreopsis mutica*: flavonoid chemistry, chromosome numbers, morphology and hybridization. Brittonia 22: 93-111.

Crawford, D.J. 1972. The morphology and flavonoid chemistry of synthetic infra-specific hybrids in *Coreopsis mutica* (Compositae). Taxon 21: 27-38.

Crawford, D.J. 1978. Flavonoid chemistry and angiosperm evolution. Bot. Rev. 44: 431-456.

Crawford, D.J. and M. Levy. 1978. Flavonoid profile affinities and genetic similarity. Syst. Bot. 3: 369-373.

Crawford, D.J. and E.B. Smith. 1980. Flavonoid chemistry of *Coreopsis grandiflora* (Compositae). Brittonia 32: 154-159.

Crawford, D.J. and E.B. Smith. 1983a. The distribution of anthochlor floral pigments in North American *Coreopsis*: Compositae: taxonomic and phyletic interpretations. Amer. J. Bot. 70: 355-362.

Crawford, D.J. and E.B. Smith. 1983b. Leaf flavonoid chemistry of North American *Coreopsis* (Compositae): intra- and intersectional variation. Bot. Gaz. 144: 577-583.

Crawford, D.J., E.B. Smith and A.M. Mueller. 1980. Leaf flavonoid chemistry of *Coreopsis* (Compositae) Section Palmatae. Brittonia 32: 452-463.

Cronquist, A.J. 1952. Compositae *In* H.A. Gleason, Britton & Brown Illustrated Flora of Northeastern United States and adjacent Canada 3: 323-546. New York Botanical Garden, NY.

Cronquist, A. 1955. Compositae *in* C.L. Hitchcock, A. Cronquist, M. Ownbey and J.W. Thompson. Vascular Plants of the Pacific Northwest. Univ. Washington Press, Seattle, part 5, 343 p.

Cronquist, A. 1977. The Compositae revisited. Brittonia 29: 137-240.

Cronquist, A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York.

Cronquist, A. 1985. History of generic concepts in the Compositae. Taxon 34(1): 6-10.

Denford, K.E. 1973. Flavonoids of *Arctostaphylos uva-ursi* (Ericaceae). Experimentia 29: 939.

Denford, K.E. 1980. Flavonol glycosides and seed coat structure in certain species of *Epilobium* - a correlation? Experientia 36: 299-300.

Denford, K.E. 1984. Phytochemical approaches to Biosystematics. *in* W.F. Grant (ed.). Plant Biosystematics. Academic Press, Toronto, pp 359-376.

Denford, K.E. and I. Karas. 1975. A study of the flavonoids of certain species of *Cassiope* (Ericaceae). Can. J. Bot. 53(12): 1192-1195.

Dobelis, I.N., J. Dwyer and D. Rattray (eds.). 1986. Magic and Medicine of Plants. Reader's Digest Assoc., U.S.A., 464 p.

Douglas, G.W. and G. Ruyle-Douglas. 1978. Contributions to the floras of British Columbia and the Yukon Territory. I. Vascular Plants. Can. J. Bot. 56: 2296-2302.

Douglas, G.W. 1982. The sunflower family (Asteraceae) of British Columbia. Vol. I. Senecioneae. Occas. Pap. B. C. Prov. Mus. No. 23.

Downie, S.R. 1985. *in* IOPB Chromosome number reports LXXXVIII, A. Löve, (ed.). Taxon 34: 547-551.

Downie, S.R. 1987. A biosystematic study of *Arnica* subgenus *Arctica*. Ph.D. Thesis, Department of Botany, The University of Alberta, 247 p.

Downie, S.R. and K.E. Denford. 1986a. The taxonomy of *Arnica frigida* and *A. louiseana* Asteraceae. Can. J. Bot. 64: 1355-1372.

Downie, S.R. and K.E. Denford. 1986b. The flavonoids of *Arnica frigida* and *A. louiseana* Asteraceae. Can. J. Bot. 64: 2748-2752.

Downie, S.R. and K.E. Denford. 1988. Taxonomy of *Arnica* (Asteraceae) subgenus *Arctica*. Rhodora, in press.

Drury, W. H. 1969. Plant persistence in the Gulf of St. Lawrence. *In* Essays *in* K.N.H. Greenidge (ed.). Plant Geography and Ecology. Nova Scotia Museum, Nova Scotia.

Duke, J.A. 1985. C.R.C. Handbook of Medicinal Herbs. C.R.C. Press Inc., Boca Raton, Florida, 677 p.

Dutilly, A., E. Lepage and M. Duman. 1958. Contribution a la Flore des Iles (T.N.O.) et du Versant Oriental (Que.) de Baie James. Contrib. Arctic Inst. Cat. Univ. Amer. 9F, 1-199, Washington D.C.

Eaton, D.C. 1871. *in* S. Watson. Botany: Report of the Geological Exploration of the Fortieth Parallel by C. King, pp. 186-188.

Ediger, R.I., and T.M. Barkley. 1978. *Arnica. in* C.T. Rogerson (ed.). North American flora. Series II. Part 10. New York Botanical Garden, New York.

Erdtman, H. 1963. Some aspects of chemotaxonomy. *in* T. Swain (ed.). Chemical Plant Taxonomy. Academic Press, London, pp. 89-125.

Everitt, B. 1980. Cluster Analysis. 2nd ed., Halsted Press, New York, 136 p.

Evstratova, R.I., A.I. Bankovskii, V.I. Sheichenko and K.S. Rybalko. 1971. Structure of Arnifolin. Khim. Prir. Soedin 7: 270-272.

Federov, A.A. 1969. Chromosome numbers of flowering plants. V.L. Komarov Bot. Inst., Acad. Sci. U.S.S.R., Leningrad.

Ferlatte, W.J. 1974. A flora of the Trinity Alps of northern California. Univ. California Press, Berkeley, 206 p.

Fernald, M.L. 1901. The vascular plants of Mount Katahdin. Rhodora 3: 166-177.

Fernald, M.L. 1905. The genus *Arnica* in northeastern America. Rhodora 7: 146-150.

Fernald, M.L. 1925. Persistence of plants in unglaciated areas of boreal America. Mem. Amer. Acad. Arts Sci. 15:237-342.

Fernald, M.L. 1950. Gray's Manual of Botany, 8th ed., American Book Co., New York, 1632 p.

Fournier, P. 1947. Le Livre des Plantes Medicinales et Veneneuses de France. Vol. 1, 447 p.

Frost, S. & Ising, G. 1968. An investigation into the phenolic compounds in *Vaccinium myrtillus* L. (Bilberries); *Vaccinium vitis-idaea* L. (Crowberries) and the hybrid between them, Vaccinium intermedium Ruthe. employing thin-layer chromatography. Hereditas 60: 72-76.

Fulton, R.J., P.F. Karrow, P. LaSalle and D.R. Grant. 1984. Summary of Quaternary stratigraphy and history, Eastern Canada. *in* R.J. Fulton (ed.). Quaternary stratigraphy of Canada. A Canadian contribution of IGCP Project 24. Geol. Surv. Can. Pap. 84-10, pp. 193-210.

Giannasi, D.E. 1975. The flavonoid systematics of the genus *Dahlia*. Mem. N.Y. Bot. Gard. 26: 1-125.

Giannasi, D.E. 1978. Systematic aspects of flavonoid synthesis and evolution. Bot. Rev. 44(4): 399-429.

Gill, D. 1973. Modification of northern alluvial habitats by river development. Canadian Geographer 17: 138-153.

Gillett, G.W. and J.T. Howell. 1961. A flora of Lassen Volcanic National Park, California. Wasmann J. Biol. 19(1): 1-185.

Gleason, H.A. 1952. The New Britton and Brown Illustrated Flora of Northeastern United States and adjacent Canada. Vol. 3, 589 p., New York.

Glennie, C.W., J.B. Harborne, G.D. Rowley and C.J. Marchant. 1971. Correlations between flavonoid chemistry and plant geography in the *Senecio radicans* complex. Phytochemistry, 10: 2413-2417.

Gottlieb, O.R. 1982. Micromolecular Evolution, Systematics and Ecology. Springer-Verlag, Berlin, 170 p.

Gornall, R.J., B.A. Bohm and R. Dahlgren. 1979. The distribution of flavonoids in the Angiosperms. Bot. Notiser 132: 1-30.

Gornall, R.J. and B.A. Bohm. 1980. The use of flavonoids in the taxonomy of *Boykinia* and allies (Saxifragaceae). Can. J. Bot. 58: 1768-1779.

Grant, D.R. 1977. Glacial style and ice-limits, the Quaternary stratigraphic record and the changes of land and ocean level in the Atlantic Provinces, Canada. Geogr. Phys. Quat. 31: 247-260.

Grant, D.R. and L.H. King. 1984. A stratigraphic framework for the Quaternary history of the Atlantic Provinces. *in* R.J. Fulton (ed.). Quaternary stratigraphy of Canada. A Canadian contribution to IGCP project 24. Geol. Surv. Can. Pap. 84-10, pp. 173-191.

Grant, V. 1971. Plant speciation. Columbia University Press, New York.

Gray, A. 1862. Enumeration of plants of the Rocky Mountains. Amer. J. Sci. & Arts 83: 237-243.

Gray, A. 1863. Notes on miscellaneous plants. Proc. Acad. Phila. 1: 68.

Gray, A. 1874. *in* C.C. Parry. Botanical observations in western Wyoming, no. IV. Appendix, descriptions of new species, *etc.*. Amer. Nat. 8: 211-215.

Gray, A. 1884. *Arnica. in* Synoptical Flora of North America, Vol. I, Part 2. Smithsonian Institution, Washington, D.C.

Greene, E.L. 1896. New or noteworthy species. XVII. Pittonia 3: 1-149.

Greene, E.L. 1899. A series of papers relating to botany and botanists. Pittonia 4: 1-158.

Greene, E.L. 1900. A fascicle of new arnicas. Pittonia 4: 159-174.

Greene, E.L. 1901. Plantae Bakerianae 3: 1-36.

Greene, E.L. 1902. Some new northwestern Compositae. Ottawa Nat. 15: 278-282.

Greene, E.L. 1910. Some western species of *Arnica*. Ottawa Nat. 23: 213-215.

Guppy, G.A. and B.A. Bohm. 1976. Flavonoids of five *Hieracium* species of British Columbia. Biochem. Syst. Ecol. 4: 231-234.

Gustafsson, A. 1946a. The plant species in relation to polyploidy and apomixis. Hereditas 32:444-448.

Gustafsson, A. 1946b. Apomixis in the higher plants. I. The mechanism of apomixis. Lunds Univ. Arsskr. 42: 1-66.

Gustafsson, A. 1947a. Apomixis in the higher plants. II. The causal aspect of apomixis. Lunds Arsskr. 43: 71-178.

Gustafsson, A. 1947b. Apomixis in the higher plants. III. Biotype and species formation. Lunds Univ. Arsskr. 44:183-370.

Harborne, J.B. 1972. Evolution and function of flavonoids in plants. Rec. Adv. Phytochem. 4: 107-141.

Harborne, J.B. 1975. Biochemical systematics of the flavonoids. *in* J.B. Harborne, T.J. Mabry and H. Mabry (eds.). The Flavonoids. Chapman and Hall, London, pp. 1056-1095.

Harborne, J.B. 1977. Flavonoid profiles in the Compositae. *in* V.H. Heywood, J.B. Harborne and B.L. Turner (eds.). The Biology and Chemistry of the Compositae. Academic Press, London, Vol. 1, Chap. 12, pp. 359-384.

Harborne, J.B., T.J. Mabry and H. Mabry. (eds.) 1975. The Flavonoids. Chapman and Hall, London, 1204 p.

Harborne, J.B. and B.L. Turner. 1984. Plant Chemosystematics. Academic Press, London, 562 p.

Harborne, J.B. and P.S. Green. 1980. A chemotaxonomic survey of flavonoids in leaves of the Oleaceae. Bot. J. Linn. Soc. 81: 155-167.

Hegnauer, R. 1962-1973. Chemotaxonomie der Pflanzen. Vols. 1-6, Birkhauser-Verlag, Basel.

Heller, A.A. 1898. Catalogue of North American plants north of Mexico. Vol. 7, p. 130.

Herder, F.G. 1867. Plantae raddeanae monopetalae. Bull. Soc. Nat. Mosc., Sect. Biol. 4: 422-425.

Heyn, C.C. and A. Joel. 1983. Reproductive relationships between annual species of *Calendula* (Compositae). Plant Syst. Ecol. 143: 311-329.

Heywood, V.H., J.B. Harborne and B.L. Turner. 1977a. An Overture to the Compositae. *in* V.H. Heywood, J.B. Harborne and B.L. Turner (eds.). The Biology and Chemistry of the Compositae. Academic Press, London, Vol. 1, Chap. 1, pp. 1-20.

Heywood, V.H., J.B. Harborne and B.L. Turner (eds.). 1977b. The Biology and Chemistry of the Compositae. Academic Press, London, Vol. 1, 619 p.

Hinds, H.R. 1983. The rare vascular plants of New Brunswick. Nat. Mus. Can. Syllogeus 50, 38 p.

Hocking, G.M. 1945. American *Arnica* in medicine. Chem. Digest 4:10-12.

Holmgren, P.K. and W. Keuken. 1975. Index Herbariorum, Part I. The Herbaria of the World, 6th ed., Oosthoek, Scheltema & Holkema Publishers, Utrecht, Netherlands, 397 p.

Hooker, W.J. 1834. Flora Boreali-Americana or The botany of the northern parts of British America. H.G. Bohn, Covent Garden, London, Vol. 1, 351 p.

Hultén, E. 1937. Outline of the history of arctic and boreal biota during the Quaternary period. Bokförlags Akticbolaget Thule, Stockholm, Sweden.

Hultén, E. 1968. Flora of Alaska and Neighboring Territories. Stanford Univerity Press, Stanford, California, 1008 p.

Hunter, G.E. 1967. Chromatographic documentation of interspecific hybridisation in *Vernonia*: Compositae. Amer. J. Bot. 54: 437-477.

ICBN. 1983. International Code of Botanical Nomenclature. E.G. Voss *et al.* (eds.), 13th International Botanical Congress, Sydney 1981. Dr. W. Junks Publ., The Hague, 472 p.

Ives, J.D. 1963. Field problems in determining the maximum extent of Pleistocene glaciation along the eastern Canadian seaboard - a geographer's point of view. *in* A. Löve and D. Löve (eds.). North Atlantic biota and their history. MacMillan Co., New York.

Ives, J.D. 1976. Biological refugia and the nunatak hypothesis. Historical Plant Geography. Chap. 10, sect. B, pp. 605-636.

Jansen, R.K. and J.D. Palmer. 1987. A chloroplast DNA inversion marks an ancient evolutionary split in the sunflower family (Asteraceae). Proc. Nat'l. Acad. Sci. U.S.A. 84: 5818-5822.

Jepson, W.L. 1923-1925. A Manual of the Flowering Plants of California. Assoc. Students Store, Univ. California, Berkeley, California, 1238 p.

Johnson, A.W. and J.G. Packer. 1965. Polyploidy and environment in arctic Alaska. Science (Washington, D.C.), 148: 237-239.

Johnson, A.W. and J.G. Packer. 1968. Chromosome numbers in the flora of Ogotoruk Creek, Northwest Alaska. Bot. Not. 121: 403-456.

Johnson, M.P. and P.H. Raven. 1970. Natural regulation of plant species diversity. *in* T. Dobzhansky, M.K. Hecht and W.C. Steere (eds.). Evolutionary Biology. Vol. IV. Meredith Corporation, New York. pp. 127-162.

Karlstrom, T.N. and G.E. Ball (eds.). 1969. The Kodiak Island refugium: its geology, flora, fauna and history. Ryerson Press, Toronto, Ontario, 262 p.

Karrow, P.F. 1984. Quaternary stratigraphy and history, Great Lakes-St. Lawrence region. *in* R.J. Fulton (ed.). Quaternary stratigraphy of Canada - A Canadian contribution to IGCP Project 24. Geol. Surv. Can. Pap. 84-10, pp. 137-153.

Keil, D.J. and D.J. Pinkava. 1976. Chromosome counts and taxonomic notes for Compositae from the United States and Mexico. Amer. J. Bot. 63: 1393-1403.

Kershaw, L., J.K. Morton and J.N. [illegible] A computer print-out of the rare and endangered species in the Canadian flora, vascular plants. Biology Department, University of Waterloo, Ontario, unpubl. [illegible] (1983).

Kostennikova, Z.P., G.A. Panova and R.M. Dolotenkova. [illegible] Spectrophotometric determination of flavonoids in *Arnica* [illegible]. Farmatsiya (Moscow) 34: 51-53.

Kovanda, M. 1978. Chromosome numbers of miscellaneous United States dicotyledons. Rhodora 80: 431-440.

Kowalewski, Z., L. Skrzypczakowa & I. Matlawska. 1969. Chemical composition of inflorescence of some *Arnica* species. II. Polyphenolic acids. Dis. Pharm. Pharmacol. 21: 249-252.

Kyhos, D.W. and P.H. Raven. 1982. Miscellaneous chromosome numbers in Asteraceae. Madrono 29: 62.

Lessing, C.F. 1831. Synanthereae. *in* A.D. de Chamisso and D. de Schlechtendal (eds.). De Plantis in Expeditione Speculatoria Romanzoffiana. Linnaea 6: 235-239.

Levin, D.A. 1966. Chromatographic evidence of hybridization and evolution in *Phlox maculata*. Amer. J. Bot. 53: 238-245.

Levin, D.A. 1967. An analysis of hybridization in *Liatris*. Brittonia 19: 248-260.

Levin, D.A. 1968. The structure of a polyspecies hybrid swarm in *Liatris*. Evolution 22: 352-372.

Levy, M. and K. Fujii. 1978. Geographic variation of flavonoids in *Phlox carolina*. Biochem. Syst. Ecol. 6: 117-125.

Levy, M. and D.A. Levin. 1971. The origin of novel flavonoids in *Phlox* allotetraploids. Proc. Natl. Acad. Sci. U.S.A. 68: 1627-1630.

Levy, M. and D.A. Levin. 1974. Novel flavonoids and reticulate evolution in the *Phlox pilosa* - *P. drummondii* complex. Amer. J. Bot. 61: 156-167.

Levy, D.A. and D.A. Levin. 1975. The novel flavonoid chemistry and phylogenetic origin of *Phlox floridiana*. Evolution (Lawrence, Kans.) 29: 487-499.

Lewis, W.H. 1980. Polyploidy in species populations. Basic Life Sciences 13: 103-144.

Lloyd, R.M. and R.S. Mitchell. 1973. A Flora of the White Mountains, California and Nevada. Univ. California Press, Berkeley & Los Angeles. 202 p.

Löve, A. and D. Löve. 1964. *In* IOPB Chromosome number reports II. A. Löve & O.T. Solbrig (eds.). Taxon 13(6): 201-209.

Löve, A. and D. Löve. 1966. Cytotaxonomy of the alpine vascular plants of Mount Washington. Univ. Colorado Studies, ser. Biol. no. 24, 74 p., Univ. Colorado Press, Boulder.

Löve, A. and D. Löve. 1975. *In* IOPB chromosome number reports. Taxon 24:671-678.

Mabry, T.J. 1974. The chemistry of disjunct taxa. *In* G. Bendz, J. Santesson and V. Runnstrom-Reio (eds.). Chemistry in botanical classification. Nobel Symposium 25.

Mabry, T.J., K.R. Markham and M.B. Thomas. 1970. The systematic identification of flavonoids. Springer-Verlag, New York, 354 p.

Maguire, B. 1942. *Arnica* in Alaska and Yukon. Madrono, 6:153-155.

Maguire, B. 1943. A monograph of the genus *Arnica*. Brittonia, 4(3): 386-510.

Marie-Victorin, Fr. 1935. Flore Laurentienne. Impremerie De La Salle, Montreal, 916 p.

Marie-Victorin, Fr. 1938. Phytogeographical problems of eastern Canada. Amer. Midl. Nat. 19:489-558.

Markham, K.R. 1982. Techniques of flavonoid identification. Academic Press, Toronto.

Mastenbroek, O., H.C. Prentice, R. Kamp-Heinsbroek, G.T. Niemann and G. van Nigtevecht. 1983. Geographic trends in flavone-glycosylation genes and seed morphology in European *Silene pratensis* (Caryophyllaceae). Plant Syst. Evol. 141: 257-271.

Mears, J.A. 1979. Chemistry of polyploids: a summary with comments on *Parthenium* (Asteraceae-Ambrosiinae). *in* W.H. Lewis (ed.). Polyploidy, biological relevance. Plenum Press, New York.

Mears, J.A. 1980. Flavonoid diversity and geographic endemism in *Parthenium*. Biochem. Syst. Ecol. 8: 361-370.

Merfort, I. 1984. Methylated flavonoids from *Arnica montana* and *Arnica chamissonis*. Planta Med. 1: 107-108.

Merfort, I. 1985. Flavonoids from *Arnica montana* and *Arnica chamissonis*. Planta Med. 2: 136-138.

Merfort, I., Marcinek, C. and A. Eggert. 1986. Flavonoid distribution in *Arnica* subgenus *Chamissonis*. Phytochem. 25: 2901-2903.

Morton, J.F. 1977. Major Medicinal Plants, Botany, Culture and Uses. Charles C. Thomas Publ., Springfield, Illinois, 431 p.

Morton, J.K. 1981. Chromosome numbers in Compositae from Canada and the U.S.A. Bot. J. Linn. Soc. 82: 357-368.

Moss, E.H. 1959. Flora of Alberta, 1st ed. University of Toronto Press, Toronto, 546 p.

Munz, P.A. 1959. A California Flora. University of California Press, Berkeley & Los Angeles, 4th printing(1968), 1681 p.

Munz, P.A. 1963. California Mountain Wildflowers. Univ. California Press, Berkeley & Los Angeles, 122 p.

Munz, P.A. 1968. Supplement to a California Flora. University of California Press, Berkeley & Los Angeles, 224 p.

Nelson, A. 1900. Contributions from the Rocky Mountain Herbarium. I. Bot. Gaz. 30(3): 189-203.

Nelson, A. 1901. Contributions from the Rocky Mountain Herbarium. II. Bot. Gaz. 31(6): 394-409.

Nelson, A. 1904. Contributions from the Rocky Mountain Herbarium V. Bot. Gaz. 37: 260-279.

Nelson, A. 1934. Rocky Mountain Herbarium Studies II. Amer. J. Bot. 21: 573-582.

Neuman, P., B. Timmerman and T.J. Mabry. 1979. Laboratory manual for the systematic identification of flavonoids. University of Texas, Austin, unpublished.

Nordenstam, B. 1977. Senecioneae and Liabeae - systematic review. *in* V.H. Heywood, J.B. Harborne and B.L. Turner (eds.). The Biology and Chemistry of the

Compositae. Academic Press, London, Vol. II, Chap. 29, pp. 799-830.

Nuttall, T. 1818. The Genera of North American Plants, Vol. II. Philadelphia.

Nuttall, T. 1841. Descriptions of new species and genera of plants in the natural order of the Compositae. Trans. Amer. Phil. Soc., Ser. 2. 7: 283-453.

Ornduff, R., P.H. Raven, D.W. Kyhos and A.R. Kruckeberg. 1963. Chromosome numbers in Compositae. III. Senecioneae. Amer. J. Bot. 50(2): 131-139.

Ornduff, R., T. Mosquin, D.W. Kyhos, and P. Raven. 1967. Chromosome numbers in Compositae VI, Senecioneae II. Amer. J. Bot. 54: 205-213.

Ornduff, R., B.A. Bohm, and N.A.M. Saleh. 1973. Flavonoids of artificial interspecific hybrids in *Lasthenia*. Biochem. Sys. 1: 147-151.

Ornduff, R. and B.A. Bohm. 1975. Relationship of *Tracynia* and *Rigiopappus* (Compositae). Madrono 23: 53-55.

Owczarzak, A. 1952. A rapid method for mounting pollen grains, with special regard to sterility studies. Stain Technology 27: 249-251.

Pacheco, P., D.J. Crawford, T.F. Stuessy and M. Silva O. 1985. Flavonoid evolution in *Robinsonia* (Compositae) of the Juan Fernandez Island. Amer. J. Bot. 72: 989-998.

Packer, J.G. and D.H. Vitt. 1974. Mountain park: a plant refugium in the Canadian Rocky Mountains. Can. J. Bot. 52: 1393-1409.

Packer, J.G. 1980. Paleoecology of the Ice-Free Corridor: The Phytogeographical Evidence. Can. J. Anthr. 1: 33-35.

Packer, J.G. 1983. Moss's Flora of Alberta, 2nd ed. (revised), Univ. Toronto Press, 687 p.

Packer, J.G. and C. E. Bradley. 1984. A checklist of the Rare Vascular Plants in Alberta. Provincial Museum of Alberta Nat. Hist. Occ. Paper no. 5, 112 p.

Parry, C.C. 1874. Botanical observations in western Wyoming. IV. Appendix, descriptions of new species, etc. Amer. Nat. 3: 211-215.

Piper, C.V. 1920. Proc. Biol. Soc. Wash. 33: 106.

Pojar, J. 1973. Levels of polyploidy in four vegetation types of southwestern British Columbia. Can. J. Bot. 51: 621-628.

Poplawski, J., M. Holub, Z. Samek and V. Herout. 1971. Arnicolides - sesquiterpenic lactones from the leaves of *Arnica montana* L. Coll. Czech. Chem. Comm. 36: 2189-2199.

Porsild, A.E. 1974. Rocky Mountain Wild Flowers. Nat. Hist. ser. 20.2, Nat. Mus. Canada & Parks Canada, 454 p.

Prest, V.K. 1984. The late Wisconsinan glacier complex. *in* R.J. Fulton (ed.). Quaternary stratigraphy of Canada - A Canadiaan contribution to IGCP Project 24. Geol. Surv. Can. Pap. 84-10, pp. 21-36 and map 1584-A.

Pyrek, J.S. and E. Baranowska. 1973. Faradiol and arnidiol - a revision of the structure. Tetrahedron Lett. 809-810.

Radford, A.E., Dickison, W.C., Massey, J.R. and C.R. Bell. 1974. Vascular Plant Systematics. Harper and Row Publishers, Inc. New York, 891 p.

Raven, P.H. and D.I. Axelrod. 1974. Angiosperm biogeography and past continental movements. Ann. Mo. Bot. Gdn. 61: 539-673.

Regel, E.A. 1864. Supplementum Index Sachalinensis, p. 151.

Reveal, J. and E.L. Styer. 1973. Miscellaneous chromosome counts of western American plants II. Great Basin Natur. 33(1): 19-25.

Ribéreau-Gayon, P. 1972. Plant phenolics. Oliver and Boyd, Edinburgh, 254 p.

Rinn, W. 1970. Thymol isobutyrate, major components of the essential oil of *Arnica chamissonis* rhizomes and roots. Planta Med. 18: 147-149.

Ritchie, J. C. 1984. Past and Present Vegetation of the Far Northwest of Canada. University of Toronto Press, Toronto, 251 p.

Robins, D.J. 1977. Senecioneae - chemical review. *in* V.H. Heywood, J.B. Harborne and B.L. Turner (eds.). The Biology and Chemistry of the Compositae. Academic Press, London, Vol. II, Chap. 30, pp. 831-850.

Robinson, H. 1978. Studies in the Senecioneae (Asteraceae). IX. A new genus, *Dresslerothamnus*. Phytologia 40: 493-494.

Robinson, H. 1981. A revision of the tribal and subtribal limits of the Heliantheae (Asteraceae). Smithsonian Contr. Bot. 51. 102 p.

Robinson, H. and R.D. Brettell. 1973a. Tribal revisions in the Asteraceae. III. A new tribe, Liabeae. Phytologia 25: 404-407.

Robinson, H. and R.D. Brettell. 1973b. Tribal revisions in the Asteraceae. VIII. A new tribe Ursinieae. Phytologia 26: 76-85.

Robinson, H. and R.D. Brettell. 1973c. Studies in the Senecioneae (Asteraceae). I. A new genus, *Pittocaulon*. Phytologia 26: 451-453.

Robinson, H. and R.D. Brettell. 1973d. Studies in the Senecioneae. II. A new genus, *Nelsonianthus*. Phytologia 27: 53-54.

Rutter, N.W. 1984. Pleistocene history of the western Canadian Ice-free corridor. *in* R.J. Fulton (ed.). Quaternary stratigraphy of Canada - A Canadian contribution to IGCP Project 24. Geol. Surv. Can. Pap. 84-10, pp. 49-56.

Rydberg, P.A. 1900. Catalogue of the flora of Montana and the Yellowstone National Park. Mem. N.Y. Bot. Garden 1: 1-492.

Rydberg, P.A. 1901. Studies on the Rocky Mountain flora. IV. Bull. Torrey Bot. Club 28: 20-38.

Rydberg, P.A. 1905. Studies on the Rocky Mountain flora. XIV. Bull. Torrey Bot. Club 32(3): 123-138.

Rydberg, P.A. 1906. Flora of Colorado. Colorado Agric. Bull. 100: 1-448. Agric. Expt. Station, Fort Collins, Colorado.

Rydberg, P.A. 1910. Studies on the Rocky Mountain flora. XXIII. Bull. Torrey Bot. Club 37(9): 443-471.

Rydberg, P.A. 1922. Flora of the Rocky Mountains and adjacent plains. 2nd ed. (1954 reprint), Hafner Publ. Co., New York, 1144 p.

Rydberg, P.A. 1927. *Arnica*. Carduaceae: Senecioneae. North Amer. Flora. 34(4): 321-357.

Saner, A. and K. Leupin. 1966. The composition of *Arnica montana*. Pharm. Acta Helv. 41: 431-445.

Schofield, W. B. 1969. Phytogeography of northwestern North America: bryophytes and vascular plants. Madrono 20:155-207.

Schumacher, M. 1966. Serologisch - taxonomische Untersuchungen im Bereich der Synandrae insbesondere der Compositen. Ph.D. Dissertation. Christian - Albrecht - Universitaet, Kiel. *fide* Nordenstam (1977).

Scoggan, H.J. 1979. The flora of Canada, Vol. 4. Natl. Mus. Nat. Sci. (Ottawa) Publ. Bot. No. 7(4).

Scribner, F.L. 1892. Mt. Kataadn and its flora. Bot. Gaz. 17: 46-54.

Seigler, D.S., D.H. Wilken and J.J. Jakupcak. 1974. Chemical data related to the tribal affinities of *Hulsea* and *Arnica*. Biochem. Syst. Ecol. 2: 21-24.

Semple, J.C. and K.S. Semple. 1978. *Borrichia x cubana* (*B. frutescens x arborescens*): interspecific hybridisation in the Florida Keys. Syst. Bot. 2: 292-301.

Sharples, A.W. 1938. Alaska Wild Flowers. Stanford University Press, Stanford, California, 156 p.

Shelyuto, V.L., N.T. Bubon, V.I. Piotukh and L.P. Smirnova. 1976. Flavonoid from *Arnica foliosa*. Chemistry of Natural Compounds 12(4): 483.

Shetler, S.G. and L.E. Skog (eds.). 1978. A Provisional Checklist of Species for Flora North America (revised). Missouri Bot. Garden Monographs in Systematic Botany I. Missouri Bot. Garden.

Skvarla, J.J. and B.L. Turner. 1966. Systematic implications from electron microscopic studies of Compositae pollen - a review. Ann. Mo. bot. Gdn. 53: 220-256.

Smiley, F.J. 1921. A report on the boreal flora of the Sierra Nevada of California. Univ. Calif. Publ. Bot. 9: 1-423.

Smith, I. 1969. Chromatographic and electrophoretic techniques. Vol 1.Chromatography. Pitman Press, Great Britain.

Smith, R.H., F. Dufresne and H.A. Hansen. 1964. Northern Watersheds and Deltas. pp. 51-66 *in* J.P. Linduska (ed.), Waterfowl Tomorrow, U.S. Dept. of Interior, Washington.

Soltis, D.E. 1980. Flavonoids of *Sullivantia*: taxonomic implications at the generic level within the Saxifragaceae. Biochem. Syst. Ecol. 8: 149-151.

Soltis, D.A. and B.A. Bohm. 1986. Flavonoid chemistry of diploid and tetraploid cytotypes of *Tolmiea menziesii* (Saxifragaceae). Syst. Bot. 11: 20-25.

Stalker, A. MacS. 1977. The probable extent of Classical Wisconsin ice in southern and central Alberta. Can. J. Earth Sci. 14: 2614-2619.

Stebbins, G.L. 1950. Variation and evolution in plants. Columbia University Press, New York.

Stebbins, G.L. 1953. A new classification of the tribe Chichorieae, family Compositae. Madrono 12: 33-64.

Stebbins, G.L. 1984. Polyploidy and the distribution of the arctic-alpine flora: new evidence and a new approach. Bot. Helv. 94: 1-13.

Stebbins, G.L. 1985. Polyploidy, hybridization, and the invasion of new habitats. Ann. Mo. Bot. Gard. 72: 824-832.

Stevens, P.F. 1980. Evolutionary polarity of character states. Ann. Rev. Ecol. Syst. 11: 333-358.

Stix, E. 1960. Pollenmorphologische Untersuchungen an Compositen. Grana Palynol. 2: 41-114.

St. John, H. and H. Warren. 1931. Compositae. Proc. Biol. Soc. Wash. 44: 36.

Straley, G.B. 1979. *in* I.O.P.B. chromosome number reports. Taxon 28: 278.

Straley, G.B. 1982. *In* I.O.P.B. chromosome number reports. Taxon 31: 574-598.

Strother, J.L. 1972. Chromosome studies in western North American Compositae. Amer. J. Bot. 59(3): 242-247.

Stuessy, T.F., R.S. Irving and W.L. Ellison. 1973. Hybridisation and evolution of *Picradeniopsis* (Compositae). Brittonia 25: 40-56.

Stuessy, T.F. and D.J. Crawford. 1983. Flavonoids and phylogenetic reconstruction. Plant Syst. Evol. 143: 83-107.

Swain, T. (ed.) 1963. Chemical Plant Taxonomy. Academic Press, London, 543 p.

Taylor, R.L. 1967. *in* IOPB Chromosome number reports XIII. A. Löve (ed.). Taxon 16: 445-461.

Taylor, R.L. and G.A. Mulligan. 1968. Flora of the Queen Charlotte Islands. Part 2 Cytological Aspects of the Vascular Plants. Canada Department of Agriculture Monograph no. 4, part 2. Queen's Printer, Ottawa, 148 p.

Thorne, R.F. 1981. Phytochemistry and angiosperm phylogeny: a summary statement. *In* D.A. Young & D.S. Seigler (eds.) Phytochemistry and Angiosperm Phylogeny. Praeger Publ., New York, pp. 233-276.

Tijo, J.H. and A. Levan. 1950. The use of oxyquinoline in chromosome analysis. An. Estac. Exp. Aula Die Cons. Super. Invest. Cient. 2: 21-64.

Torres, A.M. and D.A. Levin. 1964. A chromatographic study of cespitose Zinnias. Amer. J. Bot. 51: 639-643.

Torrey, J.D. and A. Gray. 1843. A Flora of North America. Wiley and Putnam, New York.

Turner, B.L. and R.E. Alston. 1959. Segregation and recombination of chemical constituents in a hybrid swarm of *Baptisia laevicaulis x B. viridis* and other taxonomic implications. Amer. J. Bot. 46: 678-686.

Turner, B.L. and A.M. Powell. 1977. Helenieae - systematic review. *in* V.H. Heywood, J.B. Harborne and B.L. Turner (eds.). The Biology and Chemistry of the Compositae, Academic Press, London, Vol. II, Chap. 25, pp. 699-737.

Valant-Vetschera, K. 1982. Flavonoid pattern and systematics of the genus *Leucocyclus*. Phytochemistry 21(5): 1067-1069.

Valant-Vetschera, K. 1985. Flavonoid diversification in *Achillea ptarmica* and allied taxa. Biochem. Syst. Ecol. 13(1): 15-21.

Valant-Vetschera, K.M. 1987. Flavonoid glycoside accumulation trends of *Achillea nobilis* L. and related species. Biochem. Syst. Ecol. 15(1): 45-52.

Vanhaelen, M. 1973. Identification of carotenoids from *Arnica montana*. Planta Med. 23: 308-311.

Vincent, J.-S. 1984. Quaternary stratigraphy of the western Canadian Arctic Archipelago. *in* R.J. Fulton (ed.). Quaternary stratigraphy of Canada - A Canadian contribution to IGCP Project 24. Geol. Surv. Can. Pap. 84-10, pp. 87-100.

Vogelmann, J.E. 1984. Flavonoids of *Agastache* section *Agastache*. Biochem. Syst. Ecol. 12: 363-366.

Ward, J.H. 1963. Hierarchical grouping to optimize an objective function. J. Am. Statist. Ass. 58: 236-244.

Watson, S. 1871. Botany *in* C. King. Report of the Geological Exploration of the Fortieth Parallel. Prof. Papers U.S. Army Engineer Dept. no. 18.

Weber, W.A. 1972. Rocky Mountain Flora. 4th ed., revised. Colorado Associated University Press, 438 p.

Welsh, S.L. 1968. Nomenclatural changes in the Alaskan Flora. Great Basin Nat. 28(3): 147-156.

Welsh, S.L., N.D. Atwood, S. Goodrich and L.C. Higgins. A Utah Flora. Great Basin Memoir 9: 1-894. Brigham Young Univ., Provo, Utah.

Whalen, M.D. 1978. Foliar flavonoids of *Solanum* section *Androceras*: a systematic survey. Syst. Bot. 3: 257-276.

White, D.J. and K.L. Johnson. 1980. The rare vascular plants of Manitoba. Nat. Mus. Can. Syllogeus No. 27.

Williams, L.O. 1960. Drug and condiment plants. Agriculture Handbook No. 172. Agriculture Research Service, U.S.D.A. Washington, D.C.

Willuhn, von G. 1972. Components of *Arnica* species. VIII. Fatty acids of the essential oil of the leaves of *A. montana* and *A. longifolia*. Z. Naturforsch. B. 27: 728.

Willuhn, von G., J. Kresken and I. Merfort. 1983. *Arnica* flowers: identity and purity tests. Thin-layer chromatography of sesquiterpene lactones and flavonoids. Dtsch. Apoth. Ztg. 123: 2431-2434.

Willuhn, von G., P. Rottger and D. Wendisch. 1984. 6-0-Isobutyryl-tetrahydrohelenalin from the flowers of *Arnica montana*. Planta Med. 1: 35-37.

Wishart, D. 1978. CLUSTAN User Manual, 3rd. ed. University of St. Andrews, Scotland.

Wolf, S.J. 1980. Cytogeographical studies in the genus *Arnica* (Compositae: Senecioneae). I. Amer. J. Bot. 67: 300-308.

Wolf, S.J. 1981. A biosystematic revision of *Arnica* L. (Compositae) subgenus *Austromontana* Maguire. Ph.D. Dissertation, Department of Botany, The University of Alberta, Edmonton, Alberta, Canada, 284 p.

Wolf, S.J. 1987. Cytotaxonomic studies in the genus *Arnica* (Compositae: Senecioneae). Rhodora 89: 391-400.

Wolf, S.J. and K.E. Denford. 1983. Flavonoid variation in *Arnica cordifolia*: an apomictic polyploid complex. Biochem. Syst. Ecol. 11: 111-114.

Wolf, S.J. and K.E. Denford. 1984a. Flavonoid diversity and endemism in *Arnica* subgenus *Austromontana* Biochem. Syst. Ecol. 12: 183-188.

Wolf, S.J. and K.E. Denford. 1984b. *Arnica gracilis* (Compositae), a natural hybrid between *A. latifolia* and *A. cordifolia*. Syst. Bot. 9(1): 12-16.

Wolf, S.J. and K.E. Denford. 1984c. Taxonomy of *Arnica* (Compositae) subgenus *Austromontana*. Rhodora 86: 239-309.

Wren, R.W. 1970. Potter's new cyclopedia of botanical drugs and preparations. 7th ed., Health Science Press, Rustington, England, 400 p.

Wynne-Edwards, V. C. 1937. Isolated arctic-alpine floras in eastern North America: a discussion of their glacial and recent history. Trans. R. Soc. Can. Sect. 5, Ser. 3. 31: 33-58.

Young, D.A. and D.S. Seigler (eds.). 1981. Phytochemistry and Angiosperm Phylogeny. Praeger Publ., New York, 295 p.

Young, D.A. 1981. The usefulness of flavonoids in angiosperm phylogeny: some selected examples. *In* D.A. Young & D.S. Seigler (eds.). Phytochemistry and Angiosperm Phylogeny. Praeger Publ., New York, pp. 205-232.

Zhukova, P. 1964. The caryology of some species of Compositae growing in the Arcto-Alpine Botanic Garden (Kola Peninsula). Bot. Zh. (Leningrad) 49:1656-1659.

Zhukova, P. 1966. Chromosome numbers in some species of plants of the northeastern part of the U.S.S.R. Bot. Zh. (Leningrad) 51:1511-1516.

Zhukova, P. 1967. Chromosome numbers in some species of plants of the northeastern part of the U.S.S.R., II. Bot. Zh. (Leningrad) 52:983-987.

Appendix 1. Attributes used in TAXMAP analysis.

No.	Attribute	Mode of assessment
1	Underground parts	1=rhizome 2=caudex
2	Innovations	1=present 2=absent
3	Habit	1=stem unbranched 2=stem branched at inflorescence only 3=stem branched at or below midstem section
4	Stem pubescence	1=glabrous to sparse 2=moderate 3=dense 4=extremely dense
5	Stem glandularity	1=absent or inconspicuous 2=moderate 3=dense/abundant 4=very dense
6	Leaf position	1= below midstem 2=evenly distributed 3=above midstem
7	Leaf margin	1=entire 2=entire to slightly denticulate 3=denticulate to occasionally dentate 4=dentate 5=serrate
8	Leaf pubescence	1=glabrous to sparse 2=moderate 3=dense 4=extremely dense
9	Leaf glandularity	1=absent or inconspicuous 2=moderate 3=dense/abundant
10	Basal leaf at anthesis	1=present 2=absent
11	Basal leaf petiole	1=sessile (or subsessile) or very short and broad winged 2=narrow or broad winged and shorter than blade 3=slender winged and approximately equaling the blade 4=slender winged and longer than the blade
12	Basal leaf apex	1=acute or acuminate 2=obtuse
13	Basal leaf shape	1=linear to narrowly lanceolate 2=narrowly to broadly lanceolate 3=broadly lanceolate (to sometimes ovate) 4=narrowly oblong to oblanceolate 5=oblanceolate to spathulate
14	Bud position	1= erect 2=nodding
15	Capitula position	1=erect 2=nodding
16	Periclinium colour	1=white 2=yellow to yellowish-gold
17	Periclinium pubescence	1=glabrous to sparse 2=moderate 3=dense 4=extremely dense
18	Periclinium glandularity	1=absent or inconspicuous 2=moderate 3= abundant/dense 4=very dense
19	Achene pubescence	1=nearly glabrous 2=sparsely hirsute above middle, glabrous below 3=sparsely hirsute throughout 4=densely hirsute throughout 5=densely hirsute above middle glabrous below
20	Achene glandularity	1=absent or inconspicuous 2=moderate 3=abundant
21	Achene color	1=black 2=dark brown 3= whitish brown
22	Achene shape	1=round-cylindric 2=angular-cylindric
23	Involucral bract pubescence	1=sparingly pilose, otherwise glabrous 2=pilose at base, glabrous above 3=pilose throughout 4=densely pilose throughout

		5=dense woolly-villous
~~24~~	~~Involucral bract shape~~	~~1=narrowly lanceolate 2=broadly lanceolate~~ 3=oblanceolate
25	Involucral bract glandularity	1=absent or inconspicuous 2=moderate 3= dense/abundant 4=very dense
26	Tuft of white hairs at tip of involucral bract	1= absent 2= present
27	Ligule	1=present 2=absent
28	Ligule tip	1=entire to minutely denticulate 2=prominently dentate
29	Disc corolla pubescence	1=glabrous to sparse 2=moderate 3=dense
30	Disc corolla glandularity	1=absent or inconspicuous 2=abundant
31	Dense tufts in axils of basal leaves	1=absent 2=present
32	Capitula shape	1=broadly hemispheric 2=campanulate 3=turbinate
33	Pappus color	1=whitish brown 2= stramineous 3= tawny 4= dark brown
34	Pappus setae	1= barbellate 2= barbellate to slightly subplumose 3= subplumose 4= plumose
35	Ecology	1=nearly hydric 2=mesic 3=xeric
36	Capitula number (per stem)	
37	Cauline leaves, number of pairs	
38	Plant height	centimetres
39	Basal leaf length	centimetres
40	Basal leaf width	centimetres
41	Basal leaf length/width ratio	
42	Capitula width	millimetres
43	Capitula height	millimetres
44	Achene length	millimetres
45	Involucral bract length	millimetres
46	Involucral bract width	millimetres
47	Involucral bract length/width ratio	
48	Ligule tooth length	millimetres
49	Ligule length	millimetres
50	Ligule width	millimetres
51	Ligule length/width ratio	
52	Ligule number (per capitulum)	
53	Disc corolla length	millimetres
54	Disc corolla tube length	millimetres
55	Number major veins per leaf	
56	First cauline leaves at anthesis	1=present 2=absent
57	Cauline leaves length, 1st lowest pair	centimetres
58	Cauline leaves length, 2nd lowest pair	centimetres
59	Cauline leaves length, 3rd lowest pair	centimetres
60	Cauline leaves width, 1st lowest pair	centimetres
61	Cauline leaves width, 2nd lowest pair	centimetres
62	Cauline leaves width, 3rd lowest pair	centimetres
63	Cauline leaves l/w ratio:	1st lowest pair
64	Cauline leaves l/w ratio:	2nd lowest pair
65	Cauline leaves l/w ratio:	3rd lowest pair
66	Geographic distribution	1=western North America 2=eastern North America
67	Tip of involucral bracts	1=acute 2=acuminate 3=obtuse

Appendix 2. Collections used in numerical analyses of Arnica subgenus Chamissonis.

Analysis 1. *Arnica amplexicaulis* & *Arnica lanceolata*

OTU No.	OTU Code	Operational Taxonomic Unit (OTU) Description
		Arnica lanceolata Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo
1	AB-7177	Waterton Lakes National Park, moist bank by the side of Cameron Lake, *W.C. McCalla 7177* (ALTA 68725!).
2	AB-11616	Waterton Lakes National Park, vicinity of Cameron Lake, NW portion of lake inside *Picea mariana* forest, on boggy soil & small stream, *William Sm. Gruezo WM11616* (ALTA 91378!, WGRZ!).
3	AB-16930	Waterton Lakes National Park, N end of Cameron Lake, bog, *August J. Breitung 16930* (ALTA 16835!).
4	AK-125	Sitka, Blue Lake Trail, *L.G. Smith 125* (BRY 88462!).
5	AK-385	Misty Fjords National Monument, S-facing ridge, N of Big Goat Lake, moist draw, *Linda Vorobik 385, Ker Rice & Kathy Lucich* (ALA V072829!).
6	AK-637	Kodiak Island, Old Harbour, *W.J. Eyerdam 637* (UC M-094250!).
7	AK-1294	3.5 mi SE of pile, Bay Village, Iliamna Lake, *K.M. Reed 1294* (BRY 105118!).
8	AK-4957	Yakobi Island, West Coast, Surge Bay Lake, N side near outlet stream, sandy meadow, *Mary Clay Muller 4957* (BRY 239675!).
9	AK-94428	Port Alexander Quad, Rezanof Lake, along lakeshore, *R. Kacyon s.n.* (ALA 94428!).
10	AK-6400	Juneau, mountainside, *J.P. Anderson 6400* (RM 190709!).
11	AK-7119	Evans Island, Port San Juan, in swamp, *W.J. Eyerdam 7119* (WS 224380!).
12	BC-83	Vancouver Island, Renfrew District, Gordon River, shady places, *C.O. Rosendahl & Carl J. Brand 83* (RM 35259!).
13	CA-804	Siskiyou Co., Klamath National Forest, Preston Peak, Rattlesnake Meadow, wooded slope, *C.A. Ground 84* (RM 470624!).
14	CA-326	Siskiyou Co., Klamath National Forest, El Capitan, cliffs below Bell Echo, *J.L. Kraemer 326* (RM 470725!).
15	CA-1132	Mariposa Co., Yosemite National Park, top of Vernal Falls, *E.B. Babcock 1132* (RM 106388!).
16	CA-2531	Plumas Co., Plumas National Forest, 1/4 mi S of University of California Forestry Camp near Meadow Valley, Bidwell Bar, *Beryl O. Schreiber 2531* (RM 471089!).
17	ID-47	Lemhi Co., Lemhi Forest, Snowslide Gulch head of Mahogany Creek, *Arthur M. Cusick 47* (RM 470650!).
18	ID-1656	Bear Lake Co., St. Charles Canyon, *Ray J. Davis 1656* (WS 100189!).

19	ID-2186	Bonner Co., Kaniksu Forest, Selkirk Mts., Pack River, 0.1 mi below Pack River Bridge, 20.7 mi N of Sandpoint, *Peter F. Stickney 2186* (RM 470623!).
20	ID-6074	Bonner Co., Priest Lake, *C.V. Piper 6074* (WS 79714!).
21	ID-18131	Boundary Co., 9 mi N of Naples, on road to Leonia, on open sandy slopes on 20-mile Creek, *J.H. Christ 18131* (WS 178[illegible]47!).
22	MT-1094	Glacier National Park, meadows about Elrod Lake, *Bassett Maguire 1094* (PARATYPE, RM 135046!)-*Arnica trina* A. Nelson.
23	MT-1095	Glacier National Park, Lake Josephine, margin of woodland, alt. 4880 ft, 2 August 1932, *Bassett Maguire 1095* (HOLOTYPE, RM 135049!)-*Arnica trina* A. Nelson.
24	MT-3162	Glacier National Park, between Logan Pass & Hidden Lake, *Aven Nelson & Ruth A. Nelson 3162* (RM 177970!).
25	MT-3143	Glacier National Park, along trail to Grinnell Glacier, subalpine, *Aven Nelson & Ruth A. Nelson 3143* (RM 177951!).
26	MT-E3971	Glacier National Park, edge of stream below Rainbow Falls, S of Waterton Lake, *W.C. McCalla E3971* (ALTA 68728!).
27	NV-11460	Elko Co., Humboldt National Forest, Ruby Mountains, vicinity of Thomas Canyon Campground, near creek bridge, S bank of Lamoille Creek, edge of creek within reach of rushing waters, *William Sm. Gruezo WM11460* (ALTA 91372!, WGRZ!).
28	NV-11462	Elko Co., Humboldt National Forest, Ruby Mountains, Camp Lamoille, c. 2 km from main road, around bridge of Lamoille Creek, on road to former Boy Scout Camp, banks of creek, *William Sm. Gruezo WM11462* (ALTA 91374!, WGRZ!).
29	OR-166	Lane Co., H.J. Andrews Expt. Area, slopes in Upper Lookout Creek Basin, *J.F. Franklin & C.T. Dyrness 166* (RM 470617!).
30	OR-13152	Hood River Co., Langer, larger rocks in West Fork of Hood River, moist banks, *Louis F. Henderson s.n.* (RM 13152!).
31	OR-17218	Multnomah Co., 30 mi E of Portland, Gorge of Columbia River, basin walls & banks of Multnomah Falls, *Bassett Maguire 17218* (RM 180255!).
32	UT-1974	Salt Lake Co., Big Cottonwood Canyon, *A.O. Garrett 1974* (RM 56654!).
33	WA-2696	Chelan Co., Wenatchee Forest, Heather Pass area, 17 1/4 mi WSW of Mazama, *Ralph & Dorothy Naas 2696* (RM 470616!).
34	WA-596	Lewis Co., Gifford Pinchot Forest, rock bluffs along trail below Jordon Basin, Goat Rocks Wilderness, *Jerry F. Franklin 596* (RM 471086!).
35	WA-s.n.A	Wason City, alt. 2000-3000 ft, July 1893, *J.H. Sandberg & J.B. Leiberg s.n.* (RM 169772!).
36	WA-672	Okanogah Co., North Fork of Bridge Creek, on steep rocky flanks over which drippling water flows, *A.D.E. Elmer 672* (RM 12050!).
37	WA-1850	Skamania Co., Columbia Forest, Wind River Valley, mouth of Nine-Mile Creek, *Douglas C. Ingram 1850* (RM 470622!).

38	WA-5196	Pierce Co., Mt. Rainier National Park, terminal moraine of Nisqually Glacier, among rocks, *W.C. McCalla 5196* (ALTA 68730!).
39	WA193549	Klickitat Co., on rocks near the cold water of Larm River, *W.N. Suksdorf s.n.* (UC 193549!).
40	WY-3911	Carbon Co., Sierra Madre Mountains, *R. Dorn 3911* (RM 346424!).
		Arnica lanceolata Nutt. subsp. *lanceolata*
41	M-49	Piscataquis Co., moist cliff at falls on Katahdin brook, *E. Perot Walker 49* (PH/PENN *s.n.*!).
42	M-697005	Piscataquis Co., Mount Katahdin, from damp rocky bed to a dry brook near W side of South Basin Pond, *Francis Harper s.n.* (PH 697005!).
43	NB547980	St. John, Tobigue Narrows, *G.U. Hay s.n.* (PH 547980!).
44	NB605618	Nespisiquit, Grand Falls, *J. Fowler s.n.* (PH 605618!).
45	NH633706	Mt. Washington, Oakes Gulf, *George Golding Kennedy s.n.* (PH 633706!).
46	NH-HTS	Mt. Washington, Tuckerman's Ravine, damp cliff face, base of headwall, *H.T. Skinner s.n.* (PH/PENN *s.n.*!).
47	NH-S14	Coos Co., Mt. Washington, Tuckerman's Ravine, mountain soil near stream, headwall, *Rodney H. True S14* (PH/PENN *s.n.*!).
48	NH-47	Coos Co., Mt. Washington, Tuckerman's Ravine, *B. Long & E.B. Bartram 47* (PH 648207!).
49	NH-171	Coos Co., Mt. Washington, headwall of Tuckerman's Ravine, *A.H. Moore 171* (PENN *s.n.*!).
50	NH-1131	Mt. Washington, Tuckerman's Ravine, 27 August 1898, *Allen 1131* (PH 586725!).
51	NH-1287	White Mountains, Mt. Washington, Tuckerman's Ravine, *Willard W. Eggleston* (RM 23411!).
52	NH-1417	Mt. Washington, Tuckerman's Ravine, *C.S. Williamson 1417* (PH *s.n.*!).
53	NH-2373	Mt. Washington, Tuckerman's Ravine, *W.W. Eggleston 2373* (PH 586569!).
54	NH-3140	Mt. Washington, Tuckerman's Ravine, upper trail, *Dorothy R. Wade 3140* (SASK 27615!).
55	NH-12528	Mt. Washington, in head of Tuckerman's Ravine, *J.W. Harshberger s.n.* (PENN 12528!).
56	NH-12529	White Mountains, Brooks, *C.G. Pringle s.n.* (PENN 12529!).
57	NH-38328	White Mountains, *J.W. Chickering Jr. 38328* (CAN 191114!).
58	NH709126	White Mountains, Brooks, *C.G. Pringle s.n.* (PH 709126!).
59	Q-146	Bonaventure Co., Little Cascapedia River, alluvial thickets, *J.F. Collins & M.L. Fernald 146* (CAN 109679!).
60	Q-499	Rimouski Co., Bic, rocks along Bic River, *Edwin B. Bartram & Bayard Long 499* (PH 648526!).
61	Q-1402	Gaspé Peninsula, Tabletop Mt., alpine meadow, *H.J. Scoggan 1402* (CAN 109722!).
62	Q-1453	Bic, banks of Bic River, *C.S. Williamson 1453* (PH *s.n.*!).
63	Q-4577	Gaspé Co., on gravel bed in Malbaie River, corner of beach, *L. McI. Terrill 4577* (CAN 339301!).
64	Q-15267	Trois-Pistoles Co., Riv.-du-Loup, Trois-Pistoles, entre les rangs 2 et 3, *Ernest Lepage 15267* (CAN 304535!).

65	Q-17519	Canons de la Riviere-aux-Renards, vers les sources, tres luxuriant sur les rochers au niveau de l'eau. *F. Marie-Victorin, F. Rolland-Germain, Jules B. Brunel & Z. Rousseau 17519* (PH 626854!).
66	Q-26089	Matane Co., western slope of Mt. Logan, brooksides & subalpine meadows, *M.L. Fernald & L.B. Smith 26089* (CAN 109672!).
67	Q-26092	Matane Co., in Pease Basin, between Mts. Logan & Pembroke, alpine brooksides, *Ludlow Griscom & A.S. Pease 26092* (CAN 109670!).
68	Q-32432	Matapedia River, mill stream, gravelly flats, *J. Rousseau 32432* (RM 134704!).
69	Q-33351	Bonaventure Co., Gaspé, Riviere Grande Cascapedia, au confluent de la Jonathan, *F. Marie-Victorin, F. Rolland-Germain & E. Jacques 33351* (RM 134609!).
70	Q-33253	Gaspé, Riviere Grande Cascapedia, platieres a 14 milles de l'embouchure, *F. Marie-Victorin, F. Rolland-Germain & E. Jacques 33253* (RM 134635!).
71	Q-69113	Bonaventure Co., Grand Cascapedia River, alluvium, *E.F. Williams, J.F. Collins & M.L. Fernald 69113* (CAN 109677!).

Analysis 2. *Arnica longifolia* & *Arnica mollis*

OTU No.	OTU Code	Operational Taxonomic Unit (OTU) Description
		Arnica longifolia D.C. Eaton
1	CA73167	El Dorado Co., Sierra Nevada Mts., Glen Alpine Creek, *H.M. Hall s.n.* (RM 73167!).
2	CA20014	Mono Co., Sierra Nevada, N tributary of Slate Creek, Cabin Creek, *Philip A. Munz 20014* (RM 245268!).
3	CA-3574	Mono Co., Inyo National Forest, Slate Creek Valley, *A.R. Kruckeberg 3574* (RM 259292!).
4	CO-1914	Larimer Co., Ethel Peak, creek bottoms, *Leslie N. Goodding 1914* (RM 52151!).
5	CO-726	Gunnison Watershed, Keblar Pass, *C.F. Baker 726* (RM 169626!).
6	ID-461	Custer Co., Challis Forest, Beaver Creek, *Herman Work 461* (RM 470980!).
7	ID-431	Custer Co., Challis Forest, Swamp Creek, sandy wet soil along stream, *Herman Work 431* (RM 470979!).
8	ID-341	Lemhi Co., Salmon Forest, Cathedral Meadows, *John N. Kinney 341* (RM 470971!).
9	IDTNF937	Targhee National Forest, 14 August 1979, *Dieffenbach, Glennon, Holte, Mel, Pearson & Vieth TNF-937* (RM 470970!).
10	ID10113	Elmore Co., Sawtooth Primitive Area, meadowland 1 mi S of Lower Spangle Lake, *C.L. Hitchcock & C.V. Muhlick 10113* (RM 197898!).
11	ID20216	Blaine Co., along Big Wood River, *F.J. Hermann 20216* (RM 470981!).

12	IDRBJ175	Elmore Co. Boise Forest, Devil Creek, mouth, *R.B. Johnson RBJ-175* (RM 471037!).
13	ID-2285	Oneida Co., Bear River Range, SW corner of Franklin Basin, *Charles Piper Smith 2285* (RM 67767!).
14	ID-699	Elmore Co., Trinity Lake Region, large clumps in broken granite slides, *J. Francis Macbride 699* (RM 67433!).
15	MT13360	Stillwater Co., sandy moist meadow at Independence, head of Boulder River, Absaroka Mts., *C.L. Hitchcock & C.V. Muhlick 13360* (RM 203760!).
16	MT-338	Midvale, along R.R., 10 July 1903, *L.M. Umbach 338* (RM 169976!).
17	MT-3346	Beaverhead Co., Northern Rocky Mountain, Beaverhead National Forest, rockslide, *Lincoln Ellison & R.A. Robinson 3346* (RM 470986!).
18	MT-17	Beartooth Forest, alt. 8000 ft, 10 August 1913, *C.E.G. Sewing 17* (RM 470993!).
19	NV-335	Nevada Forest, Sec. 23 T16N R69E, Henry's Creek, alt. 8500 ft, *Frank E. Gray 335* (RM 470647!).
20	OR-154	Minam Forest, alt. 6700 ft, 25 August 1912, *C.E. Fleming 154* (RM 471049!).
21	OR-9827	Klamath Co., Crater Lake National Park, rim trail to Crater Lake Lodge, *L.R. Abrams 9827* (RM 100188!).
22	UT-1547	Salt Lake Co., Big Cottonwood Canyon, near Lake Catherine, alt. 9300 ft, 3 August 1905, *A.O. Garrett 1547* (HOLOTYPE, NY *s.n.*!; ISOTYPE, RM 52683!) - *Arnica caudata* Rydb.
23	UT14209	Cache Co., Bear River Range, Mt. Naomi Region, N of Tony Grove Lake Basin, *Bassett Maguire, Dean A. Hobson, & Ruth R. Maguire 14209* (RM 180249!).
24	UT-4103	Grand Co., La Sal Mts., alt. 11500 ft, slide rock, *Edwin B. Payson & Lois B. Payson 4103* (RM 102250!).
25	UT-5900	Piute Co., Marysvale, falls of Bullion Creek, *Marcus E. Jones 5900* (RM 64002!).
26	UT-C67	Beaver Co., Fishlake Forest, Box Canyon below Tushar Ranger Station, *H.M. Christensen C-67* (RM 470614!).
27	WA-2736	Okanogan Co., Okanogan Forest, Washington Pass Area, 12 1/4 mi WSW of Mazama, *Ralph & Dorothy Naas 2736* (RM 470620!).
28	WA-2546	Okanogan Co., Okanogan Forest, Honeymoon Pass Area, 18 1/4 mi NE of Winthrop, *Ralph & Dorothy Naas 2546* (RM 470621!).
29	WY-4588	Big Horn Co., Big Horn Mts., along Trout Creek in Cookstove Basin, *B.E. Nelson 4588* (RM 347689!).
30	WY-K36	Big Horn Co., Big Horn National Forest, Bear Creek, S & G, Bald Mountain, *Neland A. Kissinger Jr. K-36* (RM 402841!).
31	WY-574	Teton Co., Gros Ventre Mts., Lower Slide Lake, frequent along lake in dry soil, *Robert Lichvar 574* (RM 315780!).
32	WY-991	Teton Co., Gros Ventre Mts., Sportmans Ridge, infrequent in open area above treeline, *Robert Lichvar 991* (RM 315[illegible]27!).

33	WY-591	Teton Co., Gros Ventre Mts., Granite Creek, along stream in moist soil, *Robert Lichvar 591* (RM 315616!).
34	WY-4596	Sheridan Co., Big Horn Mts., c. 36 air mi WNW of Ranchester, c. 24.5 air mi NW of Burgess Junction, just S of the State line, *B.E. Nelson 4596* (RM 347753!).
35	WY-1013	Big Horn Co., Big Horn Mts., Middle Paint Rock Creek at timberline, c. 1.5 mi SW of Mistymoon Lake, c. 25 mi NNE of Ten Sleep, along cree, *Gael Fonken 1013* (RM 347679!).
36	WY-302	Carbon Co., Ferris Mts., second drainage W of Pete Creek, *Joseph Storto 302 & Thomas Wood* (RM 339690!).
37	WY-8499	Sheridan Co., Big Horn Mts., Little Goose Canyon, stony creek bottoms, *Aven Nelson 8499* (RM 37039!).
38	WY-390	Big Horn Co., Doyle Creek, woods along a stream, *Leslie N. Goodding 390* (RM 37041!).
39	WY-5925	Park Co., W of Beartooth Butte, near the look-out on Clay Butte, on clayey slopes above snowbanks, *C.L. Porter & Marjorie N. Porter 5925* (RM 222699!).
40	WY-6422	Yellowstone National Park, Snake River, among rocks on a cliff, 12 August 1899, *Aven Nelson & Elias Nelson 6422* (HOLOTYPE, RM 20774!) - *Arnica polycephala* A. Nelson.
41	WY-C142	Big Horn Co., Big Horn Forest, T54N R89W sec. 5, along Bald Mountain road, *William J. Cochran C-142* (RM 402840!).
42	WY-4638	Sheridan Co., Big Horn Mts., on NE side of Sheep Mountain, c. 35 air mi W of Ranchester, c. 21.5 air mi NW of Burgess Junction, *B.E. Nelson 4638* (RM 347752!).
43	WY-4671	Sheridan Co., Big Horn Mts., c. 30 air mi W of Ranchester, c. 15.5 air mi NW of Burgess Junction, on Boyd Ridge, *B.E. Nelson 4671* (RM 347751!).
44	WY-6535	Big Horn Co., Big Horn Mts., Salt Creek just off US 14, c. 13 air mi ENE of Shell, c. 27.5 air mi ENE of Greybull, *B.E. Nelson 6535* (RM 347750!).
45	WY-4343	Sheridan Co., Big Horn Mts., c. 5 air mi SE of Burgess Junction, c. 24 air mi WNW of Big Horn on Woodrock Road, *B.E. Nelson 4343* (RM 347754!).
46	WY-1022	Teton Co., Grand Teton National Park, moraine of Teton Glacier, *Louis Williams 1022* (RM 169923!).
47	WY-5216	Fremont Co., Southern Wind River Mts., near Christina Lake, *C.L. Porter 5216* (RM 215261!).
48	WY-374	Sublette Co., Wyoming Range, Bear Mountain, 26 air mi WSW of Daniel, limestone rock scree on steep E facing slope, *John S. Shultz 374* (RM 313150!).

Arnica mollis W.J. Hook.

49	AB-DRUMM	Rocky Mountains, alpine rivulets, *Drummond s.n.* (HOLOTYPE, K *s.n.*!) - *Arnica mollis* Hook.
50	CA-3168	Inyo Co., Onion Valley, W of Independence, *Annie M. Alexander & Louise Kellogg 3168* (RM 249834!).

51	CA-7555	Toulumne Co., Yosemite, Toulumne Meadows, grassy bank of Dog Lake, *P.A. Munz 7555* (RM 96968!).
52	CA20032	Mono Co., Sierra Nevada, Cabin Creek, tributary to Slate Creek, *Philip A. Munz 20032* (RM 245264!).
53	CA-8811	El Dorado Co., Sierra Nevada Mountains, Maggies Peak, *H.M. Hall 8811* (RM 73168!).
54	CA-8817	El Dorado Co., Half-moon Lake, *H.M. Hall 8817* (RM 106386!).
55	CA-18	Tahoe, *G.E. Poore 18* (RM 471088!).
		El Dorado Co., Sierra Nevada Mts., Maggies Peak, *H.M. Hall 8811* (RM 73168!).
56	BC19585	Along trail to Ashnola Range, rare in moist boggy area in coniferous woods at 6500 ft elev., *J.A. Calder, J.A. Parmelee & R.L. Taylor 19585* (RM 257955!).
57	CO-7256	Larimer Co., Cameron Pass, G.E. Osterhout 7256 (RM 169861!).
58	CO-762	near Boulder, Silver Lake, *Ramaley 762* (RM 31281!).
59	CO-3671	Larimer Co., Chamber's Lake, *G.E. Osterhout 3671* (RM 169961!).
60	CO-2241	Larimer Co., mountains E of North Park, *G.E. Osterhout 2241* (RM 169951!).
61	CO-4982	Larimer Co., Cameron Pass, *George E. Osterhout 4982* (RM 169950!).
62	CO-1831	Larimer Co., mountains W of North Park, west side along road to Steamboat Springs, *George E. Osterhout 1831* (RM 169949!).
63	CO-3860	Larimer Co., Cameron Pass, *G.E. Osterhout 3860* (RM 169954!).
64	CO-2665	Clear Creek Co., Pike Forest, Geneva Creek, *Gierisch 2665* (RM 471043!).
65	CO-6545	Mesa Co., Grand Mesa, moist meadow above Mesa Lake, *C.L. Porter 6545* (RM 241785!).
66	CO-170	Larimer Co., Rocky Mountain National Park, Specimen Mountain, *Dale W. McNeal Jr. 170* (RM 276537!).
67	CO-4381	Grand Co., Lulu Pass, openings in woods, *I.W. Clokey 4381* (RM 90104!).
68	ID-3594	Bonneville Co., Caribou Mt., swampy places, 8500 ft, *Edwin B. Payson & George M. Armstrong 3594* (RM 98208!).
69	ID-10394	Elmore Co., S slope of Trinity Mt., *C.L. Hitchcock & C.V. Muhlick 10394* (RM 198578!).
70	ID-3600	Custer Co., near Cape Horn, alt. 6400 ft, *J. Macbride & E.B. Payson 3600* (RM 86109!).
71	ID-2139	Valley Co., Payette Forest, vicinity of Cloochman Creek, *Peter F. Stickney 2139* (RM 471034!).
72	ID-1993	Clearwater Forest, elev. 6000 ft, *Kirkwood 1993* (RM 130547!).
73	ID11332	Lemhi Co., meadow on S Fork Camas Creek near Sleeping Deer Mt., 40 mi NW of Challis, *C.L. Hitchcock & C.V. Muhlick 11332* (RM 198577!).
74	ID-84	Custer Co., Challis Forest, head of Casino Creek, *M.G. Markle 84* (RM 471031!).
75	ID-441	Owyhee Co., Silver City, wet grassy inclines, *J. Francis Macbride 441* (RM 67431!).
76	MT-146	Park Co., Cooke City, grassy hillside, *E. & D. Pearson 146* (RM 104458!).
77	MT-420	Beartooth Forest, common name- Soft Arnica, July 1914, *A.M. Baum 420* (RM 471038!).
78	MT13345	Stillwater Co., Absaroka National Forest, head of Boulder Creek, sandy moist meadow at Independence, *C.L. Hitchcock & C.V. Muhlick 13345* (RM 202866!).

79	NV-1891	Nye Co., near the head of Pine Creek Canyon, *Gary J. Pierce 1891* (RM 293896!).
80	NV-1966	Jarbidge, moist woods, *Nelson & Macbride 1966* (RM 75324!).
81	NV-13455	Lander Co., Toiyabe National Forest, Stewart Creek, *S. Goodrich 13455* (RM 329884!).
82	NVDK151	Elko Co., Humboldt National Forest, West Jarbidge River, *Dale H. Kinnaman D.K. 51* (RM 471026!).
83	NV-1615	White Pine Co., Snake Range, Humboldt National Forest, Snake Creek drainage, just below Johnson Lake, *Noel H. Holmgren & James L. Reveal 1615* (RM 278160!).
84	679	Elko Co., Humboldt Forest, Jack Creek, *A.H. Holmgren 679* (RM 186673!).
85	NV 6315	Elko Co., Independence Mts., McAfee Peak Area, T42N R53E Sec. 23, *Arnold Tiehm 6315* (RM 336984!).
86	WA102829	Pierce Co., Mount Rainier National Park, *J.M. Grant s.n.* (RM 102829!).
87	WA-46	Wenatchee Forest, Ewing Basin, alt. 5200 ft, *Frank B. Lenzie 46* (RM 471080!).
88	WA-H10	Kittitas Co., Wenatchee Forest, Naneum Meadows, alt. 6000 ft, *Douglas Hole H-10* (RM 471095!).
89	WA-11	Yakima Co., Snoqualmie Forest, *Elbert H. Reid 11* (RM 471084!=USFS 73791!).
90	UT-1351	Uintah Mountains, Dyer Mine, spring borders, *Leslie N. Goodding 1351* (RM 41755!).
91	UT-5883	Marysvale, head of Bullion Creek, 23 August 1894, *Marcus E. Jones 5883* (PARATYPE, RM 14267!)-*Arnica chamissonis* var. *longinodosa* A. Nelson.
92	UT1645A	Salt Lake Co., Big Cottonwood Canyon, *A.O. Garrett 1645a* (RM 54077!).
93	UT-1647	Salt Lake Co., Big Cottonwood Canyon, *A.O. Garrett 1647* (RM 52684!).
94	UT-18989	Uintah Co., Atwood Lake Basin, Lake Atwood, *S. Welsh, E. Neese & D. Atwood 18989[A]* (RM 318158!).
95	UT-5057	Stillwater-La Motte Peak, along stream, *E.B. & L.B. Payson 5057* (RM 115279!).
96	UT17495	Wasatch Co., Uinta Mts., Uinta National Forest, Phelps Brook drainage, 22.25 mi E of Heber City, *S. Goodrich 17495* (RM 343247!).
97	UT-1984	Washington Co., Pine Valley Mts., Furtherwater Canyon, c. 9 mi S of Pine Valley, *Frank W. Gould 1984* (RM 196910!).
98	OR-1154	Wallowa Co., Powder River Mts., near spring at head of Aneroid Lake, *Roxana S. Ferris & Rena Duthie 1154* (RM 103010!).
99	OR-56	Santiam Forest, Whitewater Creek near Jefferson Park, *Chas. H. Flory 56* (RM 471091!).
100	OR-814	Wallowa Co., Wallowa National Forest, N Fork Imnaha River, *Elbert H. Reid 814* (RM 471096!).
101	0R-168	Minam Forest, 12 August 1912, *C.E. Fleming 168* (RM 470615!=USFS 5188!).
102	OR-B540	Ochoco Forest, Trail Station, *Douglas C. Ingram B-540* (RM 471085!=USFS 29760!).
103	OR-2489	Head of Wallowa River, 9000 ft alt., 28 August 1900, *Wm. C. Cusick 2489* (RM 31433!).
104	WY-410	Big Horn Co., Ten Sleep Lakes, moist hillsides, *Leslie N. Goodding 410* (RM 37031!).
105	WY-933	Teton Peaks, 21 August 1894, *Aven Nelson 933* (PARATYPE, RM 3571!)-*Arnica chamissonis* var. *longinodosa* A. Nelson.

106	WY-1702	Centennial Valley, 17 August 1895, *Aven Nelson 1702* (HOLOTYPE, RM 5837!) - *Arnica chamissonis* var. *longinodosa* A. Nelson.
107	WY-1785	La Plata Mines, 23 August 1895, *Aven Nelson 1785*•(PARATYPE, RM 5141!) - *Arnica chamissonis* var. *longinodosa* A. Nelson.
108	WY-6379	Yellowstone National Park, Lewis River, in bogs, 9 August 1899, *Aven Nelson & Elias Nelson 6379* (PARATYPE, RM 169905!) - *Arnica chamissonis* var. *longinodosa* A. Nelson.
109	WY-8519	Little Goose Canyon, spring bog, 28 July 1901, *Aven Nelson 8519* (RM 37034!).
110	WY-2819	Sublette Co., Surveyor Park, Fremont Lake, *Edwin B. Payson & Lois B. Payson 2819* (RM 93866!).
111	WY-8503	Little Goose Canyon, wet banks, *Aven Nelson 8503* (RM 37032!).
112	WY-1962	Carbon Co., Bridger Peak, wet creek banks, *Leslie N. Goodding 1962* (RM 52142!).
113	WY 1191	Grand Teton National Park, bog west of Taggart Lake, elev. 7500 ft, *Louis Williams 1191* (RM 135279!).
114	WY-340	Big Horn Co., Big Horn National Forest, Granite Creek, *Richard M. Hurd 340* (RM 244421!).
115	WY-496	Fremont Co., Wind River Range, Gannett Peak area, 1 mi NE of Gannett Glacier, *Francis X. Jozwik 496* (RM 273338!).
116	WY-10274	Carbon Co., Medicine Bow Range, between Lake Marie & Silver Lake, 10400 ft, *C.L. Porter & Marjorie W. Porter 10274* (RM 280948!).
117	WY-2908	Fremont Co., Togwotee Pass, Shoshone National Forest, *John F. & Mildred S. Reed 2908* (RM 220028!).
118	WY-6121	Sublette Co., vicinity of Horseshoe Lake, SE of Pinedale, *C.L. Porter & B.F. Miller 6121* (RM 229656!).
119	WY-90	Big Horn Co., Cliff Lake-Cloud Peak Area, east upper side of Lower Crater Lake, *Lawrence Lofgren 90* (RM 248691!).
120	WY-1788	Big Horn Co., Big Horn National Forest, *R.K. Gierisch 1788* (RM 402834!).
121	WY-5080	La Plata Mines, 23 August 1898, *Elias Nelson 5080* (RM 12657!).
122	WY-3365	Park Co., Hughes Creek, *R.D. Dorn 3365* (RM 319678!).
123	WY-7776	Albany Co., Nash Fork, *Aven Nelson 7776* (RM 28794!).
124	WY-308	Albany Co., Medicine Bow Mountains, Nash's Fork below University of Wyoming Science Camp, *W.G. Solheim 308* (RM 311430!).
125	WY-1029	Teton Mountains, dap soil, 26 July 1901, *Elmer D. Merrill & E.N. Wilcox 1029* (RM 32324!).
126	WY-367	Carbon Co., Sierra Madre Mountains, *R.N. Holmes 367* (RM 330855!).
127	WY-1191	Teton National Park, bog W of Taggart Lake, elev. 7500 ft, *Louis Williams 1191* (RM 142441!).
128	WY-970	Teton Co., Grand Teton National Park, Cascade Canyon, elev. 9000 ft, *Marion Ownbey 970* (RM 143278!).
129	WY-3020	Eastern slope of the Big Horn Mountains, headwaters of Clear Creek & Crazy Woman River, *Frank Tweedy 3020* (RM 38407!).
130	WY-4037	Carbon Co., Sierra Madre Mountains, *B.E. Nelson 4037 & William Blunt* (RM 329349!).

131	WY-6109	Yellowstone National Park, Obsidian Creek, 24 July 1899, *Aven Nelson & Elias Nelson 6109* (RM 20766!).
132	WY-3359	Big Horn Co., Big Horn Mountains, along South Trapper Creek, elev. 8600 ft, *B.E. Nelson 3359* (RM 347747!).
133	WY-3572	Johnson Co., Big Horn Mountains, E of Hazelton Peak, along middle fork of Crazy Woman Creek, *B.E. Nelson 3572* (RM 347746!).
134	WY-4330	Sheridan Co., Big Horn Mountains, on Woodrock Road, elev. 8400 ft, *B.E. Nelson 4330* (RM 347744!).
135	WY-4920	Big Horn Co., Big Horn Mountains, S of Paint Rock Lake, *B.E. Nelson 4920* (RM 347741!).
136	WY-6273	Big Horn Co., Big Horn Mountains, Tillets Hole, 8700 ft elev., *B.E. Nelson 6273* (RM 347777!).
137	WY-5005	Big Horn Co., Big Horn Mountains, vicinity of Edelman Pass & Emerald Lake at the headwaters of Shell Creek, elev. 10000 ft, *B.E. Nelson 5005* (RM 347774!).
138	WY-5021	Big Horn Co., Big Horn Mountains, *B.E. Nelson 5021* (RM 347773!).
139	WY-6117	Johnson Co., Big Horn Mountains, along Merle Creek, *B.E. Nelson 6117* (RM 347772!).
140	WY-7179	Johnson Co., Big Horn Mountains, along Merle Creek, *B.E. Nelson 7179* (RM 347771!).
141	WY-824	Albany Co., 2.6 mi W of Albany, on the Albany-Keystone Road then 1.9 mi NW on the road to Cinnabar Park, elev. 8800 ft, *B.E. Nelson & Linda Nelson 824* (RM 296366!).
142	WY-1055	Carbon Co., on the ridge W of Lake Marie, on the trail to Medicine Bow Peak, elev. 10900 ft, *B.E. Nelson 1055* (RM 296365!).
143	WY-912	Carbon Co., 21.7 mi W of Centennial, on Wyoming Hwy 130 at the junction with N French Creek Road, elev. 9500 ft, *B.E. Nelson 912* (RM 296363!).
144	WY-163	Albany Co., Medicine Bow, Elk Creek Study Bog, alt. 9700 ft, *David Sturges 163* (RM 272470!).
145	WY-3624	Big Horn Co., Big Horn Mountains, off Devil Canyon Road, above Little Tepee Creek, 8300 ft elev., *B.E. Nelson 3624* (RM 347745!).

Analysis 3. *Arnica chamissonis-longifolia-parryi-mollis*

OTU No.	OTU Code	**Operational Taxonomic Unit (OTU) Description**
		Arnica chamissonis Less.
1	AB-4868	3 mi S of South Ram River on Forestry Road Nordegg-Calgary, *M.G. Dumais 4868* (ALTA 25309!).
2	AB-6689	10 mi W of Calgary, low meadow along Banff Hwy, *W.C. McCalla 6689* (ALTA 68740!).
3	AB-10132	Swampy ground E of Barrhead, *W.C. McCalla 10132* (ALTA 68732!).
4	AK-283	Unalaska, Iliuliuk, *W.L. Jepson 283* (UC M-086188!).

5	AK-1650	Chugach State Park, Eklutna Valley, *LuDean Marvin 1650* (BRY 274727!).
6	AK-11939	Sterling Hwy (Hwy 1 S), c. 2.5 km before Homer proper, c. 1.9 km S of Mile post 171, *Wm. & Aida Gruezo WM11939* (ALTA 92044!).
7	AK-11940	Sterling Hwy (Hwy 1 S), c. 1 km S of Mile post 169, opposite parking area of Homer View Point, *Wm. & Aida Gruezo WM11940* (ALTA 92046!).
8	AZ-7821	Apache Co., Mountain Pass between Eagar & McNary, *Larry C. Higgins 7821* (BRY 121801!).
9	AZ-s.n.A	Apache Co., near Big Lake on Big Lake-Alpine Road, *P.D. Keener s.n.* (UC M-280074!).
10	AZ-s.n.B	Apache Co., White Mts., Apache National Forest, Winn Campground Bog, *T.R. Van Devender & F.W. Reichenbacher s.n.* (UC 1488870!).
11	BC-7690	Yoho National Park, low ground on bank of Kicking Horse River near bridge leading to Yoho Valley, *W.C. McCalla 7690* (ALTA 68733!).
12	BC-7756	Yoho National Park, flat ground now rather dry bank of Kicking Horse River below Mt. Stephen, *W.C. McCalla 7756* (ALTA 68734!).
13	BC-13476	2 mi NW of Ootsa Lake village near Ootsa Lake, *J.A. Calder, D.B.O. Savile & J.M. Ferguson 13476* (UC M-090702!, WS 235370!).
14	CA-BOLAN	Sierra Valley, in deep water strange to say but true, *H.N. Bolander, Kellogg & Keller s.n.* (HOLOTYPE, GH *s.n.*!) - *A. chamissonis* Less. var. *incana* A. Gray.
15	CA-3311	Inyo Co., Cottonwood Lakes, SW of Lone Pine, *Annie M. Alexander & Louise Kellogg 3311* (RM 200906!).
16	CA-6195	San Bernardino Co., San Bernardino Mts., Dry Lake, *P.A. Munz 6195* (RM 92082!).
17	CA-7582	Tulare Co., Whitney Creek, growing on a dried lake bed, *Peter H. Raven 7582 & G. Thomas Robbins* (RM 261076!).
18	CO-124	Gunnison Co., Parlin, wet meadows at 8000 ft, *Benjamin H. Smith 124* (PH *s.n.*!).
19	CO-9154	Jackson Co., Arapaho National Forest at Denver Creek Campground, on Hwy 125, *C.L. Porter & Marjorie W. Porter 9154* (SASK 19458!).
20	CO-22967	Park Co., Colorado Front Ranges, meadows along highway near Jefferson, *A.E. Porsild 22967 & William A. Weber* (CAN 266752!).
21	ID-301	Priest Lake, thorofare & shore, *D.T. MacDougal 301* (CAN 190984!).
22	ID-897	Adams Co., New Meadows, *Ray J. Davis 897* (UC 892052!).
23	ID-5855	Owyhee Co., 4 mi S of Riddle, Idaho Hwy 51, *Noel H. Holmgren 5855 & Patricia K. Holmgren* (BRY 167126!).
24	MN-3652	4 mi N of Winnipeg, Cross Lake, Whiskey-jack portage, *H.J. Scoggan 3652* (CAN 114790!).
25	MN-9316	120 mi NW of Winnipeg, Grahamdale, *H.J. Scoggan 9316* (CAN 210449!).
26	MN-11337	Riding Mountain National Park, roadside gravel 7 mi N of south entrance, *H.J. Scoggan 11337* (CAN 224156!).
27	MT-1098	Glacier National Park, pond N of outlet, Lower St. Mary Lake, *Bassett Maguire 1098* (HOLOTYPE, RM 135044!) - *A. maguirei* A. Nelson.

28	MT-1222	Flathead Co., c. 3 mi SW of Belton, damp ground at west end of Lake Five, *H.T. Rogers & J.M. Rogers 1222* (WS 125809!).
29	MT-15354	Glacier Co., 4 mi S of Babb, *Bassett Maguire, Ruth Maguire & C.B. Maguire 15354* (PH 781080!, UC 604319!).
30	NM-78102	Chuska Mts., Lake D., SE side of Dead Man Lake, crest of mountains W of Toadlena, 3 mi W of Toadlena, *Herbert E. Wright s.n.* (BRY 78102!).
31	NV-713	Nye Co., Upper Reese River Canyon Road, c. 9 mi S of Dieringer, *F.S. Goodner & W.H. Henning 713* (UC 901176!).
32	NV-3100	Esmeralda Co., White Mts., Chiatovitch Creek, *Victor Duran 3100* (ISOTYPE, RM 129120!) - *A. chamissonis* subsp. *foliosa* var. *jepsoniana* Maguire.
33	NV-9670	Granite Range, upper meadows of S fork of Rock Creek, c. 1.6 km (1 mi) E of Granite Peak, 16 km (10 mi) airline distance NNW of Gerlach, *Noel H. Holmgren 9670 & Patricia K. Holmgren* (BRY 283374!).
34	NWT-81	Mackenzie Mts., hot spring meadow, *E.W. Arnold 81* (CAN 264976!).
35	NWT11795	Logan Mts., Flat River Valley, c. 2 km S of Tungsten (=Cantung) proper (mining townsite), border of black spruce-fir forest & vicinity of hot springs pools, *Wm. & Aida Gruezo WM11795* (ALTA 91859!).
36	NWT11799	Logan Mts., Flat River Valley, c. 2 km S of Tungsten (=Cantung) proper (mining townsite), border of black spruce-fir forest & vicinity of hot springs pools, *Wm. & Aida Gruezo WM11799* (ALTA 91867!).
37	ON-1077	Polar Bear Provincial Park, Brant River, island near mouth of west branch, *F.N. Cowell 1077* (CAN 320596!).
38	ON-8060	Kenora District, Hudson Bay Lowlands, Winisk, clearing on riverbank at Settlement, *W.K.W. Baldwin 8060* (CAN 414797!).
39	ON-62531	James Bay, mouth of Albany River, *W. Spreadborough Geol. Suv. Can. 62531* (CAN 109600!).
40	OR-NUTT	"R. Mts. & Blue Mts. of Columbia", *Thomas Nuttall s.n.* (HOLOTYPE, BM *s.n.*!) - *Arnica foliosa* Nutt. - center specimen.
41	OR-TNUTT	"R. Mts. & Blue Mts. of Columbia", *Thomas Nuttall s.n.* (HOLOTYPE, BM *s.n.*!) - *Arnica foliosa* Nutt. - left specimen.
42	OR-NUTTA	"R. Mts. & Blue Mts. of Columbia", *Thomas Nuttall s.n.* (HOLOTYPE, BM *s.n.*!) - *Arnica foliosa* Nutt. - right specimen.
43	OR-2389	Anderson Valley, Adobe flats, *J.B. Leiberg 2389* (UC 179196!).
44	QE-33158	East coast of James Bay, Eastmain River, *E. Lepage 33158* (MT *s.n.*!).
45	SK-1246	0.6 mi NW of Hwy 120 at Mile 35, *H.G. Anderson 1246* (SASK 44114!).
46	SK-22245	S of Nipawin, edge of grain field, *G.F. Ledingham s.n.* (SASK 22245!).
47	SK-26612	Brightsand Lake, woods near lakeshore, *Robert Connell s.n.* (SASK 26612!).

48	UT-11442	Wasatch Co., Wasatch National Forest, Wasatch Mts., Brighton town proper, Brighton Bowl Ski area, c. 100 m from Seventh Adventist Church or Evergreen Chairlift, *Wm. Gruezo WM11442* (ALTA 91411!).
49	UT-12339	Cache Co., Logan Canyon, Red Banks, *Bassett Maguire & Ruth Maguire 12339* (CAN 190979!).
50	UT-18961	Garfield Co., S end of Panguitch Lake, dry gravelly shore, *Bassett Maguire 18961* (CAN 190976!).
51	WA-1498	Klickitat Co., c. 5 mi S of Glennwood, *F.G. Meyer 1498* (UC 719034!).
52	WA-6283	Klickitat Co., Falcon Valley, *Wilhelm N. Suksdorf 6283* (WS 79770!).
53	WA-10142	Klickitat Co., Falcon Valley, *Wilhelm N. Suksdorf 10142* (WS 79774!).
54	WY-766	Upper Wind River, 10 August 1894, *Aven Nelson 766* (HOLOTYPE, RM 2979!) - *Arnica ocreata* A. Nelson.
55	WY-1417	Pine Creek, 11 July 1892, *B.C. Buffum 1417* (PARATYPE, RM *s.n.*!) - *Arnica rhizomata* A. Nelson.
56	WY-1850	Loveland, 2 July 1893, *J.D. Parker 1850* (HOLOTYPE, RM *s.n.*!) - *Arnica stricta* A. Nelson.
57	WY-3587	North Vermilion Creek, 17 July 1897, *Aven Nelson 3587* (PARATYPE, RM 10610!) - *Arnica rhizomata* A. Nelson.
58	WY-5224	Yellowstone Park, Shoshone, alt. 7500 ft, 1 August 1897, *P.A. Rydberg & Ernst A. Bessey 5224* (PARATYPE, RM 21636!) - *Arnica ocreata* A. Nelson.
59	WY-7643	Albany Co., Tie City, 20 July 1900, *Aven Nelson 7643* (HOLOTYPE, RM 28788!) - *Arnica celsa* A. Nelson.
60	WY-6940	Yellowstone National Park, Yellowstone Lake, on dry sandy banks, 24 August 1899, *Aven Nelson & Elias Nelson 6940* (HOLOTYPE, RM 20772!) - *Arnica exigua* A. Nelson.
61	WY-8012	Albany Co., Lincoln Gulch, in open grassy subalpine parks, 8 August 1900, *Aven Nelson 8012* (HOLOTYPE, RM 28787!) - *Arnica rhizomata* A. Nelson.
62	WY-11315	Albany Co., Medicine Bow National Forest, c. 4.5 mi NW of Centennial, on Hwy 130, pine forest meadows near road turn-out, *Wm. Gruezo WM11315* (ALTA 91408!).
63	WY-11381	Sheridan Co., Big Horn Mountains National Forest, Hwy 14, c. 120 m W of Mile post 66, c. 10 m from roadside, *Wm. Gruezo WM11381* (ALTA 91409!).
64	WY-11403	Park Co., Shoshone National Forest, Hwy 14-16-20, c. 2 mi from Yellowstone National Park gate entrance, vicinity of Pahaska Tepee Tavern Motel, c. 500 m from Pahaska Campground, fill-side of road c. 20 m from river banks, *Wm. Gruezo WM11403* (ALTA 91410!).
65	YT-11774	Alaska Hwy, c. 3 km after Iron Creek, cut-side (right side) of a sharp road bend bordering a poplar forest, *Wm. & Aida Gruezo WM11774* (ALTA 91835!).
66	YT-11822	Klondike Hwy (Hwy 2), c. 1.6 km S of Km post 460 & c. 4.6 km S of Pelly Crossing, right side of road by edge of *Salix* thickets, *Wm. & Aida Gruezo WM11822* (ALTA 9189[illegible]).
67	YT-11953	Alaska Hwy (Hwy 1), c. 1.5 km W of Km post 1930 or c. 3 km S of Beaver Creek, border of sparse stunted *Picea-Salix* forest, left side of road en route to Koidern, *Wm. & Aida Gruezo WM11953* (ALTA 92068!).

68	YT-11964	Haines Road (Hwy 3), c. 0.5 km S of Km post 240, right side of road en route to Dezadeash, along margins of poplar (*Populus*)-spruce (*Picea*) forest, relatively sloping road shoulders, *Wm. & Aida Gruezo WM11964* (ALTA 92082!).
69	YT-11971	Alaska Hwy (Hwy 1), c. 150 m E of Km post 1590 (between Haines Junction & Whitehorse), meadow opening in poplar (*Populus*)-spruce (*Picea*) forest, *Wm. & Aida Gruezo WM11971* (ALTA 92098!).
		Arnica longifolia D.C. Eaton
70	CA73167	El Dorado Co., Sierra Nevada Mts., Glen Alpine Creek, *H.M. Hall s.n.* (RM 73167!).
71	CA20014	Mono Co., Sierra Nevada, N tributary of Slate Creek, Cabin Creek, *Philip A. Munz 20014* (RM 245268!).
72	CA-3574	Mono Co., Inyo National Forest, Slate Creek Valley, *A.R. Kruckeberg 3574* (RM 259292!).
73	CO-1914	Larimer Co., Ethel Peak, creek bottoms, *Leslie N. Goodding 1914* (RM 52151!).
74	CO-726	Gunnison Watershed, Keblar Pass, *C.F. Baker 726* (RM 169626!).
75	ID-461	Custer Co., Challis Forest, Beaver Creek, *Herman Work 461* (RM 470980!).
76	ID-431	Custer Co., Challis Forest, Swamp Creek, sandy wet soil along stream, *Herman Work 431* (RM 470979!).
77	ID-341	Lemhi Co., Salmon Forest, Cathedral Meadows, *John N. Kinney 341* (RM 470971!).
78	IDTNF937	Targhee National Forest, 14 August 1979, *Dieffenbach, Glennon, Holte, Mel, Pearson & Vieth TNF-937* (RM 470970!).
79	ID10113	Elmore Co., Sawtooth Primitive Area, meadowland 1 mi S of Lower Spangle Lake, *C.L. Hitchcock & C.V. Muhlick 10113* (RM 197898!).
80	ID20216	Blaine Co., along Big Wood River, *F.J. Hermann 20216* (RM 470981!).
81	IDRBJ175	Elmore Co. Boise Forest, Devil Creek, mouth, *R.B. Johnson RBJ-175* (RM 471037!).
82	ID-2285	Oneida Co., Bear River Range, SW corner of Franklin Basin, *Charles Piper Smith 2285* (RM 67767!).
83	ID-699	Elmore Co., Trinity Lake Region, large clumps in broken granite slides, *J. Francis Macbride 699* (RM 67433!).
84	MT13360	Stillwater Co., sandy moist meadow at Independence, head of Boulder River, Absaroka Mts., *C.L. Hitchcock & C.V. Muhlick 13360* (RM 203760!).
85	MT-338	Midvale, along R.R., 10 July 1903, *L.M. Umbach 338* (RM 169976!).
86	MT-3346	Beaverhead Co., Northern Rocky Mountain, Beaverhead National Forest, rockslide, *Lincoln Ellison & R.A. Robinson 3346* (RM 470986!).
87	MT-17	Beartooth Forest, alt. 8000 ft, 10 August 1913, *C.E.G. Sewing 17* (RM 470993!).
88	NV-335	Nevada Forest, Sec. 23 T16N R69E, Henry's Creek, alt. 8500 ft, *Frank E. Gray 335* (RM 470647!).
89	OR-154	Minam Forest, alt. 6700 ft, 25 August 1912, *C.E. Fleming 154* (RM 471049!).

90	OR-9827	Klamath Co., Crater Lake National Park, rim trail to Crater Lake Lodge, *L.R. Abrams 9827* (RM 100188!).
91	UT-1547	Salt Lake Co., Big Cottonwood Canyon, near Lake Catherine, alt. 9300 ft, 3 August 1905, *A.O. Garrett 1547* (HOLOTYPE, NY *s.n.*!; ISOTYPE, RM 52683!) - *Arnica caudata* Rydb.
92	UT14209	Cache Co., Bear River Range, Mt. Naomi Region, N of Tony Grove Lake Basin, *Bassett Maguire, Dean A. Hobson, & Ruth R. Maguire 14209* (RM 180249!).
93	UT-4103	Grand Co., La Sal Mts., alt. 11500 ft, slide rock, *Edwin B. Payson & Lois B. Payson 4103* (RM 102250!).
94	UT-5900	Piute Co., Marysvale, falls of Bullion Creek, *Marcus E. Jones 5900* (RM 64002!).
95	UT-C67	Beaver Co., Fishlake Forest, Box Canyon below Tushar Ranger Station, *H.M. Christensen C-67* (RM 470614!).
96	WA-2736	Okanogan Co., Okanogan F[illegible], Washington Pass Area, 12 1/4 mi WSW of Mazama, *Ralph & Dorothy Naas 2736* (RM 470620!).
97	WA-2546	Okanogan Co., Okanogan Forest, Honeymoon Pass Area, 18 1/4 mi NE of Winthrop, *Ralph & Dorothy Naas 2546* (RM 470621!).
98	WY-4588	Big Horn Co., Big Horn Mts., along Trout Creek in Cookstove Basin, *B.E. Nelson 4588* (RM 347689!).
99	WY-K36	Big Horn Co., Big Horn National Forest, Bear Creek, S & G, Bald Mountain, *Neland A. Kissinger Jr. K-36* (RM 402841!).
100	WY-574	Teton Co., Gros Ventre Mts., Lower Slide Lake, frequent along lake in dry soil, *Robert Lichvar 574* (RM 315780!).
101	WY-991	Teton Co., Gros Ventre Mts., Sportmans Ridge, infrequ[illegible]n open area above treeline, *Robert Lichvar 991* (RM 315627!).
102	WY-591	Teton Co., Gros Ventre Mts., Granite Creek, along stream in moist soil, *Robert Lichvar 591* (RM 315616!).
103	WY-4596	Sheridan Co., Big Horn Mts., c. 36 air mi WNW of Ranchester, c. 24.5 air mi NW of Burgess Junction, just S of the State line, *B.E. Nelson 4596* (RM 347753!).
104	WY-1013	Big Horn Co., Big Horn Mts., Middle Paint Rock Creek at timberline; c. 1.5 mi SW of Mistymoon Lake, c. 25 mi NNE of Ten Sleep, along cree, *Gael Fonken 1013* (RM 347679!).
105	WY-302	Carbon Co., Ferris Mts., second drainage W of Pete Creek, *Joseph Storto 302 & Thomas Wood* (RM 339690!).
106	WY-8499	Sheridan Co., Big Horn Mts., Little Goose Canyon, stony creek bottoms, *Aven Nelson 8499* (RM 37039!).
107	WY-390	Big Horn Co., Doyle Creek, woods along a stream, *Leslie N. Goodding 390* (RM 37041!).
108	WY-5925	Park Co., W of Beartooth Butte, near the look-out on Clay Butte, on clayey slopes above snowbanks. *C.L. Porter & Marjorie N. Porter 5925* (RM 222699!).

109	WY-6422	Yellowstone National Park, Snake River, among rocks on a cliff, 12 August 1899, *Aven Nelson & Elias Nelson 6422* (HOLOTYPE, RM 20774!) - *Arnica polycephala* A. Nelson.
110	WY-C142	Big Horn Co., Big Horn Forest, T54N R89W sec. 5, along Bald Mountain road, [illegible]*am J. Cochran C-142* (RM 402840!).
111	WY-4638	Sheridan Co., Big Horn Mts., on NE side of Sheep Mountain, c. 35 air mi [illegible] of Ranchester, c. 21.5 air mi NW of Burgess Junction, *B.E. Nelson 4638* (RM 347752!).
112	WY-4671	Sheridan Co., Big Horn Mts., c. 30 air mi W of Ranchester, c. 15.5 air mi NW of Burgess Junction, on Boyd Ridge, *B.E. Nelson 4671* (RM 347751!).
113	WY-6535	Big Horn Co., Big Horn Mts., Salt Creek just off US 14, c. 13 air mi ENE o[illegible] Shell, c. 27.5 air mi ENE of Greybull, *B.E. Nelson 6535* (RM 347750!).
114	WY-4343	Sheridan Co., Big Horn Mts., c. 5 air mi SE of Burgess Junction, c. 24 [illegible]i WNW of Big Horn on Woodrock Road, *B.E. Nelson 4343* (RM 347754!).
115	WY-1022	Teton Co., Grand Teton National Park, moraine of Teton Glacier, *Lo[illegible]illiams 1022* (RM 169923!).
116	WY-5216	Fremont Co., Southern Wind River Mts., near Christina Lake, *C.L. P[illegible]er 5216* (RM 215261!).
117	WY-374	Sublette Co., Wyoming Range, Bear Mountain, 26 air mi WSW of D[illegible]iel, limestone rock scree on steep E facing slope, *John S. Shultz 374* (RM 313150!).
		Arnica parryi A. Gray
118	CA-62940	El Dorado Co., Lake Valley, *M.S. Baker s.n.* (UC 62940!).
119	CA197311	Placer Co., Sierra Nevada Mts., Squaw Valley on Truckee River, *C.F. Sonne s.n.* (UC 197311!).
120	CO-3814	Larimer Co., Mt. Cameron, 15 August 1908, *G.E. Osterhout 3814* (HOLOTYPE, RM 159541!) - *Arnica parryi* var. *crinita* Osterhout.
121	CO-5819	Clear Creek Co., Empire, 8500 ft elev., *Frank Tweedy 5819* (RM 47866!).
122	CO-552	Uncompahgre National Forest, Ranger Station, alt. 9000 ft, opening [illegible] spruce forest, *Ernest P. Walker 552* (RM 75652!).
123	CO-270	Larimer Co., near Cameron Pass, *Geo. E. Osterhout 270* (RM 1695[illegible]).
124	CO-5827	Grand Co., Berthoud Pass, 11000 ft, *Frank Tweedy 5827* (RM 47867!).
125	CO-1552	Rabbit Ears, subalpine rocky ridge, 14 July 1903, *L.N.G. (= Leslie N. Godding ?) 1552* (RM 52154!).
126	CO10497	San Juan Co., San Juan Range, 2 mi N of Molas Pass, *C.L. Porter & Marjorie W. Porter 10497* (RM 283425!).
127	CO16734	Grand Co., Idaho Springs, near Berthoud Pass, dryish alpine meadow, *Otto Degener & Leroy Peiler 16734* (RM 193991!).
128	CO-2660	Clear Creek Co., Pike Forest, Geneva Creek, *Ralph K. Gierisch 2660* (RM 471059!).
129	CO-2734	Routt Co., Routt Forest, Black Mountain, Sec. 14 T9N R89W, *R.K. Gierisch 2734* (RM 471058!).

130	CO-59	Montrose Co., Uncompahgre Forest, head of Little Red, Sec. 24 T47N R12W, *Lancaster, Doran & Bunderson 59* (RM 471057!).
131	CO-3815	Larimer Co., Mt. Cameron, *Geo. E. Osterhout 3815* (RM 169584!).
132	CO-8491	Jackson Co., 3 mi W of Cameron Pass at the Crags Campground, *C.L. Porter & Marjorie W. Porter 8491* (RM 263022!).
133	CO-7612	Grand Co., near Rabbit Ears on U.S. 40, common in dry meadows, *C.L. Porter & Marjorie W. Porter 7612* (RM 256075!).
134	CO-4476	Grand Co., Arapahoe National Forest, along the Pawnee Lake Trail, *Aven Nelson & Ruth A. Nelson 4476* (RM 191944!).
135	CO-496	La Plata Mountains, Little Kate Mine, alt. 11000 ft, *C.F. Baker, F.S. Earle & S.M. Tracy 496* (RM 169593!).
136	ID-11431	Blaine Co., Sawtooth National Forest, road turn-off on Hwy 75 leading to Alturas Lake, c. 300 m before Alpine Creek parking area, roadside, alt. c. 2591 m (=8500 ft), *Wm. Gruezo WM11431* (ALTA 91401!, WGRZ!).
137	ID-9034	Idaho, forest, July 1896, *A.A. & E. Gertrude Heller s.n.* (RM 9034!).
138	ID10469	Blaine Co., Sawtooth Primitive Area, meadowland 2 mi below lowermost of lakes at Head, Alpine Creek, NW of Alturas, *C.L. Hitchcock & C.V. Muhlick 10469* (RM 198572!).
139	ID-3527	Bonneville Co., Caribou Mountain, wooded slopes, alt. 8500 ft, *Edwin B. Payson & George M. Armstrong 3527* (RM 98210!).
140	ID-1749	Fremont Co., along road between Ashton & Cave Falls, woods at Idaho-Wyoming Line, *Arthur Cronquist 1749* (RM 186929!).
141	MT-84	Gallatin Co., Gallatin Forest, Upper Bear Basin, alt. 8000 ft, *Eric P. White 84* (RM 471065!).
142	MT-528	Midvale, Squaw Mountain, 26 July 1903, *L.M. Umbach 528* (RM 169590!).
143	OR-1835	Wallowa Co., 16 mi SE of Imnaha, dry meadow along Hat Point Road, *Marion Ownbey & Ruth P. Ownbey 1835* (RM 183744!).
144	UT-4095	Grand Co., La Sal Mts., alt. 10500 ft, 31 July 1924, *Edwin B. Payson & Lois B. Payson 4095* (RM 102251!).
145	UT-4315	Summit Co., 3 mi W of Bald Mountain, edge of spruce woodland about meadows of Lily Lake, *Bassett Maguire, A.G. Richards & Ruth Maguire 4315* (RM 140649!).
146	UT-4618	Sanpete Co., Manti National Forest, head S Fork Cove Creek, Sec. 36 T14S R5E, *Linco[illegible] Ellison 4618* (RM 471147!).
147	''T 6609	Big Cottonwood Canyon, below Silver Lake, 4 July 1905, *P.A. Rydberg & E.C. Carlton 6609* (HOLOTYPE, NY *s.n.*!) - *Arnica arachnoidea* Rydb.
148	UT 6609	Big Cottonwood Canyon, below Silver Lake, 4 July 1905, *P.A. Rydberg & E.C. Carlton 6609* (ISOTYPE, CAN 191136!) - *Arnica arachnoidea* Rydb.
149	WA-381	Wenatchee Forest, NW1/4 Sec. 22 T26N R15E, alt. 3225 ft, *Frank B. Lenzie 381* (RM 471138!).
150	WA-21	Wenatchee Forest, meadow on TW Violette Ranch, alt. 1800 ft, *Frank B. Lenzie 21* (RM 471140!).

151	WY-11405	Yellowstone National Park Co., Yellowstone National Park, c. 2 km E of Sylvan Lake, roadside, alt. c. 2438 m (= c.8000 ft), *Wm. Gruezo WM11405* (ALTA 91399!, WGRZ!).
152	WY-11406	Yellowstone National Park Co., Yellowstone National Park, c. 2 km E of Sylvan Lake, roadside, alt. c. 2438 m (= c.8000 ft), *Wm. Gruezo WM11406* (ALTA 91400!, WGRZ!).
153	WY-3219	Yellowstone National Park, moist woods along E side of Sylvan Lake at Sylvan Pass, *Thomas W. Nelson, Jane P. Nelson, James L. Nelson & Kathy M. Nelson 3219* (RM 354755!).
154	WY-5074	La Plata Mines, 22 August 1898, *Elias Nelson 5074* (RM 12654!).
155	WY-204	Teton Co., Targhee National Forest, Teton Canyon, Treasure Mountain Scout Camp, *Loran C. Anderson 204* (RM 254238!).
156	WY16570	Lincoln Co., Sec. 15 T29N R118W, *Arthur H. Holmgren 16570, Jack Payne & Marty Lee* (RM 319232!).
157	WY-105	Natrona Co., Casper Mountain, Camp Wyoba Area, open hillside, *Robert L. Tresler 105* (RM 273825!).
158	WY67144	Yellowstone National Park, 1942 Witch Creek Fire Scar, W of Flat Mountain, *Dale L. Taylor 67-144* (RM 283723!).
159	WY-3905	Teton Co., Moose ponds W of Moose, river bottom soil under *Populus*, *W.G. & Ragnhild Solheim 3905* (RM 248353!).
160	WY-3051	Albany Co., Snowy Range, S.H. Knight Science Camp, *Ronald L. Hartman 3051* (RM 295477!).
161	WY-4198	Carbon Co., Sierra Madre Mts., T12N R86W S11, c. 17.5 air mi SW of Encampment, c. 26 air mi E of Dixon, *B.E. Nelson 4198 & William Blunt* (RM 329350!).
		Arnica mollis W.J. Hook.
162	AB-DRUMM	Rocky Mountains, alpine rivulets, *Drummond s.n.* (HOLOTYPE, K *s.n.*!) - *Arnica mollis* Hook.
163	CA-3168	Inyo Co., Onion Valley, W of Independence, *Annie M. Alexander & Louise Kellogg 3168* (RM 249834!).
164	CA-7555	Toulumne Co., Yosemite, Toulumne Meadows, grassy bank of Dog Lake, *P.A. Munz 7555* (RM 96968!).
165	CA20032	Mono Co., Sierra Nevada, Cabin Creek, tributary to Slate Creek, *Philip A. Munz 20032* (RM 245264!).
166	CA-8811	El Dorado Co., Sierra Nevada Mts., Maggies Peak, *H.M. Hall 8811* (RM 73168!).
167	BC19585	Along trail to Ashnola Range, rare in moist boggy area in coniferous woods at 6500 ft elev., *J.A. Calder, J.A. Parmelee & R.L. Taylor 19585* (RM 257955!).
168	CO-4982	Larimer Co., Cameron Pass, *George E. Osterhout 4982* (RM 169950!).
169	CO-1831	Larimer Co., mountains W of North Park, west side along road to Steamboat Springs, *George E. Osterhout 1831* (RM 169949!).

170	CO-6545	Mesa Co., Grand Mesa, moist meadow above Mesa Lake, *C.L. Porter 6545* (RM 241785!).
171	CO-170	Larimer Co., Rocky Mountain National Park, Specimen Mountain, *Dale W. McNeal Jr. 170* (RM 276537!).
172	CO-4381	Grand Co., Lulu Pass, openings in woods, *I.W. Clokey 4381* (RM 90104!).
173	ID11332	Lemhi Co., meadow on S Fork Camas Creek near Sleeping Deer Mt., 40 mi NW of Challis, *C.L. Hitchcock & C.V. Muhlick 11332* (RM 198577!).
174	ID-84	Custer Co., Challis Forest, head of Casino Creek, *M.G. Markle 84* (RM 471031!).
175	ID-441	Owyhee Co., Silver City, wet grassy inclines, *J. Francis Macbride 441* (RM 67431!).
176	MT-146	Park Co., Cooke City, grassy hillside, *E. & D. Pearson 146* (RM 104458!).
177	MT-420	Beartooth Forest, common name- Soft Arnica, July 1914, *A.M. Baum 420* (RM 471038!).
178	MT13345	Stillwater Co., Absaroka National Forest, head of Boulder Creek, sandy moist meadow at Independence, *C.L. Hitchcock & C.V. Muhlick 13345* (RM 202866!).
179	NV-1615	White Pine Co., Snake Range, Humboldt National Forest, Snake Creek drainage, just below Johnson Lake, *Noel H. Holmgren & James L. Reveal 1615* (RM 278160!).
180	NV-679	Elko Co., Humboldt Forest, Jack Creek, *A.H. Holmgren 679* (RM 186673!).
181	NV-6315	Elko Co., Independence Mts., McAfee Peak Area, T42N R53E Sec. 23, *Arnold Tiehm 6315* (RM 336984!).
182	WA102829	Pierce Co., Mount Rainier National Park, *J.M. Grant s.n.* (RM 102829!).
183	WA-46	Wenatchee Forest, Ewing Basin, alt. 5200 ft, *Frank B. Lenzie 46* (RM 471080!).
184	WA-H10	Kittitas Co., Wenatchee Forest, Naneum Meadows, alt. 6000 ft, *Douglas Hole H-10* (RM 471095!).
185	UT-5883	Marysvale, head of Bullion Creek, 23 August 1894, *Marcus E. Jones 5883* (PARATYPE, RM 14267!) - *Arnica chamissonis* var. *longinodosa* A. Nelson.
186	UT1645A	Salt Lake Co., Big Cottonwood Canyon, A.O. Garrett 1645a (RM 54077!).
187	UT-5057	Stillwater-La Motte Peak, along stream, *E.B. & L.B. Payson 5057* (RM 115279!).
188	UT17495	Wasatch Co., Uinta Mts., Uinta National Forest, Phelps Brook drainage, 22.25 mi E of Heber City, *S. Goodrich 17495* (RM 343247!).
189	UT-1984	Washington Co., Pine Valley Mts., Furtherwater Canyon, c. 9 mi S of Pine Valley, *Frank W. Gould 1984* (RM 196910!).
190	OR-1154	Wallowa Co., Powder River Mts., near spring at head of Aneroid Lake, *Roxana S. Ferris & Rena Duthie 1154* (RM 103010!).
191	OR-56	Santiam Forest, Whitewater Creek near Jefferson Park, *Chas. H. Flory 56* (RM 471091!).
192	OR-814	Wallowa Co., Wallowa National Forest, N Fork Imnaha River, *Elbert H. Reid 814* (RM 471096!).
193	OR-2489	Head of Wallowa River, 9000 ft alt., 28 August 1900, *Wm. C. Cusick 2489* (RM 31433!).
194	WY-410	Big Horn Co., Ten Sleep Lakes, moist hillsides, *Leslie N. Goodding 410* (RM 37031!).
195	WY-933	Teton Peaks, 21 August 1894, *Aven Nelson 933* (PARATYPE, RM 3571!) - *Arnica chamissonis* var. *longinodosa* A. Nelson.

196	WY-1702	Centennial Valley, 17 August 1895, *Aven Nelson 1702* (HOLOTYPE, RM 5837!) - *Arnica chamissonis* var. *longinodosa* A. Nelson.
197	WY-1785	La Plata Mines, 23 August 1895, *Aven Nelson 1785* (PARATYPE, RM 5141!) - *Arnica chamissonis* var. *longinodosa* A. Nelson.
198	WY-6379	Yellowstone National Park, Lewis River, in bogs, 9 August 1899, *Aven Nelson & Elias Nelson 6379* (PARATYPE, RM 169905!) - *Arnica chamissonis* var. *longinodosa* A. Nelson.
199	WY-8519	Little Goose Canyon, spring bog, 28 July 1901, *Aven Nelson 8519* (RM 37034!).
200	WY-2819	Sublette Co., Surveyor Park, Fremont Lake, *Edwin B. Payson & Lois B. Payson 2819* (RM 93866!).

Analysis 4 & CLUSTAN Ward's Method. *Arnica* subgenus *Chamissonis*

OTU No.	**OTU Code**	**Operational Taxonomic Unit (OTU) Description**
		Arnica chamissonis Less.
1	AB-4868	3 mi S of South Ram River on Forestry Road Nordegg-Calgary, *M.G. Dumais 4868* (ALTA 25309!).
2	AB-6689	10 mi W of Calgary, low meadow along Banff Hwy, *W.C. McCalla 6689* (ALTA 68740!).
3	AK-283	Unalaska, Iliuliuk, *W.L. Jepson 283* (UC M-086188!).
4	AK-11939	Sterling Hwy (Hwy 1 S), c. 2.5 km before Homer proper, c. 1.9 km S of Mile post 171, *Wm. & Aida Gruezo WM11939* (ALTA 92044!).
5	AK-11940	Sterling Hwy (Hwy 1 S), c. 1 km S of Mile post 169, opposite parking area of Homer View Point, *Wm. & Aida Gruezo WM11940* (ALTA 92046!).
6	AZ-7821	Apache Co., Mountain Pass between Eagar & McNary, *Larry C. Higgins 7821* (BRY 121801!).
7	AZ-s.n.B	Apache Co., White Mts., Apache National Forest, Winn Campground Bog, *T.R. Van Devender & F.W. Reichenbacher s.n.* (UC 1488870!).
8	BC-7690	Yoho National Park, low ground on bank of Kicking Horse River near bridge leading to Yoho Valley, *W.C. McCalla 7690* (ALTA 68733!).
9	BC-13476	2 mi NW of Ootsa Lake village near Ootsa Lake, *J.A. Calder, D.B.O. Savile & J.M. Ferguson 13476* (*UC M-090702!, WS 235370!*).
10	CA-BOLAN	*Sierra Valley, in deep water strange to say but true, H.N. Bolander, Kellogg & Keller s.n.* (HOLOTYPE, GH *s.n.*!) - *A. chamissonis* Less. var. *incana* A. Gray.
11	CA-3311	Inyo Co., Cottonwood Lakes, SW of Lone Pine, *Annie M. Alexander & Louise Kellogg 3311* (RM 200906!).
12	CA-6195	San Bernardino Co., San Bernardino Mts., Dry Lake, *P.A. Munz 6195* (RM 92082!).
13	CO-124	Gunnison Co., Parlin, wet meadows at 8000 ft, *Benjamin H. Smith 124* (PH *s.n.*!).

14	CO-9154	Jackson Co., Arapaho National Forest at Denver Creek Campground, on Hwy 125, *C.L. Porter & Marjorie W. Porter 9154* (SASK 19458!).
15	ID-897	Adams Co., New Meadows, *Ray J. Davis 897* (UC 892052!).
16	ID-5855	Owyhee Co., 4 mi S of Riddle, Idaho Hwy 51, *Noel H. Holmgren 5855 & Patricia K. Holmgren* (BRY 167126!).
17	MN-9316	120 mi NW of Winnipeg, Grahamdale, *H.J. Scoggan 9316* (CAN 210449!).
18	MN-11337	Riding Mountain National Park, roadside gravel 7 mi N of south entrance, *H.J. Scoggan 11337* (CAN 224156!).
19	MT-1098	Glacier National Park, pond N of outlet, Lower St. Mary Lake, *Bassett Maguire 1098* (HOLOTYPE, RM 135044!) - *A. maguirei* A. Nelson.
20	MT-1222	Flathead Co., c. 3 mi SW of Belton, damp ground at west end of Lake Five, *H.T. Rogers & J.M. Rogers 1222* (WS 125809!).
21	NM-78102	Chuska Mts., Lake D., SE side of Dead Man Lake, crest of mountains W of Toadlena, 3 mi W of Toadlena, *Herbert E. Wright s.n.* (BRY 78102!).
22	NV-3100	Esmeralda Co., White Mts., Chiatovitch Creek, *Victor Duran 3100* (ISOTYPE, RM 129120!) - *A. chamissonis* subsp. *foliosa* var. *jepsoniana* Maguire.
23	NV-9670	Granite Range, upper meadows of S fork of Rock Creek, c. 1.6 km (1 mi) E of Granite Peak, 16 km (10 mi) airline distance NNW of Gerlach, *Noel H. Holmgren 9670 & Patricia K. Holmgren* (BRY 283374!).
24	NWT11795	Logan Mts., Flat River Valley, c. 2 km S of Tungsten (=Cantung) proper (mining townsite), border of black spruce-fir forest & vicinity of hot springs pools, *Wm. & Aida Gruezo WM11795* (ALTA 91859!).
25	NWT11799	Logan Mts., Flat River Valley, c. 2 km S of Tungsten (=Cantung) proper (mining townsite), border of black spruce-fir forest & vicinity of hot springs pools, *Wm. & Aida Gruezo WM11799* (ALTA 91867!).
26	ON-1077	Polar Bear Provincial Park, Brant River, island near mouth of west branch, *F.N. Cowell 1077* (CAN 320596!).
27	ON-8060	Kenora District, Hudson Bay Lowlands, Winisk, clearing on riverbank at Settlement, *W.K.W. Baldwin 8060* (CAN 414797!).
28	OR-NUTT	"R. Mts. & Blue Mts. of Columbia", *Thomas Nuttall s.n.* (HOLOTYPE, BM *s.n.*!) - *Arnica foliosa* Nutt. - center specimen.
29	OR-TNUTT	"R. Mts. & Blue Mts. of Columbia", *Thomas Nuttall s.n.* (HOLOTYPE, BM *s.n.*!) - *Arnica foliosa* Nutt. - left specimen.
30	OR-NUTTA	"R. Mts. & Blue Mts. of Columbia", *Thomas Nuttall s.n.* (HOLOTYPE, BM *s.n.*!) - *Arnica foliosa* Nutt. - right specimen.
31	QE-33158	East coast of James Bay, Eastmain River, *E. Lepage 33158* (MT *s.n.*!).
32	SK-1246	0.6 mi NW of Hwy 120 at Mile 35, *H.G. Anderson 1246* (SASK 44114!).

33	SK-26612	Brightsand Lake, woods near lakeshore, *Robert Connell s.n.* (SASK 26612!).
34	UT-11442	Wasatch Co., Wasatch National Forest, Wasatch Mts., Brighton town proper, Brighton Bowl Ski area, c. 100 m from Seventh Adventist Church or Evergreen Chairlift, *Wm. Gruezo WM11442* (ALTA 91411!).
35	UT-12339	Cache Co., Logan Canyon, Red Banks, *Bassett Maguire & Ruth Maguire 12339* (CAN 190979!).
36	WA-1498	Klickitat Co., c. 5 mi S of Glennwood, *F.G. Meyer 1498* (UC 719034!).
37	WA-6283	Klickitat Co., Falcon Valley, *Wilhelm N. Suksdorf 6283* (WS 79770!).
38	WY-766	Upper Wind River, 10 August 1894, *Aven Nelson 766* (HOLOTYPE, RM 2979!) - *Arnica ocreata* A. Nelson.
39	WY-1417	Pine Creek, 11 July 1892, *B.C. Buffum 1417* (PARATYPE, RM *s.n.*!) - *Arnica rhizomata* A. Nelson.
40	WY-1850	Loveland, 2 July 1893, *J.D. Parker 1850* (HOLOTYPE, RM *s.n.*!) - *Arnica stricta* A. Nelson.
41	WY-3587	North Vermilion Creek, 17 July 1897, *Aven Nelson 3587* (PARATYPE, RM 10610!) - *Arnica rhizomata* A. Nelson.
42	WY-5224	Yellowstone Park, Shoshone, alt. 7500 ft, 1 August 1897, *P.A. Rydberg & Ernst A. Bessey 5224* (PARATYPE, RM 21636!) - *Arnica ocreata* A. Nelson.
43	WY-7643	Albany Co., Tie City, 20 July 1900, *Aven Nelson 7643* (HOLOTYPE, RM 28788!) - *Arnica celsa* A. Nelson.
44	WY-6940	Yellowstone National Park, Yellowstone Lake, on dry sandy banks, 24 August 1899, *Aven Nelson & Elias Nelson 6940* (HOLOTYPE, RM 20772!) - *Arnica exigua* A. Nelson.
45	WY-8012	Albany Co., Lincoln Gulch, in open grassy subalpine parks, 8 August 1900, *Aven Nelson 8012* (HOLOTYPE, RM 28787!) - *Arnica rhizomata* A. Nelson.
46	WY-11315	Albany Co., Medicine Bow National Forest, c. 4.5 mi NW of Centennial, on Hwy 130, pine forest meadows near road turn-out, *Wm. Gruezo WM11315* (ALTA 91408!).
47	WY-11381	Sheridan Co., Big Horn Mountains National Forest, Hwy 14, c. 120 m W of Mile post 66, c. 10 m from roadside, *Wm. Gruezo WM11381* (ALTA 91409!).
48	WY-11403	Park Co., Shoshone National Forest, Hwy 14-16-20, c. 2 mi from Yellowstone National Park gate entrance, vicinity of Pahaska Tepee Tavern Motel, c. 500 m from Pahaska Campground, fill-side of road c. 20 m from river banks, *Wm. Gruezo WM11403* (ALTA 91410!).
49	YT-11774	Alaska Hwy, c. 3 km after Iron Creek, cut-side (right side) of a sharp road bend bordering a poplar forest, *Wm. & Aida Gruezo WM11774* (ALTA 91835!).
50	YT-11822	Klondike Hwy (Hwy 2), c. 1.6 km S of Km post 460 & c. 4.6 km S of Pelly Crossing, right side of road by edge of *Salix* thickets, *Wm. & Aida Gruezo WM11822* (ALTA 91890!).
51	YT-11953	Alaska Hwy (Hwy 1), c. 1.5 km W of Km post 1930 or c. 3 km S of Beaver Creek, border of sparse stunted *Picea-Salix* forest, left side of road en route to Koidern, *Wm. & Aida Gruezo WM11953* (ALTA 92068!).

52	YT-11964	Haines Road (Hwy 3), c. 0.5 km S of Km post 240, right side of road en route to Dezadeash, along margins of poplar (*Populus*)-spruce (*Picea*) forest, relatively sloping road shoulders, *Wm. & Aida Gruezo WM11964* (ALTA 92082!).
53	YT-11971	Alaska Hwy (Hwy 1), c. 150 m E of Km post 1590 (between Haines Junction & Whitehorse), meadow opening in poplar (*Populus*)-spruce (*Picea*) forest, *Wm. & Aida Gruezo WM11971* (ALTA 92098!).
		Arnica longifolia D.C. Eaton
54	CA20014	Mono Co., Sierra Nevada, N tributary of Slate Creek, Cabin Creek, *Philip A. Munz 20014* (RM 245268!).
55	CA-3574	Mono Co., Inyo National Forest, Slate Creek Valley, *A.R. Kruckeberg 3574* (RM 259292!).
56	CO-1914	Larimer Co., Ethel Peak, creek bottoms, *Leslie N. Goodding 1914* (RM 52151!).
57	CO-726	Gunnison Watershed, Keblar Pass, *C.F. Baker 726* (RM 169626!).
58	ID-431	Custer Co., Challis Forest, Swamp Creek, sandy wet soil along stream, *Herman Work 431* (RM 470979!).
59	ID10113	Elmore Co., Sawtooth Primitive Area, meadowland 1 mi S of Lower Spangle Lake, *C.L. Hitchcock & C.V. Muhlick 10113* (RM 197898!).
60	ID-699	Elmore Co., Trinity Lake Region, large clumps in broken granite slides, *J. Francis Macbride 699* (RM 67433!).
61	MT13360	Stillwater Co., sandy moist meadow at Independence, head of Boulder River, Absaroka Mts., *C.L. Hitchcock & C.V. Muhlick 13360* (RM 203760!).
62	MT-3346	Beaverhead Co., Northern Rocky Mountain, Beaverhead National Forest, rockslide, *Lincoln Ellison & R.A. Robinson 3346* (RM 470986!).
63	NV-335	Nevada Forest, Sec. 23 T16N R69E, Henry's Creek, alt. 8500 ft, *Frank E. Gray 335* (RM 470647!).
64	OR-154	Minam Forest, alt. 6700 ft, 25 August 1912, *C.E. Fleming 154* (RM 471049!).
65	OR-9827	Klamath Co., Crater Lake National Park, rim trail to Crater Lake Lodge, *L.R. Abrams 9827* (RM 100188!).
66	UT-1547	Salt Lake Co., Big Cottonwood Canyon, near Lake Catherine, alt. 9300 ft, 3 August 1905, *A.O. Garrett 1547* (HOLOTYPE, NY *s.n.*!; ISOTYPE, RM 52683!) *Arnica caudata* Rydb.
67	UT14209	Cache Co., Bear River Range, Mt. Naomi Region, N of Tony Grove Lake Basin, *Bassett Maguire, Dean A. Hobson, & Ruth R. Maguire 14209* (RM 180249!).
68	UT-5900	Piute Co., Marysvale, falls of Bullion Creek, *Marcus E. Jones 5900* (RM 64002!)
69	WA-2736	Okanogan Co., Okanogan Forest, Washington Pass Area, 12 1/4 mi WSW of Mazama, *Ralph & Dorothy Naas 2736* (RM 470620!).
70	WA-2546	Okanogan Co., Okanogan Forest, Honeymoon Pass Area, 18 1/4 mi NE of Winthrop, *Ralph & Dorothy Naas 2546* (RM 470621!).

71	WY-K36	Big Horn Co., Big Horn National Forest, Bear Creek, S & G, Bald Mountain, *Neland A. Kissinger Jr. K-36* (RM 402841!).
72	WY-991	Teton Co., Gros Ventre Mts., Sportmans Ridge, infrequent in open area above treeline, *Robert Lichvar 991* (RM 315627!).
73	WY-1013	Big Horn Co., Big Horn Mts., Middle Paint Rock Creek at timberline, c. 1.5 mi SW of Mistymoon Lake, c. 25 mi NNE of Ten Sleep, along cree, *Gael Fonken 1013* (RM 347679!).
74	WY-302	Carbon Co., Ferris Mts., second drainage W of Pete Creek, *Joseph Storto 302 & Thomas Wood* (RM 339690!).
75	WY-8499	Sheridan Co., Big Horn Mts., Little Goose Canyon, stony creek bottoms, *Aven Nelson 8499* (RM 37039!).
76	WY-390	Big Horn Co., Doyle Creek, woods along a stream, *Leslie N. Goodding 390* (RM 37041!).
77	WY-5925	Park Co., W of Beartooth Butte, near the look-out on Clay Butte, on clayey slopes above snowbanks, *C.L. Porter & Marjorie N. Porter 5925* (RM 222699!).
78	WY-6422	Yellowstone National Park, Snake River, among rocks on a cliff, 12 August 1899, *[illegible] Nelson & Elias Nelson 6422* (HOLOTYPE, RM 20774!)-*Arnica polycephala* A. Nelson.
79	WY-1022	Teton Co., Grand Teton National Park, moraine of Teton Glacier, *Louis Williams [illegible]* (RM 169923!).
80	WY-5216	Fremont Co., Southern Wind River Mts., near Christina Lake, *C.L. Porter 5216* (RM 215261!).
81	WY-374	Sublette Co., Wyoming Range, Bear Mountain, 26 air mi WSW of Daniel, limestone rock scree on steep E facing slope, *John S. Shultz 374* (RM 313150!).
		Arnica parryi A. Gray
82	CA-62940	El Dorado Co., Lake Valley, *M.S. Baker s.n.* (UC 62940!).
83	CA197311	Placer Co., Sierra Nevada Mts., Squaw Valley on Truckee River, *C.F. Sonne s.n.* (UC 197311!).
84	CO-3814	Larimer Co., Mt. Cameron, 15 August 1908, *G.E. Osterhout 3814* (HOLOTYPE, RM 159541!)-*Arnica parryi* var. *crinita* Osterhout.
85	CO-552	Uncompahgre National Forest, Ranger Station, alt. 9000 ft, openings in spruce forest, *Ernest P. Walker 552* (RM 75652!).
86	CO-5827	Grand Co., Berthoud Pass, 11000 ft, *Frank Tweedy 5827* (RM 47867!).
87	CO16734	Grand Co., Idaho Springs, near Berthoud Pass, dryish alpine meadow, *Otto Degener & Leroy Peiler 16734* (RM 193991!).
88	CO-2734	Routt Co., Routt Forest, Black Mountain, Sec. 14 T9N R89W, *R.K. Gierisch 2734* (RM 471058!).
89	CO-59	Montrose Co., Uncompahgre Forest, head of Little Red, Sec. 24 T47N R12W, *Lancaster, Doran & Bunderson 59* (RM 471057!).
90	CO-8491	Jackson Co., 3 mi W of Cameron Pass at the Crags Campground, *C.L. Porter & Marjorie W. Porter 8491* (RM 263022!).

91	CO-4476	Grand Co., Arapahoe National Forest, along the Pawnee Lake Trail, *Aven Nelson & Ruth A. Nelson 4476* (RM 191944!).
92	CO-496	La Plata Mountains, Little Kate Mine, alt. 11000 ft, *C.F. Baker, F.S. Earle & S.M. Tracy 496* (RM 169593!).
93	ID-11431	Blaine Co., Sawtooth National Forest, road turn-off on Hwy 75 leading to Alturas Lake, c. 300 m before Alpine Creek parking area, roadside, alt. c. 2591 m (=8500 ft), *Wm. Gruezo WM11431* (ALTA 91401!, WGRZ!).
94	ID-1749	Fremont Co., along road between Ashton & Cave Falls, woods at Idaho-Wyoming Line, *Arthur Cronquist 1749* (RM 186929!).
95	MT-84	Gallatin Co., Gallatin Forest, Upper Bear Basin, alt. 8000 ft, *Eric P. White 84* (RM 471065!).
96	MT-528	Midvale, Squaw Mountain, 26 July 1903, *L.M. Umbach 528* (RM 169590!).
97	OR-1835	Wallowa Co., 16 mi SE of Imnaha, dry meadow along Hat Point Road, *Marion Ownbey & Ruth P. Ownbey 1835* (RM 183744!).
98	UT-4315	Summit Co., 3 mi W of Bald Mountain, edge of spruce woodland about meadows of Lily Lake, *Bassett Maguire, A.G. Richards & Ruth Maguire 4315* (RM 140649!).
99	UT-6609	Big Cottonwood Canyon, below Silver Lake, 4 July 1905, *P.A. Rydberg & E.C. Carlton 6609* (HOLOTYPE, NY *s.n.*!) - *Arnica arachnoidea* Rydb.
100	UT-6609+	Big Cottonwood Canyon, below Silver Lake, 4 July 1905, *P.A. Rydberg & E.C. Carlton 6609* (ISOTYPE, CAN 191136!) - *Arnica arachnoidea* Rydb.
101	WA-381	Wenatchee Forest, NW1/4 Sec. 22 T26N R15E, alt. 3225 ft, *Frank B. Lenzie 381* (RM 471138!).
102	WA-21	Wenatchee Forest, meadow on TW Violette Ranch, alt. 1800 ft, *Frank B. Lenzie 21* (RM 471140!).
103	WY-11405	Yellowstone National Park Co., Yellowstone National Park, c. 2 km E of Sylvan Lake, roadside, alt. c. 2438 m (= c.8000 ft), *Wm. Gruezo WM11405* (ALTA 91399!, WGRZ!).
104	WY-11406	Yellowstone National Park Co., Yellowstone National Park, c. 2 km E of Sylvan Lake, roadside, alt. c. 2438 m (= c.8000 ft), *Wm. Gruezo WM11406* (ALTA 91400!, WGRZ!).
105	WY-204	Teton Co., Targhee National Forest, Teton Canyon, Treasure Mountain Scout Camp; *Loran C. Anderson 204* (RM 254238!).
106	WY-105	Natrona Co., Casper Mountain, Camp Wyoba Area, open hillside, *Robert L. Tresler 105* (RM 273825!).
107	WY-3905	Teton Co., Moose ponds W of Moose, river bottom soil under *Populus*, *W.G. & Ragnhild Solheim 3905* (RM 248353!).
108	WY-3051	Albany Co., Snowy Range, S.H. Knight Science Camp, *Ronald L. Hartman 3051* (RM 295477!).
109	WY-4198	Carbon Co., Sierra Madre Mts., T12N R86W S11, c. 17.5 air mi SW of Encampment, c. 26 air mi E of Dixon, *B.E. Nelson 4198 & William Blunt* (RM 329350!).

Arnica mollis W.J. Hook,

110	AB-DRUMM	Rocky Mountains, alpine rivulets, *Drummond s.n.* (HOLOTYPE, K *s.n.*!) - *Arnica mollis* Hook.
111	CA-3168	Inyo Co., Onion Valley, W of Independence, *Annie M. Alexander & Louise Kellogg 3168* (RM 249834!).
112	CA-7555	Toulumne Co., Yosemite, Toulumne Meadows, grassy bank of Dog Lake, *P.A. Munz 7555* (RM 96968!).
113	CA-8811	El Dorado Co., Sierra Nevada Mts., Maggies Peak, *H.M. Hall 8811* (RM 73168!).
114	BC19585	Along trail to Ashnola Range, rare in moist boggy area in coniferous woods at 6500 ft elev., *J.A. Calder, J.A. Parmelee & R.L. Taylor 19585* (RM 257955!).
115	CO-1831	Larimer Co., mountains W of North Park, west side along road to Steamboat Springs, *George E. Osterhout 1831* (RM 169949!).
116	CO-6545	Mesa Co., Grand Mesa, moist meadow above Mesa Lake, *C.L. Porter 6545* (RM 241785!).
117	ID11332	Lemhi Co., meadow on S Fork Camas Creek near Sleeping Deer Mt., 40 mi NW of Challis, *C.L. Hitchcock & C.V. Muhlick 11332* (RM 198577!).
118	ID-441	Owyhee Co., Silver City, wet grassy inclines, *J. Francis Macbride 441* (RM 67431!).
119	MT-146	Park Co., Cooke City, grassy hillside, *E. & D. Pearson 146* (RM 104458!).
120	MT13345	Stillwater Co., Absaroka National Forest, head of Boulder Creek, sandy moist meadow at Independence, *C.L. Hitchcock & C.V. Muhlick 13345* (RM 202866!).
121	NV-1615	White Pine Co., Snake Range, Humboldt National Forest, Snake Creek drainage, just below Johnson Lake, *Noel H. Holmgren & James L. Reveal 1615* (RM 278160!).
122	NV-6315	Elko Co., Independence Mts., McAfee Peak Area, T42N R53E Sec. 23, *Arnold Tiehm 6315* (RM 336984!).
123	WA102829	Pierce Co., Mount Rainier National Park, *J.M. Grant s.n.* (RM 102829!).
124	WA-H10	Kittitas Co., Wenatchee Forest, Naneum Meadows, alt. 6000 ft, *Douglas Hole H-10* (RM 471095!).
125	UT-5883	Marysvale, head of Bullion Creek, 23 August 1894, *Marcus E. Jones 5883* (PARATYPE, RM 14267!) - *Arnica chamissonis* var. *longinodosa* A. Nelson.
126	UT-5057	Stillwater-La Motte Peak, along stream, *E.B. & L.B. Payson 5057* (RM 115279!).
127	UT17495	Wasatch Co., Uinta Mts., Uinta National Forest, Phelps Brook drainage, 22.25 mi E of Heber City, *S. Goodrich 17495* (RM 343247!).
128	UT-1984	Washington Co., Pine Valley Mts., Furtherwater Canyon, c. 9 mi S of Pine Valley, *Frank W. Gould 1984* (RM 196910!).
129	OR-1154	Wallowa Co., Powder River Mts., near spring at head of Aneroid Lake, *Roxana S. Ferris & Rena Duthie 1154* (RM 103010!).
130	OR-56	Santiam Forest, Whitewater Creek near Jefferson Park, *Chas. H. Flory 56* (RM 471091!).
131	OR-814	Wallowa Co., Wallowa National Forest, N Fork Imnaha River, *Elbert H. Reid 814* (RM 471096!).
132	OR-2489	Head of Wallowa River, 9000 ft alt., 28 August 1900, *Wm. C. Cusick 2489* (RM 31433!).

133	WY-410	Big Horn Co., Ten Sleep Lakes, moist hillsides, *Leslie N. Goodding 410* (RM 37031!).
134	WY-933	Teton Peaks, 21 August 1894, *Aven Nelson 933* (PARATYPE, RM 3571!)-*Arnica chamissonis* var. *longinodosa* A. Nelson.
135	WY-1702	Centennial Valley, 17 August 1895, *Aven Nelson 1702* (HOLOTYPE, RM 5837!)-*Arnica chamissonis* var. *longinodosa* A. Nelson.
136	WY-1785	La Plata Mines, 23 August 1895, *Aven Nelson 1785* (PARATYPE, RM 5141!)-*Arnica chamissonis* var. *longinodosa* A. Nelson.
137	WY-6379	Yellowstone National Park, Lewis River, in bogs, 9 August 1899, *Aven Nelson & Elias Nelson 6379* (PARATYPE, RM 169905!)-*Arnica chamissonis* var. *longinodosa* A. Nelson.
		Arnica lanceolata Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo
138	AB-11616	Waterton Lakes National Park, vicinity of Cameron Lake, NW portion of lake inside *Picea mariana* forest, on boggy soil & small stream, *William Sm. Gruezo WM11616* (ALTA 91378!, WGRZ!).
139	AB-16930	Waterton Lakes National Park, N end of Cameron Lake, bog, *August J. Breitung 16930* (ALTA 16835!).
140	AK-385	Misty Fjords National Monument, S-facing ridge, N of Big Goat Lake, moist draw, *Linda Vorobik 385, Ker Rice & Kathy Lucich* (ALA V072829!).
141	AK-4957	Yakobi Island, West Coast, Surge Bay Lake, N side near outlet stream, sandy meadow, *Mary Clay Muller 4957* (BRY 239675!).
142	AK-6400	Juneau, mountainside, *J.P. Anderson 6400* (RM 190709!).
143	AK-7119	Evans Island, Port San Juan, in swamp, *W.J. Eyerdam 7119* (WS 224380!).
144	BC-83	Vancouver Island, Renfrew District, Gordon River, shady places, *C.O. Rosendahl & Carl J. Brand 83* (RM 35259!).
145	CA-804	Siskiyou Co., Klamath National Forest, Preston Peak, Rattlesnake Meadow, wooded slope, *C.A. Ground 84* (RM 470624!).
146	CA-2531	Plumas Co., Plumas National Forest, 1/4 mi S of University of California Forestry Camp near Meadow Valley, Bidwell Bar, *Beryl O. Schreiber 2531* (RM 471089!).
147	ID-1656	Bear Lake Co., St. Charles Canyon, *Ray J. Davis 1656* (WS 100189!).
148	ID-2186	Bonner Co., Kaniksu Forest, Selkirk Mts., Pack River, 0.1 mi below Pack River Bridge, 20.7 mi N of Sandpoint, *Peter F. Stickney 2186* (RM 470623!).
149	ID-6074	Bonner Co., Priest Lake, *C.V. Piper 6074* (WS 79714!).
150	MT-1094	Glacier National Park, meadows about Elrod Lake, *Bassett Maguire 1094* (PARATYPE, RM 135046!)-*Arnica trina* A. Nelson.
151	MT-1095	Glacier National Park, Lake Josephine, margin of woodland, alt. 4880 ft, 2 August 1932, *Bassett Maguire 1095* (HOLOTYPE, RM 135049!)-*Arnica trina* A. Nelson.

152	NV-11460	Elko Co., Humboldt National Forest, Ruby Mountains, vicinity of Thomas Canyon Campground, near creek bridge, S bank of Lamoille Creek, edge of creek within reach of rushing waters, *William Sm. Gruezo WM11460* (ALTA 91372!, WGRZ!).
153	NV-11462	Elko Co., Humboldt National Forest, Ruby Mountains, Camp Lamoille, c. 2 km from main road, around bridge of Lamoille Creek, on road to former Boy Scout Camp, banks of creek, *William Sm. Gruezo WM11462* (ALTA 91374!, WGRZ!).
154	OR-166	Lane Co., H.J. Andrews Expt. Area, slopes in Upper Lookout Creek Basin, *J.F. Franklin & C.T. Dyrness 166* (RM 470617!).
155	OR-13152	Hood River Co., Langer, larger rocks in West Fork of Hood River, moist banks, *Louis F. Henderson s.n.* (RM 13152!).
156	UT-1974	Salt Lake Co., Big Cottonwood Canyon, *A.O. Garrett 1974* (RM 56654!).
157	WA-596	Lewis Co., Gifford Pinchot Forest, rock bluffs along trail below Jordon Basin, Goat Rocks Wilderness, *Jerry F. Franklin 596* (RM 471086!).
158	WA-672	Okanogan Co., North Fork of Bridge Creek, on steep rocky flanks over which drippling water flows, *A.D.E. Elmer 672* (RM 12050!).
159	WA-5196	Pierce Co., Mt. Rainier National Park, terminal moraine of Nisqually Glacier, among rocks, *W.C. McCalla 5196* (ALTA 68730!).
160	WY-3911	Carbon Co., Sierra Madre Mountains, *R. Dorn 3911* (RM 346424!).
		Arnica lanceolata Nutt. subsp. *lanceolata*
161	M-49	Piscataquis Co., moist cliff at falls on Katahdin brook, *E. Perot Walker 49* (PH/PENN *s.n.*!).
162	M-697005	Piscataquis Co., Mount Katahdin, from damp rocky bed to a dry brook near W side of South Basin Pond, *Francis Harper s.n.* (PH 697005!).
163	NB547980	St. John, Tobigue Narrows, *G.U. Hay s.n.* (PH 547980!).
164	NB605618	Nespisiquit, Grand Falls, *J. Fowler s.n.* (PH 605618!).
165	NH-171	Coos Co., Mt. Washington, headwall of Tuckerman's Ravine, *A.H. Moore 171* (PENN *s.n.*!).
166	NH-1287	White Mountains, Mt. Washington, Tuckerman's Ravine, *Willard W. Eggleston* (RM 23411!).
167	NH-1417	Mt. Washington, Tuckerman's Ravine, *C.S. Williamson 1417* (PH *s.n.*!).
168	NH-2373	Mt. Washington, Tuckerman's Ravine, *W.W. Eggleston 2373* (PH 586569!).
169	NH-3140	Mt. Washington, Tuckerman's Ravine, upper trail, *Dorothy R. Wade 3140* (SASK 27615!);
170	NH-12529	White Mountains, Brooks, *C.G. Pringle s.n.* (PENN 12529!).
171	Q-146	Bonaventure Co., Little Cascapedia River, alluvial thickets, *J.F. Collins & M.L. Fernald 146* (CAN 109679!).
172	Q-1453	Bic, banks of Bic River, *C.S. Williamson 1453* (PH *s.n.*!).
173	Q-4577	Gaspé Co., on gravel bed in Malbaie River, corner of beach, *L. McI. Terrill 4577* (CAN 339301!).

174	Q-15267	Trois-Pistoles Co., Riv.-du-Loup, Trois-Pistoles, entre les rangs 2 et 3, *Ernest Lepage 15267* (CAN 304535!).
175	Q-26089	Matane Co., western slope of Mt. Logan, brooksides & subalpine meadows, *M.L. Fernald & L.B. Smith 26089* (CAN 109672!).
176	Q-32432	Matapedia River, mill stream, gravelly flats, *J. Rousseau 32432* (RM 134704!).
		Arnica ovata Greene
177	AB-11504	Mountain Park, on Hwy 940 (= Forestry Trunk Road), c. 9 km S of Mountain Park proper, Cardinal Divide Viewpoint, vicinity of campground, c. 100 m from main road, *William Sm. Gruezo WM11504* (ALTA 91299!, WGRZ!).
178	AB-11511	Mountain Park, on Hwy 940 (= Forestry Trunk Road), c. 9 km S of Mountain Park proper, Cardinal Divide Viewpoint, vicinity of campground, c. 100 m from main road, *William Sm. Gruezo WM11511* (ALTA 91300!, WGRZ!).
179	AB-11536	Banff National Park, Parker Ridge, along foot trail to ridgetop, *William Sm. Gruezo WM11536* (ALTA 91302!, WGRZ!).
180	AB-11538	Banff National Park, Parker Ridge, along foot trail to ridgetop, *William Sm. Gruezo WM11538* (ALTA 91303!, WGRZ!).
181	AB-11550	Jasper National Park, Mt. Edith Cavell, along foot trail to Mt Edith Cavell meadows, inside *Picea* forest, *William Sm. Gruezo WM11550* (ALTA 91296!, WGRZ!).
182	AB-11591	Banff National Park, Sunshine Village Ski area, along foot trail to Rock Isle Lake, subalpine meadows, *William Sm. Gruezo WM11591* (ALTA 91315!, WGRZ!).
183	AB-11593	Banff National Park, Sunshine Village Ski area, c. 1/3 on the way up to Rock Isle Lake, along foot trail in subalpine meadows, *William Sm. Gruezo WM11593* (ALTA 91316!, WGRZ!).
184	AK-1315	Alaska Range, Tangle Lakes area, mountain E of Landmark Gap, at border (the front) of solifluction tongues, *Olav Gjaeveroll 1315* (CAN 225194!).
185	BC-082	Juneau Icefield, 4 mi NW of Camp 26 (FGER) on Marble Mountain Nunatak, *D.R. Lubin 082* (ALA V75361!).
186	BC-993	Selkirk Flora, small peak above timberline about 118° 20' W long. 51° 45' N lat., *Charles H. Shaw 993* (PH/PENN 43874!).
187	BC-1467	Glacier National Park, Hermit Hut Trail, trailside, *Erich Haber 1467 & M.J. Shchepanek* (CAN 363168!).
188	BC-11588	Mount Assiniboine Provincial Park, c. 300 m above Rock Isle Lake, along foot-trail to alpine summit, subalpine meadows, *William Sm. Gruezo WM11588* (ALTA 91304!, WGRZ!).
189	CA-763	Siskiyou Co., Preston/Klamath National Forest, cirque S side of Preston Peak, alpine fell-fields, *C.A. Ground 763* (RM 470845!).
190	CA-813	Siskiyou Co., Preston/Klamath National Forest, *C.A. Ground 813* (RM 471097!).

191	CO-1635	Routt Co., Fish Creek Falls, moist rocky hillsides, *Leslie N. Goodding 1635* (RM 169623!).
192	CO-67	Montrose Co., Uncompahgre National Forest, Rocky Mountain Forest & Range Experiment Station, *K.H. Lancaster, C.W. Doran & V.L. Bunderson 67* (RM 471115!).
193	CO-5299	Ouray Co. Ouray, *G.E. Osterhout 5299* (RM 169925!).
194	ID-3691A	Blaine Co., near Redfish Lake, moist open willow land, *J.F. Macbride & Edwin B. Payson 3691* (RM 86114! *p.p.mag.*).
195	OR-2463	Wallowa Co., Wallowa Mountains, abundant at head of Keystone Creek, *Wm.C. Cusick 2463* (WS 26519!).
196	OR-11474	Klamath Co., Crater Lake National Park, inside Crater Lake proper, on Rim Drive, c. 1/4 mi before Sun Notch Viewpoint, cut-side of road on edges of shallow depressions, *William Sm. Gruezo WM11474* (ALTA 91298!, WGRZ!).
197	OR-26963	Baker Co., Blue Mountains, NE of Lookout Peak, drainage into Hoffner Lake, Anthony Lakes, *Bassett Maguire & Arthur H. Holmgren 26963* (PH 824342!).
198	UT-O-122	La Sal Forest, Ducket Cabin near West Mountain, *Orange A. Olsen O-122* (RM 470844!).
199	UT-9851	Summit Co., c. 6 mi due NE of Kamas, near summit of Hoyt Peak, *E. Neese & J.L. Neese 9851* (BRY 218710!).
200	UT-3546	Utah Co., above Hidden Lake, *A.O. Garrett 3546* (RM 106891!).

Locality abbreviations: AK-Alaska, AB-Alberta, AZ-Arizona, BC-British Columbia, CA-California, CO-Colorado, ID-Idaho, M-Maine, MN-Manitoba, MT-Montana, NB-New Brunswick, NV-Nevada, NH-New Hampshire, NM-New Mexico, NWT-Northwest Territories, ON-Ontario, OR-Oregon, QE-Québec, SK-Saskatchewan, UT-Utah, WA-Washington, WY-Wyoming, YT-Yukon Territory.

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Appendix 3. Data Matrices Used in Numerical Analyses.

Analysis 1: *A. lanceolata* subsp. *amplexicaulis* (Nutt.) Gruezo & subsp. *lanceolata* Nutt.

(2A4,35F3.1,32F4.1)

AB-7177 2.01.02.02.02.02.03.01.02.01.02.02.0 2.01.01.02.03.03.04.01.02.02.03.0 1.03.01.01.01.0
3.0 1.02.02.03.02.01.0 3.0 4.032.0 8.0 2.3 3.518.017.0 5.012.0 2.5 4.8 0.320.0 4.0 5.012.0 7.0
6.0 5.0 1.0 9.5 8.0 8.4 2.5 1.7 2.0 3.8 4.7 4.2 1.0 2.0
AB-116162.01.03.02.02.02.03.01.01.01.02.02.0 5.01.01.02.02.02.03.02.03.02.03.0
1.02.01.01.01.01.0 1.02.02.03.02.01.0 4.0 5.045.0 5.0 1.5 3.310.010.0 4.0 8.0 2.0 4.0 0.517.0
4.0 4.3 8.0 6.0 5.0 3.0 1.0 8.510.2 9.5 2.5 2.6 2.5 3.4 3.9 3.8 1.0 2.0
AB-169302.01.02.02.02.02.03.01.02.01.02.02.0 5.01.01.02.02.02.03.02.03.02.03.0
1.02.01.01.01.01.0 1.02.02.03.02.01.0 3.0 4.032.5 6.0 1.8 3.312.015.0 4.012.0 2.0 6.0 0.320.0
5.0 4.012.0 6.0 5.0 3.0 1.010.0 7.5 6.5 2.3 2.0 1.9 4.3 3.8 3.4 1.0 2.0
AK-125 1.01.02.02.02.02.03.01.02.01.01.02.0 2.01.01.02.02.02.02.01.02.02.01.0
1.02.01.01.01.02.0 1.02.02.03.03.02.0 4.0 5.029.0 3.5 1.3 2.715.014.0 4.0 9.0 2.0 4.5 1.017.0
4.0 4.012.0 7.0 6.0 3.0 1.0 5.0 5.5 5.5 1.3 2.0 2.4 3.8 2.8 2.0 1.0 2.0
AK-385 1.01.01.02.02.02.03.01.02.01.01.02.0 2.01.01.02.02.02.02.01.02.02.02.0
1.02.01.01.01.02.0 1.02.02.03.03.02.0 1.0 4.036.0 5.5 2.0 2.815.012.0 6.0 10.0 2.0 5.0 0.510.0
3.0 3.314.0 7.0 6.0 3.0 1.0 9.2 8.5 7.0 2.0 2.3 2.2 4.6 3.7 3.2 1.0 2.0
AK-637 1.01.02.02.02.02.02.02.01.01.02.02.0 2.01.01.02.03.02.02.02.03.01.0 3.0
1.02.01.01.01.02.0 1.01.02.03.03.02.0 3.0 4.037.0 7.0 2.0 3.520.016.0 5.012.0 3.0 4.0 1.015.0
4.0 3.812.0 7.0 6.0 3.0 1.0 9.5 7.3 4.5 2.9 1.7 1.2 3.3 4.3 3.8 1.0 2.0
AK-1294 1.01.02.03.02.02.01.02.02.01.02.01.0 1.01.01.02.03.02.02.01.02.02.03.0
1.02.01.01.01.02.0 1.02.02.03.02.02.0 3.0 4.032.0 7.5 1.8 4.215.015.0 5.010.0 2.0 5.0 0.515.0
4.0 3.813.0 6.0 5.0 3.0 1.0 8.0 6.8 5.2 1.5 1.7 1.9 5.3 4.0 2.7 1.0 2.0
AK-4957 1.01.02.02.02.02.03.01.01.01.02.01.0 1.01.01.02.02.02.02.01.02.02.02.0
1.02.01.01.01.02.0 1.02.02.03.03.01.0 3.0 6.042.0 7.0 1.2 5.815.015.0 4.0 10.0 3.0 3.3 0.515.0
5.0 3.0 9.0 7.0 6.0 3.0 1.0 9.3 9.2 9.0 1.6 2.4 2.6 5.8 3.8 3.5 1.0 2.0
AK-944281.01.02.01.02.02.02.02.02.01.01.01.0 2.01.01.02.02.02.02.01.02.02.02.0
1.02.01.01.01.01.0 1.02.02.03.03.01.0 3.0 5.043.0 5.5 1.4 3.915.013.0 4.0 10.0 3.0 3.3 1.016.0
5.0 3.2 7.0 6.0 5.0 3.0 1.0 6.5 6.8 6.0 1.3 1.2 1.4 5.0 5.7 4.3 1.0 2.0
AK-6400 1.01.02.02.02.02.03.01.02.01.01.01.0 1.01.01.02.02.02.02.02.02.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.02.010.0 5.036.0 5.8 1.7 3.418.018.0 6.0 10.0 2.0 5.1 1.015.0
5.0 3.0 9.0 8.0 7.0 3.0 1.0 6.5 6.5 5.5 1.5 1.7 2.0 4.3 3.8 2.8 1.0 2.0
AK-7119 1.01.02.02.02.02.02.02.02.01.02.01.0 2.01.01.02.01.02.02.01.02.02.03.0
1.02.01.01.01.02.0 1.02.01.03.03.01.0 3.0 5.046.010.5 2.5 4.225.017.0 5.0 12.0 3.0 4.0 1.020.0
5.0 4.012.0 8.0 7.0 3.0 1.010.5 8.5 6.7 2.5 2.1 1.9 4.2 4.0 3.5 1.0 2.0
BC-83 2.01.02.01.01.02.04.01.01.02.0 -9 -9 -91.01.02.01.01.03.01.03.01.01.0 1.01.01.01.02.01.0
1.0 -92.02.01.02.0 1.0 7.050.0 -9 -9 -915.0 9.0 4.0 14.0 2.0 7.0 1.012.0 2.0 6.010.0 5.0 4.0 3.0
1.0 4.5 5.5 6.0 1.0 1.3 1.7 4.5 4.2 3.5 1.0 2.0
CA-804 2.01.02.01.01.02.03.01.01.01.01.01.0 2.01.01.02.01.01.03.01.01.02.01.0
1.01.01.01.01.01.0 1.02.03.01.01.02.0 3.0 6.035.0 -9 -9 -910.012.0 3.0 10.0 2.0 5.0 0.515.0 3.0
5.010.0 5.0 4.0 3.0 1.0 3.5 6.0 6.0 1.5 1.9 2.1 2.3 3.2 2.9 1.0 2.0
CA-326 2.01.01.02.02.02.02.01.01.02.0 -9 -9 -91.01.02.01.01.03.01.02.02.01.0
1.01.01.01.02.01.0 1.02.02.03.03.01.0 1.0 6.022.0 -9 -9 -915.015.0 4.0 10.0 2.0 5.0 1.015.0 2.0
7.512.0 6.0 5.5 3.0 1.0 4.5 6.0 6.0 1.1 1.7 1.3 4.1 3.5 4.6 1.0 2.0
CA-1132 2.01.02.01.01.02.02.01.01.01.01.02.0 4.01.01.01.02.02.03.01.03.01.01.0
1.02.01.01.01.01.0 1.02.02.03.02.01.0 3.0 4.028.5 5.0 2.0 2.520.012.0 4.0 11.0 2.5 4.4 0.513.0
3.0 4.312.0 6.0 5.0 3.0 1.0 7.0 7.2 5.7 2.2 2.2 2.2 3.2 3.3 2.6 1.0 2.0
CA-2531 2.01.02.01.01.02.03.01.01.02.0 -9 -9 -91.01.02.01.01.03.01.03.01.03.0
1.02.01.01.01.02.0 1.02.02.03.02.02.0 3.0 6.059.0 -9 -9 -915.013.0 4.0 10.0 2.0 5.0 0.516.0 4.0
4.010.0 6.0 5.5 3.0 1.0 8.0 9.010.5 2.4 2.5 2.4 3.3 3.6 4.4 1.0 2.0
ID-47 2.01.01.01.01.02.02.01.01.01.01.01.0 1.01.01.02.01.01.03.01.03.01.01.0

1.01.01.01.01.01.0 1.02.02.03.02.01.0 1.0 4.021.0 2.0 0.7 2.910.017.0 4.0 12.0 2.0 6.0 1.515.0
6.0 2.510.0 7.0 6.5 3.0 1.0 5.0 5.5 4.0 1.2 1.8 1.1 4.2 3.1 3.6 1.0 2.0
ID-1656 2.01.02.01.02.02.03.01.01.02.0 -9 -9 -91.01.02.02.02.04.02.02.02.03.0
1.03.01.01.01.03.0 1.01.03.03.02.01.0 2.0 6.080.0 -9 -9 -912.017.0 5.0 11.0 3.0 3.7 0.320.0 4.0
5.010.0 8.0 7.0 3.0 1.012.011.510.0 2.5 3.5 3.7 4.8 3.3 2.7 1.0 2.0
ID-2186 2.01.02.01.01.02.02.01.01.01.01.01.0 1.01.01.01.02.02.03.02.02.02.03.0
1.02.01.01.01.01.0 1.02.02.03.03.01.0 4.0 6.020.0 3.0 0.6 5.012.017.0 5.0 10.0 2.0 5.0 0.515.0
5.0 3.010.010.0 9.5 5.0 1.0 5.5 6.0 5.3 1.5 1.7 1.6 1.7 3.5 3.3 1.0 2.0
ID-6074 2.01.02.01.02.02.03.01.01.01.02.01.0 2.01.01.01.02.02.03.01.02.02.01.0
1.02.01.01.01.01.0 1.02.02.03.02.01.0 3.0 5.032.0 5.3 1.3 4.115.014.0 4.0 10.0 2.0 5.0 0.314.0
4.0 3.510.0 6.0 5.0 3.0 1.0 6.0 5.6 5.3 1.5 1.6 1.2 4.0 3.5 4.4 1.0 2.0
ID-181312.01.02.02.02.02.03.01.01.01.02.02.0 5.01.01.02.02.02.03.02.02.02.03.0
1.03.01.01.01.01.0 1.02.02.03.02.01.0 2.0 6.028.0 2.5 0.8 3.112.014.0 3.0 10.0 2.0 5.0 0.317.0
4.0 4.310.0 8.0 7.0 3.0 1.0 6.0 7.5 7.0 1.5 2.0 1.8 4.0 3.8 3.9 1.0 2.0
MT-1094 2.01.02.01.02.02.04.01.02.01.01.02.0 3.01.01.02.02.02.03.02.02.02.03.0
2.02.01.01.01.02.0 1.02.03.03.03.02.0 9.0 4.045.0 3.5 1.5 2.3 7.010.0 5.0 8.0 2.0 4.0 0.314.0 5.0
2.8 6.0 6.0 5.5 5.0 1.0 8.2 8.2 6.8 3.8 3.4 2.9 2.2 2.4 2.3 1.0 2.0
MT-1095 2.01.02.01.01.02.04.01.01.01.01.02.0 3.01.01.02.02.02.03.02.02.02.03.0
2.02.01.01.01.01.0 1.02.03.03.03.02.0 9.0 4.050.0 3.0 1.5 2.010.015.0 6.0 10.0 3.0 3.3 0.524.0
8.0 3.012.0 7.0 6.5 5.0 1.0 7.510.310.5 4.9 5.2 4.3 1.5 2.0 2.4 1.0 2.0
MT-3162 2.01.02.03.02.02.04.01.01.01.01.01.0 2.01.01.02.03.03.03.01.01.02.04.0
1.03.01.01.01.02.0 1.02.02.03.02.02.0 3.0 3.022.0 3.5 1.5 2.315.0 1.5 7.0 14.0 2.0 7.0 2.015.0
5.0 3.010.0 8.0 7.5 3.0 1.0 8.0 7.5 3.0 2.5 1.8 1.1 3.2 4.2 2.7 1.0 2.0
MT-3143 2.01.03.01.01.02.02.01.01.01.02.01.0 1.01.01.02.02.02.03.01.02.02.03.0
2.02.01.01.01.02.0 1.02.02.03.02.02.0 7.0 4.021.0 3.5 0.8 4.412.015.0 4.0 10.0 2.0 5.0 1.015.0
3.0 5.010.0 5.0 4.5 3.0 1.0 6.0 6.5 6.5 1.0 1.0 1.0 6.0 6.5 6.5 1.0 2.0
MT-E39712.01.03.01.02.02.03.01.01.01.02.01.0 3.01.01.02.02.02.04.01.03.02.03.0
1.03.01.01.01.02.0 1.02.02.03.02.01.0 5.0 6.042.0 4.5 1.6 2.813.015.0 3.5 10.0 2.0 5.0 0.316.0
4.0 4.010.0 6.0 5.0 3.0 1.0 8.0 9.5 8.4 2.5 3.0 2.2 3.2 3.2 3.8 1.0 2.0
NV-114602.01.02.02.02.02.03.01.02.02.0 -9 -9 -91.01.02.02.03.03.01.02.01.03.0
1.02.01.01.01.02.0 1.02.02.03.01.01.0 2.0 6.032.0 -9 -9 -916.015.0 4.0 11.0 2.0 5.5 1.020.0 4.0
5.011.0 7.0 6.0 3.0 1.0 5.0 9.010.0 1.5 2.0 3.0 3.3 4.5 3.3 1.0 2.0
NV-114622.01.02.01.02.02.03.01.02.02.0 -9 -9 -91.01.02.02.02.03.02.02.02.03.0
1.03.01.01.01.02.0 1.02.02.03.02.01.0 3.0 6.050.5 -9 -9 -916.014.0 4.0 14.0 2.0 7.0 0.316.0 3.0
5.310.0 8.0 7.0 3.0 1.0 7.512.514.0 2.0 2.3 2.5 3.8 5.4 5.6 1.0 2.0
OR-166 2.01.02.01.01.02.03.01.01.01.01.01.0 2.01.01.01.03.02.03.01.02.01.02.0
2.01.01.01.02.02.0 1.02.02.02.01.01.0 3.0 5.040.0 4.0 1.5 2.715.012.0 3.0 10.0 3.0 3.3 1.515.0
3.0 5.010.0 6.0 5.0 5.0 1.0 8.0 8.5 6.8 2.8 2.7 3.0 2.9 3.1 2.3 1.0 2.0
OR-131522.01.02.02.01.02.04.01.01.01.01.01.0 1.01.01.01.02.01.04.02.03.02.03.0
1.01.01.01.02.03.0 2.02.03.02.01.02.0 8.0 7.090.0 2.5 0.8 3.110.012.0 3.0 10.0 1.5 6.7 2.015.0
4.0 3.810.0 5.0 4.5 5.0 1.0 7.5 8.2 9.0 2.8 3.7 3.8 2.7 2.2 2.4 1.0 2.0
OR-172182.01.02.01.01.02.03.01.01.01.01.01.0 1.01.01.01.03.02.03.01.03.02.03.0
1.01.01.01.01.02.0 1.02.03.02.01.01.0 6.010.062.0 5.0 2.5 2.010.013.0 4.0 12.0 2.0 6.0 0.516.0
6.0 2.710.0 6.0 5.0 5.0 1.0 8.0 9.5 7.5 5.0 5.0 5.5 1.6 1.9 1.4 1.0 2.0
UT-1974 2.01.02.03.03.02.01.02.02.01.01.02.0 2.01.01.02.03.03.03.02.03.01.03.0
1.03.01.01.01.03.0 1.02.02.03.03.02.0 3.0 5.025.0 5.5 1.9 2.916.016.0 5.0 10.0 2.0 5.0 1.024.0
4.0 6.012.0 6.0 5.5 5.0 1.010.0 9.0 6.5 2.3 2.0 1.9 4.4 4.5 3.4 1.0 2.0
WA-2696 2.01.02.01.01.02.02.01.01.02.0 -9 -9 -91.01.02.01.02.03.01.03.02.01.0
1.02.01.01.01.01.0 1.02.02.03.02.01.0 3.0 5.056.0 -9 -9 -910.010.0 5.0 8.0 2.5 3.2 0.516.0 4.0
4.010.0 6.0 5.5 3.0 2.0 -9 8.5 8.0 -9 2.2 2.2 -9 3.9 3.6 1.0 2.0
WA-596 2.01.02.01.01.02.02.01.01.01.02.02.0 4.01.01.02.02.02.03.01.02.02.01.0
1.02.01.01.01.01.0 1.02.02.03.02.01.0 3.0 4.023.0 5.5 1.5 3.712.014.0 4.0 10.0 2.0 5.0 1.015.0
5.0 3.010.0 7.0 6.5 3.0 1.0 6.5 5.0 3.0 2.0 1.7 1.0 3.3 2.9 3.0 1.0 2.0
WA-s.n.A2.01.01.01.01.02.02.01.01.01.02.01.0 1.01.01.02.02.02.01.01.02.02.01.0
1.01.01.01.01.01.0 1.02.02.03.02.0 -9 1.0 6.058.0 5.0 1.0 5.012.010.0 3.0 8.0 1.5 5.3 0.513.0
4.0 3.3 8.0 6.0 5.5 3.0 1.010.311.0 9.5 2.1 2.2 1.9 4.9 5.0 5.0 1.0 2.0

WA-672 2.01.02.01.01.02.02.01.01.01.01.02.0 4.01.01.02.02.02.01.01.02.02.01.0
1.01.01.01.01.01.0 1.02.03.03.01.01.0 3.0 4.040.0 3.5 1.9 1.810.012.0 4.0 8.0 1.5 5.3 0.512.0
4.0 3.0 8.0 7.0 6.5 5.0 1.0 6.6 7.5 5.7 2.1 2.1 1.5 3.1 3.6 3.8 1.0 2.0
WA-1850 2.01.03.02.01.02.03.01.01.01.01.01.0 2.01.01.02.02.01.04.02.02.02.02.0
2.01.01.01.01.02.0 1.02.02.03.01.01.0 9.0 4.028.0 6.0 2.5 2.415.017.0 5.0 12.0 3.0 4.0 0.520.0
5.0 4.010.0 7.0 6.5 5.0 1.0 7.5 7.5 7.0 3.0 3.0 2.7 2.5 2.5 2.6 1.0 2.0
WA-5196 2.01.02.01.01.02.03.01.02.02.0 -9 -9 -91.01.02.02.03.03.02.02.02.03.0.1.03.01.01.0
3.0 1.0 7.0 6.5 3.5 2.0 2.1 1.0 3.5 3.1 3.5 2.0 2.0
NH-S14 1.01.01.01.02.02.02.02.02.01.03.01.0 1.01.01.02.03.02.02.02.02.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.02.0 1.0 5.026.512.5 1.5 8.315.014.0 4.0 10.0 2.5 4.0 1.015.0
4.0 3.813.0 6.0 5.0 3.0 1.013.5 9.0 6.0 2.0 1.3 1.1 6.8 6.9 5.5 2.0 2.0
NH-47 1.01.01.02.01.02.03.02.02.01.02.02.0 2.01.01.02.03.02.02.02.02.01.03.0
2.02.01.01.02.01.0 1.02.02.03.03.02.0 1.0 4.033.0 8.0 1.8 4.415.010.0 4.0 11.0 2.0 5.5 0.510.0
2.0 5.012.0 5.0 4.0 3.0 1.011.5 8.5 4.0 2.5 2.5 1.2 4.6 3.4 3.3 2.0 2.0
NH-171 1.01.01.02.02.02.02.01.02.01.02.01.0 1.01.01.02.03.02.02.02.02.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.02.0 3.0 5.031.0 9.5 2.0 4.815.015.0 5.0 12.0 2.0 6.0 1.017.0
4.0 4.314.0 7.0 6.0 3.0 1.015.0 7.0 6.7 1.9 1.3 1.6 7.9 5.4 4.2 2.0 2.0
NH-1131 1.01.01.01.01.02.02.01.01.01.02.01.0 2.01.01.02.03.02.02.01.02.02.01.0
1.02.01.01.01.01.0 1.02.02.03.03.02.0 1.0 5.036.0 8.0 1.5 5.315.010.0 4.0 6.0 1.8 3.4 1.010.0
2.0 5.010.0 5.0 4.0 3.0 1.014.010.0 6.2 2.4 1.9 1.5 5.8 5.3 4.1 2.0 2.0
NH-1287 1.01.02.02.03.02.03.02.02.01.01.02.0 2.01.01.02.03.03.02.02.03.02.03.0
1.01.01.01.01.02.0 1.02.02.03.03.02.0 3.0 2.026.0 3.7 1.5 2.515.010.0 6.0 10.0 2.0 5.0 1.014.0
5.0 2.814.0 6.0 5.5 3.0 1.0 8.5 7.5 -9 2.5 3.0 -9 3.4 2.5 -9 2.0 2.0
NH-1417 1.01.01.02.02.02.03.02.02.01.01.02.0 2.01.01.02.03.02.02.02.02.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.02.0 3.0 3.038.0 9.0 1.5 6.015.012.0 6.0 12.0 2.0 6.0 1.015.0
3.0 5.013.0 5.0 4.0 3.0 1.010.5 9.0 4.5 2.5 2.5 1.5 4.2 3.6 3.0 2.0 2.0
NH-2373 1.01.01.02.02.02.02.02.02.01.01.02.0 2.01.01.02.03.02.02.02.02.02.03.0
1.02.0[illegible].02.0 1.02.02.03.03.02.0 3.0 3.029.0 5.0 1.9 3.3 1.5 1.5 4.0 10.0 3.0 3.3 1.015.0
[illegible].0 3.0 1.0 8.0 7.5 3.5 2.2 3.2 1.2 3.6 2.3 2.9 2.0 2.0
NH-[illegible]2.02.02.03.01.02.01.02.02.0 2.01.01.02.02.02.02.02.03.02.03.0
1.02.0[illegible] 1.02.01.03.03.02.0 3.0 2.030.0 6.0 1.8 3.320.012.0 5.0 12.0 3.0 4.0 2.018.0
4.[illegible]5 3.0 1.0 9.0 7.5 -9 3.5 3.0 -9 2.6 2.5 -9 2.0 2.0
N[illegible].01.02.02.02.03.02.02.01.02.02.0 2.01.01.02.02.02.02.02.03.01.03.0
1.02.[illegible].01.03.0 1.02.01.03.03.02.0 1.0 3.028.0 5.0 1.2 4.215.013.0 5.0 12.0 2.0 6.0 0.516.0
6.0 2.712.0 7.0 6.5 3.0 1.0 8.0 5.6 4.2 1.8 1.5 1.9 4.4 3.7 2.2 2.0 2.0
NH-125291.01.02.02.02.02.03.02.02.01.01.02.0 2.01.01.02.03.03.02.02.03.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.02.0 2.0 2.023.5 5.2 1.6 3.315.015.0 5.0 10.0 2.0 5.0 0.515.0
5.0 3.010.0 6.0 5.5 3.0 1.0 8.0 6.5 -9 2.0 2.1 -9 4.0 3.1 -9 2.0 2.0
NH-383281.01.01.02.02.02.02.02.02.01.01.02.0 1.01.01.02.03.02.02.02.02.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.02.0 3.0 3.032.0 6.0 1.8 3.315.015.0 4.0 14.0 2.0 7.0 2.020.0
5.0 4.013.0 6.0 5.0 3.0 1.0 8.4 7.0 5.0 2.5 1.8 1.6 3.4 3.9 3.1 2.0 2.0
NH7091261.01.02.02.02.02.03.02.02.01.01.01.0 2.01.01.02.02.02.02.02.03.01.03.0
1.02.01.01.01.02.0 1.02.02.03.03.02.0 3.0 2.032.0 5.5 1.8 3.115.012.0 5.0 12.0 2.0 6.0 1.016.0
6.0 2.712.0 6.0 5.0 3.0 1.0 7.5 6.5 -9 1.5 1.8 -9 5.0 3.6 -9 2.0 2.0
Q-146 1.01.02.01.01.02.02.01.01.01.01.02.0 2.01.01.02.02.02.02.02.03.01.01.0
1.02.01.01.01.02.0 2.02.02.03.03.01.0 3.0 3.034.0 4.5 1.0 4.510.013.0 4.0 10.0 2.0 5.0 1.010.0
4.0 2.510.0 5.0 4.0 3.0 1.0 7.0 5.0 3.3 1.3 1.0 0.8 5.4 5.5 4.1 2.0 2.0
Q-499 1.01.02.02.02.02.02.01.02.01.02.01.0 2.01.01.02.02.02.02.02.02.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.01.0 3.0 4.032.010.5 2.0 5.313.015.0 5.0 12.0 2.0 6.0 1.020.0
6.0 3.310.0 6.0 5.0 3.0 1.011.0 7.0 5.0 2.0 1.5 1.3 5.5 4.7 3.8 2.0 2.0
Q-1402 1.01.02.01.01.02.03.02.02.01.01.02.0 3.01.01.02.02.02.01.01.03.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.02.0 3.0 3.053.0 5.0 2.2 2.315.014.0 5.0 10.0 2.0 5.0 1.015.0
4.0 3.713.0 6.0 5.0 3.0 1.010.3 8.2 6.0 2.7 3.0 2.4 3.8 2.7 2.5 2.0 2.0
Q-1453 1.01.01.01.01.02.02.01.01.01.02.02.0 2.01.01.02.02.02.02.02.02.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.01.0 3.0 4.045.014.5 2.7 5.415.012.0 4.0 8.0 2.0 4.0 0.015.0
4.0 3.810.0 6.0 5.0 3.0 1.013.0 9.0 6.9 2.5 2.1 1.7 5.0 4.3 4.1 2.0 2.0

Q-4577 1.01.02.01.01.02.02.01.03.01.02.01.0 2.01.01.02.02.02.02.02.02.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.01.0 3.0 3.038.0 4.0 1.3 3.115.015.0 5.0 10.0 3.0 3.3 1.018.0
4.0 4.510.0 6.0 5.0 3.0 1.0 8.5 7.8 5.0 2.2 1.8 1.2 3.9 4.3 4.2 2.0 2.0
Q-15267 1.01.01.01.01.02.02.01.02.01.03.01.0 2.01.01.02.02.02.02.01.01.02.03.0
1.01.01.01.01.02.0 1.02.02.03.03.01.0 1.0 4.049.019.5 2.2 8.915.017.0 5.0 12.0 2.0 6.0 2.016.0
4.0 4.012.0 6.0 5.0 3.0 1.011.0 6.5 5.5 1.5 1.0 0.9 7.3 6.5 6.1 2.0 2.0
Q-17519 1.01.02.02.02.02.02.01.02.01.01.01.0 2.01.01.02.02.02.03.02.03.01.03.0
1.02.01.01.01.01.0 1.02.02.03.03.01.0 3.0 3.047.0 7.0 1.7.4.115.013.0 5.0 13.0 2.0 6.5 2.018.0
6.0 3.012.0 6.0 5.0 3.0 1.0 8.5 8.0 6.0 1.2 1.9 1.7 7.1 4.2 3.5 2.0 2.0
Q-26089 1.01.02.01.01.02.03.01.02.01.01.02.0 2.01.01.02.02.02.02.02.03.01.03.0
1.01.01.01.01.02.0 1.02.02.03.03.01.0 3.0 3.034.0 7.5 2.5 3.015.013.0 5.0 15.0 3.0 5.0 1.015.0
3.0 5.013.0 7.0 6.0 3.0 1.0 9.1 7.8 -9 3.0 3.1 -9 2.0 2.5 -9 2.0 2.0
Q-26092 1.01.02.01.01.02.03.02.02.01.01.02.0 2.01.01.02.02.02.03.02.03.01.03.0
1.02.01.01.01.02.0 1.02.02.03.03.01.0 3.0 2.031.0 3.5 1.0 3.515.013.0 5.0 12.0 2.0 6.0 1.012.0
3.0 4.010.0 6.0 5.0 3.0 1.010.7 8.0 -9 1.8 1.7 -9 5.9 4.7 -9 2.0 2.0
Q-32432 1.01.02.01.02.02.02.01.02.01.02.01.0 1.01.01.02.02.02.02.02.02.02.03.0
1.02.01.01.01.02.0 1.02.02.03.03.01.0 2.0 4.034.0 9.0 1.4 6.412.015.0 5.0 13.0 2.0 6.5 1.016.0
4.0 4.012.0 7.0 6.0 3.0 1.013.0 8.0 8.5 1.9 1.0 1.6 6.8 8.0 5.3 2.0 2.0
Q-33351 1.01.02.01.01.02.02.01.01.01.01.01.0 2.01.01.02.02.02.02.01.02.02.03.0
1.02.01.01.02.01.0 1.02.02.03.03.01.0 3.0 3.047.0 -9 -9 -918.016.0 4.0 10.0 2.0 5.0 1.015.0 3.0
5.010.0 5.0 4.0 3.0 1.010.0 9.3 4.8 2.3 2.5 2.0 4.3 3.7 2.4 2.0 2.0
Q-33253 1.01.02.01.01.02.02.01.02.01.02.01.0 2.01.01.02.02.03.03.01.03.01.03.0
1.02.01.01.01.03.0 1.02.02.03.03.01.0 3.0 5.030.0 8.0 1.0 8.015.010.0 3.0 10.0 2.0 5.0 1.015.0
5.0 3.010.0 6.0 5.0 3.0 1.0 9.0 8.0 6.2 1.5 1.2 1.2 6.0 6.7 5.2 2.0 2.0
Q-69113 1.01.02.01.01.02.02.01.02.01.01.01.0 2.01.01.02.02.02.02.02.03.01.03.0
1.02.01.01.01.02.0 1.02.02.03.03.01.0 3.0 4.040.0 3.5 0.7 5.015.012.0 5.0 12.0 2.0 6.0 2.020.0
5.0 4.012.0 6.0 5.0 3.0 1.0 9.0 9.0 7.5 1.5 2.2 2.7 6.0 4.1 2.8 2.0 2.0 .010.7 8.0 -9 1.8 1.7 -9
5.9 4.7 -9 2.0 2.0

Analysis 2. *Arnica longifolia* D.C. Eaton & *A. mollis* Hook.

(2A4,35F3.1,32F4.1)

CA73167 2.01.02.01.03.02.02.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.01.01.0 3.01.03.01.01.0
1.02.02.01.02.03.02.02.0 3.0 6.047.0 -9 -9 -917.017.0 5.0 9.0 2.0 4.5 0.311.0 3.0 3.715.0 8.0
7.0 5.0 1.0 8.013.511.5 1.1 1.5 1.7 7.3 9.0 6.8 1.0 2.0
CA20014 2.01.02.01.03.02.02.01.03.02.0 -9 -9 -91.01.02.02.03.01.02.03.01.03.0 1.03.01.01.0
1.02.02.01.03.02.02.02.0 3.0 5.042.0 -9 -9 -912.012.0 4.010.0 2.0 5.0 1.013.0 3.0 4.312.0 7.0
6.0 3.0 1.0 5.512.512.0 1.4 1.6 1.4 3.9 7.8 8.6 1.0 2.0
CA-3574 2.01.02.01.03.02.02.01.03.01.01.0 1.01.01.01.02.01.03.01.02.03.01.03.0 1.03.01.01.0
1.02.02.01.02.02.02.01.0 6.0 4.036.0 3.2 0.5 6.416.013.0 4.012.0 3.0 4.0 0.314.0 3.0 4.710.0 8.0
7.0 0.0 1.0 8.0 6.5 7.5 1.2 0.9 1.3 6.7 7.2 5.8 1.0 2.0
CO-1914 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.03.03.03.01.01.0 1.03.01.01.0
1.02.02.01.03.02.02.02.0 7.0 7.047.0 -9 -9 -916.018.0 5.0 8.0 1.5 5.3 0.318.0 3.0 6.010.0 8.0
7.0 5.0 1.0 -9 5.0 9.5 -9 0.6 1.5 -9 8.3 6.3 1.0 2.0
CO-726 2.01.03.01.02.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.0 1.01.03.01.0
1.01.02.02.01.03.02.02.02.0 6.0 6.067.5 -9 -9 -910.015.011.0 9.0 2.0 4.5 0.313.0 3.0 4.310.0 8.0
7.0 3.0 1.0 -910.213.5 -9 1.3 1.7 -9 7.8 7.9 1.0 2.0
ID-461 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.0 1.01.03.01.0
1.01.02.02.01.03.02.02.02.0 6.0 7.045.0 -9 -9 -912.017.0 5.0 8.0 1.5 5.3 0.314.0 4.0 3.510.0 7.0
6.0 3.0 1.0 8.0 9.010.0 1.0 0.8 1.4 8.011.3 7.1 1.0 2.0
ID-431 2.01.03.01.03.02.01.01.03.01.0 2.01.05.01.01.02.01.03.01.03.03.01.0 3.01.03.01.0
1.01.02.02.02.02.03.03.01.0 5.0 5.040.011.0 1.7 6.514.013.0 4.011.0 2.0 5.5 0.315.0 3.0 5.010.0
7.0 6.5 3.0 1.0 9.010.0 7.0 1.0 1.3 1.0 9.0 7.7 7.0 1.0 2.0
ID-341 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.0 1.01.03.01.0
1.01.02.02.01.02.03.01.02.0 5.0 6.042.5 -9 -9 -914.010.0 5.014.0 1.014.0 0.314.0 3.0 4.710.0

7.0 6.0 3.0 1.0 -9 5.5 8.5 -9 1.0 1.0 -9 5.5 8.5 1.0 2.0
IDTNF9372.02.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0 2.01.02.01.03.02.02.02.0 4.0 5.041.0 -9 -9 -916.017.0 5.010.0 2.0 5.0 1.017.0 4.0 4.310.0 8.0 7.5 3.0 1.0 5.0 7.0 7.4 1.3 1.2 1.8 3.8 5.8 4.1 1.0 2.0
ID10113 2.0 -93.02.03.02.02.02.03.01.02.0 1.05.01.01.02.02.03.04.03.02.01.03.0 1.03.01.01.0 1.03.02.02.02.03.03.02.0 3.0 5.048.0 8.0 1.5 5.318.015.0 5.012.0 2.0 6.0 0.320.0 5.0 4.012.0 9.0 8.0 5.0 1.012.011.510.0 2.0 1.7 2.0 6.0 6.8 5.0 1.0 2.0
ID20216 2.01.02.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.02.03.01.03.03.01.01.0 1.03.01.01.0 1.02.02.02.02.02.01.02.0 7.0 6.046.0 -9 -9 -9 7.010.0 3.0 9.0 2.0 4.5 0.318.0 2.0 9.010.0 7.0 6.5 3.0 1.0 -910.012.5 -9 1.3 1.0 -9 7.712.5 1.0 2.0
IDRBJ1752.01.03.01.02.02.01.02.03.02.0 -9 -9 -91.01.02.01.03.03.03.03.01.03.0 1.03.01.01.0 1.02.02.02.02.03.02.02.0 3.0 5.066.0 -9 -9 -918.015.0 5.013.0 2.0 6.5 0.315.0 4.0 3.810.0 7.0 6.0 3.0 1.021.513.5 9.5 2.7 2.6 2.5 8.0 5.2 3.8 1.0 2.0
ID-2285 2.01.03.01.03.03.01.01.03.01.01.0 1.02.01.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0 1.02.02.01.03.03.02.02.018.0 6.040.0 2.0 0.8 2.512.015.0 5.0 8.0 2.0 4.0 0.315.0 5.0 3.010.0 8.0 7.0 5.0 1.0 6.511.511.0 1.5 1.5 1.0 4.3 7.711.0 1.0 2.0
ID-699 2.01.02.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.0 1.01.03.01.0 1.01.02.02.02.02.03.01.02.0 3.0 6.065.0 -9 -9 -912.018.0 4.010.0 2.0 5.0 0.318.0 5.0 3.612.0 9.0 8.0 5.0 1.0 -911.011.4 -9 2.0 1.8 -9 5.5 6.3 1.0 2.0
MT13360 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.02.03.01.03.03.01.01.0 1.03.01.01.0 1.02.02.01.03.03.01.02.0 7.0 6.038.0 -9 -9 -910.012.0 4.0 8.0 1.5 5.3 0.314.0 4.0 3.5 8.0 7.0 6.5 3.0 1.0 -911.0 8.5 -9 2.1 1.8 -9 5.2 4.7 1.0 2.0
MT-338 2.01.03.01.03.02.02.01.03.01.0 1.01.02.01.01.02.02.03.03.03.02.01.0 3.01.03.01.0 1.01.03.02.01.02.03.03.02.010.0 6.068.0 8.0 2.0 4.020.020.0 6.011.0 2.0 5.5 0.520.0 5.0 4.010.011.010.0 3.0 1.0 1.013.511.514.0 1.8 2.2 2.6 7.5 5.2 5.4 1.0 2.0
MT-3346 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0 1.02.02.01.03.02.01.02.0 7.0 6.038.0 -9 -9 -912.014.0 4.0 7.0 2.0 3.5 0.311.0 2.0 5.510.0 7.0 6.5 3.0 1.0 4.0 8.0 9.5 0.8 1.2 1.2 5.0 6.7 7.9 1.0 2.0
MT-17 2.01.02.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.02.03.01.03.03.01.0 1.01.03.01.0 1.01.03.02.01.03.03.01.02.0 4.0 5.034.5 -9 -9 -912.016.0 6.010.0 1.010.0 0.315.0 4.0 3.810.0 9.0 8.0 3.0 1.0 8.5 9.0 8.5 2.0 1.9 1.7 4.3 4.7 5.0 1.0 2.0
NV-335 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.0 1.01.03.01.0 1.01.02.02.02.02.03.01.02.0 4.0 4.034.0 -9 -9 -914.015.0 5.0 9.0 2.0 4.5 0.315.0 4.0 3.812.0 7.0 6.5 3.0 1.0 8.010.5 8.0 1.3 1.7 2.3 6.2 6.2 3.5 1.0 2.0
OR-154 2.01.02.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.0 1.01.03.01.0 1.01.02.02.02.03.01.02.0 5.0 6.047.0 -9 -9 -912.016.0 5.0 9.0 2.0 4.5 0.317.0 4.0 4.312.0 9.0 8.5 3.0 1.010.012.511.5 1.9 1.5 1.3 5.3 8.3 8.8 1.0 2.0
OR-9827 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0 1.02.02.02.02.03.01.02.0 9.0 6.048.0 -9 -9 -910.014.0 4.0 9.0 2.0 4.5 0.315.0 2.0 7.510.0 7.0 6.5 3.0 1.010.014.010.7 1.5 1.8 1.4 6.7 7.8 7.6 1.0 2.0
UT-1547 2.01.02.03.03.02.01.02.03.01.02.0 1.01.01.01.02.03.03.01.03.03.02.03.0 1.03.01.01.0 2.02.01.01.03.02.02.02.0 3.0 3.025.0 6.5 0.321.710.015.0 5.010.0 1.5 6.7 2.014.0 2.0 7.010.0 5.0 4.5 0.0 1.0 8.5 6.0 2.5 0.6 0.7 0.614.2 8.6 4.2 1.0 2.0
UT14209 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0 1.02.02.01.03.03.01.01.010.0 5.035.0 -9 -9 -912.015.0 5.0 7.0 1.0 7.0 0.315.0 3.0 5.010.0 7.5 7.0 5.0 1.0 4.0 7.0 7.0 1.2 1.4 1.1 3.3 5.0 6.4 1.0 2.0
UT-4103 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0 1.02.02.01.02.03.02.02.0 3.0 5.038.0 -9 -9 -920.020.0 5.010.0 1.5 6.7 0.315.0 4.0 3.812.0 9.0 8.5 5.0 1.0 8.511.0 9.0 1.5 1.4 1.6 5.7 7.9 5.6 1.0 2.0
UT-5900 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.02.01.01.0 1.03.01.01.0 1.02.02.01.03.03.01.02.0 4.0 6.050.0 -9 -9 -914.022.0 7.012.0 1.012.0 1.020.0 4.0 5.010.011.010.0 5.0 1.0 5.010.510.5 1.0 1.4 1.3 5.0 7.5 8.0 1.0 2.0
UT-C67 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.04.03.03.01.0 1.01.03.01.0 1.01.02.02.01.02.03.01.02.0 2.0 5.062.0 -9 -9 -920.016.0 5.014.0 2.0 7.0 0.320.0 4.0 5.012.0 9.0 8.5 5.0 1.012.010.016.5 2.2 1.8 2.2 5.5 5.6 7.5 1.0 2.0
WA-2736 2.01.02.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.02.01.01.0 1.03.01.01.0

1.02.02.01.03.03.01.02.0 3.0 6.030.0 -9 -9 -912.015.0 4.010.0 2.0 5.0 0.314.0 3.0 4.710.0 6.0
5.5 3.0 1.0 4.5 7.8 8.5 1.6 1.8 1.3 2.8 4.3 6.5 1.0 2.0
WA-2546 2.01.03.01.03.02.02.01.03.02.0 -9 -9 -91.01.02.02.03.04.03.03.01.01.0 1.03.01.01.0
1.03.02.01.02.03.01.02.0 4.0 5.048.5 -9 -9 -916.014.0 4.015.0 2.0 7.5 0.317.0 5.0 3.412.0 8.0
7.5 3.0 1.0 9.0 9.0 8.7 1.3 1.4 1.3 6.9 6.4 6.7 1.0 2.0
WY-4588 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.02.01.01.0 1.03.01.01.0
1.03.02.01.03.03.02.01.0 7.0 6.057.0 -9 -9 -916.014.0 5.011.0 1.5 7.3 0.3 7.0 1.5 4.712.0 7.0
6.5 3.0 1.0 -9 6.5 8.5 -9 1.3 1.6 -9 5.0 5.3 1.0 2.0
WY-K36 2.01.03.01.03.03.02.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.0 1.01.03.01.0
1.01.03.02.01.03.03.01.02.0 5.0 6.043.5 -9 -9 -916.018.0 5.010.0 2.0 5.0 0.318.0 3.0 6.010.0 9.0
9.0 3.0 1.0 -9 9.010.0 -9 2.0 2.4 -9 4.5 4.2 1.0 2.0
WY-574 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.0 1.01.03.01.0
1.01.01.02.01.03.02.01.02.0 4.0 6.055.0 -9 -9 -916.018.0 5.012.0 2.0 6.0 0.315.0 3.0 5.010.0 8.0
7.5 3.0 1.0 9.5 9.0 8.5 0.9 1.0 0.810.6 9.010.6 1.0 2.0
WY-991 2.01.02.01.02.02.01.01.03.01.0 1.01.02.01.01.02.01.03.01.03.03.01.0 1.01.03.01.0
1.01.01.02.01.02.03.01.02.0 3.0 4.038.0 3.5 0.8 4.414.014.0 4.010.0 1.5 6.7 0.315.0 4.0 3.813.0
7.0 6.5 3.0 1.0 7.0 7.8 7.0 1.4 1.8 1.5 5.0 4.3 4.7 1.0 2.0
WY-591 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.0 1.01.03.01.0
1.01.02.02.01.03.03.01.02.012.0 5.040.0 -9 -9 -912.010.0 4.011.0 1.5 7.3 1.015.0 3.0 5.0 8.0 6.0
5.0 3.0 1.010.213.514.0 1.5 1.5 2.0 6.8 9.0 7.0 1.0 2.0
WY-4596 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0
1.03.02.01.03.03.01.02.0 6.0 5.044.0 -9 -9 -916.016.0 5.0 7.0 1.0 7.0 0.318.0 4.0 4.510.0 9.0
8.5 3.0 1.0 -9 7.510.0 -9 1.6 1.6 -9 4.7 6.3 1.0 2.0
WY-1013 2.01.02.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0
1.02.02.01.02.03.02.02.0 2.0 4.033.0 -9 -9 -918.020.0 5.011.0 2.0 5.5 0.315.0 5.0 3.012.010.0
9.0 3.0 1.0 7.0 9.0 8.5 1.4 1.8 1.4 5.0 5.0 6.1 1.0 2.0
WY-302 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.02.03.01.03.02.01.0 1.01.03.01.0
1.01.03.02.01.03.03.01.02.0 5.0 7.042.0 -9 -9 -910.013.0 4.0 8.0 1.0 8.0 0.314.0 3.0 4.6 4.8 6.0
5.5 3.0 1.0 5.0 7.0 8.0 1.3 1.8 1.9 3.8 3.9 4.2 1.0 2.0
WY-8499 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.02.01.01.0 1.03.01.01.0
1.02.02.01.03.03.01.02.0 5.0 5.041.0 -9 -9 -916.016.0 4.010.0 2.0 5.0 0.318.0 3.0 6.013.0 9.0
8.5 3.0 1.0 -910.011.0 -9 1.5 1.9 -9 6.7 5.8 1.0 2.0
WY-390 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.02.01.0 1.01.03.01.0
1.01.02.02.01.02.03.01.02.0 5.0 6.063.0 -9 -9 -918.020.0 6.012.0 2.0 6.0 0.522.0 5.0 4.414.0 9.0
8.5 5.0 1.0 -911.014.5 -9 2.2 3.0 -9 5.0 4.8 1.0 2.0
WY-5925 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0
1.03.02.01.03.03.01.02.0 4.0 4.033.0 -9 -9 -914.014.0 4.0 9.0 2.0 4.5 0.317.0 4.0 4.312.0 9.0
8.5 3.0 1.0 -9 6.0 7.7 -9 1.4 1.9 -9 4.3 4.1 1.0 2.0
WY-6422 2.01.03.01.03.03.01.01.02.02.0 -9 -9 -91.01.02.01.03.01.02.02.02.01.0 1.02.01.01.0
2.01.02.01.03.02.02.02.030.0 7.056.0 -9 -9 -912.016.0 4.0 8.0 1.5 5.0 1.513.0 3.0 4.310.0 6.0
5.5 0.0 1.0 8.712.0 8.0 1.2 2.0 1.7 7.3 6.0 4.7 1.0 2.0
WY-C142 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0
1.03.02.01.03.03.01.02.0 7.0 5.032.0 -9 -9 -912.015.0 5.0 7.0 1.0 7.0 0.315.0 3.0 5.010.0 8.0
7.5 3.0 1.0 5.5 7.0 7.5 1.2 1.3 1.2 4.6 5.4 6.3 1.0 2.0
WY-4638 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.01.01.01.0 1.03.01.01.0
1.03.02.01.03.03.01.02.0 9.0 5.030.0 -9 -9 -916.016.0 6.0 8.0 2.0 4.0 0.313.0 4.0 3.310.0 8.0
7.5 3.0 1.0 5.0 6.7 6.0 0.6 0.7 1.0 8.3 9.6 6.0 1.0 2.0
WY-4671 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0
1.03.02.01.03.02.01.02.0 5.0 5.059.0 -9 -9 -915.013.0 6.0 7.0 1.5 4.7 0.313.0 2.0 6.511.0 8.0
7.0 3.0 1.0 -9 8.010.5 -9 1.6 1.7 -9 5.0 6.2 1.0 2.0
WY-6535 2.01.02.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0
1.03.02.01.03.03.01.02.0 4.0 6.046.0 -9 -9 -916.016.0 5.012.0 2.0 6.0 0.315.0 3.0 5.0 8.0 9.0
8.5 3.0 1.0 -9 7.5 9.8 -9 0.8 1.8 -9 9.4 5.4 1.0 2.0
WY-4343 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0
1.03.02.01.03.03.01.02.0 5.0 4.030.0 -9 -9 -914.018.0 5.0 7.0 1.5 4.7 0.314.0 2.0 7.0 8.0 9.0
8.5 3.0 1.0 5.0 7.0 7.0 1.0 1.2 1.2 5.0 5.8 5.8 1.0 2.0

WY-1022 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01 0 1.03.01.01.0 1.01.02.01.03.03.02.02.0 6.0 5.033.0 -9 -9 -912.010.0 5.0 8.0 2.0 4.0 0.311.0 ..0 5.5 7.0 7.0 6.0 3.0 1.0 3.5 5.5 7.0 1.0 1.4 1.4 3.5 3.9 5.0 1.0 2.0
WY-5216 2.01.02.01.03.02.02.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0 1.03.01.01.0 1.03.02.01.02.03.01.02.0 3.0 6.055.0 -9 -9 -915.015.0 5.010.0 1.5 6.7 0.315.0 4.0 3.810.0 7.0 6.5 5.0 1.0 -911.515.0 -9 2.0 2.0 -9 5.8 7.5 1.0 2.0
WY-374 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.0 1.01.03.01.0 1.01.01.02.01.03.02.01.02.0 8.0 6.028.0 -9 -9 -910.018.0 5.0 9.0 1.5 6.0 0.314.0 3.0 4.7 8.010.0 9.0 3.0 1.0 5.0 8.0 8.0 0.7 1.0 1.0 7.1 8.0 8.0 1.0 2.0
AB-DRUMM1.01.02.02.02.02.02.02.02.01.02.0 2.05.01.01.02.03.03.04.02.03.01.03.0 2.03.01.01.0 1.03.01.01.01.03.04.02.0 3.0 3.041.010.0 2.3 4.320.017.0 5.012.0 3.5 3.4 0.320.0 6.0 3.310.0 8.0 7.5 5.0 1.0 9.8 6.5 4.7 3.2 2.4 2.0 3.1 2.7 2.4 1.0 2.0
CA-3168 1.01.02.03.03.02.01.03.03.01.02.0 1.02.01.01.01.03.03.03.02.02.02.03.0 2.03.01.01.0 1.03.01.01.01.03.03.02.0 3.0 3.048.013.5 1.8 7.5 2.0 1.5 5.013.0 3.0 4.3 0.518.0 5.0 3.613.0 7.0 6.5 5.0 1.0 8.5 4.3 2.3 1.0 1.2 0.6 8.5 3.6 3.8 1.0 2.0
CA-7555 1.01.02.02.03.02.01.03.03.01.02.0 2.05.01.01.02.03.03.03.02.03.01.03.0 2.03.01.01.0 1.02.01.01.01.03.04.02.0 1.0 3.043.0 7.5 2.4 3.125.015.0 5.011.0 3.0 3.7 0.520.0 6.0 3.316.0 7.0 6.5 5.0 1.0 9.0 6.5 2.0 2.0 2.8 0.6 4.5 2.3 3.3 1.0 2.0
CA20032 1.01.02.01.01.02.01.01.02.01.02.0 2.05.01.01.01.02.02.01.01.03.01.03.0 1.02.01.01.0 2.01.01.01.02.03.04.01.0 1.0 3.026.0 8.5 2.1 4.114.010.0 5.010.0 1.5 6.7 1.015.0 4.0 3.713.0 6.0 5.5 3.0 1.012.5 7.0 3.0 3.0 2.0 0.5 4.2 3.5 6.0 1.0 2.0
CA-8811 1.01.01.01.02.01.01.01.02.01.01.0 2.02.02.01.01.01.03.03.03.02.01.03.0 2.03.01.01.0 1.03.01.01.01.03.04.02.0 1.0 3.062.0 8.5 2.3 3.722.015.0 5.013.0 2.5 5.2 0.525.0 6.0 4.214.0 8.0 7.5 5.0 1.0 8.5 5.0 3.8 1.5 1.3 1.1 5.7 3.8 3.4 1.0 2.0
CA-8817 1.01.02.02.02.02.03.02.02.01.01.0 2.02.01.01.02.02.02.03.02.02.01.03.0 1.02.01.01.0 1.02.01.01.02.03.03.02.0 1.0 4.049.0 2.5 1.0 2.515.018.0 7.014.0 2.5 5.6 0.515.0 5.0 3.010.0 8.0 7.5 3.0 1.0 7.5 8.3 5.0 2.0 2.2 1.2 3.8 3.8 4.2 1.0 2.0
CA-18 1.01.01.02.02.02.01.02.02.01.0 1.01.01.01.01.01.03.03.03.02.03.01.0 3.01.02.01.0 1.01.02.01.01.01.03.04.01.0 1.0 3.028.0 2.2 0.5 4.418.014.0 5.012.0 2.0 6.0 0.523.0 6.0 3.812.0 7.0 6.5 3.0 1.0 9.014.5 6.0 2.0 3.0 2.0 4.5 4.8 3.0 1.0 2.0
BC19585 1.01.02.01.02.02.02.01.02.01.01.0 2.01.01.01.01.02.02.03.02.02.01.03.0 1.02.01.01.0 1.01.01.01.01.04.04.01.0 3.0 3.044.0 4.0 1.2 3.320.015.0 6.013.0 3.0 4.3 0.517.0 4.0 4.312.0 7.0 6.5 5.0 1.013.5 9.5 4.8 3.0 3.0 1.6 4.5 3.2 3.0 1.0 2.0
CO-7256 1.01.02.02.02.02.02.02.02.01.01.0 2.02.01.01.02.03.03.03.02.02.02.03.0 1.03.01.01.0 1.01.01.01.01.04.04.02.0 3.0 3.040.0 6.5 1.0 6.520.017.0 6.014.0 2.5 5.6 0.518.0 5.0 3.613.0 7.0 6.5 3.0 1.0 7.5 7.0 4.5 1.0 2.0 1.0 7.5 3.5 4.5 1.0 2.0
CO-762 1.01.02.01.02.02.02.01.02.01.0 2.02.05.01.01.01.02.03.03.02.02.01.0 3.02.02.01.0 1.01.02.01.01.01.03.04.01.0 3.0 3.066.0 5.5 1.8 3.025.020.0 7.016.0 4.5 3.5 0.525.0 5.0 5.010.0 9.0 8.5 3.0 1.015.512.0 9.0 4.0 3.8 4.0 3.9 3.2 2.3 1.0 2.0
CO-3671 1.01.02.01.01.02.02.02.02.01.02.0 2.05.01.01.01.03.03.01.01.03.01.03.0 2.02.01.01.0 1.03.02.01.01.03.04.01.0 3.0 3.067.5 9.0 3.0 3.025.020.0 7.013.0 3.0 4.3 0.520.0 6.0 3.312.0 9.0 8.5 5.0 1.010.5 7.5 4.8 3.8 2.5 2.3 2.7 3.0 2.1 1.0 2.0
CO-2241 1.01.02.02.02.01.01.02.02.01.01.0 2.03.01.01.01.03.03.03.02.02.02.03.0 2.03.01.01.0 1.03.02.01.01.03.04.02.0 3.0 3.055.0 4.5 2.0 2.328.020.0 7.018.0 4.0 4.5 0.524.0 6.0 4.010.0 8.0 7.5 3.0 1.014.017.0 9.8 4.6 4.5 5.0 3.0 3.8 2.0 1.0 2.0
CO-4982 1.01.01.01.01.02.02.02.02.01.01.0 2.05.01.01.02.02.02.03.01.03.01.03.0 2.02.01.01.0 1.01.01.01.01.03.04.02.0 1.0 3.033.0 4.0 1.5 2.720.013.0 6.012.0 3.0 4.0 0.518.0 4.0 4.512.0 6.0 5.5 3.0 1.0 9.2 5.5 3.0 1.7 1.4 0.7 5.4 3.9 4.3 1.0 2.0
CO-1831 1.01.02.01.01.02.02.03.03.01.01.0 1.01.01.01.02.03.03.03.02.03.01.03.0 2.03.01.01.0 2.01.01.01.01.03.04.02.0 3.0 3.046.0 6.5 1.2 5.422.015.0 5.015.0 3.0 5.0 2.023.0 5.0 4.610.0 7.0 6.5 5.0 1.011.0 9.5 5.7 1.7 2.3 1.5 6.5 4.1 3.8 1.0 2.0
CO-6545 1.01.02.02.02.02.01.03.02.01.01.0 1.01.01.01.02.03.03.01.03.02.02.03.0 2.03.01.01.0 1.01.01.01.01.03.04.02.0 3.0 3.034.0 6.0 1.5 4.022.020.0 6.013.0 3.5 3.7 0.517.0 5.0 3.415.0 8.0 7.5 3.0 1.0 8.0 5.0 1.5 1.5 2.0 0.6 5.3 2.5 2.5 1.0 2.0
CO-3860 1.01.02.02.03.02.01.02.02.01.01.0 1.02.01.01.01.03.03.03.02.03.01.03.0 2.03.01.01.0 1.01.01.01.01.03.04.02.0 3.0 3.035.0 4.3 1.3 3.320.014.0 4.013.0 4.0 3.3 0.520.0 6.0 3.310.0 6.0

5.0 3.0 1.012.0 8.7 5.0 2.0 2.2 1.7 6.0 3.9 2.9 1.0 2.0
CO-2665 1.01.02.02.02.02.01.02.02.01.01.0 1.02.01.01.01.03.03.03.02.02.01.03.0 2.02.01.01.0
1.03.01.01.01.03.04.02.0 2.0 3.021.010.0 2.2 4.520.017.0 5.014.0 2.5 5.6 0.517.0 6.0 2.812.0 8.0
7.5 5.0 1.011.0 4.5 -9 2.6 1.8 -9 4.2 2.5 -9 1.0 2.0
CO-170 1.01.01.02.02.02.01.01.02.01.0 2.01.02.01.01.02.03.03.03.01.02.01.0 3.01.02.01.0
1.01.02.01.01.01.03.04.02.0 1.0 3.039.017.0 2.5 6.820.012.0 4.012.0 2.0 6.0 0.318.0 5.0 3.612.0
6.0 5.5 5.0 1.010.5 4.0 2.0 1.5 0.7 0.5 7.0 5.7 4.0 1.0 2.0
CO-4381 1.01.01.01.02.02.02.01.02.01.0 -9 -9 -91.01.01.03.03.03.01.03.02.03.0 2.03.01.01.0
1.02.01.01.01.03.04.02.0 1.0 3.054.5 -9 -9 -920.016.0 5.015.0 3.0 5.0 0.325.0 9.0 2.812.0 6.0
5.5 5.0 1.016.011.0 7.0 3.2 2.5 1.8 5.0 4.4 3.9 1.0 2.0
ID-3594 1.01.02.01.02.02.01.01.02.01.02.0 2.05.01.01.02.03.03.03.03.02.01.03.0 2.02.01.01.0
1.02.01.01.01.03.04.01.0 1.0 3.036.0 5.0 1.5 3.322.014.0 5.012.0 3.0 4.0 0.316.0 5.0 3.210.0 8.0
7.5 5.0 1.0 9.8 6.0 3.0 2.3 2.0 0.8 4.3 3.0 3.8 1.0 2.0
ID10394 1.0 -92.01.02.02.01.01.02.01.01.0 2.02.01.01.02.02.03.03.02.02.01.03.0 2.03.01.01.0
1.02.01.01.01.03.03.02.0 3.0 3.043.5 8.0 2.7 2.922.016.0 5.014.0 4.0 3.5 0.320.0 5.0 4.012.0 6.0
5.5 3.014.01.05 6.0 3.5 3.0 2.8 4.0 3.5 2.1 1.0 2.0
ID-3600 1.0 -92.01.02.02.01.02.02.01.01.0 2.05.01.01.02.02.02.03.02.02.01.03.0 2.02.01.01.0
1.02.01.01.01.03.04.01.0 4.0 4.058.0 8.0 2.3 3.525.020.0 6.015.0 4.0 3.8 0.322.0 5.0 4.4 9.0 7.0
6.5 3.010.0 8.5 7.2 2.5 3.0 2.8 4.0 2.8 2.6 1.0 2.0
ID-2139 1.0 -92.02.02.02.01.02.02.01.02.0 2.05.01.01.02.03.03.03.02.03.01.03.0 2.03.01.01.0
1.02.01.01.01.03.04.02.0 3.0 4.043.0 6.5 1.5 4.320.010.0 5.010.0 3.0 3.3 0.524.0 6.0 4.013.0 8.0
7.0 5.012.0 9.8 5.1 2.6 2.3 1.6 4.6 4.3 3.2 1.0 2.0
ID-1993 1.0 -92.01.02.02.02.01.01.01.02.0 2.05.01.01.01.02.02.01.01.03.01.03.0 2.03.01.01.0
1.01.01.01.01.03.04.02.0 3.0 4.059.015.5 4.2 3.722.020.0 6.012.0 3.0 4.0 0.317.0 6.0 2.810.010.0
9.0 5.025.0 9.5 4.0 4.7 2.5 1.2 5.3 3.8 3.3 1.0 2.0
ID11332 1.01.02.02.02.02.01.02.02.01.01.0 2.05.01.01.02.02.02.03.01.03.01.03.0 1.02.01.01.0
1.02.01.01.02.03.04.02.0 3.0 3.034.0 4.0 1.5 2.715.012.0 5.011.0 2.0 5.5 0.316.0 4.0 4.012.0 6.0
5.0 3.0 1.0 7.2 6.3 4.7 1.8 2.2 2.0 4.0 2.8 2.4 1.0 2.0
ID-84 1.01.02.02.02.02.01.02.02.01.0 1.02.05.01.01.02.03.03.03.02.02.01.0 3.01.03.01.0
1.01.02.01.01.01.03.04.01.0 4.0 4.034.0 3.5 1.0 3.520.015.0 5.012.0 3.0 4.0 0.314.0 5.0 2.812.0
6.0 5.5 3.0 1.0 7.0 4.5 3.7 1.2 1.0 0.8 5.8 4.5 4.6 1.0 2.0
ID-441 1.01.02.01.02.02.01.02.02.01.0 2.02.02.01.01.02.02.02.03.03.02.02.0 3.01.02.01.0
1.01.02.01.01.01.03.04.01.0 3.0 3.059.014.0 2.0 7.022.017.0 5.014.0 3.0 4.7 0.318.0 5.0 3.618.0
8.0 7.5 5.0 1.027.0 8.0 2.5 5.2 2.2 0.5 5.2 3.6 5.0 1.0 2.0
MT-146 1.01.02.02.02.02.02.02.02.01.0 2.02.05.01.01.02.02.02.04.02.03.01.0 3.02.03.01.0
1.01.02.01.01.01.03.04.02.0 1.0 3.042.010.0 2.0 5.024.015.0 6.013.0 3.0 4.3 0.330.0 8.0 3.812.0
9.0 8.0 5.0 1.014.0 6.8 4.0 4.0 2.2 1.5 3.5 3.1 2.6 1.0 2.0
MT-420 1.01.01.02.02.02.02.02.02.01.0 2.01.02.01.01.02.02.03.03.02.03.01.0 3.02.03.01.0
1.01.02.01.01.01.03.04.02.0 1.0 2.027.0 4.5 1.0 4.525.020.0 6.012.0 3.0 4.0 0.518.0 4.0 4.512.0
8.0 7.5 3.0 1.0 7.5 5.0 -9 1.4 1.5 -9 5.4 3.3 -9 1.0 2.0
MT13345 1.01.02.02.02.02.02.02.02.01.01.0 1.02.01.01.02.02.02.03.02.02.01.03.0 2.03.01.01.0
1.02.01.01.01.03.04.02.0 1.0 3.054.0 3.0 1.0 3.025.015.0 7.012.0 3.0 4.0 0.518.0 5.0 3.614.0 8.0
7.5 3.0 1.013.0 9.1 5.2 2.2 2.7 2.2 5.9 3.4 2.4 1.0 2.0
NV-1891 1.01.02.02.02.02.01.02.02.01.02.0 2.02.01.01.01.02.02.03.02.03.01.03.0 2.02.01.01.0
1.01.01.01.01.03.04.02.0 3.0 3.030.0 8.0 1.7 4.725.015.0 6.012.0 3.0 4.0 0.518.0 6.0 3.012.0 7.0
6.5 3.0 1.013.010.0 5.4 1.7 2.2 1.6 7.6 4.6 3.4 1.0 2.0
NV-1966 1.01.02.02.02.02.02.02.02.01.01.0 2.02.01.01.02.02.02.03.02.03.01.03.0 2.02.01.01.0
1.01.01.01.01.03.04.02.0 2.0 3.034.0 5.0 1.6 3.122.014.0 5.012.0 3.0 4.0 0.320.0 5.0 4.015.0 7.0
6.5 5.0 1.012.0 9.7 5.8 2.7 2.2 1.7 4.4 4.4 3.4 1.0 2.0
NV13455 1.01.01.02.02.02.01.02.02.01.02.0 1.02.01.01.01.02.02.03.01.03.01.03.0 2.02.01.01.0
1.02.01.01.01.03.04.01.0 1.0 3.058.0 6.0 1.5 4.025.017.0 5.013.0 3.0 4.3 0.320.0 5.0 4.014.0 6.0
5.5 5.0 1.013.510.0 4.5 3.5 2.5 2.5 3.8 4.0 1.8 1.0 2.0
NVDK151 1.01.02.02.02.02.01.02.02.01.01.0 2.02.01.01.02.02.02.03.02.03.03.03.0 1.02.01.01.0
1.03.01.02.01.03.04.02.0 2.0 3.024.0 2.5 0.8 3.122.014.0 5.012.0 2.0 6.0 0.315.0 5.0 3.020.0 7.0
6.5 3.0 1.0 6.5 6.0 3.0 2.0 2.0 1.2 3.3 3.0 2.5 1.0 2.0
NV-1615 1.01.02.02.02.02.01.02.02.01.01.0 1.02.01.01.02.02.02.03.02.02.01.03.0 2.02.01.01.0

1.03.01.01.01.03.04.02.0 3.0 3.040.0 6.0 2.0 3.024.018.0 8.012.0 4.0 3.0 0.518.0 6.0 3.014.0 8.0
7.5 3.0 1.0 7.7 6.0 2.8 1.8 1.8 0.7 4.3 3.3 4.0 1.0 2.0
NV-679 1.01.01.02.02.02.01.02.02.01.0 -9 -9 -91.01.01.03.02.01.02.02.02.0 3.02.02.01.0
1.01.01.01.0 -91.03.04.02.0 1.0 2.058.0 -9 -9 -928.020.0 6.016.0 4.0 4.0 0.324.0 6.0 4.015.0 7.0
6.5 5.0 1.017.5 7.5 -9 3.8 2.4 -9 4.5 3.1 -9 1.0 2.0
NV-6315 1.01.02.02.03.02.01.03.03.01.0 -9 -9 -91.01.02.02.03.03.02.02.02.03.0 2.03.01.01.0
1.02.01.01.01.03.04.02.0 3.0 3.040.0 -9 -9 -926.020.0 7.014.0 2.5 5.6 0.516.0 4.0 4.012.0 8.0
7.5 5.0 1.011.5 8.7 5.5 1.8 1.6 1.6 6.4 5.4 3.4 1.0 2.0
WA1028291.01.02.02.02.02.02.03.03.01.01.0 1.02.01.01.02.02.03.03.02.02.02.01.0 2.02.01.01.0
1.02.01.01.01.03.04.02.0 3.0 3.040.0 5.5 1.5 3.726.020.0 6.014.0 4.0 3.5 0.318.0 5.0 3.610.0 8.0
7.5 3.0 1.0 9.5 6.5 3.5 1.9 1.5 1.4 5.0 4.3 2.5 1.0 2.0
WA-46 1.01.02.02.03.02.01.01.03.01.0 1.01.01.01.01.02.03.03.03.02.02.02.0 3.02.03.01.0
1.01.02.01.01.01.03.04.02.0 3.0 3.022.5 3.5 1.0 3.5 2.0 1.2 5.011.0 3.0 3.7 0.314.0 4.0 3.513.0
7.0 6.5 3.0 1.0 9.7 6.0 2.5 1.7 1.2 0.8 5.7 5.0 3.1 1.0 2.0
WA-H10 1.01.01.02.02.02.02.01.02.01.0 2.02.03.01.01.02.03.03.04.02.02.01.0 3.02.03.01.0
1.01.02.01.01.01.03.04.02.0 1.0 3.039.0 7.0 2.9 2.420.016.0 5.013.0 3.5 3.7 0.315.0 5.0 3.012.0
7.0 6.5 5.0 1.014.0 5.5 2.2 3.2 1.5 0.7 4.4 3.7 3.1 1.0 2.0
WA-11 1.01.01.01.02.02.02.02.02.01.0 2.02.02.01.01.02.02.02.03.02.02.02.0 3.02.02.01.0
1.01.02.01.01.01.03.04.02.0 1.0 3.038.010.0 2.6 3.920.018.0 4.011.0 2.5 4.4 0.317.0 5.0 3.414.0
7.0 6.5 3.0 1.0 9.5 4.1 2.3 1.7 1.2 0.3 5.6 3.4 7.7 1.0 2.0
UT-1351 1.01.02.02.02.02.01.02.02.01.01.0 1.02.01.01.02.03.03.03.02.03.02.03.0 2.03.01.01.0
1.02.01.01.01.03.04.01.0 1.0 2.034.010.5 1.3 8.122.015.0 5.013.0 3.0 4.3 0.320.0 5.0 4.012.0 7.0
6.5 3.0 [illegible] 8.0 2.0 [illegible] -9 5.0 4.0 -9 1.0 2.0
UT-5883 1.01.01.02 [illegible] 2.02.01.02.0 2.05.01.01.02.02.02.01.01.03.02.03.0 2.02.01.01.0
1.01.01.01.01.03.04.0 [illegible] 2.039.0 6.5 2.8 2.324.020.0 7.014.0 3.0 4.7 0.522.0 7.0 3.112.0 7.0
6.0 5.0 1.0 9.0 6.0 -9 [illegible] 2.4 -9 3.3 2.5 -9 1.0 2.0
UT1645A 1.01.02.01.02.02.01.02.02.01.01.0 2.02.01.01.02.03.03.03.02.02.02.03.0 1.02.01.01.0
1.02.01.01.01.03.04.02.0 3.0 2.045.010.5 2.7 2.928.020.0 6.016.0 2.5 6.4 0.320.0 7.0 2.912.0 7.0
6.5 5.0 1.013.0 7.0 -9 3.0 2.4 -9 4.3 2.9 -9 1.0 2.0
UT-1647 1.01.02.02.02.02.01.02.02.01.02.0 1.01.01.01.02.03.03.03.02.02.02.03.0 1.02.01.01.0
1.01.01.01.01.03.04.02.0 3.0 3.040.0 3.5 1.0 3.526.015.0 5.013.0 2.5 5.2 0.322.0 6.0 3.715.0 7.0
6.5 5.0 1.012.010.0 4.1 2.2 1.8 1.2 5.5 5.6 3.4 1.0 2.0
UT18981.01.02.02.03.02.02.01.02.01.01.0 2.02.01.01.02.02.03.03.02.02.02.03.0 2.03.01.01.0
1.03.01.01.01.03.04.02.0 3.0 4.033.0 3.5 1.0 3.522.020.0 6.013.0 4.0 3.3 1.023.0 6.0 3.813.0 7.0
6.5 3.0 1.0 7.0 6.5 3.5 1.7 1.5 1.0 4.1 4.3 3.5 1.0 2.0
UT-5057 1.01.02.01.01.02.02.01.02.01.01.0 2.03.01.01.02.01.03.03.02.03.02.01.0 2.02.01.01.0
1.01.01.01.01.03.04.02.0 3.0 4.052.0 3.0 1.3 2.316.013.0 5.013.0 4.5 2.9 0.318.0 6.0 3.012.0 5.0
4.5 5.0 1.0 9.015.3 7.5 3.1 4.0 3.2 2.9 3.8 2.3 1.0 2.0
UT17495 1.01.01.02.03.02.01.02.03.01.02.0 2.02.01.01.02.02.03.03.02.02.02.03.0 2.02.01.01.0
1.02.01.01.01.03.04.02.0 1.0 1.044.0 6.5 1.2 5.418.015.0 6.012.0 3.0 4.0 0.324.0 4.0 6.010.0 7.0
6.5 5.0 1.0 6.5 -9 -9 2.3 -9 -9 2.8 -9 -9 1.0 2.0
UT-1984 1.01.01.01.02.02.01.01.02.01.02.0 1.02.01.01.02.01.03.03.02.03.02.03.0 1.02.01.01.0
1.03.01.01.02.03.04.02.0 1.0 3.040.0 7.0 1.7 4.120.018.0 7.014.0 2.0 7.0 0.320.0 4.0 5.012.0 7.0
6.5 3.0 1.013.0 8.0 4.0 2.2 1.9 0.8 5.9 4.2 5.0 1.0 2.0
OR-1154 1.01.01.01.02.02.01.01.02.01.02.0 2.01.01.01.02.01.03.01.02.03.01.01.0 1.02.01.01.0
1.02.01.01.01.03.04.02.0 1.0 3.022.0 3.4 0.5 6.818.012.0 5.011.0 2.0 5.0 0.315.0 4.0 3.810.0 6.0
5.5 3.0 1.0 6.0 5.5 2.5 1.0 1.2 0.5 6.0 4.6 5.0 1.0 2.0
OR-56 1.01.01.01.01.02.02.01.02.01.0 1.02.02.01.01.02.03.03.03.01.03.01.0 3.02.02.01.0
1.01.01.01.01.01.03.04.02.0 1.0 3.045.0 3.5 1.3 2.720.015.0 5.015.0 3.0 5.0 1.013.0 3.0 4.310.0
6.0 5.5 3.0 1.0 7.0 8.7 6.5 2.5 3.0 2.2 2.8 2.9 3.0 1.0 2.0
OR-814 1.01.02.01.02.02.01.01.03.01.0 1.02.01.01.01.02.02.03.01.02.02.01.0 3.02.02.01.0
1.01.02.01.01.02.03.04.02.0 3.0 3.038.0 2.1 0.6 3.520.020.0 7.015.0 3.0 5.0 0.516.0 6.0 2.713.0
7.0 6.5 5.0 1.0 7.5 6.5 4.0 2.0 1.9 1.5 3.8 3.4 2.7 1.0 2.0
OR-168 1.01.02.02.02.02.02.02.02.01.0 2.02.02.01.01.02.02.03.03.02.03.02.0 3.01.03.01.0
1.01.01.01.01.01.03.04.02.0 5.0 3.040.0 9.5 2.0 4.818.012.0 4.010.0 2.0 5.0 0.516.0 4.0 4.012.0
6.0 5.5 5.0 1.0 9.0 6.5 3.8 2.5 1.9 1.9 3.6 3.4 2.0 1.0 2.0

OR-B540 1.01.01.01.02.02.02.02.02.01.01.0 2.01.01.01.02.01.03.01.02.03.01.01.0 1.02.01.01.0 1.01.01.01.01.03.04.01.0 1.0 4.033.0 2.0 0.6 3.318.016.0 5.011.0 2.0 5.5 0.516.0 6.0 2.712.0 7.0 6.5 5.0 1.0 6.0 7.2 4.0 1.6 1.5 1.0 3.8 4.8 4.0 1.0 2.0
OR-2489 1.01.02.02.03.02.01.01.03.01.01.0 2.02.01.01.02.02.03.03.02.02.01.03.0 2.03.01.01.0 1.03.01.01.02.03.04.02.0 3.0 3.038.0 7.0 2.0 3.520.018.0 5.012.0 3.0 4.0 0.322.0 4.0 5.512.0 9.0 8.5 3.0 1.010.0 8.0 3.5 2.0 2.0 0.4 5.0 4.0 8.8 1.0 2.0
WY-140 1.01.03.03.03.02.01.02.03.01.0 1.02.01.01.01.02.03.03.03.03.02.02.0 3.02.03.01.0 1.01.03.01.01.01.03.04.02.0 4.0 3.036.0 3.0 1.0 3.022.018.0 5.012.0 3.0 4.0 0.518.0 6.0 3.014.0 8.0 7.0 3.0 1.0 8.0 7.5 3.5 2.5 2.0 1.4 3.2 3.8 2.5 1.0 2.0
WY-933 1.01.02.01.02.02.02.02.02.01.0 2.02.05.01.01.02.02.02.03.01.03.01.0 3.02.02.01.0 1.01.01.01.01.01.03.04.02.0 4.0 2.054.011.5 3.0 3.820.015.0 6.015.0 3.0 5.0 0.322.0 5.0 4.414.0 6.0 5.5 3.0 1.014.5 7.8 -9 2.5 2.2 -9 5.8 3.5 -9 1.0 2.0
WY-1702 1.01.01.01.02.02.02.01.01.01.02.0 2.05.01.01.02.02.02.03.02.03.01.03.0 1.02.01.01.0 1.02.01.01.02.03.04.02.0 1.0 3.059.014.0 3.5 4.020.018.0 5.014.0 2.5 5.6 0.322.0 5.0 4.414.0 7.0 6.5 3.0 1.014.010.0 5.7 4.5 4.7 3.0 3.1 2.1 1.5 1.0 2.0
WY-1785 1.01.01.01.02.02.02.01.02.01.02.0 1.02.01.01.02.02.02.01.01.03.01.03.0 1.02.01.01.0 1.01.01.01.01.03.04.02.0 1.0 2.049.010.5 1.5 7.025.018.0 6.014.0 3.0 4.7 0.528.0 6.0 4.616.0 8.0 7.0 3.0 1.0 7.5 5.5 -9 2.3 2.5 -9 3.3 2.2 -9 1.0 2.0
WY-6379 1.01.02.02.02.02.02.03.03.01.02.0 1.02.01.01.02.03.03.03.02.02.01.03.0 1.03.01.01.0 1.02.01.01.01.03.04.01.0 3.0 3.055.0 6.0 1.2 5.024.018.0 5.012.0 3.0 4.0 0.318.0 4.0 4.513.0 7.0 6.0 3.0 1.0 7.0 6.0 3.5 2.2 2.3 1.3 3.2 2.6 2.7 1.0 2.0
WY-8519 1.01.02.02.03.02.02.02.02.01.01.0 2.02.01.01.02.03.03.03.02.02.01.03.0 2.03.01.01.0 1.03.01.01.01.03.04.01.0 3.0 4.051.5 9.0 2.5 3.620.015.0 7.013.0 3.0 4.3 0.320.0 5.0 4.015.0 7.0 6.5 5.0 1.016.510.0 6.0 3.5 2.7 2.2 4.7 3.7 2.7 1.0 2.0
WY-2819 1.01.02.02.03.02.02.02.03.01.01.0 2.03.01.01.02.02.03.01.02.03.01.03.0 2.03.01.01.0 1.03.01.01.01.03.04.01.0 4.0 4.066.0 7.5 2.5 3.022.015.0 6.012.0 3.0 4.0 0.325.0 7.0 3.613.0 8.0 7.0 5.0 1.016.014.010.3 5.0 4.6 4.5 3.2 3.0 2.3 1.0 2.0
WY-8503 1.01.02.02.03.02.02.02.02.01.01.0 1.02.01.01.01.03.03.03.02.03.01.03.0 2.03.01.01.0 1.03.01.01.01.03.04.01.0 2.0 3.048.010.0 3.3 3.026.020.0 6.014.0 3.0 4.7 0.320.0 7.0 2.916.0 8.0 7.0 5.0 1.010.0 9.0 6.2 3.8 3.5 2.3 2.6 2.6 2.7 1.0 2.0
WY-1962 1.01.02.02.02.02.02.02.02.01.02.0 2.02.01.01.02.03.03.03.02.02.02.03.0 2.03.01.01.0 1.01.01.01.01.03.04.01.0 3.0 4.054.0 7.5 2.3 3.324.022.0 6.514.0 3.5 4.0 0.324.0 7.0 3.412.0 8.0 7.0 5.0 1.014.0 8.0 5.0 3.8 2.8 2.7 3.7 2.9 1.8 1.0 2.0
WY-1191 1.01.02.02.03.02.02.02.03.01.02.0 2.02.01.01.02.03.03.03.02.02.01.03.0 2.03.01.01.0 1.02.01.01.01.03.04.01.0 3.0 3.044.0 5.2 0.9 5.820.015.0 4.013.0 3.0 4.3 0.317.0 4.0 4.314.0 7.0 6.0 5.0 1.010.5 6.6 3.8 2.3 2.1 0.8 4.6 3.1 4.8 1.0 2.0
WY-340 1.01.02.01.02.02.02.02.02.01.0 1.01.02.01.01.02.02.03.01.01.03.01.0 3.02.03.01.0 1.01.01.01.01.01.03.04.01.0 3.0 3.040.0 6.0 1.5 4.020.015.0 5.015.0 4.0 3.8 1.023.0 5.0 4.613.0 7.0 6.0 5.0 1.0 6.3 4.3 -9 1.5 1.6 -9 4.2 2.7 -9 1.0 2.0
WY-496 1.01.02.02.03.02.01.01.02.01.0 -9 -9 -91.01.02.02.03.03.02.02.02.0 3.01.03.01.0 1.01.02.01.01.01.03.04.02.0 3.0 3.041.0 -9 -9 -922.020.0 7.012.0 2.5 4.8 0.524.0 7.0 3.412.0 8.0 7.0 5.0 1.0 9.5 8.0 4.7 2.0 3.0 1.4 4.8 2.7 3.4 1.0 2.0
WY10274 1.01.02.02.02.02.01.02.02.01.01.0 1.01.01.01.02.03.03.03.01.02.02.03.0 2.03.01.01.0 1.02.01.01.01.03.04.02.0 3.0 3.050.0 3.5 0.9 3.922.017.0 5.013.0 3.0 4.3 1.021.0 5.0 4.212.0 7.0 6.5 5.0 1.0 9.0 6.3 4.2 1.8 1.7 1.6 ~~5.0 3~~.7 2.6 1.0 2.0
WY-2908 1.01.02.02.02.02.02.02.03.01.0 -9 -9 -91.01.02.02.03.03.01.03.01.03.0 2.03.01.01.0 1.02.01.01.01.03.04.01.0 3.0 3.045.0 -9 -9 -920.012.0 4.015.0 3.0 5.0 0.514.0 4.0 3.520.0 5.0 5.0 5.0 1.013.0 8.5 4.5 2.7 2.3 1.8 4.8 3.7 2.5 1.0 2.0
WY-6121 1.01.02.01.02.02.01.01.03.01.01.0 1.02.01.01.02.02.03.03.01.03.01.03.0 2.03.01.01.0 1.01.01.01.01.03.04.02.0 2.0 3.035.0 7.5 2.0 3.818.010.0 5.013.0 3.0 4.3 0.324.0 6.0 4.012.0 6.0 5.0 3.0 1.0 9.5 6.0 4.3 2.0 2.2 1.4 4.8 2.7 3.1 1.0 2.0
WY-90 1.01.01.02.03.02.02.02.03.01.0 2.01.01.01.01.02.03.03.03.01.03.01.0 3.02.03.01.0 1.01.02.01.01.01.03.04.02.0 1.0 3.022.0 5.0 0.7 7.118.017.0 5.010.0 2.5 4.0 0.316.0 5.0 ~~3.2~~14.0 7.0 6.0 3.0 1.0 7.0 3.8 1.6 1.6 0.9 0.2 4.4 4.2 8.0 1.0 2.0
WY-1788 1.01.02.01.03.02.02.02.03.01.01.0 1.02.01.01.02.02.03.04.01.03.01.03.0 2.03.01.01.0 1.02.01.01.01.03.04.02.0 3.0 3.024.0 7.0 1.7 4.122.012.0 5.012.0 3.0 4.0 0.317.0 4.0 4.316.0 6.0

5.0 5.0 1.0 8.0 4.6 3.0 1.2 1.1 1.0 6.7 4.2 3.0 1.0 2.0
WY-5080 1.01.01.02.03.02.02.02.02.01.02.0 2.02.01.01.02.02.03.04.02.02.01.04.0 2.03.01.02.0 1.03.01.01.01.03.04.02.0 1.0 3.049.010.5 2.5 4.226.020.0 6.016.0 4.0 4.0 2.035.0 7.0 5.016.010.0 9.0 5.0 1.015.4 8.9 3.5 5.2 3.5 1.1 3.0 2.5 3.2 1.0 2.0
WY-3365 1.01.01.03.02.02.02.02.03.01.02.0 1.01.01.01.02.02.03.03.01.03.01.03.0 2.03.01.01.0 1.02.01.01.01.03.04.02.0 1.0 3.023.0 8.0 1.5 5.320.018.0 5.012.0 3.0 4.0 0.320.0 5.0 4.013.0 7.0 6.0 3.0 1.0 6.0 4.0 1.5 1.0 1.2 0.3 6.0 3.3 5.0 1.0 2.0
WY-7776 1.01.02.02.03.02.02.02.03.01.01.0 2.02.01.01.02.02.03.03.02.02.01.03.0 2.03.01.01.0 2.02.01.01.01.03.04.02.0 3.0 3.044.0 5.5 1.7 3.224.020.0 7.015.0 3.0 5.0 2.025.0 6.0 4.214.0 7.0 6.5 3.0 1.012.0 8.5 5.0 2.6 2.3 1.3 4.6 3.7 3.8 4.1 2.0
WY-308 1.01.02.01.02.02.02.02.02.01.0 1.02.02.01.01.02.02.03.03.02.03.01.0 3.02.03.01.0 1.01.02.01.01.01.03.04.02.0 3.0 3.039.0 5.5 2.0 2.824.020.0 7.013.0 3.0 4.3 0.324.0 6.0 4.014.010.0 9.0 3.0 1.0 8.2 9.5 6.0 2.8 1.7 1.5 2.9 5.6 4.0 1.0 2.0
WY-1029 1.01.01.02.02.02.01.02.02.01.01.0 2.02.01.01.02.03.03.04.02.03.01.03.0 1.02.01.01.0 1.02.02.01.01.03.04.02.0 1.0 3.038.0 5.5 1.8 3.118.014.0 5.012.0 2.0 6.0 0.318.0 4.0 4.514.0 7.0 6.5 3.0 1.012.5 7.5 3.0 2.8 2.3 0.8 4.5 3.3 3.8 1.0 2.0
WY-367 1.01.02.01.02.02.02.01.02.01.0 2.02.02.01.01.02.02.03.04.02.03.01.0 3.02.03.01.0 1.01.02.01.01.01.03.04.02.0 2.0 4.051.010.0 2.4 4.222.020.0 5.013.0 4.0 3.3 0.320.2 6.0 3.312.0 7.0 6.5 5.0 1.018.0 9.0 4.5 3.0 1.8 1.2 6.0 5.0 3.8 1.0 2.0
WY-1191 1.01.02.02.02.02.01.02.02.01.01.0 2.02.01.01.02.03.03.03.02.03.01.03.0 2.03.01.01.0 1.01.01.01.01.03.04.01.0 3.0 4.050.0 6.5 2.5 2.622.012.0 4.012.0 3.0 4.0 0.314.0 3.0 4.712.0 6.0 5.5 5.0 1.012.0 7.5 6.5 3.0 3.2 2.7 4.0 2.3 2.4 1.0 2.0
WY-970 1.01.02.02.03.02.02.01.02.01.0 1.02.02.01.01.02.03.03.03.02.03.01.0 3.02.03.01.0 1.01.03.01.01.01.03.04.02.0 3.0 3.040.0 5.0 1.2 4.220.020.0 6.012.0 3.0 4.0 0.518.0 5.0 3.615.0 7.0 6.5 3.0 1.010.0 8.7 5.0 2.9 2.5 1.6 3.4 3.5 3.1 1.0 2.0
WY-3020 1.01.02.02.02.02.01.01.02.01.02.0 2.02.01.01.02.03.03.04.02.02.02.03.0 2.03.01.01.0 1.03.01.01.01.03.04.02.0 3.0 3.066.012.5 3.3 3.824.020.0 8.017.0 3.0 5.7 0.526.0 6.0 4.314.010.0 9.0 5.0 1.018.011.7 6.0 4.3 3.5 2.8 4.2 3.3 2.1 1.0 2.0
WY-4037 1.01.02.02.02.02.02.01.02.01.01.0 2.02.01.01.02.03.03.04.02.03.01.03.0 2.03.01.01.0 1.02.02.01.01.03.04.01.0 4.0 3.060.0 5.5 2.4 2.326.018.0 6.016.0 3.0 5.3 1.023.0 5.0 4.619.0 9.0 8.5 5.0 1.0 8.5 7.5 5.5 3.6 4.0 2.4 2.4 1.9 2.3 1.0 2.0
WY-6109 1.01.02.02.02.02.02.02.02.01.01.0 1.02.01.01.02.03.03.03.02.03.01.03.0 1.03.01.01.0 1.02.01.01.01.03.04.02.0 1.0 3.037.0 3.5 0.8 4.416.015.0 5.012.0 2.5 4.8 0.320.0 6.0 3.313.0 7.0 6.5 3.0 1.013.0 7.5 4.2 2.4 1.8 1.2 5.4 4.2 3.5 1.0 2.0
WY-3359 1.01.02.02.02.02.01.03.03.01.01.0 1.02.01.01.02.03.03.03.02.03.01.03.0 1.02.01.01.0 1.02.01.01.01.03.04.02.0 3.0 3.035.0 8.0 1.2 6.724.014.0 5.014.0 3.0 4.7 0.316.0 5.0 3.217.0 7.0 6.0 3.0 1.011.510.0 5.5 1.5 2.0 2.0 7.7 5.0 2.8 1.0 2.0
WY-3572 1.01.02.02.02.02.02.02.03.01.02.0 2.02.01.01.02.02.02.04.02.02.01.03.0 2.03.01.01.0 1.02.01.01.01.03.04.02.0 3.0 3.056.013.0 2.6 5.026.016.0 6.014.0 3.0 4.7 0.320.0 5.0 4.016.0 8.0 7.5 5.0 1.014.5 7.1 4.5 3.0 2.8 1.9 4.8 2.5 2.4 1.0 2.0
WY-4330 1.01.01.02.02.02.01.02.02.01.02.0 1.02.01.01.02.03.03.03.01.03.01.03.0 1.03.01.01.0 1.02.01.01.01.03.04.02.0 1.0 3.043.018.5 3.7 5.024.015.0 5.014.0 3.0 4.7 0.315.0 5.0 3.015.0 7.0 6.0 5.0 1.014.0 7.5 3.5 3.0 1.8 1.0 4.7 4.2 3.5 1.0 2.0
WY-4920 1.01.02.02.02.02.01.02.02.01.02.0 2.02.01.01.02.02.03.03.01.03.01.03.0 2.03.01.01.0 1.02.01.01.01.03.04.01.0 3.0 3.039.015.3 3.0 5.126.020.0 6.013.0 4.0 3.3 0.325.0 6.0 4.216.0 7.5 6.5 5.0 1.010.5 5.5 2.5 1.8 1.7 0.6 5.8 3.2 4.2 1.0 2.0
WY-6273 1.01.02.01.02.02.01.02.03.01.02.0 2.02.01.01.02.02.03.03.01.03.01.03.0 2.02.01.01.0 1.02.01.01.01.03.04.02.0 3.0 4.042.0 7.5 2.4 3.126.015.0 4.014.0 3.0 4.7 0.320.0 5.0 4.013.0 7.0 6.5 5.0 1.013.0 8.7 4.5 2.0 1.4 1.0 6.5 6.2 4.5 1.0 2.0
WY-5005 1.01.02.01.02.02.01.01.02.01.02.0 1.02.01.01.02.02.03.03.01.02.01.03.0 1.03.01.01.0 1.03.01.01.01.03.04.01.0 3.0 3.051.0 -9 -9 -924.017.0 5.010.0 2.0 5.0 0.317.0 4.0 4.314.0 7.0 6.5 3.0 1.012.010.5 6.2 1.4 2.0 2.0 8.6 5.3 3.1 1.0 2.0
WY-5021 1.01.02.02.03.02.01.03.03.01.01.0 1.01.01.01.02.03.03.03.01.03.01.03.0 1.03.01.01.0 1.01.01.01.02.03.04.02.0 3.0 3.027.5 6.0 1.2 5.018.015.0 5.011.0 3.0 3.7 0.320.0 6.0 3.313.0 7.0 6.5 3.0 1.0 7.5 4.3 3.5 1.1 1.0 1.0 6.8 4.3 3.5 1.0 2.0
WY-6117 1.01.01.01.02.02.02.02.02.01.01.0 2.02.01.01.02.03.03.04.03.03.01.03.0 2.03.01.01.0

1.03.01.01.01.03.04.01.0 1.0 3.041.0 9.5 3.0 3.228.020.0 6.017.0 5.0 3.4 0.325.0 5.0 5.010.0 8.0
7.5 5.0 1.0 8.0 5.7 3.0 2.8 2.3 0.7 2.9 2.5 4.3 1.0 2.0
WY-7179 1.01.02.01.02.02.02.01.02.01.01.0 2.02.02.01.01.02.03.03.04.03.02.02.0 3.02.02.01.0
1.01.03.01.01.01.03.04.02.0 2.0 3.044.0 9.5 2.3 4.126.022.0 7.0164.0 4.0 0.330.010.0
3.010.010.0 9.0 5.0 1.014.0 8.0 4.5 3.5 2.0 1.2 4.0 4.0 3.8 1.0 2.0
WY-824 1.01.02.01.01.02.01.01.02.01.0 2.01.01.01.01.02.02.03.03.02.03.01.0 3.02.02.01.0
1.01.02.01.01.01.03.04.01.0 3.0 4.048.0 5.0 0.8 6.326.014.0 5.014.0 4.0 3.5 0.320.0 5.0 4.015.0
7.0 6.0 5.0 1.010.2 9.0 5.5 2.3 2.0 1.9 4.4 4.5 2.9 1.0 2.0
WY-1055 1.01.02.02.02.02.01.02.03.01.01.0 1.02.01.01.02.02.03.03.02.02.01.03.0 2.03.01.01.0
1.01.01.01.01.03.04.02.0 3.0 3.028.0 5.0 1.3 3.818.014.0 5.012.0 3.0 4.0 0.324.0 6.0 4.012.0 7.0
6.5 3.0 1.0 5.5 4.0 2.5 0.9 0.8 0.6 6.1 5.0 4.2 1.0 2.0
WY-912 1.01.02.01.02.02.02.02.02.01.0 1.02.02.01.01.02.02.03.03.02.02.02.0 3.02.03.01.0
1.01.01.01.01.01.03.04.01.0 3.0 3.047.0 1.5 2.6 4.420.012.0 5.017.0 3.0 5.7 1.024.0 4.0 6.016.0
6.0 5.5 5.0 1.012.0 6.5 4.0 2.1 1.7 1.0 5.7 3.8 4.0 1.0 2.0
WY-163 1.01.01.02.02.02.01.02.02.01.0 1.01.02.01.01.02.02.02.03.02.03.01.0 3.01.02.01.0
1.01.02.01.01.01.03.04.01.0 1.0 3.035.010.0 1.6 6.322.017.0 5.014.0 2.0 7.0 0.320.0 5.0 4.016.0
7.0 6.5 5.0 1.010.0 5.5 3.0 1.8 1.5 1.0 5.6 3.7 3.0 1.0 2.0
WY-3624 1.01.02.02.02.02.02.02.03.01.02.0 2.02.01.01.02.03.03.04.03.02.01.03.0 1.03.01.01.0
1.03.01.01.02.03.04.01.0 2.0 3.047.0 8.0 2.0 4.018.017.0 6.015.0 3.0 5.0 0.320.0 5.0 4.011.0 7.0
6.5 5.0 1.012.0 7.0 4.5 [illegible] 2.4 1.4 4.3 2.9 3.2 1.0 2.0

Analysis 3. *Arnica chamissonis-longifolia-parryi-mollis.*

(2A4,35F3.1,32F4.1)

AB-4868 1.01.02.03.02.02.02.02.02.01.0 [illegible] 1.02.01.01.01.03.02.03.01.03.01.01.0
1.02.02.01.01.03.01.01.02.02.01.02.0 [illegible] 026.013.0 2.3 5.720.015.0 4.010.0 2.0 5.0 0.515.0 3.0
5.012.0 8.0 7.0 5.0 1.013.012.511.5 2 [illegible] .2 5.2 5.4 5.2 1.0 1.0
AB-6689 1.01.02.03.03.02.02.03.03.01 [illegible] 02.01.01.01.03.02.03.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 [illegible] 7.015.3 2.5 6.120.020.0 4.010.0 2.0 5.0 0.518.0 3.0
6.014.0 7.0 6.0 5.0 1.015.013.010.0 2 [illegible] 6.0 5.2 4.0 1.0 1.0
AB-10132 1.01.03.02.02.02.02.02.02.02 [illegible] -91.01.01.03.02.03.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.010.0 7.075.0 -9 -9 -920.020.0 4.012.0 3.0 4.0 0.518.0 4.0
4.515.010.0 9.0 5.0 1.017.014.512.0 3.4 3.5 3.8 5.0 4.1 3.2 1.0 1.0
AK-283 1.01.02.02.02.02.02.01.02.02.0 -9 -9 -91.01.02.02.02.03.01.03.01.01.0
1.02.02.01.01.03.01.01.02.02.01.01.0 3.0 4.057.0 -9 -9 -920.020.0 5.011.0 2.0 5.5 0.520.0 5.0
4.014.010.0 9.0 5.0 2.0 -914.012.0 -9 2.7 2.8 -9 5.2 4.3 1.0 1.0
AK-1650 1.01.02.02.02.02.02.01.02.01.0 2.02.02.01.01.01.01.02.03.01.01.01.01.0
1.02.02.01.01.03.01.01.02.02.01.02.0 4.0 6.054.0 5.0 0.7 7.120.018.0 4.010.0 2.0 5.0 0.518.0 4.0
4.512.0 7.0 6.0 5.0 1.010.512.510.5 2.0 2.0 1.8 5.3 6.3 5.8 1.0 1.0
AK-11939 1.01.02.02.02.02.02.02.02.01.0 2.01.02.01.01.01.02.02.03.01.02.01.03.0
1.02.02.01.01.02.01.01.02.02.01.02.0 3.0 5.060.0 7.5 1.8 4.220.012.0 4.0 9.0 3.0 3.0 0.515.0 5.0
3.012.0 8.0 7.0 5.0 1.012.514.012.5 2.0 2.7 2.7 6.3 5.2 4.6 1.0 1.0
AK-11940 1.01.02.03.02.02.02.02.02.01.0 2.01.02.01.01.01.02.02.03.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 6.044.011.0 1.5 7.315.010.0 4.0 9.0 2.5 3.6 0.515.0 3.0
5.012.0 6.0 5.0 5.0 1.014.512.011.0 3.5 3.0 2.7 4.1 1.0 4.1 1.0 1.0
AZ-7821 1.01.02.02.02.02.02.03.02.01.0 2.01.02.01.01.01.02.02.03.01.02.01.01.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 5.032.0 8.0 2.0 4.018.015.0 5.0 8.0 2.0 4.0 0.515.0 3.0
5.012.0 6.0 5.0 5.0 1.0 7.5 6.0 5.0 1.6 1.2 1.0 4.7 5.0 5.0 1.0 1.0
AZ-s.n.A 1.01.02.02.02.02.01.03.02.01.0 3.01.02.01.01.01.02.02.01.02.01.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 5.0 5.038.515.0 2.0 7.515.012.0 5.0 8.0 2.0 4.0 0.5 8.0 2.0
4.012.0 6.0 5.0 5.0 1.014.5 9.5 5.0 2.0 1.8 1.7 7.3 5.3 2.9 1.0 1.0
AZ-s.n.B 1.01.02.02.02.02.02.03.02.01.0 2.01.02.01.01.01.02.02.01.02.03.01.01.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 4.028.0 8.5 1.7 5.018.012.0 4.0 8.0 1.5 5.3 0.516.0 4.0
4.013.0 8.0 7.0 5.0 1.0 7.0 3.3 1.8 1.3 0.6 0.5 5.4 5.5 3.6 1.0 1.0
BC-7690 1.01.02.03.02.02.01.02.02.01.0 2.01.02.01.01.01.03.02.03.01.03.01.03.0

1.02.02.01.01.03.01.01.02.02.01.02.0 9.0 4.028.010.0 1.5 6.715.012.0 5.0 8.0 2.0 4.0 0.516.0 4.0
4.016.010.0 9.0 5.0 1.010.8 9.0 8.0 1.2 1.3 1.0 9.0 6.9 8.0 1.0 1.0
BC-7756 1.01.02.03.02.02.01.03.02.01.0 2.01.02.01.01.01.03.02.03.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 5.040.0 9.5 1.6 5.915.015.0 3.0 9.0 1.0 9.0 0.518.0 4.0
4.516.0 9.0 8.0 5.0 1.011.011.0 7.7 1.5 1.3 1.0 7.3 8.5 7.7 1.0 1.0
BC-134761.01.03.02.02.02.02.01.02.01.0 2.01.02.01.01.01.02.03.03.01.03.01.03.0
2.02.02.01.01.03.01.01.02.02.01.02.0 6.0 6.044.014.5 2.0 7.324.020.0 5.011.0 3.0 3.6 0.520.0 4.0
5.015.010.0 9.0 5.0 1.014.015.011.5 3.0 3.0 4.0 4.7 5.0 2.9 1.0 1.0
CA-BOLAN1.01.03.04.03.03.02.04.03.02.0 -9 -9 -91.01.01.04.01.04.01.03.01.05.0
2.01.02.01.01.03.01.01.02.02.01.01.0 4.0 5.057.0 -9 -9 -918.015.0[illegible]10.0 3.0 3.3 0.314.0 3.0
4.618.0 9.0 8.0 3.0 1.015.312.0 8.5 1.8 1.6 1.4 8.5 7.5 6.1 1.0 1.0
CA-3311 1.01.01.04.03.02.01.04.03.01.0 2.01.01.01.01.01.02.02.03.02.03.01.01.0
2.03.02.01.01.03.01.01.02.02.01.02.0 2.0 4.025.010.5 1.4 7.516.012.0 3.0 9.0 2.5 3.6 0.312.0 4.0
3.014.0 7.0 6.5 5.0 1.0 8.7 7.5 4.0 1.3 1.1 0.7 6.7 6.8 5.7 1.0 1.0
CA-6195 1.0 -92.03.03.02.01.04.03.01.0 2.01.02.01.01.01.03.03.03.02.02.01.05.0
2.03.02.01.01.03.01.02.02.01.01.02.0 3.0 5.047.511.0 1.8 6.120.018.0 5.0 7.0 2.0 3.5 0.313.0 3.0
4.315.0 7.0 6.5 5.0 1.010.0 6.5 4.0 1.8 1.5 1.0 5.6 4.3 4.0 1.0 3.0
CA-7582 1.01.02.03.03.02.01.03.03.01.0 2.01.01.01.01.02.02.02.03.02.01.01.03.0
1.02.02.01.01.03.01.02.02.02.01.02.0 3.0 4.022.0 4.5 0.9 5.016.013.0 4.010.0 3.0 3.3 0.313.0 3.0
4.312.0 7.0 6.5 5.0 1.0 6.0 6.0 3.5 1.1 1.0 0.9 5.5 6.0 3.9 1.0 1.0
CO-124 1.01.02.01.02.02.01.01.02.02.0 -9 -9 -91.01.01.02.02.03.01.01.01.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 3.0 7.043.5 -9 -9 -910.013.0 3.0 8.0 2.0 4.0 0.512.0 3.0
4.012.0 6.0 5.0 5.0 1.0 7.5 8.5 6.5 1.0 1.3 1.2 7.5 6.5 5.4 1.0 1.0
CO-9154 1.01.02.03.02.02.01.02.02.01.0 2.01.02.01.01.01.03.02.03.01.01.01.03.0
2.02.02.01.01.03.01.01.02.02.01.02.0 8.0 4.024.0 7.0 2.5 2.812.014.0 4.010.0 2.5 4.0 0.514.0 3.0
4.714.0 7.0 6.0 5.0 1.011.0 9.0 6.0 3.3 3.0 2.0 3.3 3.0 3.0 1.0 1.0
CO-229671.01.02.03.03.02.01.04.02.01.0 2.01.02.01.01.01.03.02.01.02.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 4.0 5.033.0 7.0 1.5 4.712.012.0 3.0 8.0 2.0 4.0 0.516.0 2.0
8.012.0 7.0 6.0 5.0 1.0 6.0 8.0 5.5 1.2 2.0 1.8 5.0 4.0 3.1 1.0 1.0
ID-301 1.01.02.03.03.02.01.02.02.01.0 2.01.02.01.01.01.02.02.01.02.02.01.03.0
1.02.02.01.01.02.02.01.02.02.01.02.0 2.0 8.041.011.0 2.0 5.512.012.0 3.0 6.0 1.5 4.0 0.516.0 3.0
5.3 8.0 6.0 5.0 5.0 1.010.0 9.510.0 2.0 2.2 2.5 5.0 4.3 4.0 1.0 1.0
ID-897 1.01.02.01.02.02.02.01.02.01.0 2.01.02.01.01.01.01.02.01.02.03.01.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 5.0 4.043.014.0 2.5 5.620.015.0 3.0 8.0 2.0 4.0 0.512.0 2.0
6.012.0 8.0 7.0 5.0 1.014.011.0 7.0 2.0 1.8 1.4 7.0 6.1 5.0 1.0 1.0
ID-5855 1.01.02.04.01.03.02.03.02.01.0 -9 -9 -91.01.01.02.02.01.02.03.01.01.0
1.02.02.01.01.01.02.01.02.02.01.03.0 3.0 4.052.0 -9 -9 -916.012.0 4.0 9.0 2.0 4.5 0.512.0 3.0
4.012.0 6.0 5.0 5.0 1.011.012.5 5.0 1.8 2.0 0.8 6.1 6.3 6.3 1.0 1.0
MN-3652 1.01.03.03.03.02.01.02.02.01.0 2.01.02.01.01.01.03.02.03.01.03.01.03.0
1.02.02.01.01.03.01.02.02.02.01.02.025.0 5.038.010.0 2.0 5.015.018.0 5.012.0 2.0 6.0 0.520.0
5.0 4.014.0 9.0 8.0 5.0 1.010.510.0 7.5 3.0 2.0 1.6 3.5 5.0 4.7 1.0 1.0
MN-9316 1.01.03.02.02.02.01.02.02.01.0 2.01.02.01.01.01.03.03.03.01.02.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.020.0 5.043.012.0 2.0 6.018.018.0 4.0 9.0 2.0 4.[illegible]0.520.0 4.0
5.014.0 8.0 7.0 5.0 1.012.0 9.0 6.5 2.5 2.5 2.0 4.8 3.6 3.3 1.0 1.0
MN-11337 1.01.02.03.02.02.02.02.02.01.0 2.01.02.01.01.01.03.03.01.01.03.01.03.0
1.02.02.01.01.02.01.01.02.02.01.02.016.0 8.056.011.5 1.5 7.712.010.0 3.012.0 3.0 4.0 0.520.0
4.0 5.016.0 7.0 6.0 5.0 1.016.015.315.3 3.0 2.8 3.0 5.3 5.5 5.1 1.0 1.0
MT-1098 1.01.02.02.02.02.01.01.01.02.0 -9 -9 -91.01.01.02.01.01.01.02.01.02.0
1.01.02.01.01.03.01.0 -92.02.01.02.0 5.010.099.0 -9 -9 -920.015.0 3.0 8.0 2.0 [illegible]0.315.0[illegible]
5.012.0 7.0 6.5 1.010.022.018.016.5 5.0 5.5 6.0 4.4 3.3 2.8 1.0 1.0
MT-1222 1.01.02.02.02.02.01.02.02.02.0 -9 -9 -91.01.01.02.02.03.01.01.01.03.0
3.02.02.01.01.03.01.01.02.02.01.02.0 4.0 8.071.0 -9 -9 -916.018.0 4.0 7.0 1.0 7.0 0.516.0 4.0
4.012.0 8.0 7.0 5.0 1.015.313.013.0 2.0 1.8 2.4 7.7 7.2 5.4 1.0 1.0
MT-153541.01.03.02.02.02.01.02.02.01.0 2.01.02.01.01.01.02.02.01.02.03.01.03.0
2.02.02.01.01.03.01.01.02.02.01.02.0 5.0 6.048.015.0 3.5 4.316.015.0 3.0 9.0 3.0 3.0[illegible]
3.212.0 6.0 5.0 5.0 1.014.515.013.0 3.5 3.3 3.0 4.1 4.6 4.3 1.0 1.0

NM-781021.01.02.02.02.02.02.03.02.01.0 2.01.02.01.01.01.02.02.03.01.03.01.01.0
2.02.02.01.01.02.01.01.02.02.01.02.0 3.0 3.020.0 9.0 2.0 4.516.013.0 4.0 9.0 2.0 4.5 0.514.0 3.0
4.712.0 7.0 6.0 5.0 1.0 7.0 5.5 3.3 1.0 0.7 0.5 7.0 7.9 6.0 1.0 1.0
NV-713 1.01.02.03.03.02.01.03.03.01.0 2.01.02.01.01.02.02.02.01.01.03.01.03.0
1.02.02.01.01.02.01.01.02.02.01.02.0 5.0 5.049.012.0 2.4 5.012.015.0 3.0 9.0 2.0 4.5 0.510.0 3.0
3.312.012.011.0 5.0 1.011.511.0 9.0 2.2 2.0 1.8 5.2 5.5 5.0 1.0 1.0
NV-3100 1.01.02.01.01.02.01.02.02.01.0 2.01.02.01.01.02.01.02.03.02.01.01.01.0
2.02.02.01.01.03.01.01.02.02.02.02.0 9.0 3.059.012.0 2.5 4.615.017.0 5.010.0 3.5 2.9 0.520.0 6.0
4.012.0 8.0 7.0 5.0 1.015.010.0 6.3 4.0 3.0 2.3 3.8 3.3 2.7 1.0 1.0
NV-9670 1.01.02.04.03.02.01.04.03.02.0 -9 -9 -91.01.01.04.02.03.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 4.039.0 -9 -9 -915.010.0 4.010.0 2.0 5.0 0.512.0 3.0
4.017.013.012.0 5.0 1.010.0 9.0 6.0 2.0 2.0 1.0 5.0 4.5 6.0 1.0 3.0
NWT-81 1.01.02.02.02.02.01.01.02.02.0 -9 -9 -91.01.01.02.02.03.01.03.01.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 2.0 5.040.0 -9 -9 -916.015.0 4.010.0 2.0 5.0 0.516.0 4.0
4.012.0 7.0 6.0 5.0 2.0 -910.0 9.2 -9 1.8 1.8 -9 5.6 5.1 1.0 1.0
NWT117951.01.02.02.02.02.02.02.02.01.0 2.01.02.01.01.01.02.02.01.02.02.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 5.031.0 4.5 1.2 3.818.013.0 4.011.0 2.0 5.5 0.525.0 5.0
5.015.0 9.0 8.0 5.0 1.0 9.5 9.5 8.7 1.2 1.4 2.0 7.9 6.8 4.4 1.0 1.0
NWT117991.01.02.03.02.01.01.04.03.01.0 2.01.02.01.01.01.03.03.04.01.03.01.04.0
2.03.02.01.01.03.01.01.02.02.01.02.0 3.0 5.032.0 7.0 1.0 7.020.017.0 4.012.0 3.5 3.4 0.520.0 5.0
4.012.0 9.0 8.0 5.0 1.010.0 9.5 6.5 1.7 1.2 1.0 5.9 7.9 6.5 1.0 1.0
ON-1077 1.01.01.03.02.02.01.02.02.01.0 2.01.01.01.01.01.02.02.01.02.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 1.0 5.031.0 8.0 1.0 8.015.018.0 4.0 9.0 2.0 4.5 0.516.0 4.0
4.018.0 8.0 7.0 5.0 1.010.0 8.5 7.0 2.0 1.4 1.2 5.0 6.1 5.8 2.0 1.0
ON-8060 1.01.02.03.02.02.01.02.02.01.0 2.01.02.01.01.01.03.02.03.01.03.01.03.0
2.02.02.01.01.03.01.01.02.02.01.02.0 5.0 4.040.0 8.5 1.6 5.316.012.0 4.010.0 3.0 3.3 0.512.0 3.0
4.020.0 7.0 6.0 5.0 1.0 8.510.0 8.0 1.6 2.0 2.0 5.3 5.0 4.0 2.0 1.0
ON-625311.01.02.02.02.02.01.01.02.01.0 2.01.01.01.01.01.02.02.01.02.03.01.04.0
1.02.02.01.01.03.01.01.02.02.01.02.0 1.0 8.057.510.0 0.714.320.020.0 5.012.0 2.0 6.0 0.523.0
3.0 7.720.0 8.0 7.0 5.0 1.012.014.012.0 1.5 2.0 2.0 8.0 7.0 6.0 2.0 1.0
OR-NUTT 1.01.02.02.03.02.02.02.03.01.0 2.01.01.01.01.01.03.03.04.02.02.01.01.0
1.02.02.01.01.03.01.02.02.02.01.02.0 4.0 5.025.0 8.0 1.9 4.214.016.0 4.0 8.0 2.0 4.0 0.312.0 3.0
4.012.0 8.0 7.0 5.0 1.0 9.3 9.0 7.5 2.0 1.8 1.5 4.7 5.0 5.0 1.0 1.0
OR-TNUTT1.01.02.02.02.02.01.02.02.02.0 -9 -9 -91.01.02.02.03.01.02.02.01.01.0
1.01.02.01.01.03.01.01.02.02.01.02.0 4.0 4.033.0 -9 -9 -916.015.0 4.0 6.0 2.0 3.0 0.313.0 3.0
4.312.0 6.0 5.5 3.0 1.0 9.5 7.0 5.0 0.8 0.5 0.6 11.914.0 8.3 1.0 1.0
OR-NUTTA1.01.03.03.03.02.02.03.03.01.0 1.01.01.01.01.02.02.03.03.02.01.01.01.0
1.02.02.01.01.03.01.02.02.02.01.02.0 4.0 3.019.5 8.2 1.7 4.815.015.0 4.0 9.0 2.0 4.5 0.312.0 2.0
6.010.0 7.0 6.0 3.0 1.0 7.5 5.5 2.0 1.5 1.4 0.8 5.0 3.9 2.5 1.0 1.0
OR-2389 1.01.02.04.04.02.02.04.03.02.0 -9 -9 -91.01.01.04.03.01.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.01.0 3.0 4.057.0 -9 -9 -920.015.0 4.010.0 2.0 5.0 0.515.0 3.0
5.014.0 6.0 5.0 5.0 1.012.510.5 7.5 2.0 3.0 2.4 6.3 3.5 3.1 1.0 1.0
QE-331581.01.02.03.02.02.01.02.02.01.0 2.01.02.01.01.01.03.02.03.02.03.01.03.0
2.02.02.01.01.03.01.01.02.02.01.02.0 3.0 5.030.0 6.5 1.4 4.618.015.0 4.010.0 2.0 5.0 0.316.0 3.0
5.324.0 9.0 8.0 5.0 1.010.5 9.5 8.5 2.0 2.4 1.5 5.3 4.0 5.7 2.0 3.0
SK-1246 1.01.03.02.02.02.01.02.02.01.0 2.01.02.01.01.01.02.02.04.02.01.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 5.0 6.049.010.5 3.0 3.518.018.0 5.0 9.0 2.0 4.5 0.316.0 4.0
4.014.010.0 9.0 5.0 1.013.013.011.0 2.3 3.6 2.0 5.7 3.6 5.5 1.0 1.0
SK-222451.01.03.02.02.02.01.02.02.02.0 -9 -9 -91.01.01.03.02.03.02.01.01.04.0
1.02.02.01.01.03.01.01.02.02.01.02.013.0 5.031.0 -9 -9 -914.012.0 3.0 7.0 1.5 4.7 0.314.0 4.0
3.516.0 6.0 5.0 5.0 1.0 8.0 8.5 8.0 0.8 1.8 1.6 10.0 4.7 5.0 1.0 1.0
SK-266121.01.02.02.02.02.02.02.02.01.0 2.01.02.01.01.01.02.02.04.01.03.01.03.0
1.02.02.01.01.02.01.01.02.02.01.02.0 6.0 7.072.012.0 2.0 6.018.018.0 3.010.0 2.0 5.0 0.320.0 4.0
5.014.0 7.0 6.0 5.0 1.021.014.514.0 4.0 4.0 4.2 5.3 3.6 3.3 1.0 1.0
UT-114421.01.01.03.02.02.02.02.02.02.0 -9 -9 -91.01.01.01.02.01.01.01.01.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 1.0 4.034.0 -9 -9 -914.012.0 3.0 8.0 2.0 4.0 0.315.0 3.0

5.010.0 6.0 5.0 5.0 1.011.0 8.5 5.0 2.3 2.0 1.5 4.8 4.3 3.3 1.0 1.0
UT-123391.01.02.01.02.02.01.01.02.01.0 2.01.02.01.01.01.02.02.01.02.03.01.03.0
1.01.02.01.01.03.01.01.02.02.01.02.0 5.0 5.073.012.0 3.0 4.016.015.0 4.0 9.0 2.0 4.5 0.320.0 5.0
4.010.0 7.0 6.0 5.0 1.014.014.512.8 3.5 3.5 3.5 4.0 4.1 3.7 1.0 1.0
UT-189611.01.02.04.02.01.01.03.02.01.0 2.01.02.01.01.01.03.02.04.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.03.0 3.0 4.021.0 6.5 1.5 4.314.015.0 4.0 8.0 2.0 4.0 0.314.0 4.0
3.512.0 7.0 6.0 5.0 1.0 7.2 5.5 3.5 1.6 0.7 0.6 4.5 7.9 5.8 1.0 1.0
WA-1498 1.01.02.03.02.02.01.03.02.01.0 2.01.02.01.01.01.03.02.01.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 6.0 5.037.010.5 2.2 4.814.012.0 5.0 8.0 1.0 8.0 0.314.0 2.0
7.012.0 6.0 5.0 5.0 1.011.510.0 6.5 1.5 2.0 1.8 7.7 5.0 3.6 1.0 1.0
WA-6283 1.01.02.03.02.02.01.02.02.02.0 -9 -9 -91.01.01.02.02.03.02.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 8.0 9.055.0 -9 -9 -918.012.0 4.011.0 1.5 7.3 0.312.0 2.0
6.017.0 6.0 5.0 5.0 1.012.014.016.0 2.0 2.2 2.5 6.0 6.4 6.4 1.0 2.0
WA-101421.01.02.04.03.02.03.04.03.01.0 2.01.03.01.01.01.04.03.03.02.01.01.05.0
1.02.02.01.01.03.02.01.02.02.01.02.013.0 7.026.013.0 3.5 3.716.012.0 4.0 7.0 2.0 3.5 0.314.0 3.0
4.714.0 6.0 5.0 5.0 1.012.513.012.0 4.0 5.0 5.5 3.1 2.6 2.2 1.0 1.0
WY-766 1.01.02.01.02.02.01.01.02.01.0 1.01.02.01.01.02.02.02.01.01.03.02.01.0
1.01.02.01.01.01.01.01.02.02.01.02.0 5.0 6.038.0 9.0 1.5 6.015.012.0 4.0 7.0 1.5 4.7 0.312.0 3.0
4.014.0 6.0 5.5 3.0 1.010.510.0 9.0 2.4 2.0 2.0 4.4 5.0 4.5 1.0 1.0
WY-1417 1.01.02.03.03.01.01.03.03.01.0 2.01.01.01.01.01.03.02.03.01.02.01.02.0
1.02.02.01.01.02.01.02.02.02.01.02.0 4.0 5.028.0 8.0 1.0 8.015.017.0 5.012.0 2.5 4.8 0.315.0 4.0
3.812.0 9.0 8.5 3.0 1.0 8.5 8.0 5.5 1.0 1.8 1.5 8.5 4.4 3.7 1.0 1.0
WY-1850 1.01.02.03.03.01.01.03.03.01.0 2.01.01.01.01.01.04.02.04.01.02.02.03.0
1.02.02.01.01.03.01.02.02.02.01.02.0 5.0 5.028.0 7.5 1.2 6.312.014.0 4.0 8.0 2.0 4.0 0.314.0 4.0
3.510.0 8.0 7.5 3.0 1.0 7.5 6.0 5.2 1.0 1.0 0.8 7.5 6.0 6.5 1.0 1.0
WY-3587 1.01.02.03.02.02.01.02.02.01.0 2.01.01.01.01.02.02.02.04.02.02.02.02.0
2.01.02.01.02.02.01.01.02.02.01.02.0 6.0 4.028.010.0 2.0 5.015.015.0 5.011.0 2.0 5.5 1.517.0 4.0
4.316.0 8.0 7.5 5.0 1.011.010.5 7.5 3.2 2.8 2.3 3.4 3.8 3.3 1.0 3.0
WY-5224 1.01.02.02.02.02.01.01.02.01.0 2.01.01.01.01.02.02.02.03.02.02.02.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 3.0 7.029.0 8.0 1.0 8.014.015.0 4.0 7.0 1.5 4.7 1.016.0 4.0
4.010.0 5.0 4.5 5.0 1.0 9.0 9.0 7.5 1.0 1.4 1.4 9.0 6.4 5.4 1.0 3.0
WY-7643 1.01.02.01.01.02.01.02.02.01.0 2.01.01.01.01.02.02.02.03.02.02.01.01.0
1.01.02.01.01.03.01.01.02.02.01.01.0 5.0 8.060.0 7.0 1.5 4.715.015.0 5.0 7.0 1.5 4.7 0.315.0 3.0
5.012.0 8.0 7.0 3.0 1.0 9.010.0 8.0 1.5 1.5 1.0 6.0 6.7 8.0 1.0 1.0
WY-6940 1.01.03.03.02.02.01.02.02.01.0 1.01.02.01.01.01.03.02.01.01.03.01.02.0
2.01.02.01.01.02.01.01.02.02.01.03.0 8.0 3.016.0 6.0 1.5 4.015.013.0 4.0 9.0 2.0 4.5 0.312.0 3.0
4.012.0 7.0 6.5 3.0 1.0 7.5 6.5 5.0 2.8 2.4 1.5 2.7 2.7 3.3 1.0 1.0
WY-8012 1.01.02.03.03.02.01.03.03.01.0 2.01.02.01.01.02.03.03.03.02.02.02.02.0
1.02.02.01.01.03.01.02.02.02.01.02.0 7.0 5.036.010.0 2.5 4.012.013.0 4.010.0 2.0 5.0 0.310.0 3.0
3.310.0 7.0 6.8 5.0 1.010.5 8.5 8.0 2.5 2.0 2.5 4.2 4.3 3.2 1.0 1.0
WY-113151.01.02.03.02.02.01.02.02.02.0 -9 -9 -91.01.01.03.02.01.01.03.01.04.0
1.02.02.01.01.02.01.01.02.02.01.02.0 5.0 4.037.0 -9 -9 -916.012.0 3.011.0 2.0 5.5 0.312.0 3.0
4.012.0 6.0 5.0 5.0 1.012.511.0 7.0 1.5 1.7 1.0 8.3 6.5 7.0 1.0 1.0
WY-113811.01.01.02.03.02.01.01.02.01.0 2.01.02.01.01.01.01.02.03.01.03.01.01.0
1.02.02.01.01.03.01.01.02.02.01.02.0 1.0 4.030.0 6.0 1.5 4.020.015.0 4.0 9.0 2.0 4.5 0.316.0 4.0
4.015.0 8.0 7.0 5.0 1.010.0 8.5 4.5 1.8 1.5 1.0 5.6 5.7 4.5 1.0 1.0
WY-114031.01.02.01.02.02.01.01.02.02.0 -9 -9 -91.01.01.01.02.01.02.01.01.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 4.0 5.041.0 -9 -9 -912.012.0 4.0 8.0 2.0 4.0 0.316.0 3.0
5.310.0 5.0 4.0 5.0 1.010.510.0 7.0 1.5 1.3 1.0 7.0 7.7 7.0 1.0 1.0
YT-117741.01.03.03.02.02.02.03.02.01.0 2.01.02.01.01.01.03.03.01.01.02.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.014.0 7.066.015.0 2.3 6.518.015.0 5.013.0 3.0 4.3 0.514.0
3.0 4.712.0 7.0 6.0 5.0 1.014.015.511.2 3.0 3.2 3.3 4.7 4.8 3.4 1.0 1.0
YT-118221.01.02.04.02.02.01.04.03.01.0 2.01.02.01.01.01.03.03.04.01.03.01.04.0
2.02.02.01.01.03.01.01.02.02.01.02.0 5.0 6.030.0 5.1 0.6 8.514.012.0 3.010.0 2.0 5.0 0.520.0 3.0
6.712.0 7.0 6.0 5.0 1.0 7.0 9.2 8.0 1.2 1.0 1.0 5.8 9.2 8.0 1.0 1.0
YT-119531.01.02.03.02.02.01.03.02.01.0 2.01.02.01.01.01.03.02.01.01.03.01.03.0

1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 5.042.0 7.0 0.8 8.814.012.0 3.0 9.0 2.0 4.5 0.318.0 3.0
6.017.0 7.0 6.0 5.0 1.010.5 9.0 7.0 1.8 1.9 1.5 5.8 4.7 4.7 1.0 1.0
YT-119641.01.03.01.02.02.02.01.02.01.0 2.01.02.01.01.01.02.02.03.02.01.02.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 9.0 4.051.0 9.5 1.6 5.9 2.5 1.8 5.012.0 3.0 4.0 0.518.0 4.0
4.516.010.0 1.0 5.0 1.014.013.0 9.5 3.3 3.0 2.8 4.2 4.3 3.4 1.0 1.0
YT-119711.01.03.04.02.02.01.03.02.01.0 2.02.03.01.01.01.04.02.01.03.03.01.05.0
1.03.02.01.01.03.01.01.02.02.01.02.0 6.0 5.019.013.0 5.2 2.520.014.0 3.011.0 2.0 5.5 0.520.0 4.0
5.016.0 8.0 7.0 5.0 1.0 8.513.512.5 3.0 5.2 3.5 2.8 2.6 3.6 1.0 1.0
CA73167 2.01.02.01.03.02.02.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.01.01.03.0
1.03.01.01.01.02.02.01.02.03.02.02.0 3.0 6.047.0 -9 -9 -917.017.0 5.0 9.0 2.0 4.5 0.311.0 3.0
3.715.0 8.0 7.0 5.0 1.0 8.013.511.5 1.1 1.5 1.7 7.3 9.0 6.8 1.0 2.0
CA20014 2.01.02.01.03.02.02.01.03.02.0 -9 -9 -91.01.02.02.03.01.02.03.01.03.0
1.03.01.01.01.02.02.01.03.02.02.02.0 3.0 5.042.0 -9 -9 -912.012.0 4.010.0 2.0 5.0 1.013.0 3.0
4.312.0 7.0 6.0 3.0 1.0 5.512.512.0 1.4 1.6 1.4 3.9 7.8 8.6 1.0 2.0
CA-3574 2.01.02.01.03.02.02.01.03.01.0 1.01.01.01.01.02.01.03.01.02.03.01.03.0
1.03.01.01.01.02.02.01.02.02.02.01.0 6.0 4.036.0 3.2 0.5 6.416.013.0 4.012.0 3.0 4.0 0.314.0 3.0
4.710.0 8.0 7.0 0.0 1.0 8.0 6.5 7.5 1.2 0.9 1.3 6.7 7.2 5.8 1.0 2.0
CO-1914 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.03.03.03.01.01.0
1.03.01.01.01.02.02.01.03.02.02.02.0 7.0 7.047.0 -9 -9 -916.018.0 5.0 8.0 1.5 5.3 0.318.0 3.0
6.010.0 8.0 7.0 5.0 1.0 -9 5.0 9.5 -9 0.6 1.5 -9 8.3 6.3 1.0 2.0
CO-726 2.01.03.01.02.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.02.02.02.0 6.0 6.067.5 -9 -9 -910.015.011.0 9.0 2.0 4.5 0.313.0 3.0
4.310.0 8.0 7.0 3.0 1.0 -910.213.5 -9 1.3 1.7 -9 7.8 7.9 1.0 2.0
ID-461 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.02.02.02.0 6.0 7.045.0 -9 -9 -912.017.0 5.0 8.0 1.5 5.3 0.314.0 4.0
3.510.0 7.0 6.0 3.0 1.0 8.0 9.010.0 1.0 0.8 1.4 8.011.3 7.1 1.0 2.0
ID-431 2.01.03.01.03.02.01.01.03.01.0 2.01.05.01.01.02.01.03.01.03.03.01.03.0
1.03.01.01.01.02.02.02.02.03.03.01.0 5.0 5.040.011.0 1.7 6.514.013.0 4.011.0 2.0 5.5 0.315.0 3.0
5.010.0 7.0 6.5 3.0 1.0 9.010.0 7.0 1.0 1.3 1.0 9.0 7.7 7.0 1.0 2.0
ID-341 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.02.03.01.02.0 5.0 6.042.5 -9 -9 -914.010.0 5.014.0 1.014.0 0.314.0 3.0
4.710.0 7.0 6.0 3.0 1.0 -9 5.5 8.5 -9 1.0 1.0 -9 5.5 8.5 1.0 2.0
IDTNF9372.02.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.02.01.02.01.03.02.02.02.0 4.0 5.041.0 -9 -9 -916.017.0 5.010.0 2.0 5.0 1.017.0 4.0
4.310.0 8.0 7.5 3.0 1.0 5.0 7.0 7.4 1.3 1.2 1.8 3.8 5.8 4.1 1.0 2.0
ID10113 2.0 -93.02.03.02.02.02.03.01.0 2.01.05.01.01.02.02.03.04.03.02.01.03.0
1.03.01.01.01.03.02.02.02.03.03.02.0 3.0 5.048.0 8.0 1.5 5.318.015.0 5.012.0 2.0 6.0 0.320.0
4.012.0 9.0 8.0 5.0 1.012.011.510.0 2.0 1.7 2.0 6.0 6.8 5.0 1.0 2.0
ID20216 2.01.02.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.02.03.01.03.03.01.01.0
1.03.01.01.01.02.02.02.02.02.01.02.0 7.0 6.046.0 -9 -9 -9 7.010.0 3.0 9.0 2.0 4.5 0.318.0 2.0
9.010.0 7.0 6.5 3.0 1.0 -910.012.5 -9 1.3 1.0 -9 7.712.5 1.0 2.0
IDRBJ1752.01.03.01.02.02.01.02.03.02.0 -9 -9 -91.01.02.01.03.03.03.03.01.03.0
1.03.01.01.01.02.02.02.02.03.02.02.0 3.0 5.066.0 -9 -9 -918.015.0 5.013.0 2.0 6.5 0.315.0 4.0
3.810.0 7.0 6.0 3.0 1.021.513.5 9.5 2.7 2.6 2.5 8.0 5.2 3.8 1.0 2.0
ID-2285 2.01.03.01.03.03.01.01.03.01.0 1.01.02.01.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.03.02.02.018.0 6.040.0 2.0 0.8 2.512.015.0 5.0 8.0 2.0 4.0 0.315.0 5.0
3.010.0 8.0 7.0 5.0 1.0 6.511.511.0 1.5 1.5 1.0 4.3 7.711.0 1.0 2.0
ID-699 2.01.02.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.02.02.03.01.02.0 3.0 6.065.0 -9 -9 -912.018.0 4.010.0 2.0 5.0 0.318.0 5.0
3.612.0 9.0 8.0 5.0 1.0 -911.011.4 -9 2.0 1.8 -9 5.5 6.3 1.0 2.0
MT13360 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.02.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.03.01.02.0 7.0 6.038.0 -9 -9 -910.012.0 4.0 8.0 1.5 5.3 0.314.0 4.0
3.5 8.0 7.0 6.5 3.0 1.0 -911.0 8.5 -9 2.1 1.8 -9 5.2 4.7 1.0 2.0
MT-338 2.01.03.01.03.02.02.01.03.01.0 1.01.02.01.01.02.02.03.03.03.02.01.03.0
1.03.01.01.01.03.02.01.02.03.03.02.010.0 6.068.0 8.0 2.0 4.020.020.0 6.011.0 2.0 5.5 0.520.0 5.0
4.010.011.010.0 3.0 1.0 1.013.511.514.0 1.8 2.2 2.6 7.5 5.2 5.4 1.0 2.0

MT-3346 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.02.01.02.0 7.0 6.038.0 -9 -9 -912.014.0 4.0 7.0 2.0 . .5 0.311.0 2.0
5.510.0 7.0 6.5 3.0 1.0 4.0 8.0 9.5 0.8 1.2 1.2 5.0 6.7 7.9 1.0 2.0
MT-17 2.01.02.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.02.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 4.0 5.034.5 -9 -9 -912.016.0 6.010.0 1.010.0 0.315.0 4.0
3.810.0 9.0 8.0 3.0 1.0 8.5 9.0 8.5 2.0 1.9 1.7 4.3 4.7 5.0 1.0 2.0
NV-335 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.02.02.03.01.02.0 4.0 4.034.0 -9 -9 -914.015.0 5.0 9.0 2.0 4.5 0.315.0 4.0
3.812.0 7.0 6.5 3.0 1.0 8.010.5 8.0 1.3 1.7 2.3 6.2 6.2 3.5 1.0 2.0
OR-154 2.01.02.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.02.02.03.01.02.0 5.0 6.047.0 -9 -9 -912.016.0 5.0 9.0 2.0 4.5 0.317.0 4.0
4.312.0 9.0 8.5 3.0 1.010.012.511.5 1.9 1.5 1.3 5.3 8.3 8.8 1.0 2.0
OR-9827 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.02.02.03.01.02.0 9.0 6.048.0 -9 -9 -910.014.0 4.0 9.0 2.0 4.5 0.315.0 2.0
7.510.0 7.0 6.5 3.0 1.010.014.010.7 1.5 1.8 1.4 6.7 7.8 7.6 1.0 2.0
UT-1547 2.01.02.03.03.02.01.02.03.01.0 2.01.01.01.01.02.03.03.01.03.03.02.03.0
1.03.01.01.02.02.01.01.03.02.02.02.0 3.0 3.025.0 6.5 0.321.710.015.0 5.010.0 1.5 6.7 2.014.0 2.0
7.010.0 5.0 4.5 0.0 1.0 8.5 6.0 2.5 0.6 0.7 0.6 14.2 8.6 4.2 1.0 2.0
UT14209 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.03.01.01.010.0 5.035.0 -9 -9 -912.015.0 5.0 7.0 1.0 7.0 0.315.0 3.0
5.010.0 7.5 7.0 5.0 1.0 4.0 7.0 7.0 1.2 1.4 1.1 3.3 5.0 6.4 1.0 2.0
UT-4103 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.02.03.02.02.0 3.0 5.038.0 -9 -9 -920.020.0 5.010.0 1.5 6.7 0.315.0 4.0
3.812.0 9.0 8.5 5.0 1.0 8.511.0 9.0 1.5 1.4 1.6 5.7 7.9 5.6 1.0 2.0
UT-5900 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.02.01.01.0
1.03.01.01.01.02.02.01.03.03.01.02.0 4.0 6.050.0 -9 -9 -914.022.0 7.012.0 1.012.0 1.020.0 4.0
5.010.011.010.0 5.0 1.0 5.010.510.5 1.0 1.4 1.3 5.0 7.5 8.0 1.0 2.0
UT-C67 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.04.03.03.01.01.0
1.03.01.01.01.02.02.01.02.03.01.02.0 2.0 5.062.0 -9 -9 -920.016.0 5.014.0 2.0 7.0 0.320.0 4.0
5.012.0 9.0 8.5 5.0 1.012.010.016.5 2.2 1.8 2.2 5.5 5.6 7.5 1.0 2.0
WA-2736 2.01.02.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.02.01.01.0
1.03.01.01.01.02.02.01.03.03.01.02.0 3.0 6.030.0 -9 -9 -912.015.0 4.010.0 2.0 5.0 0.314.0 3.0
4.710.0 6.0 5.5 3.0 1.0 4.5 7.8 8.5 1.6 1.8 1.3 2.8 4.3 6.5 1.0 2.0
WA-2546 2.01.03.01.03.02.02.01.03.02.0 -9 -9 -91.01.02.02.03.04.03.03.01.01.0
1.03.01.01.01.03.02.01.02.03.01.02.0 4.0 5.048.5 -9 -9 -916.014.0 4.015.0 2.0 7.5 0.317.0 5.0
3.412.0 8.0 7.5 3.0 1.0 9.0 9.0 8.7 1.3 1.4 1.3 6.9 6.4 6.7 1.0 2.0
WY-4588 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.02.01.01.0
1.03.01.01.01.03.02.01.03.03.02.01.0 7.0 6.057.0 -9 -9 -916.014.0 5.011.0 1.5 7.3 0.3 7.0 1.5
4.712.0 7.0 6.5 3.0 1.0 -9 6.5 8.5 -9 1.3 1.6 -9 5.0 5.3 1.0 2.0
WY-K36 2.01.03.01.03.03.02.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 5.0 6.043.5 -9 -9 -916.018.0 5.010.0 2.0 5.0 0.318.0 3.0
6.010.0 9.0 9.0 3.0 1.0 -9 9.010.0 -9 2.0 2.4 -9 4.5 4.2 1.0 2.0
WY-574 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.01.02.01.03.02.01.02.0 4.0 6.055.0 -9 -9 -916.018.0 5.012.0 2.0 6.0 0.315.0 3.0
5.010.0 8.0 7.5 3.0 1.0 9.5 9.0 8.5 0.9 1.0 0.8 10.6 9.010.6 1.0 2.0
WY-991 2.01.02.01.02.02.01.01.03.01.0 1.01.02.01.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.01.02.01.02.03.01.02.0 3.0 4.038.0 3.5 0.8 4.414.014.0 4.010.0 1.5 6.7 0.315.0 4.0
3.813.0 7.0 6.5 3.0 1.0 7.0 7.8 7.0 1.4 1.8 1.5 5.0 4.3 4.7 1.0 2.0
WY-591 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.03.01.02.012.0 5.040.0 -9 -9 -912.010.0 4.011.0 1.5 7.3 1.015.0 3.0
5.0 8.0 6.0 5.0 3.0 1.010.213.514.0 1.5 1.5 2.0 6.8 9.0 7.0 1.0 2.0
WY-4596 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 6.0 5.044.0 -9 -9 -916.016.0 5.0 7.0 1.0 7.0 0.318.0 4.0
4.510.0 9.0 8.5 3.0 1.0 -9 7.510.0 -9 1.6 1.6 -9 4.7 6.3 1.0 2.0
WY-1013 2.01.02.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.02.03.02.02.0 2.0 4.033.0 -9 -9 -918.020.0 5.011.0 2.0 5.5 0.315.0 5.0

3.012.010.0 9.0 3.0 1.0 7.0 9.0 8.5 1.4 1.8 1.4 5.0 5.0 6.1 1.0 2.0
WY-302 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.02.03.01.03.02.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 5.0 7.042.0 -9 -9 -910.013.0 4.0 8.0 1.0 8.0 0.314.0 3.0
4.6 4.8 6.0 5.5 3.0 1.0 5.0 7.0 8.0 1.3 1.8 1.9 3.8 3.9 4.2 1.0 2.0
WY-8499 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.02.01.01.0
1.03.01.01.01.02.02.01.03.03.01.02.0 5.0 5.041.0 -9 -9 -916.016.0 4.010.0 2.0 5.0 0.318.0 3.0
6.013.0 9.0 8.5 3.0 1.0 -910.011.0 -9 1.5 1.9 -9 6.7 5.8 1.0 2.0
WY-390 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.02.01.01.0
1.03.01.01.01.02.02.01.02.03.01.02.0 5.0 6.063.0 -9 -9 -918.020.0 6.012.0 2.0 6.0 0.522.0 5.0
4.414.0 9.0 8.5 5.0 1.0 -911.014.5 -9 2.2 3.0 -9 5.0 4.8 1.0 2.0
WY-5925 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 4.0 4.033.0 -9 -9 -914.014.0 4.0 9.0 2.0 4.5 0.317.0 4.0
4.312.0 9.0 8.5 3.0 1.0 -9 6.0 7.7 -9 1.4 1.9 -9 4.3 4.1 1.0 2.0
WY-6422 2.01.03.01.03.03.01.01.02.02.0 -9 -9 -91.01.02.01.03.01.02.02.02.01.0
1.02.01.01.02.01.02.01.03.02.02.02.030.0 7.056.0 -9 -9 -912.016.0 4.0 8.0 1.5 5.0 1.513.0 3.0
4.310.0 6.0 5.5 0.0 1.0 8.712.0 8.0 1.2 2.0 1.7 7.3 6.0 4.7 1.0 2.0
WY-C142 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 7.0 5.032.0 -9 -9 -912.015.0 5.0 7.0 1.0 7.0 0.315.0 3.0
5.010.0 8.0 7.5 3.0 1.0 5.5 7.0 7.5 1.2 1.3 1.2 4.6 5.4 6.3 1.0 2.0
WY-4638 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.01.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 9.0 5.030.0 -9 -9 -916.016.0 6.0 8.0 2.0 4.0 0.313.0 4.0
3.310.0 8.0 7.5 3.0 1.0 5.0 6.7 6.0 0.6 0.7 1.0 8.3 9.6 6.0 1.0 2.0
WY-4671 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.03.02.01.02.0 5.0 5.059.0 -9 -9 -915.013.0 6.0 7.0 1.5 4.7 0.313.0 2.0
6.511.0 8.0 7.0 3.0 1.0 -9 8.010.5 -9 1.6 1.7 -9 5.0 6.2 1.0 2.0
WY-6535 2.01.02.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 4.0 6.046.0 -9 -9 -916.016.0 5.012.0 2.0 6.0 0.315.0 3.0
5.0 8.0 9.0 8.5 3.0 1.0 -9 7.5 9.8 -9 0.8 1.8 -9 9.4 5.4 1.0 2.0
WY-4343 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 5.0 4.030.0 -9 -9 -914.018.0 5.0 7.0 1.5 4.7 0.314.0 2.0
7.0 8.0 9.0 8.5 3.0 1.0 5.0 7.0 7.0 1.0 1.2 1.2 5.0 5.8 5.8 1.0 2.0
WY-1022 2.01.03.01.03.02.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.01.02.01.03.03.02.02.0 6.0 5.033.0 -9 -9 -912.010.0 5.0 8.0 2.0 4.0 0.311.0 2.0
5.5 7.0 7.0 6.0 3.0 1.0 3.5 5.5 7.0 1.0 1.4 1.4 3.5 3.9 5.0 1.0 2.0
WY-5216 2.01.02.01.03.02.02.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.02.03.01.02.0 3.0 6.055.0 -9 -9 -915.015.0 5.010.0 1.5 6.7 0.315.0 4.0
3.810.0 7.0 6.5 5.0 1.0 -911.515.0 -9 2.0 2.0 -9 5.8 7.5 1.0 2.0
WY-374 2.01.03.01.03.03.01.01.03.02.0 -9 -9 -91.01.02.01.03.01.03.03.01.01.0
1.03.01.01.01.01.02.01.03.02.01.02.0 8.0 6.028.0 -9 -9 -910.018.0 5.0 9.0 1.5 6.0 0.314.0 3.0
4.7 8.010.0 9.0 3.0 1.0 5.0 8.0 8.0 0.7 1.0 1.0 7.1 8.0 8.0 1.0 2.0
CA-629401.01.03.04.03.01.01.04.03.01.0 2.01.02.02.01.02.02.03.04.03.01.02.04.0
1.03.01.01.01.03.01.01.03.02.01.02.0 9.0 3.059.510.0 1.3 7.712.015.0 6.015.0 2.0 7.5 0.314.0 2.0
7.010.010.0 9.0 5.0 1.0 9.0 4.5 2.8 1.4 1.0 0.6 6.4 4.5 4.7 1.0 2.0
CA1973111.01.02.03.02.01.01.03.02.01.0 4.01.02.02.01.02.02.03.03.01.02.02.03.0
1.03.01.01.01.03.01.01.03.02.01.02.0 5.0 4.063.519.0 2.7 7.016.017.0 6.013.0 2.0 6.5 0.316.0 4.0
4.010.0 8.0 6.0 5.0 1.011.0 5.5 3.5 1.6 1.3 1.0 6.9 4.2 3.5 1.0 2.0
CO-3814 1.01.02.02.02.01.02.03.03.01.0 2.01.02.02.01.02.03.03.04.02.01.02.04.0
1.03.01.01.01.03.01.02.03.02.02.02.0 3.0 2.039.0 8.0 2.5 3.217.019.0 6.014.0 2.0 7.0 0.312.0 4.0
3.0 6.0 7.0 6.5 1.0 7.0 6.5 3.5 -9 1.5 0.7 -9 4.3 5.0 -9 1.0 2.0
CO-5819 1.01.02.02.03.01.01.02.03.01.0 2.01.02.02.01.02.02.03.04.01.01.02.03.0
1.03.01.01.01.03.01.02.03.02.01.02.0 1.0 2.027.010.5 2.0 5.316.020.0 6.017.0 3.0 5.7 1.017.0 4.0
4.3 6.010.0 9.0 3.0 1.0 7.5 1.5 -9 1.1 0.3 -9 6.8 5.0 -9 1.0 2.0
CO-552 1.01.02.02.03.01.01.02.02.01.0 2.01.02.02.01.02.03.03.01.01.01.01.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 5.0 2.042.0 8.0 1.5 5.312.017.0 5.011.0 1.5 7.3 0.0 0.0 0.0 0.0 0.0 9.0
8.0 5.0 1.0 9.0 5.8 -9 2.0 1.3 -9 4.5 4.5 -9 1.0 2.0
CO-270 1.01.01.02.02.01.02.01.02.01.0 2.02.03.02.01.02.03.03.01.01.02.01.03.0 1.02.01.02.0

-92.01.01.03.02.02.02.0 1.0 3.040.0 7.0 2.3 3.012.015.0 5.011.0 2.0 5.5 0.0 0.0 0.0 0.0 0.0 8.0
7.0 5.0 1.0 9.5 4.0 1.7 1.6 0.8 0.4 5.9 5.0 4.3 1.0 2.0
CO-5827 1.01.02.02.03.01.01.02.03.01.0 2.01.02.02.01.02.03.04.04.01.02.01.04.0 1.04.01.02.0
-93.01.02.03.02.02.02.0 3.0 3.056.010.0 2.4 4.218.017.0 5.014.0 3.0 4.7 0.0 0.0 0.0 0.0 0.0 9.0
8.0 5.0 1.011.0 5.0 2.5 2.5 1.2 0.6 4.4 4.2 4.2 1.0 2.0
CO-1552 1.01.02.02.03.01.02.02.03.01.0 2.02.03.02.01.02.03.04.02.01.02.01.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 6.0 3.048.0 9.0 2.7 3.312.015.0 4.012.0 1.5 8.0 0.0 0.0 0.0 0.0 0.0 9.0
8.0 7.0 1.010.5 4.5 -9 2.5 0.7 -9 4.2 6.4 -9 1.0 2.0
CO10497 1.01.02.02.02.01.01.02.02.01.0 2.01.02.02.01.02.03.03.04.01.02.01.03.0 1.03.01.02.0
-93.01.02.03.02.02.02.0 3.0 2.032.0 6.5 1.7 3.812.012.0 4.013.0 2.0 6.5 0.0 0.0 0.0 0.0 0.0 6.0
5.0 5.0 1.0 6.5 3.5 -9 1.0 0.5 -9 6.5 7.0 -9 1.0 2.0
CO16734 1.01.02.01.02.01.02.01.03.01.0 2.01.01.02.01.02.03.03.04.01.01.01.03.0 1.03.01.02.0
-93.01.01.03.02.01.02.0 3.0 2.031.0 9.0 1.5 6.012.018.0 5.013.0 2.0 6.5 0.0 0.0 0.0 0.0 0.0 8.0
7.0 5.0 1.0 6.0 1.5 0.8 0.7 0.3 0.2 8.6 5.0 4.0 1.0 2.0
CO-2660 1.01.02.01.02.01.02.01.02.01.0 2.01.01.02.01.02.03.03.04.01.01.01.03.0 1.03.01.02.0
-93.01.01.03.02.02.02.0 2.0 2.024.510.0 1.7 5.910.015.0 5.011.0 2.0 5.5 0.0 0.0 0.0 0.0 0.0 8.0
7.0 5.0 1.0 4.5 1.9 -9 0.7 0.3 -9 6.4 6.3 -9 1.0 2.0
CO-2734 1.01.02.01.02.01.01.01.01.01.0 2.01.02.02.01.02.03.03.04.01.01.02.03.0 1.03.01.02.0
-93.01.01.03.02.01.02.0 3.0 3.085.011.0 2.8 3.914.016.0 5.013.0 3.0 4.3 0.0 0.0 0.0 0.0
0.012.011.0 5.0 1.019.5 9.5 4.0 4.8 2.3 1.1 4.1 4.1 3.6 1.0 2.0
CO-59 1.01.02.02.02.01.01.02.01.01.0 2.02.03.02.01.02.02.03.01.01.01.01.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 2.0 3.033.0 8.0 1.9 4.210.016.0 4.010.0 2.5 4.0 0.0 0.0 0.0 0.0
0.013.012.0 5.0 1.013.5 9.5 2.6 2.3 1.3 0.5 5.9 7.3 5.2 1.0 2.0
CO-3815 1.01.02.02.03.01.02.02.03.01.0 1.01.03.02.01.02.03.03.01.01.03.01.03.0 1.03.01.02.0
-93.01.01.03.02.02.02.0 5.0 2.048.0 6.5 2.2 2.912.015.0 4.013.0 2.0 6.5 0.0 0.0 0.0 0.0 0.0 7.0
6.5 5.0 1.011.5 6.5 -9 2.5 1.3 -9 4.6 5.0 -9 1.0 2.0
CO-8491 1.01.02.02.02.02.02.02.02.01.0 2.01.03.02.01.02.03.03.04.01.01.02.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 3.0 3.049.0 9.0 2.7 3.312.015.0 4.010.0 2.0 5.0 0.0 0.0 0.0 0.0 0.0 7.0
6.5 5.0 1.0 7.5 4.5 2.2 1.5 0.8 0.5 5.0 5.6 4.4 1.0 2.0
CO-7612 1.01.02.02.03.01.01.02.03.01.0 2.02.03.02.01.02.03.03.01.01.01.01.03.0 1.03.01.02.0
-91.01.02.03.02.01.02.0 6.0 3.034.0 5.0 1.8 2.812.015.0 4.011.0 2.0 5.5 0.0 0.0 0.0 0.0 0.0 7.0
6.5 5.0 1.0 6.5 4.5 -9 1.5 0.6 -9 4.3 7.5 -9 1.0 2.0
CO-4476 1.01.02.02.03.01.01.02.02.01.0 2.01.02.02.01.02.03.03.02.01.01.01.03.0 1.03.01.02.0
-93.01.02.03.02.02.01.0 5.0 3.043.0 7.5 2.6 2.918.018.0 5.013.0 2.0 6.5 0.0 0.0 0.0 0.0 0.0 7.0
6.5 5.0 1.0 9.0 4.0 2.0 2.0 0.7 0.5 4.5 5.7 4.0 1.0 2.0
CO-496 1.01.02.02.03.01.01.02.02.01.0 2.02.03.02.01.02.03.03.05.01.03.01.01.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 7.0 3.055.010.0 2.3 4.315.015.0 5.014.0 2.0 7.0 0.0 0.0 0.0 0.0 0.0 8.0
7.5 5.0 1.010.0 5.0 2.7 2.2 0.9 0.5 4.5 5.6 5.4 1.0 2.0
ID-11431 1.01.02.02.03.01.01.02.03.01.0 2.02.03.02.01.02.03.03.03.02.01.01.04.0
1.03.01.01.02.02.01.01.03.02.01.02.0 3.0 3.044.0 3.5 1.5 2.312.013.0 5.014.0 3.0 4.7 1.012.0 3.0
4.0 6.0 8.0 7.0 5.0 1.010.2 5.5 2.1 3.0 1.8 0.3 3.4 3.1 7.0 1.0 2.0
ID-9034 1.01.02.02.02.02.02.02.02.01.0 3.01.03.02.01.02.01.03.01.01.02.01.01.0 1.03.01.02.0
-92.01.01.03.02.01.02.0 4.0 3.052.015.0 3.0 5.014.015.0 4.010.0 1.5 6.7 0.0 0.0 0.0 0.0 0.0 8.0
7.0 5.0 1.0 9.0 3.0 0.8 1.8 0.6 0.3 5.0 5.0 2.7 1.0 2.0
ID10469 1.01.02.02.03.01.01.02.03.01.0 1.02.03.02.01.02.03.03.05.02.02.01.03.0 1.03.01.02.0
-92.01.02.03.02.01.02.0 5.0 3.034.0 2.7 1.2 2.314.015.0 5.012.0 2.0 6.0 0.0 0.0 0.0 0.0 0.0 9.0
8.0 5.0 1.0 5.5 4.4 1.4 1.3 0.7 0.4 4.2 6.3 3.5 1.0 2.0
ID-3527 1.01.02.02.03.01.01.02.02.01.0 2.01.03.02.01.02.02.03.01.01.03.01.03.0 1.03.01.02.0
-92.01.02.03.02.01.02.0 5.0 3.060.014.0 3.0 4.712.015.0 4.013.0 1.5 8.7 0.0 0.0 0.0 0.0 0.0 9.0
8.0 5.0 1.014.0 5.5 2.5 2.2 1.0 0.4 6.4 5.5 6.3 1.0 2.0
ID-1749 1.01.02.01.03.02.01.02.02.01.0 2.01.03.02.01.02.03.03.05.01.03.01.03.0 1.03.01.02.0
-93.01.01.03.02.02.02.0 5.0 3.067.018.5 4.0 4.620.020.0 5.015.0 3.0 5.0 0.0 0.0 0.0 0.0 0.0 9.0
8.0 5.0 1.014.0 6.0 3.0 2.9 1.5 0.9 4.8 4.0 3.3 1.0 2.0
MT-84 1.01.01.02.03.01.01.02.02.01.0 2.02.03.02.01.02.03.03.05.01.02.01.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 1.0 3.032.5 6.0 1.7 3.512.014.0 4.012.0 1.012.0 0.0 0.0 0.0 0.0 0.0 8.0
7.0 5.0 1.0 7.0 3.5 1.9 1.0 0.5 0.3 7.0 7.0 6.3 1.0 2.0

MT-528 1.01.02.02.02.01.01.02.02.01.0 2.02.02.02.01.02.02.03.01.01.02.01.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 4.0 3.045.0 9.0 2.0 4.518.017.0 6.015.0 2.0 7.5 0.0 0.0 0.0 0.0
0.011.010.0 5.0 1.012.5 6.0 2.0 2.2 1.0 0.5 5.7 6.0 4.0 1.0 2.0
OR-1835 1.01.02.01.03.01.01.01.02.01.0 2.02.03.02.01.02.02.03.02.01.01.02.03.0 1.03.01.02.0
-93.01.02.03.02.01.03.0 9.0 3.061.0 7.0 3.4 2.112.016.0 5.011.0 2.0 5.5 0.0 0.0 0.0 0.0 0.0 8.0
7.0 5.0 1.011.5 6.5 2.7 3.0 1.5 0.8 3.8 4.3 3.4 1.0 2.0
UT-4095 1.01.02.02.03.01.02.02.02.01.0 2.01.03.02.01.02.03.03.05.01.01.01.03.0 1.03.01.02.0
-93.01.01.03.02.01.02.0 7.0 4.049.013.0 3.7 3.512.018.0 5.013.0 2.0 6.5 0.0 0.0 0.0 0.0 0.010.0
9.0 5.0 1.015.5 8.0 3.3 3.0 2.0 1.0 5.2 4.0 3.3 1.0 2.0
UT-4315 1.01.02.02.03.01.02.02.03.01.0 2.02.03.02.01.02.02.03.05.01.01.02.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 6.0 3.044.0 7.0 3.0 2.312.018.0 4.013.0 2.0 6.5 0.0 0.0 0.0 0.0 0.0 8.0
7.5 5.0 1.0 7.013.5 8.0 3.0 3.1 1.2 2.3 4.4 6.7 1.0 2.0
UT-4618 1.01.02.02.03.01.01.02.02.01.0 2.02.03.02.01.02.02.03.05.01.01.02.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 6.0 4.040.0 7.0 2.4 2.916.020.0 6.016.0 2.0 8.0 0.0 0.0 0.0 0.0 0.010.0
9.0 5.0 1.0 9.5 5.0 2.1 2.0 0.8 0.5 4.8 6.3 4.2 1.0 2.0
UT-6609 1.01.03.03.03.02.01.03.03.01.0 2.02.03.02.01.02.03.03.04.03.03.01.03.0
1.03.01.01.01.03.01.02.02.02.02.02.0 4.0 3.029.011.0 2.8 3.920.020.0 7.014.[illegible]2.0 7.0 0.514.0 4.0
3.5 3.0 8.0 7.5 5.0 1.0 9.5 5.2 1.5 2.0 1.7 0.5 4.8 3.1 3.0 1.0 2.0
UT-6609+1.01.02.03.03.01.01.03.03.01.0 2.02.05.02.01.02.03.03.04.03.03.01.03.0
1.03.01.01.01.03.01.02.02.02.02.02.0 3.0 [illegible].029.0 5.0 2.5 2.320.018.0 7.014.0 2.0 7.0 2.015.0 3.0
5.0 8.0 9.0 8.0 3.0 1.0 9.0 5.5 2.5 2.5 1.7 0.5 3.6 3.2 5.0 1.0 2.0
WA-381 1.01.02.01.02.01.01.03.02.01.0 2.01.03.02.01.02.03.03.05.01.03.01.03.0 1.03.01.02.0
-93.01.02.03.02.01.03.0 3.0 3.042.0 6.5 2.3 2.814.020.0 5.016.0 2.5 6.4 0.0 0.0 0.0 0.0 0.0 8.0
7.5 5.0 1.0 9.0 4.0 1.5 1.8 1.0 0.5 5.0 4.0 3.0 1.0 2.0
WA-21 1.01.02.02.03.01.01.03.02.01.0 2.02.03.02.01.02.02.03.01.01.02.01.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 7.0 3.038.0 8.5 2.2 3.916.018.0 5.011.0 2.0 5.5 0.0 0.0 0.0 0.0 0.0 9.0
8.5 5.0 1.010.6 5.2 3.0 2.0 1.0 0.6 5.3 5.2 5.0 1.0 2.0
WY-114051.01.02.02.02.01.02.02.01.01.0 2.02.03.02.01.02.03.04.04.02.01.02.04.0 1.03.01.02.0
-92.01.01.03.02.01.02.0 3.0 4.059.0 9.0 3.0 3.018.018.0 5.017.0 2.0 8.5 0.0 0.0 0.0 0.0 0.0 7.0
6.0 6.0 1.015.5 9.0 4.7 3.5 2.1 1.0 4.4 4.3 4.7 1.0 2.0
WY-114061.01.02.02.03.01.01.02.02.01.0 2.02.03.02.01.02.02.03.04.02.01.02.04.0 1.03.01.02.0
-93.01.01.03.02.01.02.0 5.0 4.054.0 9.5 2.3 4.115.015.0 6.016.0 2.0 8.0 0.0 0.0 0.0 0.0 0.0 8.0
7.0 7.0 1.010.5 6.0 2.7 2.2 1.4 0.7 4.8 4.3 3.9 1.0 2.0
WY-3219 1.01.02.01.02.02.01.02.02.01.0 2.01.03.02.01.02.03.03.04.01.01.02.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 4.0 3.066.013.7 2.9 4.716.016.0 5.012.0 2.0 6.0 0.0 0.0 0.0 0.0 0.0 7.0
6.0 5.0 1.0 9.5 4.2 -9 1.8 0.6 -9 5.3 7.0 -9 1.0 2.0
WY-5074 1.01.02.02.03.02.02.02.02.01.0 2.01.02.02.01.02.03.03.01.01.01.02.03.0 1.03.01.02.0
-91.01.02.03.02.02.02.0 3.0 3.057.011.0 2.1 5.218.020.0 6.016.0 2.0 8.0 0.0 0.0 0.0 0.0 0.0 9.0
8.0 5.0 1.0 7.6 4.2 1.9 1.6 1.0 0.4 4.8 4.2 4.8 1.0 2.0
WY-204 1.01.02.02.03.02.02.02.01.01.0 2.01.03.02.01.02.03.03.01.01.03.01.03.0 1.03.01.02.0
-92.01.02.02.03.02.02.0 3.0 3.073.816.5 4.0 4.124.018.0 5.016.0 2.0 8.0 0.0 0.0 0.0 0.0 0.0 8.0
7.5 5.0 1.019.010.5 4.0 4.0 2.2 0.9 4.8 4.8 4.4 1.0 2.0
WY16570 1.01.02.02.03.01.01.02.02.01.0 2.02.03.02.01.02.03.03.01.01.03.01.03.0 1.03.01.02.0
-91.01.02.03.02.01.02.0 5.0 3.035.0 7.0 2.0 3.510.015.0 4.013.0 2.0 6.5 0.0 0.0 0.0 0.0 0.0 8.0
7.5 5.0 1.013.7 9.5 3.0 3.1 1.4 0.6 4.4 6.8 5.0 1.0 2.0
WY-105 1.01.02.02.03.02.02.02.03.01.0 2.01.02.02.01.02.03.03.01.01.03.01.03.0 1.03.01.02.0
-91.01.02.03.03.02.02.0 3.0 4.042.0 7.0 1.5 4.716.015.0 4.015.0 2.0 7.5 0.0 0.0 0.0 0.0 0.0 9.0
8.5 5.0 1.011.010.2 5.5 2.0 1.5 1.3 5.5 6.8 4.2 1.0 2.0
WY67144 1.01.02.02.03.01.01.02.02.01.0 2.01.02.02.01.02.03.03.01.01.02.01.[illegible].0 1.03.01.02.0
-93.01.02.03.02.01.02.0 4.0 4.047.010.5 2.5 4.213.016.0 5.014.0 2.[illegible]0 0.0 0.0 0.0 0.0 0.010.0
9.0 5.0 1.012.0 5.3 2.0 2.0 0.9 0.5 6.0 5.9 4.0 1.0 2.0
WY-3905 1.01.02.01.03.02.02.02.02.01.0 2.01.03.02.01.02.03.03.01.01.02.01.03.0 1.03.01.02.0
-93.01.02.03.03.02.02.0 4.0 4.072.0 6.5 2.5 2.618.018.0 6.014.0 2.0 7.0 0.0 0.0 0.0 0.0 0.0 8.0
7.5 5.0 1.014.015.0 5.7 3.1 2.7 1.3 4.5 5.6 4.4 1.0 2.0
WY-3051 1.01.02.01.02.02.02.02.03.01.0 2.02.03.02.01.02.03.03.02.01.03.01.03.0 1.03.01.02.0
-91.01.02.03.02.02.02.0 4.0 3.054.0 4.5 1.5 3.016.014.0 4.012.0 2.0 6.0 0.0 0.0 0.0 0.0 0.0 8.0

7.5 5.0 1.013.510.0 4.0 3.0 1.7 0.7 4.5 5.9 5.7 1.0 2.0
WY-4198 1.0 -93.01.03.02.02.02.03.01.0 2.01.03.02.01.02.03.03.01.01.01.02.03.0 2.03.01.02.0
-93.01.02.03.02.02.02.014.0 3.052.014.5 4.0 3.614.018.0 6.014.0 3.0 4.7 0.0 0.0 0.0 0.0 0.0 9.0
8.0 5.0 1.013.0 8.0 4.5 3.0 2.0 1.5 4.3 4.0 3.0 1.0 2.0
AB-DRUMM1 .01.02.02.02.02.02.02.02.01.0 2.02.05.01.01.02.03.03.04.02.03.01.03.0
2.03.01.01.01.03.01.01.01.03.04.02.0 3.0 3.041.010.0 2.3 4.320.017.0 5.012.0 3.5 3.4 0.320.0 6.0
3.310.0 8.0 7.5 5.0 1.0 9.8 6.5 4.7 3.2 2.4 2.0 3.1 2.7 2.4 1.0 2.0
CA-3168 1.01.02.03.03.02.01.03.03.01.0 2.01.02.01.01.01.03.03.03.02.02.02.03.0
2.03.01.01.01.03.01.01.01.03.03.02.0 3.0 3.048.013.5 1.8 7.5 2.0 1.5 5.013.0 3.0 4.3 0.518.0 5.0
3.613.0 7.0 6.5 5.0 1.0 8.5 4.3 2.3 1.0 1.2 0.6 8.5 3.6 3.8 1.0 2.0
CA-7555 1.01.02.02.03.02.01.03.03.01.0 2.02.05.01.01.02.03.03.03.02.03.01.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 1.0 3.043.0 7.5 2.4 3.125.015.0 5.011.0 3.0 3.7 0.520.0 6.0
3.316.0 7.0 6.5 5.0 1.0 9.0 6.5 2.0 2.0 2.8 0.6 4.5 2.3 3.3 1.0 2.0
CA20032 1.01.02.01.01.02.01.01.02.01.0 2.02.05.01.01.01.02.02.01.01.03.01.03.0
1.02.01.01.02.01.01.01.02.03.04.01.0 1.0 3.026.0 8.5 2.1 4.114.010.0 5.010.0 1.5 6.7 1.015.0 4.0
3.713.0 6.0 5.5 3.0 1.012.5 7.0 3.0 3.0 2.0 0.5 4.2 3.5 6.0 1.0 2.0
CA-8811 1.01.01.01.02.01.01.01.02.01.0 1.2.02.02.01.01.01.03.03.03.02.031.03.0
2.02.01.01.01.03.01.01.01.03.04.02.0 1.0 3.062.0 8.5 2.3 3.722.015.0 5.013.0 2.5 5.2 0.525.0 6.0
4.214.0 8.0 7.5 5.0 1.0 8.5 5.0 3.8 1.5 1.3 1.1 5.7 3.8 3.4 1.0 2.0
BC19585 1.01.02.01.02.02.02.01.02.01.0 1.02.01.01.01.01.02.02.03.02.02.01.03.0
1.02.01.01.01.01.01.01.01.04.04.01.0 3.0 3.044.0 4.0 1.2 3.320.015.0 6.013.0 3.0 4.3 0.517.0 4.0
4.312.0 7.0 6.5 5.0 1.013.5 9.5 4.8 3.0 3.0 1.6 4.5 3.2 3.0 1.0 2.0
CO-4982 1.01.01.01.01.02.02.02.02.01.0 1.02.05.01.01.02.02.02.03.01.03.01.03.0
2.02.01.01.01.01.01.01.01.03.04.02.0 1.0 3.033.0 4.0 1.5 2.720.013.0 6.012.0 3.0 4.0 0.518.0 4.0
4.512.0 6.0 5.5 3.0 1.0 9.2 5.5 3.0 1.7 1.4 0.7 5.4 3.9 4.3 1.0 2.0
CO-1831 1.01.02.01.01.02.02.03.03.01.0 1.01.01.01.01.02.03.03.03.02.03.01.03.0
2.03.01.01.02.01.01.01.01.03.04.02.0 3.0 3.046.0 6.5 1.2 5.422.015.0 5.015.0 3.0 5.0 2.023.0 5.0
4.610.0 7.0 6.5 5.0 1.011.0 9.5 5.7 1.7 2.3 1.5 6.5 4.1 3.8 1.0 2.0
CO-6545 1.01.02.02.02.02.01.03.02.01.0 1.01.01.01.01.02.03.03.01.03.02.02.03.0
2.03.01.01.01.01.01.01.01.03.04.02.0 3.0 3.034.0 6.0 1.5 4.022.020.0 6.013.0 3.5 3.7 0.517.0 5.0
3.415.0 8.0 7.5 3.0 1.0 8.0 5.0 1.5 1.5 2.0 0.6 5.3 2.5 2.5 1.0 2.0
CO-170 1.01.01.02.02.02.01.01.02.01.0 2.01.02.01.01.02.03.03.03.01.02.01.03.0
1.02.01.01.01.02.01.01.01.03.04.02.0 1.0 3.039.017.0 2.5 6.820.012.0 4.012.0 2.0 6.0 0.318.0 5.0
3.612.0 6.0 5.5 5.0 1.010.5 4.0 2.0 1.5 0.7 0.5 7.0 5.7 4.0 1.0 2.0
CO-4381 1.01.01.01.02.02.02.01.02.01.0 -9 -9 -91.01.01.03.03.03.01.03.02.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 1.0 3.054.5 -9 -9 -920.016.0 5.015.0 3.0 5.0 0.325.0 9.0
2.812.0 6.0 5.5 5.0 1.016.011.0 7.0 3.2 2.5 1.8 5.0 4.4 3.9 1.0 2.0
ID11332 1.01.02.02.02.02.01.02.02.01.0 1.02.05.01.01.02.02.02.03.01.03.01.03.0
1.02.01.01.01.02.01.01.02.03.04.02.0 3.0 3.034.0 4.0 1.5 2.715.012.0 5.011.0 2.0 5.5 0.316.0 4.0
4.012.0 6.0 5.0 3.0 1.0 7.2 6.3 4.7 1.8 2.2 2.0 4.0 2.8 2.4 1.0 2.0
ID-84 1.01.02.02.02.02.01.02.02.01.0 1.02.05.01.01.02.03.03.03.02.02.01.03.0
1.03.01.01.01.02.01.01.01.03.04.01.0 4.0 4.034.0 3.5 1.0 3.520.015.0 5.012.0 3.0 4.0 0.314.0 5.0
2.812.0 6.0 5.5 3.0 1.0 7.0 4.5 3.7 1.2 1.0 0.8 5.8 4.5 4.6 1.0 2.0
ID-441 1.01.02.01.02.02.01.02.02.01.0 2.02.02.01.01.02.02.02.03.03.02.02.03.0
1.02.01.01.01.02.01.01.01.03.04.01.0 3.0 3.059.014.0 2.0 7.022.017.0 5.014.0 3.0 4.7 0.318.0 5.0
3.618.0 8.0 7.5 5.0 1.027.0 8.0 2.5 5.2 2.2 0.5 5.2 3.6 5.0 1.0 2.0
MT-146 1.01.02.02.02.02.02.02.02.01.0 2.02.05.01.01.02.02.02.04.02.03.01.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 1.0 3.042.010.0 2.0 5.024.015.0 6.013.0 3.0 4.3 0.330.0 8.0
3.812.0 9.0 8.0 5.0 1.014.0 6.8 4.0 4.0 2.2 1.5 3.5 3.1 2.6 1.0 2.0 3.5 3.1 2.6 1.0 2.0
MT-420 1.01.01.02.02.02.02.02.02.01.0 2.01.02.01.01.02.02.03.03.02.03.01.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 1.0 2.027.0 4.5 1.0 4.525.020.0 6.012.0 3.0 4.0 0.518.0 4.0
4.512.0 8.0 7.5 3.0 1.0 7.5 5.0 -9 1.4 1.5 -9 5.4 3.3 -9 1.0 2.0
MT13345 1.01.02.02.02.02.02.02.02.01.0 1.01.02.01.01.02.02.02.03.02.02.01.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 1.0 3.054.0 3.0 1.0 3.025.015.047.012.0 3.0 4.0 0.518.0 5.0
3.614.0 8.0 7.5 3.0 1.013.0 9.1 5.2 2.2 2.7 2.2 5.9 3.4 2.4 1.0 2.0
NV-1615 1.01.02.02.02.02.01.02.02.01.0 1.01.02.01.01.02.02.02.03.02.02.01.03.0

2.02.01.01.01.03.01.01.01.03.04.02.0 3.0 3.040.0 6.0 2.0 3.024.018.0 8.012.0 4.0 3.0 0.518.0 6.0
3.014.0 8.0 7.5 3.0 1.0 7.7 6.0 2.8 1.8 1.8 0.7 4.3 3.3 4.0 1.0 2.0
NV-679 1.01.01.02.02.02.01.02.02.01.0 -9 -9 -91.01.01.03.02.01.02.02.02.03.0
2.02.01.01.01.01.01.0 -91.03.04.02.0 1.0 2.058.0 -9 -9 -928.020.0 6.016.0 4.0 4.0 0.324.0 6.0
4.015.0 7.0 6.5 5.0 1.017.5 7.5 -9 3.8 2.4 -9 4.5 3.1 -9 1.0 2.0
NV-6315 1.01.02.02.03.02.01.03.03.01.0 -9 -9 -91.01.02.02.03.03.02.02.02.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 3.0 3.040.0 -9 -9 -926.020.0 7.014.0 2.5 5.6 0.516.0 4.0
4.012.0 8.0 7.5 5.0 1.011.5 8.7 5.5 1.8 1.6 1.6 6.4 5.4 3.4 1.0 2.0
WA1028291.01.02.02.02.02.02.03.03.01.0 1.01.02.01.01.02.02.03.03.02.02.02.01.0
2.02.01.01.01.02.01.01.01.03.04.02.0 3.0 3.040.0 5.5 1.5 3.726.020.0 6.014.0 4.0 3.5 0.318.0 5.0
3.610.0 8.0 7.5 3.0 1.0 9.5 6.5 3.5 1.9 1.5 1.4 5.0 4.3 2.5 1.0 2.0
WA-46 1.01.02.02.03.02.01.01.03.01.0 1.01.01.01.01.02.03.03.03.02.02.02.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 3.0 3.022.5 3.5 1.0 3.5 2.0 1.2 5.011.0 3.0 3.7 0.314.0 4.0
3.513.0 7.0 6.5 3.0 1.0 9.7 6.0 2.5 1.7 1.2 0.8 5.7 5.0 3.1 1.0 2.0
WA-H10 1.01.01.02.02.02.02.01.02.01.0 2.02.03.01.01.02.03.03.04.02.02.01.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 1.0 3.039.0 7.0 2.9 2.420.016.0 5.013.0 3.5 3.7 0.315.0 5.0
3.012.0 7.0 6.5 5.0 1.014.0 5.5 2.2 3.2 1.5 0.7 4.4 3.7 3.1 1.0 2.0
UT-5883 1.01.01.02.02.02.02.02.02.01.0 2.02.05.01.01.02.02.02.01.01.03.02.03.0
2.02.01.01.01.01.01.01.01.03.04.02.0 1.0 2.039.0 6.5 2.8 2.324.020.0 7.014.0 3.0 4.7 0.522.0 7.0
3.112.0 7.0 6.0 5.0 1.0 9.0 6.0 -9 2.7 2.4 -9 3.3 2.5 -9 1.0 2.0
UT1645A 1.01.02.01.02.02.01.02.02.01.0 1.02.02.01.01.02.03.03.03.02.02.02.03.0
1.02.01.01.01.02.01.01.01.03.04.02.0 3.0 2.045.010.5 2.7 2.928.020.0 6.016.0 2.5 6.4 0.320.0 7.0
2.912.0 7.0 6.5 5.0 1.013.0 7.0 -9 3.0 2.4 -9 4.3 2.9 -9 1.0 2.0
UT-5057 1.01.02.01.01.02.02.01.02.01.0 1.02.03.01.01.02.01.03.03.02.03.02.01.0
2.02.01.01.01.01.01.01.01.03.04.02.0 3.0 4.052.0 3.0 1.3 2.316.013.0 5.013.0 4.5 2.9 0.318.0 6.0
3.012.0 5.0 4.5 5.0 1.0 9.015.3 7.5 3.1 4.0 3.2 2.9 3.8 2.3 1.0 2.0
UT17495 1.01.01.02.03.02.01.02.03.01.0 2.02.02.01.01.02.02.03.03.02.02.02.03.0
2.02.01.01.01.02.01.01.01.03.04.02.0 1.0 1.044.0 6.5 1.2 5.418.015.0 6.012.0 3.0 4.0 0.324.0 4.0
6.010.0 7.0 6.5 5.0 1.0 6.5 -9 -9 2.3 -9 -9 2.8 -9 -9 1.0 2.0
UT-1984 1.01.01.01.02.02.01.01.02.01.0 2.01.02.01.01.02.01.03.03.02.03.02.03.0
1.02.01.01.01.03.01.01.02.03.04.02.0 1.0 3.040.0 7.0 1.7 4.120.018.0 7.014.0 2.0 7.0 0.320.0 4.0
5.012.0 7.0 6.5 3.0 1.013.0 8.0 4.0 2.2 1.9 0.8 5.9 4.2 5.0 1.0 2.0
OR-1154 1.01.01.01.02.02.01.01.02.01.0 2.02.01.01.01.02.01.03.01.02.03.01.01.0
1.02.01.01.01.02.01.01.01.03.04.02.0 1.0 3.022.0 3.4 0.5 6.818.012.0 5.011.0 2.0 5.0 0.315.0 4.0
3.810.0 6.0 5.5 3.0 1.0 6.0 5.5 2.5 1.0 1.2 0.5 6.0 4.6 5.0 1.0 2.0
OR-56 1.01.01.01.01.02.02.01.02.01.0 1.02.02.01.01.02.03.03.03.01.03.01.03.0
2.02.01.01.01.01.01.01.01.03.04.02.0 1.0 3.045.0 3.5 1.3 2.720.015.0 5.015.0 3.0 5.0 1.013.0 3.0
4.310.0 6.0 5.5 3.0 1.0 7.0 8.7 6.5 2.5 3.0 2.2 2.8 2.9 3.0 1.0 2.0
OR-814 1.01.02.01.02.02.01.01.03.01.0 1.02.01.01.01.02.02.03.01.02.02.01.03.0
2.02.01.01.01.02.01.01.02.03.04.02.0 3.0 3.038.0 2.1 0.6 3.520.020.0 7.015.0 3.0 5.0 0.516.0 6.0
2.713.0 7.0 6.5 5.0 1.0 7.5 6.5 4.0 2.0 1.9 1.5 3.8 3.4 2.7 1.0 2.0
OR-2489 1.01.02.02.03.02.01.01.03.01.0 1.02.02.01.01.02.02.03.03.02.02.01.03.0
2.03.01.01.01.03.01.01.02.03.04.02.0 3.0 3.038.0 7.0 2.0 3.520.018.0 5.012.0 3.0 4.0 0.322.0 4.0
5.512.0 9.0 8.5 3.0 1.010.0 8.0 3.5 2.0 2.0 0.4 5.0 4.0 8.8 1.0 2.0
WY-410 1.01.03.03.03.02.01.02.03.01.0 1.02.01.01.01.02.03.03.03.03.02.02.03.0
2.03.01.01.01.03.01.01.01.03.04.02.0 4.0 3.036.0 3.0 1.0 3.022.018.0 5.012.0 3.0 4.0 0.518.0 6.0
3.014.0 8.0 7.0 3.0 1.0 8.0 7.5 3.5 2.5 2.0 1.4 3.2 3.8 2.5 1.0 2.0
WY-933 1.01.02.01.02.02.02.02.02.01.0 2.02.05.01.01.02.02.02.03.01.03.01.03.0
2.02.01.01.01.01.01.01.01.03.04.02.0 4.0 2.054.011.5 3.0 3.820.015.0 6.015.0 3.0 5.0 0.322.0 5.0
4.414.0 6.0 5.5 3.0 1.014.5 7.8 -9 2.5 2.2 -9 5.8 3.5 -9 1.0 2.0
WY-1702 1.01.01.01.02.02.02.01.01.01.0 2.02.05.01.01.02.02.02.03.02.03.01.03.0
1.02.01.01.01.02.01.01.02.03.04.02.0 1.0 3.059.014.0 3.5 4.020.018.0 5.014.0 2.5 5.6 0.322.0 5.0
4.414.0 7.0 6.5 3.0 1.014.010.0 5.7 4.5 4.7 3.0 3.1 2.1 1.5 1.0 2.0
WY-1785 1.01.01.01.02.02.02.01.02.01.0 2.01.02.01.01.02.02.02.01.01.03.01.03.0
1.02.01.01.01.01.01.01.01.03.04.02.0 1.0 2.049.010.5 1.5 7.025.018.0 6.014.0 3.0 4.7 0.528.0 6.0
4.616.0 8.0 7.0 3.0 1.0 7.5 5.5 -9 2.3 2.5 -9 3.3 2.2 -9 1.0 2.0

WY-6379 1.01.02.02.02.02.02.03.03.01.0 2.01.02.01.01.02.03.03.03.02.02.03.03.0
1.03.01.01.01.02.01.01.01.03.04.01.0 3.0 3.055.0 6.0 1.2 5.024.018.0 5.012.0 3.0 4.0 0.318.0 4.0
4.513.0 7.0 6.0 3.0 1.0 7.0 6.0 3.5 2.2 2.3 1.3 3.2 2.6 [illegible].7 1.0 2.0
WY-8519 1.01.02.02.03.02.02.02.02.01.0 1.02.02.01.01.02.03.03.03.02.02.01.03.0
2.03.01.01.01.03.01.01.01.03.04.01.0 3.0 4.051.5 9.0 2.5 3.620.015.0 7.013.0 3.0 4.3 0.320.0 5.0
4.015.0 7.0 6.5 5.0 1.016.510.0 6.0 3.5 2.7 2.2 4.7 3.7 2.7 1.0 2.0
WY-2819 1.01.02.02.03.02.02.02.03.01.0 1.02.03.01.01.02.02.03.01.02.03.01.03.0
2.03.01.01.01.03.01.01.01.03.04.01.0 4.0 4.066.0 7.5 2.5 3.022.015.0 6.012.0 3.0 4.0 0.325.0 7.0
3.613.0 8.0 7.0 5.0 1.016.014.010.3 5.0 4.6 4.5 3.2 3.0 2.3 1.0 2.0

Analysis 4 & CLUSTAN Ward's Method. *Arnica* L. subgenus *Chamissonis* Maguire.

(2A4,35F3.1,32F4.1)

AB-4868 1.01.02.03.02.02.02.02.02.0 1.02.01.02.01.01.01.0 3.02.03.01.03.01.01.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 5.026.013.0 2.3 5.720.015.0 4.010.0 2.0 5.0 0.515.0 3.0
5.012.0 8.0 7.0 5.0 1.013.012.511.5 2.5 2.3 2.2 5.2 5.4 5.2 1.0 1.0
AB-6689 1.01.02.03.03.02.02.03.03.0 1.02.01.02.01.01.01.0 3.02.03.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 9.0 4.037.015.3 2.5 6.120.020.0 4.010.0 2.0 5.0 0.518.0 3.0
6.014.0 7.0 6.0 5.0 1.015.013.010.0 2.5 2.5 2.5 6.0 5.2 4.0 1.0 1.0
AK-283 1.01.02.02.02.02.02.01.02.0 2.0 -9 -9 -91.01.02.0 2.02.03.01.03.01.01.0
1.02.02.01.01.03.01.01.02.02.01.01.0 3.0 4.057.0 -9 -9 -920.020.0 5.011.0 2.0 5.5 0.520.0 5.0
4.014.010.0 9.0 5.0 2.0 -914.012.0 -9 2.7 2.8 -9 5.2 4.3 1.0 1.0
AK-119391.01.02.02.02.02.02.02.02.0 1.02.01.02.01.01.01.0 2.02.03.01.02.01.03.0
1.02.02.01.01.02.01.01.02.02.01.02.0 3.0 5.060.0 7.5 1.8 4.220.012.0 4.0 9.0 3.0 3.0 0.515.0 5.0
3.012.0 8.0 7.0 5.0 1.012.514.012.5 2.0 2.7 2.7 6.3 5.2 4.6 1.0 1.0
AK-119401.01.02.03.02.02.02.02.02.0 1.02.01.02.01.01.01.0 2.02.03.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 6.044.011.0 1.5 7.315.010.0 4.0 9.0 2.5 3.6 0.515.0 3.0
5.012.0 6.0 5.0 5.0 1.014.512.011.0 3.5 3.0 2.7 4.1 4.0 4.1 1.0 1.0
AZ-7821 1.01.02.02.02.02.02.03.02.0 1.02.01.02.01.01.01.0 2.02.03.01.02.01.01.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 5.032.0 8.0 2.0 4.018.015.0 5.0 8.0 2.0 4.0 0.515.0 3.0
5.012.0 6.0 5.0 5.0 1.0 7.5 6.0 5.0 1.6 1.2 1.0 4.7 5.0 5.0 1.0 1.0
AZ-s.n.B1.01.02.02.02.02.02.03.02.0 1.02.01.02.01.01.01.0 2.02.01.02.03.01.01.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 4.028.0 8.5 1.7 5.018.012.0 4.0 8.0 1.5 5.3 0.516.0 4.0
4.013.0 8.0 7.0 5.0 1.0 7.0 3.3 1.8 1.3 0.6 0.5 5.4 5.5 3.6 1.0 1.0
BC-7690 1.01.02.03.02.02.01.02.02.0 1.02.01.02.01.01.01.0 3.02.03.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 9.0 4.028.010.0 1.5 6.715.012.0 5.0 8.0 2.0 4.0 0.516.0 4.0
4.016.010.0 9.0 5.0 1.010.8 9.0 8.0 1.2 1.3 1.0 9.0 6.9 8.0 1.0 1.0
BC-134761.01.03.02.02.02.02.01.02.0 1.02.01.02.01.01.01.0 2.03.03.01.03.01.03.0
2.02.02.01.01.03.01.01.02.02.01.02.0 6.0 6.044.014.5 2.0 7.324.020.0 5.011.0 3.0 3.6 0.520.0 4.0
5.015.010.0 9.0 5.0 1.014.015.011.5 3.0 3.0 4.0 4.7 5.0 2.9 1.0 1.0
CA-BOLAN1.01.03.04.03.03.02.04.03.0 2.0 -9 -9 -91.01.01.0 4.01.04.01.03.01.05.0
2.01.02.01.01.03.01.01.02.02.01.01.0 4.0 5.057.0 -9 -9 -918.015.0 4.010.0 3.0 3.3 0.314.0 3.0
4.618.0 9.0 8.0 3.0 1.015.312.0 8.5 1.8 1.6 1.4 8.5 7.5 6.1 1.0 1.0
CA-3311 1.01.01.04.03.02.01.04.03.0 1.02.01.01.01.01.01.0 2.02.03.02.03.01.01.0
2.03.02.01.01.03.01.01.02.02.01.02.0 2.0 4.025.010.5 1.4 7.516.012.0 3.0 9.0 2.5 3.6 0.312.0 4.0
3.014.0 7.0 6.5 5.0 1.0 8.7 7.5 4.0 1.3 1.1 0.7 6.7 6.8 5.7 1.0 1.0
CA-6195 1.0 -92.03.03.02.01.04.03.0 1.02.01.02.01.01.01.0 3.03.03.02.02.01.05.0
2.03.02.01.01.03.01.02.02.01.01.02.0 3.0 5.047.511.0 1.8 6.120.018.0 5.0 7.0 2.0 3.5 0.313.0 3.0
4.315.0 7.0 6.5 5.0 1.010.0 6.5 4.0 1.8 1.5 1.0 5.6 4.3 4.0 1.0 3.0
CO-124 1.01.02.01.02.02.01.01.02.0 2.0 -9 -9 -91.01.01.0 2.02.03.01.01.01.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 3.0 7.043.5 -9 -9 -910.013.0 3.0 8.0 2.0 4.0 0.512.0 3.0
4.012.0 6.0 5.0 5.0 1.0 7.5 8.5 6.5 1.0 1.3 1.2 7.5 6.5 5.4 1.0 1.0
CO-9154 1.01.02.03.02.02.01.02.02.0 1.02.01.02.01.01.01.0 3.02.03.01.01.01.03.0
2.02.02.01.01.03.01.01.02.02.01.02.0 8.0 4.024.0 7.0 2.5 2.812.014.0 4.010.0 2.5 4.0 0.514.0 3.0
4.714.0 7.0 6.0 5.0 1.011.0 9.0 6.0 3.3 3.0 2.0 3.3 3.0 3.0 1.0 1.0

ID-897 1.01.02.01.02.02.02.01.02.0 1.02.01.02.01.01.01.0 [illegible]2.01.02.03.01.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 5.0 4.043.014.0 2.5 5.620.015.0 3.0 8.0 2.0 4.0 0.512.0 2.0
6.012.0 8.0 7.0 5.0 1.014.011.0 7.0 2.0 1.8 1.4 7.0 6.1 5.0 1.0 1.0
ID-5855 1.01.02.04.01.03.02.03.02.0 1.0 -9 -9 -91.01.01.0 2.02.01.02.03.01.01.0
1.02.02.01.01.01.02.01.02.02.01.03.0 3.0 4.052.0 -9 -9 -916.012.0 4.0 9.0 2.0 4.5 0.512.0 3.0
4.012.0 6.0 5.0 5.0 1.011.012.5 5.0 1.8 2.0 0.8 6.1 6.3 6.3 1.0 1.0
MN-9316 1.01.03.02.02.02.01.02.02.0 1.02.01.02.01.01.01.0 3.03.03.01.02.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.020.0 5.043.012.0 2.0 6.018.018.0 4.0 9.0 2.0 4.5 0.520.0 4.0
5.014.0 8.0 7.0 5.0 1.012.0 9.0 6.5 2.5 2.5 2.0 4.8 3.6 3.3 1.0 1.0
MN-113371.01.02.03.02.02.02.02.02.0 1.02.01.02.01.01.01.0 3.03.01.01.03.01.03.0
1.02.02.01.01.02.01.01.02.02.01.02.016.0 8.056.011.5 1.5 7.712.010.0 3.012.0 3.0 4.0 0.520.0
4.0 5.016.0 7.0 6.0 5.0 1.016.015.315.3 3.0 2.8 3.0 5.3 5.5 5.1 1.0 1.0
MT-1098 1.01.02.02.02.02.01.01.01.0 2.0 -9 -9 -91.01.01.0 2.01.01.01.02.01.02.0
1.01.02.01.01.03.01.0 -92.02.01.02.0 5.010.099.0 -9 -9 -920.015.0 3.0 8.0 2.0 4.0 0.315.0 3.0
5.012.0 7.0 6.5 1.010.022.018.016.5 5.0 5.5 6.0 4.4 3.3 2.8 1.0 1.0
MT-1222 1.01.02.02.02.02.01.02.02.0 2.0 -9 -9 -91.01.01.0 2.02.03.01.01.01.03.0
3.02.02.01.01.03.01.01.02.02.01.02.0 4.0 8.071.0 -9 -9 -916.018.0 4.0 7.0 1.0 7.0 0.516.0 4.0
4.012.0 8.0 7.0 5.0 1.015.313.013.0 2.0 1.8 2.4 7.7 7.2 5.4 1.0 1.0
NM-781021.01.02.02.02.02.02.03.02.0 1.02.01.02.01.01.01.0 2.02.03.01.03.01.01.0
2.02.02.01.01.02.01.01.02.02.01.02.0 3.0 3.020.0 9.0 2.0 4.516.013.0 4.0 9.0 2.0 4.5 0.514.0 3.0
4.712.0 7.0 6.0 5.0 1.0 7.0 5.5 3.3 1.0 0.7 0.5 7.0 7.9 6.0 1.0 1.0
NV-3100 1.01.02.01.01.02.01.02.02.0 1.02.01.02.01.01.02.0 1.02.03.02.01.01.01.0
2.02.02.01.01.03.01.01.02.02.02.02.0 9.0 3.059.012.0 2.5 4.615.017.0 5.010.0 3.5 2.9 0.520.0 5.0
4.012.0 8.0 7.0 5.0 1.015.010.0 6.3 4.0 3.0 2.3 3.8 3.3 2.7 1.0 1.0
NV-9670 1.01.02.04.03.02.01.04.03.0 2.0 -9 -9 -91.01.01.0 4.02.03.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 4.039.0 -9 -9 -915.010.0 4.010.0 2.0 5.0 0.512.0 3.0
4.017.013.012.0 5.0 1.010.0 9.0 6.0 2.0 2.0 1.0 5.0 4.5 6.0 1.0 3.0
NWT117951.01.02.02.02.02.02.02.02.0 1.02.01.02.01.01.01.0 2.02.01.02.02.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 5.031.0 4.5 1.2 3.818.013.0 4.011.0 2.0 5.5 0.525.0 5.0
5.015.0 9.0 8.0 5.0 1.0 9.5 9.5 8.7 1.2 1.4 2.0 7.9 6.8 4.4 1.0 1.0
NWT117991.01.02.03.02.01.01.04.03.0 1.02.01.02.01.01.01.0 3.03.04.01.03.01.04.0
2.03.02.01.01.03.01.01.02.02.01.02.0 3.0 5.032.0 7.0 1.0 7.020.017.0 4.012.0 3.5 3.4 0.520.0 5.0
4.012.0 9.0 8.0 5.0 1.010.0 9.5 6.5 1.7 1.2 1.0 5.9 7.9 6.5 1.0 1.0
ON-1077 1.01.01.03.02.02.01.02.02.0 1.02.01.01.01.01.01.0 2.02.01.02.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 1.0 5.031.0 8.0 1.0 8.015.018.0 4.0 9.0 2.0 4.5 0.516.0 4.0
4.018.0 8.0 7.0 5.0 1.010.0 8.5 7.0 2.0 1.4 1.2 5.0 6.1 5.8 2.0 1.0
ON-8060 1.01.02.03.02.02.01.02.02.0 1.02.01.02.01.01.01.0 3.02.03.01.03.01.03.0
2.02.02.01.01.03.01.01.02.02.01.02.0 5.0 4.040.0 8.5 1.6 5.316.012.0 4.010.0 3.0 3.3 0.512.0 3.0
4.020.0 7.0 6.0 5.0 1.0 8.510.0 8.0 1.6 2.0 2.0 5.3 5.0 4.0 2.0 1.0
OR-NUTT 1.01.02.02.03.02.02.02.03.0 1.02.01.01.01.01.01.0 3.03.04.02.02.01.01.0
1.02.02.01.01.03.01.02.02.02.01.02.0 4.0 5.025.0 8.0 1.9 4.214.016.0 4.0 8.0 2.0 4.0 0.312.0 3.0
4.012.0 8.0 7.0 5.0 1.0 9.3 9.0 7.5 2.0 1.8 1.5 4.7 5.0 5.0 1.0 1.0
OR-TNUTT1.01.02.02.02.02.01.02.02.0 2.0 -9 -9 -91.01.02.0 2.03.01.02.02.01.01.0
1.01.02.01.01.03.01.01.02.02.01.02.0 4.0 4.033.0 -9 -9 -916.015.0 4.0 6.0 2.0 3.0 0.313.0 3.0
4.312.0 6.0 5.5 3.0 1.0 9.5 7.0 5.0 0.8 0.5 0.611.914.0 8.3 1.0 1.0
OR-NUTTA1.01.03.03.03.02.02.03.03.0 1.01.01.01.01.01.02.0 2.03.03.02.01.01.01.0
1.02.02.01.01.03.01.02.02.02.01.02.0 4.0 3.019.5 8.2 1.7 4.815.015.0 4.0 9.0 2.0 4.5 0.312.0 2.0
6.010.0 7.0 6.0 3.0 1.0 7.5 5.5 2.0 1.5 1.4 0.8 5.0 3.9 2.5 1.0 1.0
QE-331581.01.02.03.02.02.01.02.02.0 1.02.01.02.01.01.01.0 3.02.03.02.03.01.03.0
2.02.02.01.01.03.01.01.02.02.01.02.0 3.0 5.030.0 6.5 1.4 4.618.015.0 4.010.0 2.0 5.0 0.316.0 3.0
5.324.0 9.0 8.0 5.0 1.010.5 9.5 8.5 2.0 2.4 1.5 5.3 4.0 5.7 2.0 3.0
SK-1246 1.01.03.02.02.02.01.02.02.0 1.02.01.02.01.01.01.0 2.02.04.02.01.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 5.0 6.049.010.5 3.0 3.518.018.0 5.0 9.0 2.0 4.5 0.316.0 4.0
4.014.010.0 9.0 5.0 1.013.013.011.0 2.3 3.6 2.0 5.7 3.6 5.5 1.0 1.0
SK-266121.01.02.02.02.02.02.02.02.0 1.02.01.02.01.01.01.0 2.02.04.01.03.01.03.0
1.02.02.01.01.02.01.01.02.02.01.02.0 6.0 7.072.012.0 2.0 6.018.018.0 3.010.0 2.0 5.0 0.320.0 4.0

5.014.0 7.0 6.0 5.0 1.021.014.514.0 4.0 4.0 4.2 5.3 3.6 3.3 1.0 1.0
UT-114421.01.01.03.02.02.02.02.02.0 2.0 -9 -9 -91.01.01.0 1.02.01.01.01.01.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 1.0 4.034.0 -9 -9 -914.012.0 3.0 8.0 2.0 4.0 0.315.0 3.0
5.010.0 6.0 5.0 5.0 1.011.0 8.5 5.0 2.3 2.0 1.5 4.8 4.3 3.3 1.0 1.0
UT-123391.01.02.01.02.02.01.01.02.0 1.02.01.02.01.01.01.0 2.02.01.02.03.01.03.0
1.01.02.01.01.03.01.01.02.02.01.02.0 5.0 5.073.012.0 3.0 4.016.015.0 4.0 9.0 2.0 4.5 0.320.0 5.0
4.010.0 7.0 6.0 5.0 1.014.014.512.8 3.5 3.5 3.5 [illegible] 4.1 3.7 1.0 1.0
WA-1498 1.01.02.03.02.02.01.03.02.0 1.02.01.02.01.01.01.0 3.02.01.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 6.0 5.037.010.5 2.2 4.814.012.0 5.0 8.0 1.0 8.0 0.314.0 2.0
7.012.0 6.0 5.0 5.0 1.011.510.0 6.5 1.5 2.0 1.8 7.7 5.0 3.6 1.0 1.0
WA-6283 1.01.02.03.02.02.01.02.02.0 2.0 -9 -9 -91.01.01.0 2.02.03.02.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 8.0 9.055.0 -9 -9 -918.012.0 4.011.0 1.5 7.3 0.312.0 2.0
6.017.0 6.0 5.0 5.0 1.012.014.016.0 2.0 2.2 2.5 6.0 6.4 6.4 1.0 2.0
WY-766 1.01.02.01.02.02.01.01.02.0 1.01.01.02.01.01.02.0 2.02.01.01.03.02.01.0
1.01.02.01.01.01.01.01.02.02.01.02.0 5.0 6.038.0 9.0 1.5 6.015.012.0 4.0 7.0 1.5 4.7 0.312.0 3.0
4.014.0 6.0 5.5 3.0 1.010.510.0 9.0 2.4 2.0 2.0 4.4 5.0 4.5 1.0 1.0
WY-1417 1.01.02.03.03.01.01.03.03.0 1.02.01.01.01.01.01.0 3.02.03.01.02.01.02.0
1.02.02.01.01.02.01.02.02.02.01.02.0 4.0 5.028.0 8.0 1.0 8.015.017.0 5.012.0 2.5 4.8 0.315.0 4.0
3.812.0 9.0 8.5 3.0 1.0 8.5 8.0 5.5 1.0 1.8 1.5 8.5 4.4 3.7 1.0 1.0
WY-1850 1.01.02.03.03.01.01.03.03.0 1.02.01.01.01.01.01.0 4.02.04.01.02.02.03.0
1.02.02.01.01.03.01.02.02.02.01.02.0 5.0 5.028.0 7.5 1.2 6.312.014.0 4.0 8.0 2.0 4.0 0.314.0 4.0
3.510.0 8.0 7.5 3.0 1.0 7.5 6.0 5.2 1.0 1.0 0.8 7.5 6.0 6.5 1.0 1.0
WY-3587 1.01.02.03.02.02.01.02.02.0 1.02.01.01.01.01.02.0 2.02.04.02.02.02.02.0
2.01.02.01.02.02.01.01.02.02.01.02.0 6.0 4.028.010.0 2.0 5.015.015.0 5.011.0 2.0 5.5 1.517.0 4.0
4.316.0 8.0 7.5 5.0 1.011.010.5 7.5 3.2 2.8 2.3 3.4 3.8 3.3 1.0 3.0
WY-5224 1.01.02.02.02.02.01.01.02.0 1.02.01.01.01.01.02.0 2.02.03.02.02.02.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 3.0 7.029.0 8.0 1.0 8.014.015.0 4.0 7.0 1.5 4.7 1.016.0 4.0
4.010.0 5.0 4.5 5.0 1.0 9.0 9.0 7.5 1.0 1.4 1.4 9.0 6.4 5.4 1.0 3.0
WY-7643 1.01.02.01.01.02.01.02.02.0 1.02.01.01.01.01.02.0 2.02.03.02.02.01.01.0
1.01.02.01.01.03.01.01.02.02.01.01.0 5.0 8.060.0 7.0 1.5 4.715.015.0 5.0 7.0 1.5 4.7 0.315.0 3.0
5.012.0 8.0 7.0 3.0 1.0 9.010.0 8.0 1.5 1.5 1.0 6.0 6.7 8.0 1.0 1.0
WY-6940 1.01.03.03.02.02.01.02.02.0 1.01.01.02.01.01.01.0 3.02.01.01.03.01.02.0
2.01.02.01.01.02.01.01.02.02.01.03.0 8.0 3.016.0 6.0 1.5 4.015.013.0 4.0 9.0 2.0 4.5 0.312.0 3.0
4.012.0 7.0 6.5 3.0 1.0 7.5 6.5 5.0 2.8 2.4 1.5 2.7 2.7 3.3 1.0 1.0
WY-8012 1.01.02.03.03.02.01.03.03.0 1.02.01.02.01.01.02.0 3.03.03.02.02.02.02.0
1.02.02.01.01.03.01.02.02.02.01.02.0 7.0 5.036.010.0 2.5 4.012.013.0 4.010.0 2.0 5.0 0.310.0 3.0
3.310.0 7.0 6.8 5.0 1.010.5 8.5 8.0 2.5 2.0 2.5 4.2 4.3 3.2 1.0 1.0
WY-113151.01.02.03.02.02.01.02.02.0 2.0 -9 -9 -91.01.01.0 3.02.01.01.03.01.04.0
1.02.02.01.01.02.01.01.02.02.01.02.0 5.0 4.037.0 -9 -9 -916.012.0 3.011.0 2.0 5.5 0.312.0 3.0
4.012.0 6.0 5.0 5.0 1.012.511.0 7.0 1.5 1.7 1.0 8.3 6.5 7.0 1.0 1.0
WY-113811.01.01.02.03.02.01.01.02.0 1.02.01.02.01.01.01.0 1.02.03.01.03.01.01.0
1.02.02.01.01.03.01.01.02.02.01.02.0 1.0 4.030.0 6.0 1.5 4.020.015.0 4.0 9.0 2.0 4.5 0.316.0 4.0
4.015.0 8.0 7.0 5.0 1.010.0 8.5 4.5 1.8 1.5 1.0 5.6 5.7 4.5 1.0 1.0
WY-114031.01.02.01.02.02.01.01.02.0 2.0 -9 -9 -91.01.01.0 1.02.01.02.01.01.01.0
1.02.02.01.01.02.01.01.02.02.01.02.0 4.0 5.041.0 -9 -9 -912.012.0 4.0 8.0 2.0 4.0 0.316.0 3.0
5.310.0 5.0 4.0 5.0 1.010.510.0 7.0 1.5 1.3 1.0 7.0 7.7 7.0 1.0 1.0
YT-117741.01.03.03.02.02.02.03.02.0 1.02.01.02.01.01.01.0 3.03.01.01.02.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.014.0 7.066.015.0 2.3 6.518.015.0 5.013.0 3.0 4.3 0.514.0
3.0 4.712.0 7.0 6.0 5.0 1.014.015.511.2 3.0 3.2 3.3 4.7 4.8 3.4 1.0 1.0
YT-118221.01.02.04.02.02.01.04.03.0 1.02.01.02.01.01.01.0 3.03.04.01.03.01.04.0
2.02.02.01.01.03.01.01.02.02.01.02.0 5.0 6.030.0 5.1 0.6 8.514.012.0 3.010.0 2.0 5.0 0.520.0 3.0
6.712.0 7.0 6.0 5.0 1.0 7.0 9.2 8.0 1.2 1.0 1.0 5.8 9.2 8.0 1.0 1.0
YT-119531.01.02.03.02.02.01.03.02.0 1.02.01.02.01.01.01.0 3.02.01.01.03.01.03.0
1.02.02.01.01.03.01.01.02.02.01.02.0 3.0 5.042.0 7.0 0.8 8.814.012.0 3.0 9.0 2.0 4.5 0.318.0 3.0
6.017.0 7.0 6.0 5.0 1.010.5 9.0 7.0 1.8 1.9 1.5 5.8 4.7 4.7 1.0 1.0
YT-119641.01.03.01.02.02.02.01.02.0 1.02.01.02.01.01.01.0 2.02.03.02.01.02.03.0

1.02.02.01.01.03.01.01.02.02.01.02.0 9.0 4.051.0 9.5 1.6 5.9 2.5 1.8 5.012.0 3.0 4.0 0.518.0 4.0
4.516.010.0 1.0 5.0 1.014.013.0 9.5 3.3 3.0 2.8 4.2 4.3 3.4 1.0 1.0
YT-119711.01.03.04.02.02.01.03.02.0 1.02.02.03.01.01.01.0 4.02.01.03.03.01.05.0
1.03.02.01.01.03.01.01.02.02.01.02.0 6.0 5.019.013.0 5.2 2.520.014.0 3.011.0 2.0 5.5 0.520.0 4.0
5.016.0 8.0 7.0 5.0 1.0 8.513.512.5 3.0 5.2 3.5 2.8 2.6 3.6 1.0 1.0
CA20014 2.01.02.01.03.02.02.01.03.0 2.0 -9 -9 -91.01.02.0 2.03.01.02.03.01.03.0
1.03.01.01.01.02.02.01.03.02.02.02.0 3.0 5.042.0 -9 -9 -912.012.0 4.010.0 2.0 5.0 1.013.0 3.0
4.312.0 7.0 6.0 3.0 1.0 5.512.512.0 1.4 1.6 1.4 3.9 7.8 8.6 1.0 2.0
CA-3574 2.01.02.01.03.02.02.01.03.0 1.01.01.01.01.01.02.0 1.03.01.02.03.01.03.0
1.03.01.01.01.02.02.01.02.02.02.01.0 6.0 4.036.0 3.2 0.5 6.416.013.0 4.012.0 3.0 4.0 0.314.0 3.0
4.710.0 8.0 7.0 0.0 1.0 8.0 6.5 7.5 1.2 0.9 1.3 6.7 7.2 5.8 1.0 2.0
CO-1914 2.01.03.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.03.03.03.01.01.0
1.03.01.01.01.02.02.01.03.02.02.02.0 7.0 7.047.0 -9 -9 -916.018.0 5.0 8.0 1.5 5.3 0.318.0 3.0
6.010.0 8.0 7.0 5.0 1.0 -9 5.0 9.5 -9 0.6 1.5 -9 8.3 6.3 1.0 2.0
CO-726 2.01.03.01.02.03.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.02.02.02.0 6.0 6.067.5 -9 -9 -910.015.011.0 9.0 2.0 4.5 0.313.0 3.0
4.310.0 8.0 7.0 3.0 1.0 -910.213.5 -9 1.3 1.7 -9 7.8 7.9 1.0 2.0
ID-431 2.01.03.01.03.02.01.01.03.0 1.02.01.05.01.01.02.0 1.03.01.03.03.01.03.0
1.03.01.01.01.02.02.02.02.03.03.01.0 5.0 5.040.011.0 1.7 6.514.013.0 4.011.0 2.0 5.5 0.315.0 3.0
5.010.0 7.0 6.5 3.0 1.0 9.010.0 7.0 1.0 1.3 1.0 9.0 7.7 7.0 1.0 2.0
ID10113 2.0 -93,02.03.02.02.02.03.0 1.02.01.05.01.01.02.0 2.03.04.03.02.01.03.0
1.03.01.01.01.03.02.02.02.03.03.02.0 3.0 5.048.0 8.0 1.5 5.318.015.0 5.012.0 2.0 6.0 0.320.0 5.0
4.012.0 9.0 8.0 5.0 1.012.011.510.0 2.0 1.7 2.0 6.0 6.8 5.0 1.0 2.0
ID-699 2.01.02.01.03.03.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.02.02.02.02.03.01.02.0 3.0 6.065.0 -9 -9 -912.018.0 4.010.0 2.0 5.0 0.318.0 5.0
3.612.0 9.0 8.0 5.0 1.0 -911.011.4 -9 2.0 1.8 -9 5.5 6.3 1.0 2.0
MT13360 2.01.03.01.03.03.01.01.03.0 2.0 -9 -9 -91.01.02.0 2.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.03.01.02.0 7.0 6.038.0 -9 -9 -910.012.0 4.0 8.0 1.5 5.3 0.314.0 4.0
3.5 8.0 7.0 6.5 3.0 1.0 -911.0 8.5 -9 2.1 1.8 -9 5.2 4.7 1.0 2.0
MT-3346 2.01.03.01.03.03.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.02.01.02.0 7.0 6.038.0 -9 -9 -912.014.0 4.0 7.0 2.0 3.5 0.311.0 2.0
5.510.0 7.0 6.5 3.0 1.0 4.0 8.0 9.5 0.8 1.2 1.2 5.0 6.7 7.9 1.0 2.0
NV-335 2.01.03.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.02.02.02.02.03.01.02.0 4.0 4.034.0 -9 -9 -914.015.0 5.0 9.0 2.0 4.5 0.315.0 4.0
3.812.0 7.0 6.5 3.0 1.0 8.010.5 8.0 1.3 1.7 2.3 6.2 6.2 3.5 1.0 2.0
OR-154 2.01.02.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.02.02.02.02.03.01.02.0 5.0 6.047.0 -9 -9 -912.016.0 5.0 9.0 2.0 4.5 0.317.0 4.0
4.312.0 9.0 8.5 3.0 1.010.012.511.5 1.9 1.5 1.3 5.3 8.3 8.8 1.0 2.0
OR-9827 2.01.03.01.03.03.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.02.02.02.02.03.01.02.0 9.0 6.048.0 -9 -9 -910.014.0 4.0 9.0 2.0 4.5 0.315.0 2.0
7.510.0 7.0 6.5 3.0 1.010.014.010.7 1.5 1.8 1.4 6.7 7.8 7.6 1.0 2.0
UT-1547 2.01.02.03.03.02.01.02.03.0 1.02.01.01.01.01.02.0 3.03.01.03.03.02.03.0
1.03.01.01.02.02.01.01.03.02.02.02.0 3.0 3.025.0 6.5 0.321.710.015.0 5.010.0 1.5 6.7 2.014.0 2.0
7.010.0 5.0 4.5 0.0 1.0 8.5 6.0 2.5 0.6 0.7 0.614.2 8.6 4.2 1.0 2.0
UT14209 2.01.03.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.03.03.01.01.010.0 5.035.0 -9 -9 -912.015.0 5.0 7.0 1.0 7.0 0.315.0 3.0
5.010.0 7.5 7.0 5.0 1.0 4.0 7.0 7.0 1.2 1.4 1.1 3.3 5.0 6.4 1.0 2.0
UT-5900 2.01.03.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.02.01.01.0
1.03.01.01.01.02.02.01.03.03.01.02.0 4.0 6.050.0 -9 -9 -914.022.0 7.012.0 1.012.0 1.020.0 4.0
5.010.011.010.0 5.0 1.0 5.010.510.5 1.0 1.4 1.3 5.0 7.5 8.0 1.0 2.0
WA-2736 2.01.02.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.02.01.01.0
1.03.01.01.01.02.02.01.03.03.01.02.0 3.0 6.030.0 -9 -9 -912.015.0 4.010.0 2.0 5.0 0.314.0 3.0
4.710.0 6.0 5.5 3.0 1.0 4.5 7.8 8.5 1.6 1.8 1.3 2.8 4.3 6.5 1.0 2.0
WA-2546 2.01.03.01.03.02.02.01.03.0 2.0 -9 -9 -91.01.02.0 2.03.04.03.03.01.01.0
1.03.01.01.01.03.02.01.02.03.01.02.0 4.0 5.048.5 -9 -9 -916.014.0 4.015.0 2.0 7.5 0.317.0 5.0
3.412.0 8.0 7.5 3.0 1.0 9.0 9.0 8.7 1.3 1.4 1.3 6.9 6.4 6.7 1.0 2.0

WY-K36 2.01.03.01.03.03.02.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 5.0 6.043.5 -9 -9 -916.018.0 5.010.0 2.0 .0 0.318.0 3.0
6.010.0 9.0 9.0 3.0 1.0 -9 9.010.0 -9 2.0 2.4 -9 4.5 4.2 1.0 2.0
WY-991 2.01.02.01.02.02.01.01.03.0 1.01.01.02.01.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.01.02.01.02.03.01.02.0 3.0 4.038.0 3.5 0.8 4.414.014.0 4.010.0 1.5 6.7 0.315.0 4.0
3.813.0 7.0 6.5 3.0 1.0 7.0 7.8 7.0 1.4 1.8 1.5 5.0 4.3 4.7 1.0 2.0
WY-1013 2.01.02.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.02.02.01.02.03.02.02.0 2.0 4.033.0 -9 -9 -918.020.0 5.011.0 2.0 5.5 0.315.0 5.0
3.012.010.0 9.0 3.0 1.0 7.0 9.0 8.5 1.4 1.8 1.4 5.0 5.0 6.1 1.0 2.0
WY-302 2.01.03.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 2.03.01.03.02.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 5.0 7.042.0 -9 -9 -910.013.0 4.0 8.0 1.0 8.0 0.314.0 3.0
4.6 4.8 6.0 5.5 3.0 1.0 5.0 7.0 8.0 1.3 1.8 1.9 3.8 3.9 4.2 1.0 2.0
WY-8499 2.01.03.01.03.03.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.02.01.01.0
1.03.01.01.01.02.02.01.03.03.01.02.0 5.0 5.041.0 -9 -9 -916.016.0 4.010.0 2.0 5.0 0.318.0 3.0
6.013.0 9.0 8.5 3.0 1.0 -910.011.0 -9 1.5 1.9 -9 6.7 5.8 1.0 2.0
WY-390 2.01.03.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.02.01.01.0
1.03.01.01.01.02.02.01.02.03.01.02.0 5.0 6.063.0 -9 -9 -918.020.0 6.012.0 2.0 6.0 0.522.0 5.0
4.414.0 9.0 8.5 5.0 1.0 -911.014.5 -9 2.2 3.0 -9 5.0 4.8 1.0 2.0
WY-5925 2.01.03.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.03.03.01.02.0 4.0 4.033.0 -9 -9 -914.014.0 4.0 9.0 2.0 4.5 0.317.0 4.0
4.312.0 9.0 8.5 3.0 1.0 -9 6.0 7.3 -9 1.4 1.9 -9 4.3 4.1 1.0 2.0
WY-6422 2.01.03.01.03.03.01.01.02.0 2.0 -9 -9 -91.01.02.0 1.03.01.02.02.02.01.0
1.02.01.01.02.01.02.01.03.02.02.02.030.0 7.056.0 -9 -9 -912.016.0 4.0 8.0 1.5 5.0 1.513.0 3.0
4.310.0 6.0 5.5 0.0 1.0 8.712.0 8.0 1.2 2.0 1.7 7.3 6.0 4.7 1.0 2.0
WY-1022 2.01.03.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.01.02.01.03.03.02.02.0 6.0 5.033.0 -9 -9 -912.010.0 5.0 8.0 2.0 4.0 0.311.0 2.0
5.5 7.0 7.0 6.0 3.0 1.0 3.5 5.5 7.0 1.0 1.4 1.4 3.5 3.9 5.0 1.0 2.0
WY-5216 2.01.02.01.03.02.02.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.03.02.01.02.03.01.02.0 3.0 6.055.0 -9 -9 -915.015.0 5.010.0 1.5 6.7 0.315.0 4.0
3.810.0 7.0 6.5 5.0 1.0 -911.515.0 -9 2.0 2.0 -9 5.8 7.5 1.0 2.0
WY-374 2.01.03.01.03.03.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.03.01.01.0
1.03.01.01.01.01.02.01.03.02.01.02.0 8.0 6.028.0 -9 -9 -910.018.0 5.0 9.0 1.5 6.0 0.314.0 3.0
4.7 8.010.0 9.0 3.0 1.0 5.0 8.0 8.0 0.7 1.0 1.0 7.1 8.0 8.0 1.0 2.0
CA-629401.01.03.04.03.01.01.04.03.0 1.02.01.02.02.01.02.0 2.03.04.03.01.02.04.0
1.03.01.01.01.03.01.01.03.02.01.02.0 9.0 3.059.510.0 1.3 7.912.015.0 6.015.0 2.0 7.5 0.314.0 2.0
7.010.010.0 9.0 5.0 1.0 9.0 4.5 2.8 1.4 1.0 0.6 6.4 4.5 4.7 1.0 2.0
CA1973111.01.02.03.02.01.01.03.02.0 1.04.01.02.02.01.02.0 2.03.03.01.02.02.03.0
1.03.01.01.01.03.01.01.03.02.01.02.0 5.0 4.063.519.0 2.7 7.016.017.0 6.013.0 2.0 6.5 0.316.0 4.0
4.010.0 8.0 6.0 5.0 1.011.0 5.5 3.5 1.6 1.3 1.0 6.9 4.2 3.5 1.0 2.0
CO-3814 1.01.02.02.02.01.02.03.03.0 1.02.01.02.02.01.02.0 3.03.04.02.01.02.04.0
1.03.01.01.01.03.01.02.03.02.02.02.0 3.0 2.039.0 8.0 2.5 3.217.019.0 6.014.0 2.0 7.0 0.312.0 4.0
3.0 6.0 7.0 6.5 1.0 7.0 6.5 3.5 -9 1.5 0.7 -9 4.3 5.0 -9 1.0 2.0
CO-552 1.01.02.02.03.01.01.02.02.0 1.02.01.02.02.01.02.0 3.03.01.01.01.01.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 5.0 2.042.0 8.0 1.5 5.312.017.0 5.011.0 1.5 7.3 0.0 0.0 0.0 0.0 0.0 9.0
8.0 5.0 1.0 9.0 5.8 -9 2.0 1.3 -9 4.5 4.5 -9 1.0 2.0
CO-5827 1.01.02.02.03.01.01.02.03.0 1.02.01.02.02.01.02.0 3.04.04.01.02.01.04.0 1.04.01.02.0
-93.01.02.03.02.02.02.0 3.0 3.056.010.0 2.4 4.218.017.0 5.014.0 3.0 4.7 0.0 0.0 0.0 0.0 0.0 9.0
8.0 5.0 1.011.0 5.0 2.5 2.5 1.2 0.6 4.4 4.2 4.2 1.0 2.0
CO16734 1.01.02.01.02.01.02.01.03.0 1.02.01.01.02.01.02.0 3.03.04.01.01.01.03.0 1.03.01.02.0
-93.01.01.03.02.01.02.0 3.0 2.031.0 9.0 1.5 6.012.018.0 5.013.0 2.0 6.5 0.0 0.0 0.0 0.0 0.0 8.0
7.0 5.0 1.0 6.0 1.5 0.8 0.7 0.3 0.2 8.6 5.0 4.0 1.0 2.0
CO-2734 1.01.02.01.02.01.01.01.01.0 1.02.01.02.02.01.02.0 3.03.04.01.01.02.03.0 1.03.01.02.0
-93.01.01.03.02.01.02.0 3.0 3.085.011.0 2.8 3,914.016.0 5.013.0 3.0 4.3 0.0 0.0 0.0 0.0
0.012.011.0 5.0 1.019.5 9.5 4.0 4.8 2.3 1.1 4.1 4.1 3.6 1.0 2.0
CO-59 1.01.02.02.02.01.01.02.01.0 1.02.02.03.02.01.02.0 2.03.01.01.01.01.03.0 1.03.01.02.0
-93.01.02.03.02.01.02.0 2.0 3.033.0 8.0 1.9 4.210.016.0 4.010.0 2.5 4.0 0.0 0.0 0.0 0.0

0.013.012.0 5.0 1.013.5 9.5 2.6 2.3 1.3 0.5 5.9 7.3 5.2 1.0 2.0
CO-8491 1.01.02.02.02.02.02.02.02.0 1.02.01.03.02.01.02.0 3.03.04.01.01.02.03.0 1.03.01.02.0 -93.01.02.03.02.01.02.0 3.0 3.049.0 9.0 2.7 3.312.015.0 4.010.0 2.0 5.0 0.0 0.0 0.0 0.0 0.0 7.0 6.5 5.0 1.0 7.5 4.5 2.2 1.5 0.8 0.5 5.0 5.6 4.4 1.0 2.0.
CO-4476 1.01.02.02.03.01.01.02.02.0 1.02.01.02.02.01.02.0 3.03.02.01.01.01.03.0 1.03.01.02.0 -93.01.02.03.02.02.01.0 5.0 3.043.0 7.5 2.6 2.918.018.0 5.013.0 2.0 6.5 0.0 0.0 0.0 0.0 0.0 7.0 6.5 5.0 1.0 9.0 4.0 2.0 2.0 0.7 0.5 4.5 5.7 4.0 1.0 2.0
CO-496 1.01.02.02.03.01.01.02.02.0 1.02.02.03.02.01.02.0 3.03.05.01.03.01.01.0 1.03.01.02.0 -93.01.02.03.02.01.02.0 7.0 3.055.010.0 2.3 4.315.015.0 5.014.0 2.0 7.0 0.0 0.0 0.0 0.0 0.0 8.0 7.5 5.0 1.010.0 5.0 2.7 2.2 0.9 0.5 4.5 5.6 5.4 1.0 2.0
ID-114311.01.02.02.03.01.01.02.03.0 1.02.02.03.02.01.02.0 3.03.03.02.01.01.04.0 1.03.01.01.02.02.01.01.03.02.01.02.0 3.0 3.044.0 3.5 1.5 2.312.013.0 5.014.0 3.0 4.7 1.012.0 3.0 4.0 6.0 8.0 7.0 5.0 1.010.2 5.5 2.1 3.0 1.8 0.3 3.4 3.1 7.0 1.0 2.0
ID-1749 1.01.02.01.03.02.01.02.02.0 1.02.01.03.02.01.02.0 3.03.05.01.03.01.03.0 1.03.01.02.0 -93.01.01.03.02.02.02.0 5.0 3.067.018.5 4.0 4.620.020.0 5.015.0 3.0 5.0 0.0 0.0 0.0 0.0 0.0 9.0 8.0 5.0 1.014.0 6.0 3.0 2.9 1.5 0.9 4.8 4.0 3.3 1.0 2.0
MT-84 1.01.01.02.03.01.01.02.02.0 1.02.02.03.02.01.02.0 3.03.05.01.02.01.03.0 1.03.01.02.0 -93.01.02.03.02.01.02.0 1.0 3.032.5 6.0 1.7 3.512.014.0 4.012.0 1.012.0 0.0 0.0 0.0 0.0 0.0 8.0 7.0 5.0 1.0 7.0 3.5 1.9 1.0 0.5 0.3 7.0 7.0 6.3 1.0 2.0
MT-528 1.01.02.02.02.01.01.02.02.0 1.02.02.02.02.01.02.0 2.03.01.01.02.01.03.0 1.03.01.02.0 -93.01.02.03.02.01.02.0 4.0 3.045.0 9.0 2.0 4.518.017.0 6.015.0 2.0 7.5 0.0 0.0 0.0 0.0 0.011.010.0 5.0 1.012.5 6.0 2.0 2.2 1.0 0.5 5.7 6.0 4.0 1.0 2.0
OR-1835 1.01.02.01.03.01.01.01.02.0 1.02.02.03.02.01.02.0 2.03.02.01.01.02.03.0 1.03.01.02.0 -93.01.02.03.02.01.03.0 9.0 3.061.0 7.0 3.4 2.112.016.0 5.011.0 2.0 5.5 0.0 0.0 0.0 0.0 0.0 8.0 7.0 5.0 1.011.5 6.5 2.7 3.0 1.5 0.8 3.8 4.3 3.4 1.0 2.0
UT-4315 1.01.02.02.03.01.02.02.03.0 1.02.02.03.02.01.02.0 2.03.05.01.01.02.03.0 1.03.01.02.0 -93.01.02.03.02.01.02.0 6.0 3.044.0 7.0 3.0 2.312.018.0 4.013.0 2.0 6.5 0.0 0.0 0.0 0.0 0.0 8.0 7.5 5.0 1.0 7.013.5 8.0 3.0 3.1 1.2 2.3 4.4 6.7 1.0 2.0
UT-6609 1.01.03.03.03.02.01.03.03.0 1.02.02.03.02.01.02.0 3.03.04.03.03.01.03.0 1.03.01.01.01.03.01.02.02.02.02.02.0 4.0 3.029.011.0 2.8 3.920.020.0 7.014.0 2.0 7.0 0.514.0 4.0 3.5 3.0 8.0 7.5 5.0 1.0 9.5 5.2 1.5 2.0 1.7 0.5 4.8 3.1 3.0 1.0 2.0
UT-6609+1.01.02.03.03.01.01.03.03.0 1.02.02.05.02.01.02.0 3.03.04.03.03.01.03.0 1.03.01.01.01.03.01.02.02.02.02.02.0 3.0 3.029.0 5.0 2.5 2.320.018.0 7.014.0 2.0 7.0 2.015.0 3.0 5.0 8.0 9.0 8.0 3.0 1.0 9.0 5.5 2.5 2.5 1.7 0.5 3.6 3.2 5.0 1.0 2.0
WA-381 1.01.02.01.02.01.01.03.02.0 1.02.01.03.02.01.02.0 3.03.05.01.03.01.03.0 1.03.01.02.0 -93.01.02.03.02.01.03.0 3.0 3.042.0 6.5 2.3 2.814.020.0 5.016.0 2.5 6.4 0.0 0.0 0.0 0.0 0.0 8.0 7.5 5.0 1.0 9.0 4.0 1.5 1.8 1.0 0.5 5.0 4.0 3.0 1.0 2.0
WA-21 1.01.02.02.03.01.01.03.02.0 1.02.02.03.02.01.02.0 2.03.01.01.02.01.03.0 1.03.01.02.0 -93.01.02.03.02.01.02.0 7.0 3.038.0 8.5 2.2 3.916.018.0 5.011.0 2.0 5.5 0.0 0.0 0.0 0.0 0.0 9.0 8.5 5.0 1.010.6 5.2 3.0 2.0 1.0 0.6 5.3 5.2 5.0 1.0 2.0
WY-114051.01.02.02.02.01.02.02.01.0 1.02.02.03.02.01.02.0 3.04.04.02.01.02.04.0 1.03.01.02.0 -92.01.01.03.02.01.02.0 3.0 4.059.0 9.0 3.0 3.018.018.0 5.017.0 2.0 8.5 0.0 0.0 0.0 0.0 0.0 7.0 6.0 6.0 1.015.5 9.0 4.7 3.5 2.1 1.0 4.4 4.3 4.7 1.0 2.0
WY-114061.01.02.02.03.01.01.02.02.0 1.02.02.03.02.01.02.0 2.03.04.02.01.02.04.0 1.03.01.02.0 -93.01.01.03.02.01.02.0 5.0 4.054.0 9.5 2.3 4.115.015.0 6.016.0 2.0 8.0 0.0 0.0 0.0 0.0 0.0 8.0 7.0 7.0 1.010.5 6.0 2.7 2.2 1.4 0.7 4.8 4.3 3.9 1.0 2.0.
WY-204 1.01.02.02.03.02.02.02.01.0 1.02.01.03.02.01.02.0 3.03.01.01.03.01.03.0 1.03.01.02.0 -92.01.02.02.03.02.02.0 3.0 3.073.816.5 4.0 4.124.018.0 5.016.0 2.0 8.0 0.0 0.0 0.0 0.0 0.0 8.0 7.5 5.0 1.019.010.5 4.0 4.0 2.2 0.9 4.8 4.8 4.4 1.0 2.0
WY-105 1.01.02.02.03.02.02.02.03.0 1.02.01.02.02.01.02.0 3.03.01.01.03.01.03.0 1.03.01.02.0 -91.01.02.03.03.02.02.0 3.0 4.042.0 7.0 1.5 4.716.015.0 4.015.0 2.0 7.5 0.0 0.0 0.0 0.0 0.0 9.0 8.5 5.0 1.011.010.2 5.5 2.0 1.5 1.3 5.5 6.8 4.2 1.0 2.0
WY-3905 1.01.02.01.03.02.02.02.02.0 1.02.01.03.02.01.02.0 3.03.01.01.02.01.03.0 1.03.01.02.0 -93.01.02.03.03.02.02.0 4.0 4.072.0 6.5 2.5 2.618.018.0 6.014.0 2.0 7.0 0.0 0.0 0.0 0.0 0.0 8.0 7.5 5.0 1.014.015.0 5.7 3.1 2.7 1.3 4.5 5.6 4.4 1.0 2.0
WY-3051 1.01.02.01.02.02.02.02.03.0 1.02.02.03.02.01.02.0 3.03.02.01.03.01.03.0 1.03.01.02.0

-91.01.02.03.02.02.02.0 4.0 3.054.0 4.5 1.5 3.016.014.0 4.012.0 2.0 6.0 0.0 0.0 0.0 0.0 0.0 8.0
7.5 5.0 1.013.510.0 4.0 3.0 1.7 0.7 4.5 5.9 5.7 1.0 2.0
WY-4198 1.0 -93.01.03.02.02.02.03.0 1.02.01.03.02.01.02.0 3.03.01.01.01.02.03.0 2.03.01.02.0
-93.01.02.03.02.02.02.014.0 3.052.014.5 4.0 3.614.018.0 6.014.0 3.0 4.7 0.0 0.0 0.0 0.0 0.0 9.0
8.0 5.0 1.013.0 8.0 4.5 3.0 2.0 1.5 4.3 4.0 3.0 1.0 2.0
AB-DRUMM1.02.02.02.02.02.02.02.02.0 1.02.02.05.01.01.02.0 3.03.04.02.03.01.03.0
2.03.01.01.01.03.01.01.01.03.04.02.0 3.0 3.041.010.0 2.3 4.320.017.0 5.012.0 3.5 3.4 0.320.0 6.0
3.310.0 8.0 7.5 5.0 1.0 9.8 6.5 4.7 3.2 2.4 2.0 3.1 2.7 2.4 1.0 2.0
CA-3168 1.01.02.03.03.02.01.03.03.0 1.02.01.02.01.01.01.0 3.03.03.02.02.02.03.0
2.03.01.01.01.03.01.01.01.03.03.02.0 3.0 3.048.013.5 1.8 7.5 2.0 1.5 5.013.0 3.0 4.3 0.518.0 5.0
3.613.0 7.0 6.5 5.0 1.0 8.5 4.3 2.3 1.0 1.2 0.6 8.5 3.6 3.8 1.0 2.0
CA-7555 1.01.02.02.03.02.01.03.03.0 1.02.02.05.01.01.02.0 3.03.03.02.03.01.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 1.0 3.043.0 7.5 2.4 3.125.015.0 5.011.0 3.0 3.7 0.520.0 6.0
3.316.0 7.0 6.5 5.0 1.0 9.0 6.5 2.0 2.0 2.8 0.6 4.5 2.3 3.3 1.0 2.0
CA-8811 1.01.01.01.02.01.01.01.02.0 1.01.02.02.02.01.01.0 1.03.03.03.02.031.03.0
2.02.01.01.01.03.01.01.01.03.04.02.0 1.0 3.062.0 8.5 2.3 3.722.015.0 5.013.0 2.5 5.2 0.525.0 6.0
4.214.0 8.0 7.5 5.0 1.0 8.5 5.0 3.8 1.5 1.3 1.1 5.7 3.8 3.4 1.0 2.0
BC19585 1.01.02.01.02.02.02.01.02.0 1.01.02.01.01.01.01.0 2.02.03.02.02.01.03.0
1.02.01.01.01.01.01.01.01.04.04.01.0 3.0 3.044.0 4.0 1.2 3.320.015.0 6.013.0 3.0 4.3 0.517.0 4.0
4.312.0 7.0 6.5 5.0 1.013.5 9.5 4.8 3.0 3.0 1.6 4.5 3.2 3.0 1.0 2.0
CO-1831 1.01.02.01.01.02.02.03.03.0 1.01.01.01.01.01.02.0 3.03.03.02.03.01.03.0
2.03.01.01.02.01.01.01.01.03.04.02.0 3.0 3.046.0 6.5 1.2 5.422.015.0 5.015.0 3.0 5.0 2.023.0 5.0
4.610.0 7.0 6.5 5.0 1.011.0 9.5 5.7 1.7 2.3 1.5 6.5 4.1 3.8 1.0 2.0
CO-6545 1.01.02.02.02.02.01.03.02.0 1.01.01.01.01.01.02.0 3.03.01.03.02.02.03.0
2.03.01.01.01.01.01.01.01.03.04.02.0 3.0 3.034.0 6.0 1.5 4.022.020.0 6.013.0 3.5 3.7 0.517.0 5.0
3.415.0 8.0 7.5 3.0 1.0 8.0 5.0 1.5 1.5 2.0 0.6 5.3 2.5 2.5 1.0 2.0
ID11332 1.01.02.02.02.02.01.02.02.0 1.01.02.05.01.01.02.0 2.02.03.01.03.01.03.0
1.02.01.01.01.02.01.01.02.03.04.02.0 3.0 3.034.0 4.0 1.5 2.715.012.0 5.011.0 2.0 5.5 0.316.0 4.0
4.012.0 6.0 5.0 3.0 1.0 7.2 6.3 4.7 1.8 2.2 2.0 4.0 2.8 2.4 1.0 2.0
ID-441 1.01.02.01.02.02.01.02.02.0 1.02.02.02.01.01.02.0 2.02.03.03.02.02.03.0
1.02.01.01.01.02.01.01.01.03.04.01.0 3.0 3.059.014.0 2.0 7.022.017.0 5.014.0 3.0 4.7 0.318.0 5.0
3.618.0 8.0 7.5 5.0 1.027.0 8.0 2.5 5.2 2.2 0.5 5.2 3.6 5.0 1.0 2.0
MT-146 1.01.02.02.02.02.02.02.02.0 1.02.02.05.01.01.02.0 2.02.04.02.03.01.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 1.0 3.042.010.0 2.0 5.024.015.0 6.013.0 3.0 4.3 0.330.0 8.0
3.812.0 9.0 8.0 5.0 1.014.0 6.8 4.0 4.0 2.2 1.5 3.5 3.1 2.6 1.0 2.0
MT13345 1.01.02.02.02.02.02.02.02.0 1.01.01.02.01.01.02.0 2.02.03.02.02.01.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 1.0 3.054.0 3.0 1.0 3.025.015.0 7.012.0 3.0 4.0 0.518.0 5.0
3.614.0 8.0 7.5 3.0 1.013.0 9.1 5.2 2.2 2.7 2.2 5.9 3.4 2.4 1.0 2.0
NV-1615 1.01.02.02.02.02.01.02.02.0 1.01.01.02.01.01.02.0 2.02.03.02.02.01.03.0
2.02.01.01.01.03.01.01.01.03.04.02.0 3.0 3.040.0 6.0 2.0 3.024.018.0 8.012.0 4.0 3.0 0.518.0 6.0
3.014.0 8.0 7.5 3.0 1.0 7.7 6.0 2.8 1.8 1.8 0.7 4.3 3.3 4.0 1.0 2.0
NV-6315 1.01.02.02.03.02.01.03.03.0 1.0 -9 -9 -91.01.02.0 2.03.03.02.02.02.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 3.0 3.040.0 -9 -9 -926.020.0 7.014.0 2.5 5.6 0.516.0 4.0
4.012.0 8.0 7.5 5.0 1.011.5 8.7 5.5 1.8 1.6 1.6 6.4 5.4 3.4 1.0 2.0
WA1028291.01.02.02.02.02.02.03.03.0 1.01.01.02.01.01.02.0 2.03.03.02.02.02.01.0
2.02.01.01.01.02.01.01.01.03.04.02.0 3.0 3.040.0 5.5 1.5 3.726.020.0 6.014.0 4.0 3.5 0.318.0 5.0
3.610.0 8.0 7.5 3.0 1.0 9.5 6.5 3.5 1.9 1.5 1.4 5.0 4.3 2.5 1.0 2.0
WA-H10 1.01.01.02.02.02.02.01.02.0 1.02.02.03.01.01.02.0 3.03.04.02.02.01.03.0
2.03.01.01.01.02.01.01.01.03.04.02.0 1.0 3.039.0 7.0 2.9 2.420.016.0 5.013.0 3.5 3.7 0.315.0 5.0
3.012.0 7.0 6.5 5.0 1.014.0 5.5 2.2 3.2 1.5 0.7 4.4 3.7 3.1 1.0 2.0
UT-5883 1.01.01.02.02.02.02.02.02.0 1.02.02.05.01.01.02.0 2.02.01.01.03.02.03.0
2.02.01.01.01.01.01.01.01.03.04.02.0 1.0 2.039.0 6.5 2.8 2.324.020.0 7.014.0 3.0 4.7 0.522.0 7.0
3.112.0 7.0 6.0 5.0 1.0 9.0 6.0 -9 2.7 2.4 -9 3.3 2.5 -9 1.0 2.0
UT-5057 1.01.02.01.01.02.02.01.02.0 1.01.02.03.01.01.02.0 1.03.03.02.03.02.01.0
2.02.01.01.01.01.01.01.01.03.04.02.0 3.0 4.052.0 3.0 1.3 2.316.013.0 5.013.0 4.5 2.9 0.318.0 6.0
3.012.0 5.0 4.5 5.0 1.0 9.015.3 7.5 3.1 4.0 3.2 2.9 3.8 2.3 1.0 2.0

UT17495 1.01.01.02.03.02.01.02.03.0 1.02.02.02.01.01.02.0 2.03.03.02.02.02.03.0
2.02.01.01.01.02.01.01.01.03.04.02.0 1.0 1.044.0 6.5 1.2 5.418.015.0 6.012.0 3.0 4.0 0.324.0 4.0
6.010.0 7.0 6.5 5.0 1.0 6.5 -9 -9 2.3 -9 -9 2.8 -9 -9 1.0 2.0
UT-1984 1.01.01.01.02.02.01.01.02.0 1.02.01.02.01.01.02.0 1.03.03.02.03.02.03.0
1.02.01.01.01.03.01.01.02.03.04.02.0 1.0 3.040.0 7.0 1.7 4.120.018.0 7.014.0 2.0 7.0 0.320.0 4.0
5.012.0 7.0 6.5 3.0 1.013.0 8.0 4.0 2.2-1.9 0.8 5.9 4.2 5.0 1.0 2.0
OR-1154 1.01.01.01.02.02.01.01.02.0 1.02.02.01.01.01.02.0 1.03.01.02.03.01.01.0
1.02.01.01.01.02.01.01.01.03.04.02.0 1.0 3.022.0 3.4 0.5 6.818.012.0 5.011.0 2.0 5.0 0.315.0 4.0
3.810.0 6.0 5.5 3.0 1.0 6.0 5.5 2.5 1.0 1.2 0.5 6.0 4.6 5.0 1.0 2.0
OR-56 1.01.01.01.01.02.02.01.02.0 1.01.02.02.01.01.02.0 3.03.03.01.03.01.03.0
2.02.01.01.01.01.01.01.01.03.04.02.0 1.0 3.045.0 3.5 1.3 2.720.015.0 5.015.0 3.0 5.0 1.013.0 3.0
4.310.0 6.0 5.5 3.0 1.0 7.0 8.7 6.5 2.5 3.0 2.2 2.8 2.9 3.0 1.0 2.0
OR-814 1.01.02.01.02.02.01.01.03.0 1.01.02.01.01.01.02.0 2.03.01.02.02.01.03.0
2.02.01.01.01.02.01.01.02.03.04.02.0 3.0 3.038.0 2.1 0.6 3.520.020.0 7.015.0 3.0 5.0 0.516.0 6.0
2.713.0 7.0 6.5 5.0 1.0 7.5 6.5 4.0 2.0 1.9 1.5 3.8 3.4 2.7 1.0 2.0
OR-2489 1.01.02.02.03.02.01.01.03.0 1.01.02.02.01.01.02.0 2.03.03.02.02.01.03.0
2.03.01.01.01.03.01.01.02.03.04.02.0 3.0 3.038.0 7.0 2.0 3.520.018.0 5.012.0 3.0 4.0 0.322.0 4.0
5.512.0 9.0 8.5 3.0 1.010.0 8.0 3.5 2.0 2.0 0.4 5.0 4.0 8.8 1.0 2.0
WY-410 1.01.03.03.03.02.01.02.03.0 1.01.02.01.01.01.02.0 3.03.03.03.02.02.03.0
2.03.01.01.01.03.01.01.01.03.04.02.0 4.0 3.036.0 3.0 1.0 3.022.018.0 5.012.0 3.0 4.0 0.518.0 6.0
3.014.0 8.0 7.0 3.0 1.0 8.0 7.5 3.5 2.5 2.0 1.4 3.2 3.8 2.5 1.0 2.0
WY-933 1.01.02.01.02.02.02.02.02.0 1.02.02.05.01.01.02.0 2.02.03.01.03.01.03.0
2.02.01.01.01.01.01.01.01.03.04.02.0 4.0 2.054.011.5 3.0 3.820.015.0 6.015.0 3.0 5.0 0.322.0 5.0
4.414.0 6.0 5.5 3.0 1.014.5 7.8 -9 2.5 2.2 -9 5.8 3.5 -9 1.0 2.0
WY-1702 1.01.01.01.02.02.02.01.01.0 1.02.02.05.01.01.02.0 2.02.03.02.03.01.03.0
1.02.01.01.01.02.01.01.02.03.04.02.0 1.0 3.059.014.0 3.5 4.020.018.0 5.014.0 2.5 5.6 0.322.0 5.0
4.414.0 7.0 6.5 3.0 1.014.010.0 5.7 4.5 4.7 3.0 3.1 2.1 1.5 1.0 2.0
WY-1785 1.01.01.01.02.02.02.01.02.0 1.02.01.02.01.01.02.0 2.02.01.01.03.01.03.0
1.02.01.01.01.01.01.01.01.03.04.02.0 1.0 2.049.010.5 1.5 7.025.018.0 6.014.0 3.0 4.7 0.528.0 6.0
4.616.0 8.0 7.0 3.0 1.0 7.5 5.5 -9 2.3 2.5 -9 3.3 2.2 -9 1.0 2.0
WY-6379 1.01.02.02.02.02.02.03.03.0 1.02.01.02.01.01.02.0 3.03.03.02.02.01.03.0
1.03.01.01.01.02.01.01.01.03.04.01.0 3.0 3.055.0 6.0 1.2 5.024.018.0 5.012.0 3.0 4.0 0.318.0 4.0
4.513.0 7.0 6.0 3.0 1.0 7.0 6.0 3.5 2.2 2.3 1.3 3.2 2.6 2.7 1.0 2.0
AB-116162.01.03.02.02.02.03.01.01.0 1.02.02.05.01.01.02.0 2.02.03.02.03.02.03.0
1.02.01.01.01.01.01.02.02.03.02.01.0 4.0 5.045.0 5.0 1.5 3.310.010.0 4.0 8.0 2.0 4.0 0.517.0 4.0
4.3 8.0 6.0 5.0 3.0 1.0 8.510.2 9.5 2.5 2.6 2.5 3.4 3.9 3.8 1.0 2.0
AB-169302.01.02.02.02.02.03.01.02.0 1.02.02.05.01.01.02.0 2.02.03.02.03.02.03.0
1.02.01.01.01.01.01.02.02.03.02.01.0 3.0 4.032.5 6.0 1.8 3.312.015.0 4.012.0 2.0 6.0 0.320.0 5.0
4.012.0 6.0 5.0 3.0 1.010.0 7.5 6.5 2.3 2.0 1.9 4.3 3.8 3.4 1.0 2.0
AK-385 1.01.01.02.02.02.03.01.02.0 1.01.02.02.01.01.02.0 2.02.02.01.02.02.02.0
1.02.01.01.01.02.01.02.02.03.03.02.0 1.0 4.036.0 5.5 2.0 2.815.012.0 6.010.0 2.0 5.0 0.510.0 3.0
3.314.0 7.0 6.0 3.0 1.0 9.2 8.5 7.0 2.0 2.3 2.2 4.6 3.7 3.2 1.0 2.0
AK-4957 1.01.02.02.02.02.03.01.01.0 1.02.01.01.01.01.02.0 2.02.02.01.02.02.02.0
1.02.01.01.01.02.01.02.02.03.03.01.0 3.0 6.042.0 7.0 1.2 5.815.015.0 4.010.0 3.0 3.3 0.515.0 5.0
3.0 9.0 7.0 6.0 3.0 1.0 9.3 9.2 9.0 1.6 2.4 2.6 5.8 3.8 3.5 1.0 2.0
AK-6400 1.01.02.02.02.02.03.01.02.0 1.01.01.01.01.01.02.0 2.02.02.02.02.02.03.0
1.02.01.01.01.02.01.02.02.03.03.02.010.0 5.036.0 5.8 1.7 3.418.018.0 6.010.0 2.0 5.1 1.015.0 5.0
3.0 9.0 8.0 7.0 3.0 1.0 6.5 6.5 5.5 1.5 1.7 2.0 4.3 3.8 2.8 1.0 2.0
AK-7119 1.01.02.02.02.02.02.02.02.0 1.02.01.02.01.01.02.0 1.02.02.01.02.02.03.0
1.02.01.01.01.02.01.02.01.03.03.01.0 3.0 5.046.010.5 2.5 4.225.017.0 5.012.0 3.0 4.0 1.020.0 5.0
4.012.0 8.0 7.0 3.0 1.010.5 8.5 6.7 2.5 2.1 1.9 4.2 4.0 3.5 1.0 2.0
BC-83 2.01.02.01.01.02.04.01.01.0 2.0 -9 -9 -91.01.02.0 1.01.03.01.03.01.01.0
1.01.01.01.02.01.01.0 -92.02.01.02.0 1.0 7.050.0 -9 -9 -915.0 9.0 4.014.0 2.0 7.0 1.012.0 2.0
6.010.0 5.0 4.0 3.0 1.0 4.5 5.5 6.0 1.0 1.3 1.7 4.5 4.2 3.5 1.0 2.0
CA-804 2.01.02.01.01.02.03.01.01.0 1.01.01.02.01.01.02.0 1.01.03.01.01.02.01.0
1.01.01.01.01.01.01.02.03.01.01.02.0 3.0 6.035.0 -9 -9 -910.012.0 3.010.0 2.0 5.0 0.515.0 3.0

5:010.0 5.0 4.0 3.0 1.0 3.5 6.0 6.0 1.5 1.9 2.1 2.3 3.2 2.9 1.0 2.0
CA-2531 2.01.02.01.01.02.03.01.01.0 2.0 -9 -9 -91.01.02.0 1.01.03.01.03.01.03.0
1.02.01.01.01.02.01.02.02.03.02.02.0 3.0 6.059.0 -9 -9 -915.013.0 4.010.0 2.0 5.0 0.516.0 4.0
4.010.0 6.0 5.5 3.0 1.0 8.0 9.010.5 2.4 2.5 2.4 3.3 3.6 4.4 1.0 2.0
ID-1656 2.01.02.01.02.02.03.01.01.0 2.0 -9 -9 -91.01.02.0 2.02.04.02.02.02.03.0
1.03.01.01.01.03.01.01.03.03.02.01.0 2.0 6.080.0 -9 -9 -912.017.0 5.011.0 3.0 3.7 0.320.0 4.0
5.010.0 8.0 7.0 3.0 1.012.011.510.0 2.5 3.5 3.7 4.8 3.3 2.7 1.0 2.0
ID-2186 2.01.02.01.01.02.02.01.01.0 1.01.01.01.01.01.01.0 2.02.03.02.02.02.03.0
1.02.01.01.01.01.01.02.02.03.03.01.0 4.0 6.020.0 3.0 0.6 5.012.017.0 5.010.0 2.0 5.0 0.515.0 5.0
3.010.010.0 9.5 5.0 1.0 5.5 6.0 5.3 1.5 1.7 1.6 3.7 3.5 3.3 1.0 2.0
ID-6074 2.01.02.01.02.02.03.01.01.0 1.02.01.02.01.01.01.0 2.02.03.01.02.02.01.0
1.02.01.01.01.01.01.02.02.03.02.01.0 3.0 5.032.0 5.3 1.3 4.115.014.0 4.010.0 2.0 5.0 0.314.0 4.0
3.510.0 6.0 5.0 3.0 1.0 6.0 5.6 5.3 1.5 1.6 1.2 4.0 3.5 4.4 1.0 2.0
MT-1094 2.01.02.01.02.02.04.01.02.0 1.01.02.03.01.01.02.0 2.02.03.02.02.02.03.0
2.02.01.01.01.02.01.02.03.03.03.02.0 9.0 4.045.0 3.5 1.5 2.3 7.010.0 5.0 8.0 2.0 4.0 0.314.0 5.0
2.8 6.0 6.0 5.5 5.0 1.0 8.2 8.2 6.8 3.8 3.4 2.9 2.2 2.4 2.3 1.0 2.0
MT-1095 2.01.02.01.01.02.04.01.01.0 1.01.02.03.01.01.02.0 2.02.03.02.02.02.03.0
2.02.01.01.01.01.01.02.03.03.03.02.0 9.0 4.050.0 3.0 1.5 2.010.015.0 6.010.0 3.0 3.3 0.524.0 8.0
3.012.0 7.0 6.5 5.0 1.0 7.510.310.5 4.9 5.2 4.3 1.5 2.0 2.4 1.0 2.0
NV-114602.01.02.02.02.02.03.01.02.0 2.0 -9 -9 -91.01.02.0 2.03.03.01.02.01.03.0
1.02.01.01.01.02.01.02.02.03.01.01.0 2.0 6.032.0 -9 -9 -916.015.0 4.011.0 2.0 5.5 1.020.0 4.0
5.011.0 7.0 6.0 3.0 1.0 5.0 9.010.0 1.5 2.0 3.0 3.3 4.5 3.3 1.0 2.0
NV-114622.01.02.01.02.02.03.01.02.0 2.0 -9 -9 -91.01.02.0 2.02.03.02.02.02.03.0
1.03.01.01.01.02.01.02.02.03.02.01.0 3.0 6.050.5 -9 -9 -916.014.0 4.014.0 2.0 7.0 0.316.0 3.0
5.310.0 8.0 7.0 3.0 1.0 7.512.514.0 2.0 2.3 2.5 3.8 5.4 5.6 1.0 2.0
OR-166 2.01.02.01.01.02.03.01.01.0 1.01.01.02.01.01.01.0 3.02.03.01.02.01.02.0
2.01.01.01.02.02.01.02.02.02.01.01.0 3.0 5.040.0 4.0 1.5 2.715.012.0 3.010.0 3.0 3.3 1.515.0 3.0
5.010.0 6.0 5.0 5.0 1.0 8.0 8.5 6.8 2.8 2.7 3.0 2.9 3.1 2.3 1.0 2.0
OR-131522.01.02.02.01.02.04.01.01.0 1.01.01.01.01.01.01.0 2.01.04.02.03.02.03.0
1.01.01.01.02.03.02.02.03.02.01.02.0 8.0 7.090.0 2.5 0.8 3.110.012.0 3.010.0 1.5 6.7 2.015.0 4.0
3.810.0 5.0 4.5 5.0 1.0 7.5 8.2 9.0 2.8 3.7 3.8 2.7 2.2 2.4 1.0 2.0
UT-1974 2.01.02.03.03.02.01.02.02.0 1.01.02.02.01.01.02.0 3.03.03.02.03.01.03.0
1.03.01.01.01.03.01.02.02.03.03.02.0 3.0 5.025.0 5.5 1.9 2.916.016.0 5.010.0 2.0 5.0 1.024.0 4.0
6.012.0 6.0 5.5 5.0 1.010.0 9.0 6.5 2.3 2.0 1.9 4.4 4.5 3.4 1.0 2.0
WA-596 2.01.02.01.01.02.02.01.01.0 1.02.02.04.01.01.02.0 2.02.03.01.02.02.01.0
1.02.01.01.01.01.01.02.02.03.02.01.0 3.0 4.023.0 5.5 1.5 3.712.014.0 4.010.0 2.0 5.0 1.015.0 5.0
3.010.0 7.0 6.5 3.0 1.0 6.5 5.0 3.0 2.0 1.7 1.0 3.3 2.9 3.0 1.0 2.0
WA-672 2.01.02.01.01.02.02.01.01.0 1.01.02.04.01.01.02.0 2.02.01.01.02.02.01.0
1.01.01.01.01.01.01.02.03.03.01.01.0 3.0 4.040.0 3.5 1.9 1.810.012.0 4.0 8.0 1.5 5.3 0.512.0 4.0
3.0 8.0 7.0 6.5 5.0 1.0 6.6 7.5 5.7 2.1 2.1 1.5 3.1 3.6 3.8 1.0 2.0
WA-5196 2.01.02.01.01.02.03.01.02.0 2.0 -9 -9 -91.01.02.0 2.03.03.02.02.02.03.0
1.03.01.01.01.02.01.02.02.03.02.01.0 8.0 7.059.0 -9 -9 -912.014.0 3.0 9.0 2.0 4.5 0.316.0 4.0
4.010.0 7.0 6.0 3.0 1.0 8.010.0 8.6 2.9 2.7 2.2 2.8 3.7 3.9 1.0 2.0
WY-3911 2.01.02.02.02.01.02.02.02.0 1.02.01.02.01.01.02.0 2.03.03.01.02.01.03.0
1.03.01.01.02.02.01.02.02.03.03.01.0 3.0 4.037.5 5.5 1.7 3.214.018.0 5.011.0 2.0 5.5 1.518.0 4.0
4.512.0 7.0 6.0 5.0 1.014.0 8.0 6.0 2.3 1.5 1.7 6.1 5.3 3.5 1.0 2.0
M-49 1.01.02.02.02.02.03.02.02.0 1.01.01.03.01.01.02.0 2.02.02.02.02.01.03.0
1.02.01.01.01.02.01.02.01.03.03.01.0 3.0 3.028.0 8.0 3.0 2.615.014.0 4.012.0 3.0 4.0 0.516.0 4.0
4.012.0 6.0 5.0 3.0 1.0 8.0 6.0 -9 2.5 2.0 -9 3.2 3.0 -9 2.0 2.0
M-6970051.01.01.01.02.02.02.01.01.0 1.02.01.02.01.01.02.0 2.02.03.02.02.02.03.0
1.02.01.01.01.02.01.02.03.03.03.02.0 1.0 5.022.0 8.0 2.0 4.010.015.0 5.010.0 2.0 5.0 0.512.0 5.0
2.410.0 6.0 5.5 3.0 1.011.0 6.6 4.5 1.6 1.0 0.9 6.9 6.6 5.0 2.0 2.0
NB5479801.01.01.02.01.02.02.01.01.0 1.02.02.02.01.01.02.0 2.02.02.01.03.02.03.0
1.02.01.01.01.02.01.02.02.03.03.02.0 1.0 3.025.0 6.0 1.5 4.012.010.0 5.012.0 2.0 6.0 1.020.0 4.0
5.012.0 6.0 5.0 3.0 1.011.5 9.0 7.0 2.0 1.6 1.5 5.8 5.6 4.7 2.0 2.0
NB6056181.01.02.02.02.02.02.01.02.0 1.02.02.02.01.01.02.0 2.02.03.02.02.02.03.0

1.02.01.01.01.02.01.02.02.03.03.01.0 3.0 5.033.0 7.0 1.5 4.712.014.0 5.013.0 ?.0 6.5 0.516.0 5.0
3.210.0 7.0 6.5 3.0 1.010.8 7.7 5.2 2.2 1.4 0.8 4.9 5.5 6.5 2.0 2.0
NH-171 1.01.01.02.02.02.02.01.02.0 1.02.01.01.01.01.02.0 3.02.02.02.02.02.03.0
1.02.01.01.01.02.01.02.02.03.03.02.0 3.0 5.031.0 9.5 2.0 4.815.015.0 5.012.0 2.0 6.0 1.017.0 4.0
4.314.0 7.0 6.0 3.0 1.015.0 7.0 6.7 1.9 1.3 1.6 7.9 5.4 4.2 2.0 2.0
NH-1287 1.01.02.02.03.02.03.02.02.0 1.01.02.02.01.01.02.0 3.03.02.02.03.02.03.0
1.01.01.01.01.02.01.02.02.03.03.02.0 3.0 2.026.0 3.7 1.5 2.515.010.0 6.010.0 2.0 5.0 1.014.0 5.0
2.814.0 6.0 5.5 3.0 1.0 8.5 7.5 -9 2.5 3.0 -9 3.4 2.5 -9 2.0 2.0
NH-1417 1.01.01.02.02.02.03.02.02.0 1.01.02.02.01.01.02.0 3.02.02.02.02.02.03.0
1.02.01.01.01.02.01.02.02.03.03.02.0 3.0 3.038.0 9.0 1.5 6.015.012.0 6.012.0 2.0 6.0 1.015.0 3.0
5.013.0 5.0 4.0 3.0 1.010.5 9.0 4.5 2.5 2.5 1.5 4.2 3.6 3.0 2.0 2.0
NH-2373 1.01.01.02.02.02.02.02.02.0 1.01.02.02.01.01.02.0 3.02.02.02.02.02.03.0
1.02.01.01.01.02.01.02.02.03.03.02.0 3.0 3.029.0 5.0 1.9 3.3 1.5 1.5 4.010.0 3.0 3.3 1.015.0 4.5
3.315.0 6.0 5.0 3.0 1.0 8.0 7.5 3.5 2.2 3.2 1.2 3.6 2.3 2.9 2.0 2.0
NH-3140 1.01.02.02.02.02.03.01.02.0 1.02.02.02.01.01.02.0 2.02.02.02.03.02.03.0
1.02.01.01.01.02.01.02.01.03.03.02.0 3.0 2.030.0 6.0 1.8 3.320.012.0 5.012.0 3.0 4.0 2.018.0 4.0
4.512.0 5.0 4.5 3.0 1.0 9.0 7.5 -9 3.5 3.0 -9 2.6 2.5 -9 2.0 2.0
NH-125291.01.02.02.02.02.03.02.02.0 1.01.02.02.01.01.02.0 3.03.02.02.03.02.03.0
1.02.01.01.01.02.01.02.02.03.03.02.0 2.0 2.023.5 5.2 1.6 3.315.015.0 5.010.0 2.0 5.0 0.515.0 5.0
3.010.0 6.0 5.5 3.0 1.0 8.0 6.5 -9 2.0 2.1 -9 4.0 3.1 -9 2.0 2.0
Q-146 1.01.02.01.01.02.02.01.01.0 1.01.02.02.01.01.02.0 2.02.02.02.03.01.01.0
1.02.01.01.01.02.02.02.02.03.03.01.0 3.0 3.034.0 4.5 1.0 4.510.013.0 4.010.0 2.0 5.0 1.010.0 4.0
2.510.0 5.0 4.0 3.0 1.0 7.0 5.0 3.3 1.3 1.0 0.8 5.4 5.5 4.1 2.0 2.0
Q-1453 1.01.01.01.01.02.02.01.01.0 1.02.02.02.01.01.02.0 2.02.02.02.02.02.03.0
1.02.01.01.01.02.01.02.02.03.03.01.0 3.0 4.045.014.5 2.7 5.415.012.0 4.0 8.0 2.0 4.0 0.015.0 4.0
3.810.0 6.0 5.0 3.0 1.013.0 9.0 6.9 2.5 2.1 1.7 5.0 4.3 4.1 2.0 2.0
Q-4577 1.01.02.01.01.02.02.01.03.0 1.02.01.02.01.01.02.0 2.02.02.02.02.02.03.0
1.02.01.01.01.02.01.02.02.03.03.01.0 3.0 3.038.0 4.0 1.3 3.115.015.0 5.010.0 3.0 3.3 1.018.0 4.0
4.510.0 6.0 5.0 3.0 1.0 8.5 7.8 5.0 2.2 1.8 1.2 3.9 4.3 4.2 2.0 2.0
Q-15267 1.01.01.01.01.02.02.01.02.0 1.03.01.02.01.01.02.0 2.02.02.01.01.02.03.0
1.01.01.01.01.02.01.02.02.03.03.01.0 1.0 4.049.019.5 2.2 8.915.017.0 5.012.0 2.0 6.0 2.016.0 4.0
4.012.0 6.0 5.0 3.0 1.011.0 6.5 5.5 1.5 1.0 0.9 7.3 6.5 6.1 2.0 2.0
Q-26089 1.01.02.01.01.02.03.01.02.0 1.01.02.02.01.01.02.0 2.02.02.02.03.01.03.0
1.01.01.01.01.02.01.02.02.03.03.01.0 3.0 3.034.0 7.5 2.5 3.015.013.0 5.015.0 3.0 5.0 1.015.0 3.0
5.013.0 7.0 6.0 3.0 1.0 9.1 7.8 -9 3.0 3.1 -9 3.0 2.5 -9 2.0 2.0
Q-32432 1.01.02.01.02.02.02.01.02.0 1.02.01.01.01.01.02.0 2.02.02.02.02.02.03.0
1.02.01.01.01.02.01.02.02.03.03.01.0 2.0 4.034.0 9.0 1.4 6.412.015.0 5.013.0 2.0 6.5 1.016.0 4.0
4.012.0 7.0 6.0 3.0 1.013.0 8.0 8.5 1.9 1.0 1.6 6.8 8.0 5.3 2.0 2.0
AB-115041.01.01.01.03.02.03.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.03.02.02.02.01.0
1.03.01.01.01.02.01.01.02.03.03.02.0 1.0 3.038.0 -9 -9 -915.013.0 5.013.0 2.0 6.5 0.316.0 5.0
3.210.0 6.0 5.0 5.0 1.0 8.210.0 5.5 3.7 3.4 2.2 2.2 2.9 2.5 1.0 2.0
AB-115111.01.02.01.03.02.03.01.02.0 1.03.02.03.01.01.02.0 1.04.03.03.02.02.01.0
1.03.01.01.01.02.01.01.03.03.03.02.0 3.0 3.041.0 6.0 1.8 3.312.018.0 7.012.0 3.0 4.0 0.316.0 4.0
4.010.0 8.0 7.0 5.0 1.011.0 7.2 2.5 3.2 2.5 0.4 3.4 2.9 6.3 1.0 2.0
AB-115361.01.02.01.03.02.03.01.03.0 1.03.02.03.01.01.02.0 1.03.04.02.02.02.01.0
1.03.01.01.01.02.01.01.03.03.03.02.0 3.0 3.043.0 4.0 1.7 2.418.022.0 7.013.0 2.5 5.2 0.320.0 5.0
4.010.0 8.0 7.0 5.0 1.0 8.5 5.5 2.7 3.0 2.5 0.8 2.8 2.2 3.4 1.0 2.0
AB-115381.01.02.01.03.02.03.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.04.01.02.02.01.0
1.03.01.01.01.02.01.01.03.03.03.02.0 3.0 3.030.5 -9 -9 -914.016.0 6.013.0 2.0 6.5 0.316.0 3.0
5.310.0 7.0 6.0 5.0 1.0 5.0 4.5 2.3 2.6 2.0 1.0 1.9 2.3 2.3 1.0 2.0
AB-115501.01.02.01.03.02.03.01.03.0 1.02.02.03.01.01.02.0 1.03.04.01.02.02.01.0
1.03.01.01.01.01.01.01.02.03.03.02.0 3.0 2.033.0 5.0 1.4 3.615.014.0 6.012.0 3.0 4.0 0.318.0 5.0
3.610.0 7.0 6.0 5.0 1.0 7.0 4.2 -9 2.7 1.8 -9 2.6 2.3 -9 1.0 2.0
AB-115911.01.02.01.03.02.03.01.03.0 1.02.02.03.01.01.02.0 1.03.03.02.03.02.01.0
1.03.01.01.01.03.01.01.03.03.03.02.0 3.0 4.028.0 2.5 1.8 1.410.018.0 7.010.0 2.0 5.0 0.314.0 3.0
4.710.0 8.0 7.0 5.0 1.0 7.5 6.0 4.2 3.0 2.4 1.5 2.5 2.5 2.8 1.0 2.0

AB-115931.01.02.01.03.02.03.01.03.0 2.0 -9 -9 -91.01.01.0 1.03.03.02.02.02.01.0
1.03.01.01.01.02.01.01.03.03.03.02.0 5.0 3.035.0 -9 -9 -914.016.0 7.013.0 2.5 5.2 0.316.0 4.0
4.012.0 8.0 7.0 5.0 1.0 6.5 6.5 4.5 3.0 3.0 2.2 2.2 2.2 2.0 1.0 2.0
AK-1315 1.01.02.01.02.02.03.01.02.0 2.0 -9 -9 -91.01.02.0 2.03.03.02.02.01.03.0
1.02.01.01.01.02.01.01.03.02.03.02.0 3.0 4.045.0 -9 -9 -918.020.0 7.012.0 2.0 6.0 0.520.0 4.0
5.015.0 7.0 6.0 5.0 1.0 8.0 9.2 5.5 2.8 3.5 2.0 2.9 2.6 2.8 1.0 2.0
BC-082 1.01.02.01.02.02.03.01.03.0 1.02.02.03.01.01.02.0 1.03.04.01.02.02.01.0
1.03.01.01.01.02.01.01.03.03.03.02.0 5.0 3.029.0 3.5 2.4 1.512.012.0 6.010.0 2.0 5.0 0.316.0 4.0
4.010.0 6.0 5.0 5.0 1.0 4.5 4.5 3.5 2.0 2.2 2.0 2.3 2.0 1.8 1.0 2.0
BC-993 1.01.02.01.03.02.03.01.03.0 1.02.02.03.01.01.02.0 1.04.03.01.03.02.03.0
1.03.01.01.01.01.01.01.03.03.03.02.0 3.0 3.024.0 4.0 2.0 2.012.013.0 5.011.0 2.0 5.5 0.312.0 3.0
4.010.0 6.0 5.0 5.0 1.0 6.0 4.3 2.0 2.5 1.8 1.0 2.4 2.4 2.0 1.0 2.0
BC-1467 1.01.02.01.02.02.03.01.02.0 2.0 -9 -9 -91.01.02.0 1.03.03.02.02.02.03.0
1.03.01.01.01.01.01.01.02.03.03.02.0 1.0 3.031.0 -9 -9 -915.015.0 6.011.0 2.0 5.5 0.516.0 2.0
8.010.0 7.0 6.0 7.0 1.0 7.2 5.6 2.7 3.3 1.6 0.5 2.2 3.5 5.4 1.0 2.0
BC-115881.01.02.01.03.02.03.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.02.02.02.01.0
1.03.01.01.01.01.01.01.03.03.03.02.0 3.0 3.041.0 -9 -9 -916.016.0 7.013.0 2.5 5.2 0.316.0 4.0
4.010.0 8.0 7.0 5.0 1.0 9.5 6.0 3.5 4.0 3.0 1.0 2.4 2.0 3.5 1.0 2.0
CA-763 1.01.03.01.01.02.03.01.02.0 2.0 -9 -9 -91.01.02.0 1.02.01.02.02.01.01.0
1.02.01.01.01.02.01.01.03.02.03.02.0 7.0 3.034.0 -9 -9 -913.016.0 8.012.0 2.0 6.0 0.515.0 3.5
4.3 9.0 6.0 5.5 3.0 1.0 9.5 8.0 4.0 4.5 3.0 1.8 2.0 2.7 2.2 2.0 2.0
CA-813 1.01.02.01.02.02.02.01.02.0 1.01.02.01.01.01.02.0 1.02.01.01.02.01.01.0
1.02.01.01.01.02.01.01.03.02.03.02.0 2.0 3.031.0 1.5 0.5 3.012.015.0 6.010.0 2.0 5.0 0.514.0 4.0
3.513.0 6.0 5.5 3.0 1.0 5.0 5.0 2.7 1.7 1.8 1.0 2.9 2.7 2.7 1.0 2.0
CO-1635 1.01.03.02.02.02.03.01.02.0 1.02.02.03.01.01.02.0 1.02.03.01.02.01.01.0
1.02.01.01.01.01.01.01.03.02.03.02.010.0 4.042.0 3.5 2.0 1.812.015.0 7.011.0 2.0 5.5 0.514.0 4.0
3.5 8.0 7.0 6.5 5.0 1.0 7.5 9.0 7.0 5.0 5.5 4.5 1.5 1.6 1.6 1.0 2.0
CO-67 1.01.02.01.02.02.03.01.02.0 1.02.01.03.01.01.02.0 1.02.03.02.03.01.01.0
1.02.01.01.01.02.01.01.03.02.03.02.0 3.0 5.050.0 8.5 2.5 3.412.015.0 5.012.0 3.0 4.0 0.516.0 5.0
3.2 8.0 7.0 6.5 6.0 1.015.313.0 6.0 5.0 4.4 2.6 3.0 3.0 2.3 1.0 2.0
CO-5299 1.01.02.01.02.02.02.02.01.0 1.01.02.03.01.01.02.0 1.02.03.02.02.02.01.0
1.02.01.01.01.01.01.01.03.02.03.02.0 3.0 4.035.0 2.7 1.7 1.612.015.0 5.0 9.0 2.0 4.5 0.515.0 5.0
3.0 8.0 5.0 4.5 5.0 1.0 6.5 6.2 4.0 3.0 2.4 1.8 2.2 2.6 2.2 1.0 2.0
ID-3691A1.01.02.01.02.02.03.01.02.0 2.0 -9 -9 -91.01.02.0 1.02.04.01.02.01.01.0
1.02.01.01.01.01.01.01.03.02.03.02.0 3.0 3.037.0 -9 -9 -915.018.0 9.011.0 1.011.0 0.213.0 4.0
3.3 8.0 8.0 7.5 3.0 1.0 3.5 8.2 5.0 1.5 2.9 2.2 2.3 2.8 2.3 1.0 2.0
OR-2463 1.01.01.01.02.02.03.01.03.0 1.02.02.03.01.01.02.0 2.03.03.02.02.02.03.0
1.03.01.01.01.02.01.01.02.03.03.02.0 1.0 3.021.0 3.0 1.0 3.012.013.0 6.011.0 2.0 5.5 0.312.0 3.0
4.010.0 8.0 7.0 5.0 1.0 5.2 3.7 2.2 2.0 1.0 0.8 2.6 3.7 2.8 1.0 2.0
OR-114741.01.02.01.03.02.01.01.03.0 2.0 -9 -9 -91.01.02.0 1.03.01.03.01.01.01.0
1.03.01.01.01.02.01.01.03.03.03.02.0 4.0 3.033.0 -9 -9 -917.015.0 7.011.0 2.0 5.5 0.312.0 3.0
4.010.0 6.0 5.0 5.0 1.0 5.2 5.7 4.4 2.9 2.0 1.7 1.8 2.9 2.6 1.0 2.0
OR-269631.01.02.01.03.02.03.01.03.0 1.02.02.03.01.01.02.0 1.03.03.01.03.02.01.0
1.03.01.01.01.01.01.01.03.03.03.02.0 3.0 3.024.0 4.3 2.0 2.215.018.0 5.012.0 3.0 4.0 0.318.0 4.0
4.510.012.011.0 5.0 1.0 6.0 5.0 1.7 2.4 2.0 0.8 2.5 2.5 2.1 1.0 2.0
UT-O-1221.01.01.01.02.02.02.01.02.0 1.01.02.01.01.01.02.0 1.02.01.02.03.01.01.0
1.02.01.01.01.02.01.01.02.02.02.02.0 1.0 3.015.0 1.0 0.5 2.016.018.0 6.012.0 2.0 6.0 0.512.0 3.0
4.0 8.0 8.0 7.5 3.0 1.0 5.5 6.0 4.2 2.6 2.5 1.5 2.1 2.4 2.8 1.0 2.0
UT-9851 1.01.03.01.01.02.02.01.01.0 1.01.02.01.01.01.02.0 1.02.03.03.02.01.01.0
1.02.01.01.01.02.01.01.03.02.03.02.0 6.0 3.037.0 4.5 1.5 3.015.017.0 7.011.0 2.5 4.4 0.515.0 5.0
3.010.0 7.0 6.0 5.0 1.0 7.0 5.1 2.5 2.6 2.0 1.0 2.7 2.6 2.5 1.0 2.0
UT-3546 1.01.03.01.03.02.02.01.02.0 1.01.01.01.01.01.02.0 2.03.03.03.03.02.01.0
1.03.01.01.01.01.01.01.03.02.03.02.0 5.0 4.044.0 2.5 1.0 2.513.015.0 6.011.0 2.5 4.4 0.517.0 5.0
3.4 9.0 7.0 6.5 5.0 1.0 7.0 9.0 5.5 2.0 2.4 1.7 3.5 3.8 3.2 1.0 2.0

Appendix 4. Sources of Population Samples for Flavonoid Study

A. chamissonis Less.

U.S.A., **Alaska**: Richardson Hwy (Hwy 4), c. 1.1 km S of Mile post 69, *Wm. & Aida Gruezo WM11881* (ALTA 91947!, ALTA 91948!, WGRZ!); Richardson Hwy (Hwy 4), c. 100 m before Ernestine Station & 125 m S of Mile post 62, *Wm. & Aida Gruezo WM11883* (ALTA 91950!, ALTA 91951!, WGRZ!). Glenn Hwy (Hwy 1), Mile post 59, left side of road en route to Anchorage, c. 80 m from Hilltop Cafe & Tesoro Gas Station, growing on stony-sandy grassy soil in road shoulders, *Wm. & Aida Gruezo WM11914* (ALTA!, WGRZ!); Glenn Hwy (Hwy 1), vicinity of Mile post 59.8, left side of road en route to Anchorage, c. 75 m from Hilltop Cafe & Tesoro Gas Station, *Wm. & Aida Gruezo WM11915* (ALTA!, WGRZ!); Glenn Hwy (Hwy 1 SE), Turnagain Arm area, vicinity of Mile post 94.3, left side of road en route to Girdwood, *Wm. & Aida Gruezo WM11916* (ALTA!, WGRZ!); Girdwood proper, in front of Double Musky Inn, along edge of road canal & lawn of Double Musky Inn, *Wm. & Aida Gruezo WM11919* (ALTA!, WGRZ!); Girdwood proper, along Alyeska Hwy, c. 0.8 km from junction of Glenn Hwy (Hwy 1 SE) & Alyeska Hwy, *Wm. & Aida Gruezo WM11920* (ALTA!, WGRZ!); Glenn Hwy (Hwy 1 SE), c. 66 mi N of Seward, right side of road en route to Seward, *Wm. & Aida Gruezo WM11921* (ALTA!, WGRZ!); Glenn Hwy (Hwy 1, S), vicinity of entrance road to Chugach National Forest Campground, Granite Creek, c. 1.5 km S of Mile post 62, *Wm. & Aida Gruezo WM11922* (ALTA!, WGRZ!); Glenn Hwy (Hwy 1 S), c. 1 km N of Mile post 49, *Wm. & Aida Gruezo WM11923* (ALTA!, WGRZ!). Hwy 9, Moose Pass proper, behind garage of Chevron Gas Station, *Wm. Gruezo WM11925* (ALTA!, WGRZ!). Seward Township, Hwy 9, c. 6 mi N of Seward proper, right side of road en route Seward, *Wm. & Aida Gruezo WM11928* (ALTA!, WGRZ!). Kenai Township, Hwy 1, c. 2 mi before Kenai proper, corner of Hwy 1 & McCollum Drive, *Wm. & Aida Gruezo WM11932* (ALTA!, WGRZ!). Hwy 1(S), c. 4 mi N of Kasilof, vicinity of Mile post 103, *Wm. & Aida Gruezo WM11934* (ALTA!, WGRZ!); Hwy 1(S), Ninilchik proper, right side of road to town center & opposite Hylen's camper park signpost/access road, c. 1 km before the townhall, *Wm. & Aida Gruezo WM11935* (ALTA!, WGRZ!). Sterling Hwy (Hwy 1, S), c. 0.8 km N of Mile post 164 & c. 3.2 km S of Anchor Point, left side of road en route to Homer, *Wm. & Aida Gruezo WM11936* (ALTA!, WGRZ!); Sterling Hwy (Hwy 1, S), c. 1 km S of Mile post 168 & 0.2 km from corner of Green Timber Road & Sterling Hwy, *Wm. & Aida Gruezo WM11937* (ALTA!, WGRZ!); Sterling Hwy (Hwy 1, S), c. 2.5 km before Homer proper or c. 1.9 km S of Mile post 171, *Wm. & Aida Gruezo WM11939* (ALTA!, WGRZ!); Sterling Hwy (Hwy 1, S), c. 1 km S of Mile post 169, cut-side of road opposite parking area of Homer View Point, *Wm. & Aida Gruezo WM11940* (ALTA!, WGRZ!). Ninilchik proper, corner of Sterling Hwy (Hwy 1) & Oilwell Road & beside the Calvary Baptist Church & Christian School, *Wm. & Aida Gruezo WM11941* (ALTA 92048!, ALTA 92049!, ALTA 92050!, ALTA 92055!, ALTA 92056!, WGRZ!).

Idaho: Blaine Co., Sawtooth National Forest, Hwy 75, c. 500 m N of Mile post 168, turn-off road to Lake Alturas, *Wm. Gruezo WM11424* (ALTA!, WGRZ!).

Montana: Glacier Co., Marias Pass Divide, Clark & Lewis National Forest (CLNF), c. 400-600 m from CLNF Campground site no. 3, along abandoned rough road, *Wm. & Aida Gruezo WM11678* (ALTA!, WGRZ!); *Wm. & Aida Gruezo WM11679* (ALTA!, WGRZ!); *Wm. & Aida Gruezo WM11680* (ALTA!, WGRZ!); *Wm. & Aida Gruezo WM11683* (ALTA!, WGRZ!); *Wm. & Aida Gruezo WM12001* (ALTA!, WGRZ!). **Oregon**: Klamath Co., Hwy 31, Paulina Marsh, c. 1.8 km N of Silver Lake town proper, on rough road to Fort Rock, *Wm. Gruezo WM11469* (ALTA 92160!, WGRZ!). Hwy 22, Ochoco National Forest, c. 4 km E of Ochoco Forest Ranger Station, c. 15 m from roadside parking area, *Wm. Gruezo WM11479* (ALTA 91423!, WGRZ!). Umatilla Co., Hwy 244, Blue Mountains, c. 1.5 km W of Mile post 12, vicinity of Lane Creek Campground, just before entering boundary of Umatilla National Forest, *Wm. Gruezo WM11485* (ALTA!, WGRZ!); Umatilla Co., Hwy 244, c. 100 m W of Mile post 21, within the boundary zone between Umatilla National Forest & Wallowa-Whitman National Forest, *Wm. Gruezo WM11486* (ALTA!, WGRZ!). Grant Co., Hwy 26, c. 300 m W of Mile post 76, E bank of creek near foot of bridge, *Wm. Gruezo WM11480* (ALTA!, WGRZ!).

Utah: Wasatch Co., Wasatch National Forest, Wasatch Mts., Brighton town proper, vicinity of Brighton Bowl Ski area, *Wm. Gruezo WM11442* (ALTA 91411!, WGRZ!).

Wyoming: Albany Co., Medicine Bow National Forest, c. 4.5 mi NW of Centennial, on Hwy 130, *Wm. Gruezo WM11315* (ALTA 91408!, WGRZ!); Johnson Co., Big Horn Mts. National Forest, Hwy 16, Crazy Woman Campground, vicinity of Fisherman parking site, *Wm. Gruezo WM11375* (ALTA!, WGRZ!); Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 120 m W of Mile post 66, *Wm. Gruezo WM11381* (ALTA 91409!, WGRZ!). Big Horn Co., Big Horn National Forest, Hwy 14, c. 1 km E of Camp Bethel & Prune Creek Campground, *Wm. Gruezo WM11388* (ALTA!, WGRZ!). Park Co., Shoshone National Forest, Hwy 14-16-20, c. 2 mi from Yellowstone National Park gate entrance, vicinity of Pahaska Tepee Tavern Motel, c. 500 m from Pahaska Campground, *Wm. Gruezo WM11403* (ALTA 91410!, WGRZ!).

Canada, Alberta: High Level, c. 5 km N of High Level & c. 1.8 km S of High Level airport, west side of Hwy 35 near swampy/boggy area on edge of *Populus tremuloides* forest, *Wm. & Aida Gruezo WM11723* (ALTA!, WGRZ!); Hwy 40, Luscar, vicinity of Cardinal River Coal Mine Factory (= Luscar Coal Mine), *Wm. Gruezo WM11492* (ALTA!, WGRZ!); Hwy 40, c. 40 km SE of Hinton, vicinity of Luscar Creek, *Wm. Gruezo WM11494* (ALTA 91414!, WGRZ!). Hwy 940 (= Forestry Trunk Road), c. 1 km S of Cadomin proper, *Wm. Gruezo WM11495* (ALTA 91415!, WGRZ!); Hwy 940 (= Forestry Trunk Road), c. 3 km S of Cadomin proper, *Wm. Gruezo WM11497* (ALTA 91417!, WGRZ!), *Wm. Gruezo WM11498* (ALTA 91418!, WGRZ!), *Wm. Gruezo WM11499* (ALTA 91419!, WGRZ!). Mountain Park, on Hwy 940 (= Forestry Trunk Road), c. 2 km S of Cardinal River Recreational Area, *Wm. Gruezo WM11532* (ALTA 91432!, WGRZ!); *Wm. Gruezo WM11533* (ALTA!, WGRZ!). Waterton Lakes National Park, Hwy 6 S, inside Belly River Campground, front right side of campsite no. 14, *Wm. Gruezo WM11600* (ALTA 92164!, WGRZ!).

British Columbia: John Hart Hwy (Hwy 97), c. 17.4 km N of Bear Lake proper or 1.6 km N of Red Rocky Creek, vicinity of Davie Lake, *Wm. & Aida Gruezo WM11281* (ALTA 91407!, WGRZ!). Cassiar Hwy (Hwy 37), c. 1 km from Natadesleen Lake, corner of access road to lake, *Wm. Gruezo WM11981* (ALTA 92119!, ALTA 92120!, WGRZ!); Cassiar Hwy (Hwy 37), c. 50 m S of Cranberry River Bridge, *Wm. & Aida Gruezo WM11982* (ALTA 92121!, ALTA 92122!, WGRZ!). Yellowhead Trail (Hwy 16), corner of highway & Loiseau Road, c. 22 km W of Houston, *Wm. Gruezo WM11986* (ALTA 92127!, ALTA 92128!, ALTA 92129!); Yellowhead Trail (Hwy 16), c. 17 km NW of Ross Lake or c. 41 km NW of Burns Lake, *Wm. & Aida Gruezo WM11987* (ALTA 92130!, ALTA 92131!, WGRZ!). Yellowhead Trail (Hwy 16, Fraser Lake proper, c. 150 m before the Ministry of Highway & Public Works Maintenance yard, *Wm. & Aida Gruezo WM11988* (ALTA 92132!, ALTA 92133!, ALTA 92134!, WGRZ!); Yellowhead Trail (Hwy 16), c. 21.2 km W of Prince George, intersection of Domano Blvd. & Yellowhead Trail, *Wm. & Aida Gruezo WM11989* (ALTA 92135!, ALTA 92136!, ALTA 92137!, WGRZ!).

Northwest Territories: Logan Mountains, Flat River Valley, c. 2 km S of Tungsten (= Cantung) proper (mining townsite), border of black spruce-fir forest & vicinity of hotsprings pools, *Wm. & Aida Gruezo WM11795* (ALTA!, WGRZ!).

Yukon: Johnsons Crossing, E bank of Teslin River, c. 50 m N of bridge base, c. 5 m from waterline, *Wm. Gruezo WM11153* (ALTA!, WGRZ!); Alaska Hwy (Hwy 1), Kluane National

Park, c. 100 m N of Km post 1636, c. 1 km from Haines Junction, *Wm. Gruezo WM11245* (ALTA!, WGRZ!); Alaska Hwy (Hwy 1), Km post 1633, on ridge near *Populus* forest, *Wm. Gruezo WM11250* (ALTA!, WGRZ!); Klondike Hwy (Hwy 2), Km post 344.5, north of Carmacks, roadside, *Wm. Gruezo WM11252* (ALTA!, WGRZ!); Klondike Hwy (Hwy 2), Km post 218.5, north of Carmacks, *Wm. Gruezo WM11253* (ALTA!, WGRZ!). Alaska Hwy, c. 3 km after Iron Creek, cut-side (right side) of a sharp road bend bordering a poplar forest, *Wm. & Aida Gruezo WM11774* (ALTA 91835!, WGRZ!). Klondike Hwy (Hwy 2), c. 200 m S of Km post 228 just behind the Lake Laberge signboard or c. 2 km N of Lake Laberge & c. 40 m from Fox Creek, *Wm. Gruezo WM11257* (ALTA!, WGRZ!). Klondike Hwy (Hwy 2), c. 1.6 km S of Km post 460 & c. 4.6 km S of Pelly Crossing, *Wm. & Aida Gruezo WM11832* (ALTA 91890!, WGRZ!). Alaska Hwy (Hwy 1), c. 1.5 km W of Km post 1390 or c. 3 km S of Beaver Creek, *Wm. & Aida Gruezo WM11953* (ALTA 92068!, ALTA 92069!, WGRZ!); Alaska Hwy (Hwy 1), c. 1 km N of Haines Junction proper & 0.5 km S of Kluane National Park Wardens Office, *Wm. & Aida Gruezo WM11961* (ALTA 92077!, ALTA 92078!, WGRZ!). Haines Road (Hwy 3), c. 2 km from Haines Junction en route to Dezadeash, *Wm. & Aida Gruezo WM11963* (ALTA 92080!, ALTA 92081!, WGRZ!); Haines Road (Hwy 3), c. 0.5 km S of Km post 240, right side of road en route to Dezadeash, *Wm. & Aida Gruezo WM11964* (ALTA 92082!, ALTA 92083!, WGRZ!); Haines Road (Hwy 3), c. 20 m before Dezadeash Lodge, right side of road en route to Haines, *Wm. & Aida Gruezo WM11965* (ALTA 92084!, ALTA 92085!, WGRZ!); Haines Road (Hwy 3), c. 0.6 km S of Km post 222, right side of road en route to Haines Junction, *Wm. & Aida Gruezo WM11967* (ALTA 92087!, ALTA 92088!, ALTA 92089!, WGRZ!); Haines Road (Hwy 3), vicinity of Km post 230, c. 50 m before Kathleen Lake Lodge and Chevron Gas Station, right side of road en route to Haines Junction, *Wm. & Aida Gruezo WM11970* (ALTA 92093!, ALTA 92094!, ALTA 92095!, ALTA 92096!, WGRZ!); Alaska Hwy (Hwy 1), c. 7.5 km NW of Teslin proper, vicinity of Mile post 813, inside the compound of Teslin Lake Campground, c. 5 m from shore of lake, *Wm. & Aida Gruezo WM11973* (ALTA 92105!, ALTA 92106!, ALTA 92107!, WGRZ!); Alaska Hwy (Hwy 1), c. 1.2 km E of Km post 1130, W of Rancheria, right side of road en route to Watson Lake, *Wm. & Aida Gruezo WM11977* (ALTA 92110!, ALTA 92111!, ALTA 92112!, WGRZ!); Alaska Hwy (Hwy 1), vicinity of Km post 1082, E of Little Rancheria Creek, *Wm. & Aida Gruezo WM11980* (ALTA 92116!, ALTA 92117!, ALTA 92118!, WGRZ!).

A. **longifolia** D.C. Eaton

U.S.A., **Idaho**: Blaine Co., Sawtooth National Forest, road turn-off on Hwy 75 leading to Alturas Lake, c. 1 km before Alpine Creek parking area, cut-side of road, *Wm. Gruezo WM11432* (ALTA!, WGRZ!); Blaine Co., Sawtooth National Forest, Hwy 75, c. 300 m N of Mile post 154, along roadside bend, *Wm. Gruezo WM11435* (ALTA 91434!, WGRZ!).

Oregon: Klamath Co., Crater Lake National Park, on Rim Drive c. 100 m after the Pinnalli Junction, *Wm. Gruezo WM11471* (ALTA 91435!, WGRZ!); Klamath Co., Crater Lake National Park, on Rim Drive c.300 m from Crater Lake Lodge & Crater Lake Park Headquarters, *Wm. Gruezo WM11475* (ALTA 91436!, WGRZ!).

Wyoming: Johnson Co., Big Horn Mts. National Forest, Hwy 16, vicinity of Mile post 44, c. 150 m from Deerhaven Lodge, *Wm. Gruezo WM11373* (ALTA 91424!, WGRZ!). Sheridan Co., Big Horn Mts. National Forest, Hwy 14, on cut-side of road directly opposite Sibley Lake, *Wm. Gruezo WM11385* (ALTA 91426!, WGRZ!). Big Horn Co., Big Horn National Forest, Hwy 14A, c. 2.7 km E of Pole Creek or c. 44 km E of Lovell, *Wm. Gruezo WM11395* (ALTA 91429!, WGRZ!); Big Horn Co., Big Horn National Forest, Hwy 14A, vicinity of Mile post 38, N side of Observation Point (Scenic area), *Wm. Gruezo WM11396* (ALTA 91430!, WGRZ!). Yellowstone National Park, c. 5 mi E of East Gate Entrance, *Wm. Gruezo WM11404* (ALTA 91427!, WGRZ!); Yellowstone National Park, c. 2 km N of Dunraven

Pass peak, *Wm. Gruezo WM11408* (ALTA 91431!, WGRZ!).

Canada, Alberta: Waterton Lakes National Park, NW shore of Lake Bertha, vicinity of Horse Corral, *Wm. Gruezo WM11666* (ALTA 91724!, WGRZ!).

A. **parryi** A. Gray

U.S.A., Idaho: Blaine Co., road turn-off on Hwy 75 to Alturas Lake, c.300 m before Alpine Creek parking area, *Wm. Gruezo WM11431* (ALTA 91401!, WGRZ!).

Montana: Glacier Co., Marias Pass Divide, Clark & Lewis National Forest Campground, c. 150 m from campsite no. 3, near small creek, *Wm. & Aida Gruezo WM11682* (ALTA 93006!, WGRZ!); Glacier Co., Marias Pass Divide, Clark & Lewis National Forest Campground, vicinity of campsite no. 3, *Wm. & Aida Gruezo WM12000* (ALTA 93005!, WGRZ!).

Wyoming: Yellowstone National Park, c. 2 km E of Sylvan Lake, *Wm. Gruezo WM11405* (ALTA!, WGRZ!).

A. **ovata** Greene

Wyoming: Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 42, *Wm. Gruezo WM11350* (ALTA 91297!, WGRZ!).

Canada, Alberta: Jasper National Park, Mt. Edith Cavell, *Wm. Gruezo WM11558* (ALTA 91295!, WGRZ!). Jasper National Park, The Bald Hills, vicinity of summit, *Wm. Gruezo WM11571* (ALTA 91308!, WGRZ!); Jasper National Park, The Bald Hills, along rough road to former site of Fire Watch Tower, c.1/4 way up, *Wm. Gruezo WM11579* (ALTA 91309!, WGRZ!); Jasper National Park, The Bald Hills, c. 1 km from Maligne Road, along rough road to former site of Fire Watch Tower, *Wm. Gruezo WM11584* (ALTA 91313!, WGRZ!); Jasper National Park, The Bald Hills, c. 0.5 km from Maligne Road, along rough road to former site of Fire Watch Tower, *Wm. Gruezo WM11586* (ALTA 91314!, WGRZ!). Banff National Park, Sunshine Village Ski Area, along foot trail to Rock Isle Lake, *Wm. Gruezo WM11591* (ALTA 91315!, WGRZ!), *Wm. Gruezo WM11593* (ALTA 91316!, WGRZ!). Banff National Park, Parker Ridge, along foot trail to ridgetop, *Wm. Gruezo WM11536* (ALTA 91302!, WGRZ!), *Wm. Gruezo WM11538* (ALTA 91303!, WGRZ!).

British Columbia: Mount Assiniboine Provincial Park, above Rock Isle Lake, along foot-trail to alpine summit, subalpine meadows, *Wm. Gruezo WM11588* (ALTA!, WGRZ!).

A. **lanceolata** Nutt. subsp. **amplexicaulis** (Nutt.) Gruezo

U.S.A., Alaska: Glenn Hwy (Hwy 1 SE), Turnagain Arm area, vicinity of Mile post 93.8, left side of road en route to Girdwood, *Wm. & Aida Gruezo WM11917* (ALTA 91986!, ALTA 91987!, ALTA 91988!, WGRZ!); Hwy 1, c. 4 km SE of Girdwood, right side of road en route to Girdwood, *Wm. & Aida Gruezo WM11944* (ALTA 92052!, ALTA 92053!, ALTA 92054!, ALTA 92057!, WGRZ!).

Nevada: Elko Co., Humboldt National Forest, Ruby Mts., Lamoille Township, c. 3.9 km E of road corner near Presbyterian Church, *Wm. Gruezo WM11448* (ALTA 91371!, WGRZ!); Elko Co., Humboldt National Forest, Ruby Mts., vicinity of Thomas Canyon Campground, near creek bridge, S bank of Lamoille Creek, *Wm. Gruezo WM11460* (ALTA 91372!, WGRZ!); Elko Co., Humboldt National Forest, Ruby Mts., Lamoille Canyon Campground Power House Picnic Area, near bridge on main road, *Wm. Gruezo WM11463* (ALTA 91373!, WGRZ!), *Wm. Gruezo WM11465* (ALTA 91375!, WGRZ!).

Canada, Alberta: Waterton Lakes National Park, vicinity of Cameron Lake, NW portion of lake, *Wm. Gruezo WM11616* (ALTA 91378!, WGRZ!). Waterton Lakes National Park, vicinity of Lower Bertha Falls, c. 5 m from waterfalls & with clumps c. 5 m from log bridge, *Wm. Gruezo WM11669* (ALTA 91728!, WGRZ!); Waterton Lakes National Park, vicinity of Cameron Lake, NW of lake c. 300 m from parking area inside spruce(*Picea mariana*) forest, *Wm. Gruezo WM11673* (ALTA 91732!, WGRZ!); Waterton Lakes National Park, vicinity of Cameron lake, NW of lake, along Cameron Lake Footpath, c. 0.55 km from parking area, c. 0.5 km from waterline, *Wm. Gruezo WM11675* (ALTA 91734!, WGRZ!); Waterton Lakes National Park, NW shore of Lake Bertha, along trail c. 400 m from Horse Corral, *Wm. Gruezo WM11667* (ALTA 91726!, WGRZ!); Waterton Lakes National Park, shore of Lake Bertha, side of small creek along trail to lake, *Wm. Gruezo WM11677* (ALTA!, WGRZ!).

A. **mollis** Hook.

U.S.A., **Wyoming**: Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 37 nearby sharp roadbend, *Wm. Gruezo WM11343* (ALTA 91325!, WGRZ!); Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 42, near lake shore, cut-side of road, *Wm. Gruezo WM11350* (ALTA!, WGRZ!); Carbon Co., Medicine Bow National Forest, Hwy 130, vicinity of Mile post 43, c. 700 m from roadside turn-out, *Wm. Gruezo WM11359* (ALTA 91327!, WGRZ!); Carbon Co., Medicine Bow National Forest, Hwy 130, E of Mile post 49 on way to Saratoga, c.200 m from intersection to French Creek Campground, *Wm. Gruezo WM11360* (ALTA 91329!, WGRZ!), *Wm. Gruezo WM11361* (ALTA 91330!, WGRZ!). Johnson Co., Big Horn Mts. National Forest, Powder River Pass, Hwy 16, S-facing slope, rock out-crops, *Wm. Gruezo WM11368* (ALTA!, WGRZ!); Johnson Co., Big Horn Mts. National Forest, Hwy 16, c. 1.5 km E of Powder River Pass peak, *Wm. Gruezo WM11369*.(ALTA!, WGRZ!); Johnson Co., Big Horn Mts. National Forest, Hwy 16, c. 200 m W of Canyon Creek, *Wm. Gruezo WM11371* (ALTA 91332!, WGRZ!). Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 4.8 km E of Mile post 67, *Wm. Gruezo WM11378* (ALTA 91333!, WGRZ!); Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 120 m W of Mile post 66, *Wm. Gruezo WM11382* (ALTA!, WGRZ!); Sheridan Co., Big Horn Mts. National Forest, Hwy 14, c. 150 m W of Mile post 66, *Wm. Gruezo WM11384* (ALTA!, WGRZ!). Big Horn Co., Big Horn National Forest, Hwy 14, c. 1 km E of Camp Bethel & Prune Creek Campground, *Wm. Gruezo WM11387* (ALTA 91336!, WGRZ!); Big Horn Co., Big Horn National Forest, Hwy 14A, c. 1.5 km E of Medicine Wheel Archeological Site turn-off road, *Wm. Gruezo WM11397* (ALTA 91338!, WGRZ!).

Canada, Alberta: Jasper National Park, Mt. Edith Cavell, along foot trail to Mt. Edith Cavell meadows, *Wm. Gruezo WM11549* (ALTA 91503!, ALTA 91504!, WGRZ!), *Wm. Gruezo WM11551* (ALTA!, WGRZ!). Jasper National Park, The Bald Hills, vicinity of summit, N-facing steep slope, along blurred foot-trail in subalpine meadows, *Wm. Gruezo WM11569* (ALTA!, WGRZ!); Jasper National Park, The Bald Hills, vicinity of summit, NW-facing steep slope, end of foot-trail from former site of Fire Watch Tower, subalpine meadows, *Wm. Gruezo WM11570* (ALTA!, WGRZ!); Jasper National Park, The Bald Hills, along rough road to former site of Fire Watch Tower, subalpine meadows with patches of *Picea* sp., *Wm. Gruezo WM11572* (ALTA!, WGRZ!), *Wm. Gruezo WM11575* (ALTA!, WGRZ!);

Jasper National Park, The Bald Hills, along rough road to former site of Fire Watch Tower, c. 20 m before the junction of Skyline trail and Bald Hills trail, *Wm. Gruezo WM11578* (ALTA!, WGRZ!); Jasper National Park, The Bald Hills, along rough road to former site of Fire Watch Tower, c.1/5 way up, *Wm. Gruezo WM11581* (ALTA!, WGRZ!); Jasper National Park, The Bald Hills, c. 1/6 of the way up to former site of Fire Watch Tower, *Wm. Gruezo WM11582* (ALTA!, WGRZ!). Banff National Park, Parker Ridge, along foot trail to ridgetop, *Wm. Gruezo WM11537* (ALTA 91346!, WGRZ!), *Wm. Gruezo WM11539* (ALTA 91347!, WGRZ!), *Wm. Gruezo WM11541* (ALTA!, WGRZ!); Banff National Park, Sunshine Village Ski Area, c. 200 m above Sunshine Village Gondola Station, along trail to Meadow Park summit, in subalpine meadows adjacent to thin stands of *Picea* sp., *Wm. Gruezo WM11598* (ALTA!, WGRZ!). Waterton Lakes National Park, vicinity of Summit Lake, along banks of creek outlet N of lake, Wm. Gruezo WM11605 (ALTA!, WGRZ!).

British Columbia: Mount Assiniboine Provincial Park, vicinity of Rock Isle Lake, along foot trail to alpine summit, *Wm. Gruezo WM11590* (ALTA!, WGRZ!).

Appendix 5. Collections examined for Pollen Stainability

Arnica chamissonis Less.

CANADA: Alberta.
Drummond s.n. ex BM 14742 (CAN 109576!-**16%**);
M.O. Malte & W.R. Watson 1843 (RM 280381!-**23%**, UC M-309731!);
Bernard Boivin & J.-M. Perron 12398 (ALTA 73351!, MT *s.n.*!, RM 305718!-**18%**, SASK 64478!-**46%**);
A.J. Breitung 5638 (MT *s.n.*!, RM 213920!-**53%**);
W.G. Dore 12235 (RM 221060!-**27%**);

British Columbia.
J.A. Calder, D.B.O. Savile & J.M. Ferguson 13637 (RM 257954!-**1%**).

Manitoba.
H.J. Scoggan 3652 (ALTA 16889!, CAN 114790!-**0%**);
H.J. Scoggan 9277 (CAN 210448!-**78%**);
H.J. Scoggan 9316 (CAN 210449!-**66%**);
H.J. Scoggan 11337 (CAN 224156!-**66%**).

Northwest Territories.
W.J. Cody & C.C. Loan 4208 (RM 233194!-**22%**, WS 215755!);
W.J. Cody & J.M. Matte 8759 (RM 276906!, SASK 24348!, SASK 282801!-**5%**, WS 259086!).

Ontario.
W.K.W. Baldwin & A.E. Porsild et al. 6728 (CAN 413462!-**27%**);
W.K.W. Baldwin 8060 (CAN 414797!-**13%**);
W. Spreadborough Geol. Surv. Can. 62530 (CAN 109599!-**5%**);
W. Spreadborough Geol. Surv. Can. 62531 (CAN 109600!-**9%**);
D.R. Moir 1434 (CAN 261278!-**10%**);
D.R. Moir 1603 (CAN 261277!-**18%**);
F.N. Cowell 1077 (CAN 320596!-**24%**).

Saskatchewan.
Alice Winifred Anderson s.n. (CAN 387402!-**18%**);
H.G. Anderson 1246 (SASK 44114!-**23%**);
George W. Argus & John J. Hudson 4627 (RM 277602!, SASK 24987!-**34%**);
W.K.W. Baldwin & J. Macpherson 10583 (CAN 437583!-**22%**);
Bernard Boivin et D. Dunbar 10427 (RM 305717!-**41%**, SASK 64477!);
Bernard Boivin et T. Mosquin 10830 (SASK 64476!-**35%**);
August J. Breitung 1753 (CAN 204201!, RM 233250!-**45%**);
Vernon L. Harms 16800 (SASK 42718!-**27%**);
Vernon L. Harms 20183 (SASK 47965!-**32%**).

Yukon.
George W. Scotter 24549 & Teuvo Ahti (ALTA 82902!-**24%**);
George W. Scotter 24637 (ALTA 82901!-**12%**);
A.E. Porsild & A.J. Breitung 10321 (CAN 109565!-**18%**);
A.E. Porsild & A.J. Breitung 10872 (ALA 40954!, KLUANE!, UC 994969!-**25%**);
A.E. Porsild & A.J. Breitung 11494 (CAN 109568!, UC 994968!-**12%**);
A.E. Porsild & A.J. Breitung 11495 (ALTA 29668!, CAN 109569!-**15%**, UC 994967!);
H.M. & L.G. Raup 12074 (ALA 20289!-**15%**, KLUANE!, RM 271861!-**17%**, SASK 22230!);

G.W. & G.G. Douglas 5954 (CAN 463335!-**57%**);
H.M. & L.G. Raup 12952 (ALA 20290!-**8%**, CAN 278899!, KLUANE!, RM 271862!-**2%**, SASK 22231!, WS 250483!-**3%**);
H.M. Raup & D.S. Correll 10959 (ALA 20288!, CAN 278898!-**39%**, KLUANE!, RM 271863!, SASK 22237!, WS 250501!);
Maxcine Williams 1379 (BRY 49374!-**56%**).

U.S.A.: Alaska.
Bob Karlen 31 (ALA V75284!-**27%**);
Aline Strutz 1249 (BRY 61349!-**10%**);
S.L. Welsh 4669 (BRY 142202!-**36%**);
J.W. Smith 78-28 (ALA 83833!-**30%**);
Maxcine Williams 2563 (ALA 43557!-**17%**, BRY 94059!);
Catherine H. Ellis s.n. (BRY 85527!-**26%**);
Catherine H. Ellis s.n. (BRY 85551!-**14%**);
Ethel H. Looff & Henry B. Looff 539 (ND 011127!-**39%**, RM 234443!);
Ethel H. Looff & Henry B. Looff 1176 (RM 184148!-**29%**);
M.A. Hatch 481 (ALA 95656!-**60%**);
M.A. Hatch 497 (ALA 95788!-**47%**);
Brian Lawhead 108 (ALA 95042!-**19%**);
W.B. Miller 1694 (ALA 2686!-**34%**);
B.F. Friedman 80-195 (ALA V75240!-**33%**);
B.F. Friedman 81-81 (ALA V74649!-**35%**);
Kincaid s.n. (NDG 062423/G 46845!-**28%**);
K. Roberson 137 (ALA 38333!-**18%**);
J. Harbo 3 (ALA 24780!-**34%**).

Arizona.
Larry C. Higgins 7821 (BRY 121801!-**27%**);
T.R. Van Devender & F.W. Reichenbacher s.n. (UC 1488870!-12%);
George J. Goodman & Lois Butler Payson 2937 (UC 892097!-33%);
Cottam 2681 (BRY 15864!-**1%**).

California.
A.L. Hormay 8 (RM 470722!-**94%**, UC M- 142923!);
Leland S. Smith 1007 (CAN 325204!, JEPS 35881!, RM 471056!-**33%**);
Harry S. Yates 5991 (RM 470717!-**66%**, UC M-119288!);
I. Merfort et al. s.n.(Univ. Dusseldorf, Inst. Pharm. Biol. Herb. *s.n.*!-**55%**);
Elmer P. Boyle EPB-43 (RM 470629!-**25%**);
Joe C. Johnson JJ-144 (RM 470628!-**88%**, WS 198457!);
I. Merfort et al. s.n. (Univ. Dusseldorf, Inst. Pharm. Biol. Herb. *s.n.*!-**14%**);
I. Merfort et al. s.n. (Univ. Dusseldorf, Inst. Pharm. Biol. Herb. *s.n.*!-**3%**);
L. Constance 2437 (RM 179112!-**88%**, UC 614637!, WS 101061);
James L. Reveal & Jack L. Reveal 446 (RM 301445!-**86%**, UC 1338630!);
Ira L. Wiggins 9509 (CAN 190982!, RM 189729!-**20%**);
Annie M. Alexander & Louise Kellogg 3311 (RM 200906!-**27%**, UC 703945!, WS 163753!);
Bassett Maguire & Arthur H. Holmgren 26149 (BRY 20117!-35%, CAN 190991!, PH 810077!, RM 200523!, WS 169595!);
Joseph Andorfer Ewan 1366 (RM 119165!-**91%**);
P.A. Munz 6195 (JEPS 22840!, RM 92082!-**59%**);
Philip A. Munz 14271 (RM 216133!-**60%**, UC 809676!);
Peter Raven & G. Thomas Robbins 7582 (RM 261076!-**47%**);
Parkinson 36 (RM 470726!-**63%**);
Lassen 1927 G.S. Crew 41 (RM 470724!-**29%**);
Lassen 1927 G.S. Crew 77 (RM 470723!-**82%**).
Leland S. Smith 2090 (RM 470718!-**0%**).

Colorado.
W.S. Cooper 240 (RM 48434!-**12%**);
Leslie N. Goodding 1863 (BRY 193196!, CAN 441751!, PH 523770!, RM 52150!-**20%**, RM 169839!, UC 69439!);
G.E. Osterhout 269 (RM 169852!-**9%**);
G.E. Osterhout 1373 (RM 169851!-**12%**);
C.L. Porter & Marjorie W. Porter 9154 (RM 268341!-**35%**, SASK 19458!, UC M-246693!);
C.L. Porter 3926 (RM 203995!-**49%**);
G.E. Osterhout 3017 (RM 169842!-**11%**);
G.E. Osterhout 3597 (RM 169840!-**12%**);
Kenneth K. Mackenzie 214 (RM 30565!-**7%**);
C.F. Baker 665 (RM 33184!-**59%**, RM 169848!-**80%**, UC 29622!, WS 26626!);
B.C. Buffum s.n. (RM 311720!-**11%**);
C.S. Crandall s.n. (RM 13208!-**35%**);
Aven Nelson & Ruth A. Nelson 2218 (RM 178127!-**18%**, UC 614075!);
G.E. Osterhout s.n. (RM 312969!-**37%**);
Francis Ramaley 9407 (RM 76082!-**30%**);
Francis Ramaley & W.W. Robbins 3637 (RM 61580!-**32%**);
Ramaley & Robbins 6838 (RM 64590!-**14%**);
W.W. Robbins 10254 (RM 81414!-**22%**);
L.M. & N.T. Schedin 514 (RM 97899!-**36%**);
L.M. & N.T. Schedin 548 (RM 97697!-**31%**);
H.N. Wheeler 451 (RM 31280!-**21%**);
H.N. Wheeler 551 (RM 31293!-**35%**).

Idaho.
L. Constance 1948 (CAN 190983!, RM 180177!-**60%**, UC 572871!, UC 604329!, WS 80454!);
L. Constance s.n. (RM 180176!-**56%**);
J. William Thompson 13897 (RM 181978!-**92%**, UC 609872!);
Arthur Buckingham 134 (RM 470658!-**99%**);
Aven Nelson & J.F. Macbride 1535 (RM 71131!-**18%**);
Aven Nelson & J.F. Macbride 1577 (CAN 190971!, RM 71130!, RM 169916!-**25%**, UC 165240!);
J.F. Macbride & E.B. Payson 2912 (RM 86357!-**56%**, RM 92888!-**64%**, UC 256388!);
J.F. Macbride & Edwin B. Payson 3730 (RM 86108!-**95%**, UC 256369!);
J. Francis Macbride 624 (RM 67122!-**99%**, UC 160494!, WS 44715!);
Ralph K. Gierisch RG-715 (RM 470648!-**39%**);
Aven Nelson & J. Francis Macbride 1804 (RM 75464!-**51%**).
O. Cusick 91 (RM 470649!-**28%**).

Montana.
G.E. Osterhout 8011 (RM 169974!-**92%**);
Jack E. Schmautz JES-6 (RM 470667!-**20%**);
C.L. Hitchcock & C.V. Muhlick 12589 (CAN 190977!, PH 837718!, RM 202875!-**89%**, UC 757603!, WS 158767!);
C.L. Hitchcock & C.V. Muhlick 13114 (PH 837710!, RM 202871!-**97%**);
J.E. Kirkwood 2398 (PH 696210!, RM 112377!-**97%**, RM 130518!, UC 352479!);
Wyatt N. Jones s.n. (RM 73880!-**3%**).

Nevada.
P.B. Kennedy 555 (RM 39633!-**41%**, UC 65512!);
B. Leonard BL-68 (RM 470652!-**50%**);
C.F. Baker 1354 (CAN 190993!, RM 44161!-**40%**, RM 169849!, UC 75359!);
Mont E. Lewis 1741 (RM 470651!-**46%**);
Basil K. Crane BC-256 (RM 470630!-**77%**);
W.B. Hamlin H-7 (RM 470645!-**13%**).

New Mexico.
Ronald L. Hartman 2350 (RM 298230!-**12%**);
Ronald L. Hartman 2595 (RM 298201!-**19%**).

Oregon.
Charles Feddema 3417 (RM 470605!-**70%**);
Charles Feddema 3433 (RM 470604!-**38%**);
Dorothy & Ralph Naas 3073 (RM 470706!-**28%**);
Roxana S. Ferris & Rena Duthie 725 (RM 103025!-**31%**);
R.M. Porter 1020 (RM 470707!-**60%**);
Arthur Cronquist 7464 (RM 240393!-**63%**, UC M-000112!, WS 210459!);
Wm.C. Cusick 2638 (RM 35167!-**10%**, UC 34394!);
Max R. King MK-32 (RM 470711!-**46%**);
L.R. Abrams 9655 (RM 101147!-**74%**);

Utah.
George J. Goodman 288 (RM 113905!-**24%**);
A.O. Garrett 1528 (PH 524302!, RM 52704!-**29%**);
Helen Dixon 575 (RM 134817!-**9%**);
T. Lommasson 213 (RM 470632!-**34%**, RM 470633!-**22%**);
H.M. Peterson P-121 (RM 470655!-**18%**);
D. Atwood 8159 (BRY 232218!, RM 337145!-**21%**);
Wilford Bentley 157 (RM 470639!-**62%**);
E. Neese & S. White 3874A (BRY 172903!, RM 471030!-**21%**).

Washington.
G.W. Turesson s.n. (RM 76316!-**85%**);
T.S. Brandegee 109 (UC 178400!-**42%**);
F.G. Meyer 1498 (UC 719034!, WS 122669!-**37%**);
W.N. Suksdorf s.n. (PH *s.n.*!-**28%**);
Wilhelm N. Suksdorf 10142 (UC 892049!-**61%**, WS 79774!);
W.N. Suksdorf 38348 (CAN 190987!-**34%**).

Wyoming.
Richard M. Hurd 308 (RM 236761!-**70%**, RM 402978!);
Aven Nelson 8527 (RM 37040!-**28%**, UC 892060!);
B.E. Nelson 3785 & Keith H. Dueholm (RM 347690!-**29%**);
Gael Fonken 643 & B.E. Nelson (RM 347680!-**52%**);
Leslie N. Goodding 357 (RM 37035!-**9%**, UC 51066!);
E.F. Evert 2977 (RM 341673!-**21%**);
Ronald L. Hartman 8349 (RM 338319!-**94%**);
Aven Nelson & Elias Nelson 6740 (RM 20771!-**95%/91%**);
Gael Fonken 522 & B.E. Nelson (RM 347681!-**24%**);
B.E. Nelson 7245 & Gael Fonken (RM 347685!-**22%**);
B.E. Nelson 7256 & Gael Fonken (RM 347684!-**31%**);
Frank Tweedy 3022 (RM 38401!-**24%**, WS 26627!);
Frank Tweedy 3024 (RM 38408!-**24%**);
B.E. Nelson 3547 (RM 347691!-**38%**);
B.E. Nelson 8192 (RM 347682!-**13%**);
B.E. Nelson 7044 & Gael Fonken (RM 347687!-**29%**);
B.E. Nelson 7063 & Gael Fonken (RM 347686!-**53%**);
B.E. Nelson 7279 & Gael Fonken (RM 347683!- **82%**);
C.L. Porter 4369 (RM 207424!-**12%**);
Robert Lichvar 854 (RM 315629!-**32%**);
Elmer D. Merrill & E.N. Wilcox 1092 (RM 32326!-**91%**);
Louis Williams & Rua Pierson 1332 (RM 135276!-**99%**);

W.G. & Ragnhild Solheim 4128 (RM 100322-S!- **80%**);
W.G. Solheim 4214 (RM 248567!-**54%**, UC M-040090!);
Ronald L. Hartman 10473 (RM 347678!-**7%**);
F.J. Hermann 12277 (RM 248629!-**34%**);
C.L. Porter & Marjorie W. Porter 8426 (RM 263233!-**22%**, UC M-187496!);
Richard W. Scott 207 (RM 274428!-**36%**).
Edwin B. Payson & Lois B. Payson 2928 (PH 602531!, RM 93860!-**20%**, UC 279562!);
Edwin B. Payson & Lois B. Payson 4632 (RM 103897!-**9%**);
Geo. J. Goodman 5130 (RM 215546!-**36%**);
Orval C. Harrison 139 (RM 297870!-**33%**);
Orval C. Harrison 333 (RM 343268!-**50%**);
Louis Williams 818 (RM 129871!, RM 169922!-**41%**);
Ralph K. Gierisch 1994 (RM 402980!-**34%**);
Aven Nelson & Ruth A. Nelson 969 (RM 138219!-**35%**);
Aven Nelson 7731 (RM 52089!-**23%**, UC 128260!);
Aven Nelson 9080 (RM 64954!-**10%**);
B.E. Nelson 788 (RM 296362!-**20%**);
B.E. Nelson 997 (RM 296368!-**59%**);
B.E. Nelson & Linda Nelson 952 (RM 296369!-**52%**);
Ann Aldrich 570 (RM 330360!-**73%**);
G.E. Ostehout 35 (RM 169841!-**39%**);
J.A. Sanford s.n. (UC 29624!-**12%**).

Arnica mollis Hook.

CANADA: Alberta.
A.E. Porsild & A.J. Breitung 13449 (CAN 109732!- **19%**);
A.E. Porsild & Johannes Lid 19572 (CAN 293159!- **13%**);
George W. Scotter 17236 (ALTA 76402!-**32%**);
N.B. Sanson s.n. (CAN 465339!-**33%**);
Mrs. Chas. Schaffer 814 (PH 532141!-**39%**).

British Columbia.
J.H. Soper 12595, M.J. Shchepanek & A.F. Szczawinski (CAN 342459!-**17%**);
J.A. Calder, J.A. Parmelee & R.L. Taylor 19585 (RM 257955!-**56%**);
Edith Scamman 6719 (CAN 245392!-**38%**);
J.M. Macoun Geol. Surv. Canada 14721 (CAN 109746!-**11%**);

U.S.A.: California.
Annie M. Alexander & Louise Kellogg 5080 (UC 936190!-**81%**);
L.S. Smith 147 (JEPS 35913!, RM 470721!-**7%**);
William J. Ferlatte & Alice Q. Howard 1295 (JEPS 74632!-**30%**);
H.M. Hall 8811 (RM 73168!-**64%**, UC 148930!-**80%**);
Herbert McLean Evans s.n. (UC 311654!-**4%**);
Gladys L. Smith 2249 (JEPS 71777!-**46%**);
Philip A. Munz 20032 (RM 245264!-**6%**);
P.A. Munz 7555 (RM 96968!-**7%**, UC 284159!);
Adele Lewis Grant 100 (JEPS 35685!-**35%**);
R.F. Hoover 3640 (JEPS 20965!, UC 767460!-**49%**);
Annie M. Alexander & Louise Kellogg 3168 (CAN 249683!, RM 249834!-**3%**, UC M-036099!-**6%**, WS 218335!);
Katharine Brandegee s.n. (UC 131541!-**4%**);
Katharine Brandegee s.n. (UC 220230!-**16%**);
Frances Payne 99 (JEPS 35883!-**2%**);
G. Thomas Robbins 3763 (JEPS 15964!-**4%**).

Colorado.
Leslie N. Goodding 1822 (PH 523771!, RM 52144!-**53%**, RM 169906!, UC 69441!);
George E. Osterhout 1831 (RM 169949!-**45%**);
George E. Osterhout 2241 (RM 169951!-**54%**, RM 312684!);
E. Neese 16149 (BRY 275157!-**38%**);
George E. Osterhout 268 (RM 169948!-**34%**);
George E. Osterhout 7256 (RM 169861!-**39%**);
George E. Osterhout 4982 (RM 169950!-**37%**);
George E. Osterhout 3860 (RM 169954!-**36%**);
George E. Osterhout 3671 (RM 169961!-**41%**);
Leslie N. Goodding 1814 (CAN 441747!, BRY 193071!-**31%**, RM 52145!, SASK 67099!);
Lee Snyder 11091 (WS 288145!-**43%**);
Francis Ramaley 762 (RM 31281!-**34%**);
I.W. Clokey 4381 (ND 011154!, PH 591420!, RM 90104!, UC 892169!-**38%**);
Otto Degener & Leroy Peiler 16782 (RM 193990!-**55%**);
Francis Ramaley 9385 (RM 75031!-**57%**);
H.M. Hall 10478 (UC 204736!, UC 217424!-**39%**);
I.W. Clokey 3502 (CAN 191137!, RM 93422!, UC 892192!, WS 36477!-**45%**);
C.L. Porter 6545 (RM 241785!-**4%**, UC M-009693!);
Edgar T. Wherry C3733 (PH/PENN *s.n.*!-**53%**).

Idaho.
C.L. Hitchcock & C.V. Muhlick 11332 (RM 198577! -**46%**, UC 968619!-**63%**, WS 155970!);
J.E. Kirkwood 1993 (RM 130547!-**72%**);
Peter F. Stickney 2139 (RM 471034!-**1%**);
J.F. Macbride & Edwin B. Payson 3600 (RM 86109!-**8%**, UC 256368!);
Edwin B. Payson & George M. Armstrong 3594 (RM 98208!-**5%**, PH 617124!);
C.L. Hitchcock & C.V. Muhlick 10394 (CAN 191118!, RM 198578!-**5%**, UC 968613!);
J. Francis Macbride 441 (RM 67431!, UC 160091!-**2%**, WS 26555!);
Bassett Maguire & Arthur H. Holmgren 26666 (CAN 191139!, PH 824341!, UC 739047!, WS 169996!-**6%**.

Montana.
Bassette Maguire 1093 (RM 131268!-**9%**);
C.L. Hitchcock & C.V. Muhlick 13345 (CAN 191112!, PH 837708!-**12%**, RM 202866!, UC 757607!, WS 158775!);
E. & D. Pearson 146 (RM 104458!-**75%**);
Jean G. Witt 1278 (WS 184746!-**76%**);
C.L. Hitchcock & C.V. Muhlick 13106 (RM 202757!-**28%**);
H.W. Elofson 38 (RM 471045!-**85%**);
J.E. Kirkwood 1682 (RM 130665!-**35%**).

Nevada.
A.A. Heller 9402 (UC 196039!-**1%**);
Aven Nelson & J. Francis Macbride 1966 (RM 75324!**5%**);
Bassett Maguire & Arthur H. Holmgren 22581 (PH 813509!-**5%**);
Bassett Maguire & Arthur H. Holmgren 22646 (CAN 191115!-**8%**);
Dale H. Kinnaman D.K.51 (RM 471026!-**9%**);
Bassett Maguire & A.H. Holmgren 22467 (UC 711479!-**2%**);
Arnold Tiehm 6315 (RM 336984!-**4%**);
S. Goodrich 13455 (BRY 209928!, RM 329884!-**73%**);
Noel H. Holmgren & James L. Reveal 1615 (BRY 48941!, RM 278160!-**1%**);
S. Goodrich, F. Smith & J.S. Tuhy 20052 (BRY 257854!-**1%**);
Gary J. Pierce 1891 (RM 293896!-**1%**).

Oregon.
Elbert H. Reid 814 (RM 471096!-**20%**);
Wm.C. Cusick 2096 (NDG 062422/GR 46837!-**38%**, UC 29593!, UC 91136!-**48%** , WS 26650!);
Roxana S. Ferris & Rena Duthie 1154 (RM 103010!-**2%**);
Wm.C. Cusick 2489 (JEPS 20960!, NDG 062548/HG 45920!, RM 31433!-**10%**, UC 29652!, WS 26638!);
Wm.C. Cusick 2491 (JEPS 20961!, NDG 062549/HG 45919!, RM 31434!, UC 29651!, WS 26637!-**14%**);
Wm.C. Cusick 3557 (RM 72466!, WS 26554!, WS 69974!-**2%**);
C.S. English Jr. 749 (WS 43238!-**68%**);
Chas. H. Flory 56 (RM 471091!-**76%**);
C.E. Fleming 168 (RM 470615!-**1%**);
Morton E. Peck 18766 (UC 892165!-**67%**);
Douglas C. Ingram B-540 (RM 471085!-**5%**).

Utah.
J.E. Wilson s.n. (BRY 238473!-**1%**);
B.F. Harrison 10752 (BRY 18836!-**14%**, UC 712064!-**25%**);
E. Neese 10861 (BRY 225781!-**20%**);
S.L. Welsh 1629 (BRY 30833!-**13%**, BRY 142223!);
S.L. Welsh & G. Moore 6657a (BRY 63626!-**6%**);
S. Welsh, E. Neese & D. Atwood 18989 (BRY 198351!, RM 318158!-**66%/27%**);
Bassett Maguire, A.G. Richards & Ruth Maguire 4311 (RM 140647!-**15%**, UC 533006!);
S.L. Welsh & E. Neese 19973 (BRY 213959!-**21%**);
S. Goodrich 17486 (BRY 240758!-**16%**);
S. Goodrich 17495 (BRY 240767!, RM 343247!-**2%**);
A.O. Garrett 1645a (RM 54077!-**3%**);
A.O. Garrett 1647 (PH 524304!, RM 52684!-**3%**);
A.O. Garrett 1974 (RM 56654!-**29%**);
Fred Rowland 16961 (BRY 31558!-**15%**).
R. Foster & J. Henriod 7080 (BRY 186786!, RM 314822!-**25%**);
S. Goodrich 18963 (BRY 256313!-**63%**);
D. Atwood 8009 (BRY 231974!-**4%**);
S. Welsh, M. Welsh & J. Henriod 17740 (BRY 186502!, RM 314449!-**0%**).
Frank W. Gould 1984 (ND 011137!, PH 824732!-**5%**, RM 196910!, UC 892188!).
Leslie N. Goodding 1351 (RM 41755!-**4%**).
E.B. & L.B. Payson 5057 (PH 659989!, RM 115279!-**1%**, UC 395913!, WS 52392!).

Washington.
Douglas Hole H-10 (RM 471095!-**11%**);
J.M. Grant s.n. (RM 102829!-**37%**);
Frank B. Lenzie 46 (RM 471080!-**7%**).

Wyoming.
B.E. Nelson 4330 (RM 347744!-**23%**);
B.E. Nelson 4470 (RM 347743!-**19%**);
Leslie N. Goodding 410 (RM 37031!-**3%**, UC 51065!);
Leslie N. Goodding 391 (RM 37033!-**65%**, UC 892189!);
Richard M. Hurd 340 (RM 244421!-**18%**, RM 402835!);
Lawrence Lofgren 90 (RM 248691!-**30%**);
B.E. Nelson 5021 (RM 347773!-**18%**);
B.E. Nelson 5005 (RM 347774!-**34%**);
B.E. Nelson 3359 (RM 347747!-**9%**);
B.E. Nelson 4920 (RM 347741!-**23%**);
B.E. Nelson 3624 (RM 347745!-**19%**);

B.E. Nelson 6273 (RM 347777!-**24%**);
R.K. Gierisch 1788 (RM 402834!-**25%**);
Frank Tweedy 3020 (RM 38407!-**59%**, WS 26651!);
F.A. Williams s.n. (RM 35348!-**12%**);
R.D. Dorn 3365 (RM 319678!-**24%**);
P.A. Robertson 693 (RM 330752!-**27%**).
Aven Nelson & Elias Nelson 6109 (BRY 193204!, RM 20766!-**17%**,RM 20767!, RM 169963!, UC 34252!, UC 892218!, WS 26512!);
Thomas W. Nelson, Jane P. Nelson, James L. Nelson & Kathy M. Nelson 3217 (RM 354746!-**76%**);
H.S. Conard 1934 (RM 105178!-**45%**);
B.E. Nelson 3572 (RM 347746!-**79%**);
B.E. Nelson 4758 (RM 347742!-**8%**);
B.E. Nelson 6117 (RM 347772!-**10%**);
B.E. Nelson 7179 & Gael Fonken (RM 347771!-**18%**);
Marion Ownbey 970 (RM 143278!-**12%**);
Louis Williams 1358 (RM 135281!, RM 142436!-**20%**);
John Merkle 63-18 (RM 273967!-**29%**);
John Merkle 63-59 (RM 273968!-**1%**);
Louis Williams 1191 (RM 135279!-**80%**, RM 142441!-**69%**);
Elmer D. Merrill & E.N. Wilcox 1029 (RM 32324!-**10%**);
John F. & Mildred S. Reed 2908 (RM 220028!-**38%**, WS 194615!);
T.A. Bell s.n. (RM 7438-s!-**1%**);
C.L. Porter & B.F. Miller 6121 (RM 229656!-**29%**, UC 984202!);
Edwin B. Payson & Lois B. Payson 2819 (PH 602585!, RM 93866!-**33%**, UC 279560!);
Orval C. Harrison 332 (RM 343284!-**38%**);
Edwin B. Payson & Lois B. Payson 2234 (RM 88561!-**9%**);
L.C. Bliss 538 (RM 253984!-**5%**);
Aven & Ruth Nelson 5779 (BRY 203396!, RM 209648!-**37%**);
Aven Nelson 9241 (RM 123977!-**42%**, UC 467232!);
Aven Nelson 11014 (RM 138812!-**22%**);
Aven Nelson 7776 (RM 28794!-**58%**);
B.E. Nelson & Linda Nelson 824 (RM 296366!-**6%**);
W.G. Solheim 308 (RM 311430!-**67%**);
David Sturges 163 (RM 272470!-**53%**);
A. Lorin Ward 19 (RM 283898!-**26%**);
Leslie N. Goodding 1962 (RM 52142!-**38%**);
R.N. Holmes 367 (RM 330855!-**29%**);
Allen Morton 9 (RM 293986!-**50%**);
B.E. Nelson 905 (RM 296364!-**45%**);
B.E. Nelson 912 (RM 296363!-**40%**);
B.E. Nelson 1055 (RM 296365!-**42%**);
B.E. Nelson 4037 & William Blunt (RM 329349!-**23%**);
C.L. Porter & Marjorie W. Porter 10274 (CAN 305082!, RM 280948!-**39%**, UC M-312265!);
Aven Nelson 995 (NDG 062566/G 45934!, RM 3572!- **44%**= Lectotype of *Arnica subplumosa* E.L. Greene);
Aven Nelson 8503 (RM 37032!-**51%**);
Aven Nelson 8519 (RM 37034!-**38%**).

Ex Hortus:

I. Merfort et al. s.n. (Univ. Dusseldorf, Inst. Pharm. Biol. Herb.-**33%**).

Arnica parryi A. Gray

CANADA: Alberta.
J.M. Macoun Geol. Surv. Canada 96017 (CAN 109757!-[illegible]7%);
A.E. Porsild & A.J. Breitung 13762 (CAN 109758!- **11%**);
Stewardson Brown 723 (PH 529829!-**36%**);
A.E. Porsild & A.J. Breitung 15746 (CAN 109763!-**57%**);
H.J. Scoggan 16332 (CAN 307516!-**43%**).

British Columbia.
Mrs. J. Norman Henry 297 (PH 680092!-**63%**);
J.W. Eastham 12077 (ALTA 16946!, CAN 109776!-**50%**);
Macoun Geol. Surv. Canada 14760 (CAN 109769!-**52%**);
Edith M. Farr s.n. (PH 37778!-**34%**);
J.M. Macoun Geol. Surv. Canada 69318 (CAN 109772!- **42%**, NDG 062609!-**50%**);
J.M. Macoun Geol. Surv. Canada 96018 (CAN 109773!-**64%**,*p.p. mag.*).

Yukon Territory.
A.E. Porsild & A.J. Breitung 10935 (ALTA 29670!, UC 994743!);
A.E. Porsild & A.J. Breitung 11777 (ALA 40956!, UC 994742!).

U.S.A.: **California.**
L.R. Abrams 12767 (UC 483411!-**25%**);
H.M. Hall & E.B. Babcock 3515 (UC 63060!);
Mrs. R.M. Austin 309 (UC 91032!);
Mrs. R.M. Austin s.n. (NDG 062540/HG 45907!);
Frederick W. Oettinger 1087 (UC 1-408811!).
A. Gray s.n. (GH *s.n.*!).

Colorado.
E. Neese 16150 (BRY 275158!-**39%**, CAN 491308!);
Geo. E. Osterhout 3815 (RM 169584!-**52%**);
C.L. Porter & Marjorie W. Porter 8491 (RM 263022!-**29%**, UC M-187530!);
D.H. Wilken & R. Henrickson 14006 (BRY 262882!-**18%**);
R.K. Gierisch 2734 (RM 471058!-**13%**);
W.A. Weber 7093 (WS 211541!-**56%**);
Leslie N. Goodding 1701 (RM 52153!-**7%**, UC 69436!);
I.W. Clokey 3163 (CAN 191153!-**43%**, RM 95447!-**0%**, UC 892209!-**0%**);
Frank Tweedy 5827 (RM 47867!-**50%**);
Alan A. Beetle 2251 (ND 011149!, RM 153743!-**46%**, RM 471064! as *B-2251*);
Otto Degener & Leroy Peiler 16734 (RM 193991!-**48%**);
C.L. Porter & Marjorie W. Porter 7612 (RM 256075!-**6%**, UC M-090194!);
L.N.G. (= Leslie N. Goodding ?) 1552 (RM 52154!-**7%**);
C.B. Clokey & I.W. Clokey 4390 (CAN 191146!-**10%**, ND 011147!, PH 591428!, RM 90097!, UC 535651!, WS 70620!);
Aven Nelson & Ruth A. Nelson 4505 (RM 191945!-**57%**);
Upson s.n. (RM 471104!-**51%**);
Aven Nelson & Ruth A. Nelson 4476 (RM 191944!-**5%**, UC 724274!, WS 133087!-**0%**);
Ralph K. Gierisch 2660 (RM 471059!-**44%**);
T. Mosquin 4856 (UC M-287584!-**31%**);
I.W. Clokey 3471 (CAN 191154!-**26%**, RM 93448!, UC 892208!, WS 36632!-**31%**);
E. Neese 15904 (BRY 274639!-**0%**);
Larry C. Higgins 3780 (BRY 93633!-**14%**);
Reed C. Rollins 1447 (ND 011150!-**11%**, RM 471062!);
C.F. Baker 792 (NDG 062537/G 45910!-**40%**, RM 33185!, RM 169594!, UC 29645!-**17%**);
Jean H. Langenheim 3907 (RM 257009!-**51%**, UC M-086619!);

Lancaster, Doran & Bunderson 59 (RM 471057!-**42%**);
Edwin Payson 204 (RM 80973!-**35%**);
C.L. Porter & Marjorie W. Porter 10497 (RM 283425!-0%);
C.F. Baker, F.S. Earle & S.M. Tracy 496 (RM 13666!-0%, RM 169593!-7%);
Frank H. Rose R-96 (RM 471061!-7%);
Harry N. Patterson s.n. (NDG 062528/G 45903!-**44%**);
Earl L. Johnston 329 (RM 117557!-**95%**).

Idaho.
Aven Nelson & Ruth A. Nelson 2996 (RM 177971!-**17%**, UC 614295!);
C.L. Hitchcock & C.V. Muhlick 11364 (UC 968683!-0%, WS 155982!);
Arthur Cronquist 1749 (RM 186929!-**9%**);
J.F. Macbride & Edwin B. Payson 3598 (RM 86107!, UC 256370!-0%);
Harley J. Helm 310 (RM 471144!-8%);
C.L. Hitchcock & C.V. Muhlick 10469 (CAN 191144!, PH 838851!-**16%**, RM 198572!, UC 968673!);
William Sm. Gruezo WM11431 (ALTA 91401!-**6%**, WGRZ!);
Dieffenbach, Glennon, Holte, Mel, Pearson & Vieth TNF-1014 (RM 471146!-**29%**);
Edwin B. Payson & George M. Armstrong 3527 (PH 617126!, RM 98210!-**21%**).

Montana.
Jean G. Witt 1324 (WS 184742!-**21%**);
Eric P. White 84 (RM 471065!-**12%**);
Orville Sparrow 153 (RM 471066!-**18%**);
L.M. Umbach 528 (RM 169590!-**15%**);
R.S. Williams s.n. (RM 24209!-**24%**).

Oregon.
Marion Ownbey & Ruth P. Ownbey 1835 (PENN/PH s.n.!, RM 183744!-**11%**, WS 101662!);
R. Daubenmire 6234 (WS 249946!-**56%**);
W.D. Foreman 12 (RM 471137!-**25%**);
Rolland Huff 16H (RM 471136!-**11%**);
Arthur Cronquist 7501 (UC M-000107!-**16%**, WS 210443!-**23%**);
L.E. Detling 7019 (WS 276338!-0%);
Donovan Yingst DY-26 (RM 471143!-**45%**);
William Sm. Gruezo WM11472 (ALTA!-**13%**, WGRZ!).
William Sm. Gruezo WM11476 (ALTA 91403!-**16%**, WGRZ!).

Utah.
Bassett Maguire, A.G. Richards & Ruth Maguire 4315 (RM 140649!-**20%**, UC 53007!);
P.A. Rydberg & A.O. Garrett 8830 (UC 176827!-**15%**);**
S. Goodrich 16013 (BRY 227006!-0%);
Mont E. Lewis 5150 (BRY 179152!-**20%**, RM 306628!);
Lincoln Ellison 4618 (RM 471147!-**32%**);
Edwin B. Payson & Lois B. Payson 4095 (RM 102251!-**39%**, UC 275313!);
H.W. Johnston 50-G (RM 471150!-**33%**);
P.A. Rydberg & E.C. Carlton 7353 (RM 59857!-**30%**);
Marcus E. Jones 5890 (RM 14268!, UC 159378!-**21%**);
A. Taye 2934 (BRY 277648!-**21%**);
Bassett Maguire & Ruth Maguire 26165 (CAN 191143!-0%, WS 170084!);
Irwin H. Johnson J-134 (RM 471149!-**27%**);
D. Atwood 6945 (BRY 186937!-0%);
Raymond Kienholz 70 (RM 471148!-**16%**).

Washington.
Earle F. Layser 1804 (WS 270987!-0%);

A.D.E. Elmer 582 (RM 12031!-**45%**, WS 26598!);
Chas. B. Fiker 493 (WS 75569!-**0%**);
A.D.E. Elmer 2622 (WS 26604!-**40%**);
J.B. Flett 130 (WS 26599!-**39%**);
George H. Ward & Anne M. Ward 707 (WS 179206!-**38%**);
J. William Thompson 7688 (PH 693027!, UC 471017!, WS 100601!-**15%**);
J. William Thompson 14968 (CAN 191149!-**49%**, PH 832707!, UC 749651!, WS 152665!);
A.R. Kruckeberg 5431 (UC M-292127!-**37%**);
Frank B. Lenzie 21 (RM 471140!-**8%**);
F.G. Renner & R.E. Nickles 729 (RM 471139!-**33%**);
C.L. Hitchcock 8050 (RM 195239!, UC 710969!, WS 130138!-**44%**);
O.D. Allen 137 (CAN 191145!, RM 10166!, UC 29648!, UC 91027!-**16%**, WS 26601!);
C.V. Piper 2159 (WS 26596!-**28%**);
J.M. Grant s.n. (RM 102833!-**23%**);
J.M. Grant s.n. (PH 628724!-**25%**);
J. William Thompson 11137 (ND 011148!-**42%**);
J. William Thompson 15152 (WS 152635!-**33%**);
Wilhelm N. Suksdorf 6337 (UC 892200!, WS 79765!-**60%**);
L.F. Henderson 4711 (CAN 191148!-**47%**).

Wyoming.
E.F. Evert 2402 (RM 334606!-**11%**);
Aven Nelson & Elias Nelson 6286 (NDG 062529/G 45902!, RM 169581!, RM 20782!-**15%**);
Aven Nelson & Elias Nelson 6148 (RM 20781!-**11%**);
William Sm. Gruezo WM11405 (ALTA 91399!-**20%**);
William Sm. Gruezo WM11406 (ALTA 91400!-**15%**);
Ray J. Davis 4882 (WS 182396!-**19%**);
Dale L. Taylor 67-144 (RM 283723!-**32%**);
C.L. Porter & Marjorie W. Porter 10296 (CAN 305083!, RM 280945!-**19%**, UC M-312277!);
W.G. & Ragnhild Solheim 3905 (RM 248353!-**12%**);
Loran C. Anderson 204 (RM 254238!, UC M-035101!-**12%**, WS 243855!);
Robert L. Tresler 105 (RM 273825!-**69%**);
Arthur H. Holmgren 16570, Jack Payne & Marty Lee (BRY 193665!-**42%**, RM 319232!, UC 1 442408!);
Orval C. Harrison 298 (RM 337274!-**31%**);
Orval C. Harrison 11 (RM 292504!-**10%**);
William Sm. Gruezo WM11323 (ALTA 92174!-**11%**);
Ronald L. Hartman 3051 (RM 295477!-**55%**);
Leslie N. Goodding 1998 (PENN 39273!, PH 523719!, RM 52155!-**80%**, UC 69435!);
B.E. Nelson 4198 & William Blunt (RM 329350!-**72%**);
C.L. Porter & Marjorie W. Porter 9707 (RM 274982!-**38%**, UC M-303990!);
Chas. H. McDonald 606 (RM 408646!-**8%**);
C.H. McDonald & Leo E. Fest McD & F-37 (RM 408645!-**35%**);
Aven Nelson 4156 (RM 10609!-**40%**);
Johnston & Hedgack 308 (RM 87558!-**42%**);
Geo. E. Osterhout 36 (RM 169585!-**80%**);
Geo. E. Osterhout 974 (RM 169588!-**50%**);
Elmer D. Merrill & E.N. Wilcox 1148 (RM 32328!-**26%**).

Arnica lanceolata Nutt. subsp. **amplexicaulis** (Nutt.) Gruezo

CANADA: Alberta.
G. Armstrong & J. Nagy 5018 (CAN 346901!-**21%**);
J. Nagy 2669 (ALTA 82439!, CAN 349727!-**57%**);
R.M. Anderson s.n. (CAN 109633!-**56%**, UC 892034!);
Macoun Geol. Surv. Canada 14715 (CAN 109627!-**57%**).

British Columbia.
J.A. Calder & K.T. MacKay 30362 (UC M-235063!-**17%**);
H.J. Scoggan 15306 (CAN 307125!-**21%**);
C.O. Rosendahl & Carl J. Brand 83 (CAN 109659!, RM 35259!-**80%**, UC 34213!-**83%**, UC 892039!);
W. Spreadborough Geol. Surv. Canada 77027 (CAN 109644!- **0%**);
J.M. Macoun Geol. Surv. Canada 26927 (CAN 109638!- **18%**);
W. Spreadborough Geol. Surv. Canada 77006 (CAN 109656!-**11%**);
W. Spreadborough Geol. Surv. Canada 77010 (CAN 109634!-**19%**, WS 31384!);
J.M. Macoun Geol. Surv. Canada 26927 (ND-G 062520/G 45983!-**17%**);
J.M. Macoun Geol. Surv. Canada 69332 (CAN 109639!- **0%**);
J.M. Macoun Geol. Surv. Canada 96039 (CAN 109636!-**0%**).

U.S.A. Alaska.
Bee Cumby 271 (ALA V071842!-**0%**);
W.J. Eyerdam 7337 (WS 224272!-**0%**);
Edmund Heller 49 (UC 146298!-**21%**);
W.J. Eyerdam 366 (UC M-094251!-**31%**);
W.J. Eyerdam 637 (UC M-094250!-**26%**);
Mary Clay Muller 4957 (ALA V072661!-**5%**, BRY 239675!-**23%**);
Mary Clay Muller 4854 (ALA V76076!-**5%**);
Jim Downs 129 (ALA V073013!-**0%**);
J.P. Anderson 6400 (ALA 1824!, ALA 35176!, CAN 109666!, RM 190709!-**8%**);
L.G. Smith 125 (BRY 88462!-**10%**);
Helen Schmuck 322 (BRY 263204!-**16%**).
W.J. Eyerdam 5983 (CAN 125364!, CAN 154963!-**4%**, WS 223404!);
Maxcine Williams 2562 (ALA 43556!-**40%**, BRY 94060!-**41%**).

California.
Geo. D. Butler 1656 (RM 73441!, UC 166160!-**2%**);
W.J. Ferlatte 464 (JEPS 74537!-**0%**);
William J. Ferlatte 1284 & Alice Q. Howard (JEPS 74635!-**0%**);
E.B. Babcock 1132 (RM 106388!-**0%**, UC 311621!-**0%**);
W.L. Jepson s.n. (JEPS 35896!-**0%**);
Beryl O. Schreiber 2531 (RM 471089!-**40%**, UC 608846!, UC M-119301!);
H.M. Hall & H.P. Chandler 649 (UC 63064!-**40%**);
P.A. Munz 15942 (UC M-004857!-**0%**);
Mrs. Joseph Clemens s.n. (RM 96067!, UC 892037!-**35%**);
H.M. Hall & H.P. Chandler 446 (PH *s.n.*!, UC 29589!-**41%**);
Annie M. Alexander & Louise Kellogg 2568 (UC 67668!-**36%**);
Annie M. Alexander & Louise Kellogg 2976 (UC 694320!-**23%**);
Roxana S. Ferris 8853 (UC 563037!-**31%**);
W.L. Jepson 5024 (JEPS 35863!-**0%**).

Idaho.
R.F. Daubenmire 44417 (WS 260933!-**0%**);
C.V. Piper 6074 (WS 79714!-**0%**);
Peter F. Stickney 2186 (RM 470623!-**16%**);
Arthur M. Cusick 47 (RM 470650!-**4%**).

Montana.
Bassett Maguire 1090 (RM 131265!-**31%**);
Bassett Maguire & George Piranian 15339 (PH 781135!-**37%**);
Aven Nelson & Ruth A. Nelson 3130 (RM 177953!, UC 614297!-**46%**);
Aven Nelson & Ruth A. Nelson 3143 (RM 177951!-**29%**, WS 614299!);
Aven Nelson & Ruth A. Nelson 3162 (RM 177970!-**23%**, UC 614296!);

F.K. Vreeland 993 (CAN 190965!-**8%**).

Nevada.
Bassett Maguire & Arthur H. Holmgren 22629b (PH 813503!-**19%**);
A.H. Holmgren 1727 (BRY 28186!, UC 675876!-**23%**);
Laura E. Mills & Kay H. Beach 1471 (UC M-035599!-**23%**);
Bassett Maguire & Arthur H. Holmgren 22044 (PH 813420!, UC 711477!-**10%**);
N.E. Nichols & L. Lund 564 (UC 892180!-**30%**);
P.A. Munz 16205 (UC M-005138!-**0%**).

Oregon.
J.W. Thompson 2739 (PH 663878!-**99%**);
J. William Thompson 11846 (PH 744705!-**99%**);
R. Ornduff 6258 (UC M-169367!-**97%**);
Bassett Maguire 17217 (PH 815006!-**98%**, UC 632283!);
Bassett Maguire 17218 (BRY 15843!, CAN 190964!, PH 815007!-**96%**, RM 180255!-**100%**, UC 632282!-**99%**, UC 892035!, WS 126367!);
L.E. Detling 7115 (UC M-185994!-**85%**);
Louis F. Henderson s.n. (RM 13152!-**98%**);
A.A. Heller 10055 (PH 537274!-**63%**);
L.R. Abrams 8798 (RM 99919!-**92%**);
W.J. Spillman s.n. (WS 26530!-**100%**);
J. William Thompson 13310 (PH 757237!-**7%**);
J.F. Franklin & C.T. Dyrness 166 (RM 470617!-**0%**);
Wm. C. Cusick 4891 (UC 892175!-**0%**, WS 79702!- **7%**);
William H. Baker 7012 (WS 219918!-**8%**);
Douglas C. Ingram 1661 (RM 470618!-**4%**).

Washington.
A.D.E. Elmer 672 (RM 12030!-**0%**, WS 26524!-**0%**);
C.L. Hitchcock 8067 (RM 195240!-**0%**, UC 710911!);
Chas. B. Fiker 1338 (WS 75812!-**19%**);
J. William Thompson 17196 (RM 269454!-**22%**, RM 269460!);
J. William Thompson 8076 (PH 692755!, UC 470598!-**9%**);
G.W. Turesson 20 (WS 66237!-**28%**);
Edith Hardin 469 (WS 65687!-**0%**);
A.D.E. Elmer 2634 (WS 26605!-**95%**);
Harold St. John 5798 (WS 129492!-**62%**);
J. William Thompson 14675 (CAN 190967!-**0%**);
Ralph & Dorothy Naas 2696 (RM 470616!-**0%**);
P.A. Munz 24244 (UC M-188071!-**23%**);
J.H. Sandberg & J.B. Leiberg 633 (CAN 190966!, UC 167604!, WS 26526!-**35%**);
J. William Thompson 7738 (ND-G 011139/G 2379!-**9%**, PH 692784!, UC 471043!, WS 100602!-**6%**);
John E. Schwartz 175 (RM 470619!-**96%**);
Fred Meyer 700 (WS 75973!-**46%**);
Fred G. Meyer 502 (WS 79836!-**96%**);
J. William Thompson 7604 (PH 691949!-**44%**);
O.D. Allen 138 (RM 10167!, UC 29633!-**50%**, UC 91023!, WS 26588!-**50%**);
J. William Thompson 7289 (PH 691869!, UC 470828!-**96%**).
Jerry F. Franklin 596 (RM 471086!-**3%**);
Wilhelm N. Suksdorf 12917 (WS 79740!-**88%**);
Wilhelm N. Suksdorf 6343 (WS 79805!-**6%**);
J. William Thompson 15069 (WS 152631!-**5%**);
O.D. Allen 285a (UC 134173!, WS 26529!-**79%**);
Douglas C. Ingram 1850 (RM 470622!, WS 52231!-**45%**);

J.H. Sandberg & J.B. Leiberg s.n. (RM 169772![illegible]

Ex Hortus:
I. Merfort *et al. s.n.* (Univ. Dusseldorf, Pharm. Biol. Herb. *s.n.*[illegible]).

Arnica lanceolata Nutt. subsp. **lanceolata**:

CANADA: New Brunswick.
J. Fowler s.n. (MT *s.n.*!-0%, PH 605618!); UC 892129!);
G.U. Hay s.n. (PH 547980!-0%).

Québec.
M.L. Fernald & A.S. Pease 25336 (CAN 109673!, MT *s.n.*!-0%);
J.K. Morton NA4030 (ALTA 86187!-0%, CAN 471348!);
M.L. Fernald & L.B. Smith 26089 (CAN 109672!, MT *s.n.*!-0%);
C.W. Dodge, A.W. Pease & L.B. Smith 26086 (CAN 109671!, MT *s.n.*!-0%);
M.L. Fernald & L.B. Smith 26094 (MT *s.n.*!-0%);
Ludlow Griscom & A.S. Pease 26092 (CAN 109670!-0%);
E.F. Williams, J.F. Collins & M.L. Fernald 69113 (*CAN 109677!-0%*);
F. Marie-Victorin, F. Rolland-Germain & E. Jacques 33351 (RM 134609!-0%);
J.F. Collins & M.L. Fernald 146 (CAN 109679!, CAN 109682!, MT *s.n.*! -0%, 2 herb. sheets; UC 147967!);
H.J. Scoggan 2183 (CAN 109718!-0%);
Lionel Cinq-Mars L-48 (PH s.n.!-0%); Edwin B. Bartram & Bayard Long 499 (PH 648526!-0%);
Charles Williamson s.n. (PENN 52110!-0%);
C.S. Williamson 1417 (PH s.n.!-0%);
A.A. Champlain 429 (MT *s.n.*!-0%);
Robert T. Clausen & Harold Trapido 2882 (UC 892166!-0%);
Pere Louis-Marie & R. Cayouette 50239 (MT *s.n.*!-0%); H.J. Scoggan 1317 (CAN 109721!-0%);
Pierre Dansereau, Marcel Raymond & James Kucyniak 17 (MT *s.n.*! - 0%, 3 herb. sheets);
S. Brisson, R. Cayouette & L. Brassard 6059 (CAN 322960!-0%);
FF. Samuel & Sylvio 4450 (MT *s.n.*!-0%);
Marcel Raymond & James Kucyniak 3985 (MT *s.n.*!-0%);
F. Marie-Victorin, F. Rolland-Germain, Jules B. Brunel & Z. Rousseau 17520 (MT *s.n.*! -0%, 2 herb. sheets);
J. Rousseau & L. Fortier 31412 (MT *s.n.*! -0%, 2 herb. sheets);
L. McI. Terrill 4577 (CAN 339301!-0%);
M.L. Fernald & L.B. Smith 26093 (CAN 109668!-0%);
F. Marie-Victorin & F. Rolland-Germian 49413 (MT *s.n.*! -0%, 2 herb. sheets; PH 827936!, UC 740887!, WS 222566!);
Pere Louis-Marie & R. Cayouette 50344 (CAN 214994!, MT *s.n.*!-0%);
P. Levesque 22 (MT *s.n.*!-0%);
J.F. Collins & M.L. Fernald 69114 (CAN 109678!-0%);
J.F. Collins & M.L. Fernald s.n. (MT *s.n.*!-0%);
H.J. Scoggan 1402 (CAN 109722!-0%);
J. Rousseau & L. Fortier 35686 (MT *s.n.*!-0%);
H.J. Scoggan 1403 (CAN 109720!-0%);
A.A. Champlain 804 (MT *s.n.*!-0%); J. Rousseau & L. Fortier 31505 (MT *s.n.*! -0%, 3 herb. sheets; RM 134318!);
Marcel & Paul Brule, Fr. Lorenzo 35241 (MT *s.n.*!-0%);
Marcel Raymond, James Kucyniak & Olof Rune 1881 (MT *s.n.*!-0%);
F. Marie-Victorin, F. Rolland-Germain, Jules B. Brunel & Z. Rousseau 17519 (MT *s.n.*! -0%, 3 herb. sheets; PH 626854!);
F. Marie-Victorin, F. Rolland-Germain & E. Jacques 33253 (MT *s.n.*!-0%, PH 686037!, RM

134635!);
Pere Louis-Marie, FF. Fabius & Adonis, M. Raymond & J. Paquin 34337 (MT *s.n.*!-0%);
F. Marie-Victorin, F. Rolland-Germain & E. Jacques 33351 (MT *s.n.*! -0%, 2 herb. sheets);
Macoun Geol. Surv. Canada 14719 (CAN 109680!-0%);
F. Marie-Victorin, F. Rolland-Germain, Jules B. Brunel & Z. Rousseau 17521 (MT *s.n.*! -0%, 2 herb. sheets; PH 626853!);
F. Marie-Victorin, F. Rolland-Germain, Jules B. Brunel & Z. Rousseau 17522 (MT *s.n.*! -0%, 2 herb. sheets);
F. Marie-Victorin, F. Rolland-Germain, Jules B. Brunel & Z. Rousseau 17523 (MT *s.n.*! -0%, 2 herb. sheets; PH 626852!);
Lionel Cinq-Mars L-214 (PH s.n.!-0%);
G.B. Rossbach 4460 (MT *s.n.*!-0%);
Ernest Lepage 15267 (CAN 304535!-0%);
J. Rousseau & H. Bonin 32210 (MT *s.n.*!-0%);
J. Rousseau 32470 (CAN 109681!, MT *s.n.*!-0%);
J. Rousseau 32454 (CAN 109675!, MT *s.n.*!-0%);
J. Rousseau 32432 (CAN 109674!, MT *s.n.*!-0%, PH 685909!, RM 134704!).

U.S.A.: Maine.
Hampton L. Carson Jr. s.n. (PENN/PH s.n.!-0%);
E. Perot Walker 49 (PENN/PH s.n.!-0%);
Francis Harper s.n. (PH 697005!-0%);
Harold St. John & George E. Nichols 2509 (CAN 191121!-0%);
A.S. Pease & R.C. Bean 28999 (CAN 191122!-0%).

New Hampshire.
J.A. Allen s.n. (UC 29641!-0%);
Allen 1131 (PH 586725!-0%);
Allen 1131 (PH 586725!-0%);
E. Facon s.n. (WS 82048!-0%);
Willard W. Eggleston s.n (RM 15678!-0%);
W.W. Eggleston s.n. (MT *s.n.*!-0%);
Willard W. Eggleston 1287 (RM 23411!-0%);
W.W. Eggleston & Alma L. Eggleston 22334 (PH 675161!-0%);
F.H. Sargent s.n. (BRY 142222!-0%);
Dorothy R. Wade 3140 (SASK 27615!-0%);
William A. Dayton 1061 (RM 471079!-0%);
F.F. Forbes s.n. (RM 50178!-0%);
F.F. Forbes s.n. (UC 892182!-0%);
George Golding Kennedy s.n. (PH 633706!-0%);
Dana S. Carpenter 4 (PENN/PH s.n.!-0%);
W.W. Eggleston 2373 (PH 586569!-0%);
Wm. F. Flint & J.H. Huntington s.n. (UC 65609!-0%);
John M. Fogg Jr. 5041 (PENN/PH s.n.!-0%);
J.W. Harshberger s.n. (PENN 12527!, PENN 12528!, PENN 43570!-0%);
B. Long & E.B. Bartram 47 (PH 648207!-0%);
A.H. Moore 171 (PENN s.n.!, UC 159422!-0%);
H.T. Skinner s.n. (PENN/PH s.n.!-0%);
Rodney H. True S14 (PENN/PH s.n.!-0%);
Charles Williamson s.n. (PENN 52338!-0%);
C.S. Williamson 1417 (PH s.n.!-0%);
J.W. Chickering Jr. 38328 (CAN 191114!-0%);
J.W. Chickering Jr. s.n. (MT *s.n.*!-0%);
J.W. Chickering Jr. s.n. (MT *s.n.*!-0%);
W.G. Farlow s.n. (PENN/PH s.n.!-0%);
F.F. Forbes s.n. (PH 769550!-0%);

George Golding Kennedy s.n. (PH 633706!-0%);
Emile F. Williams s.n. (MT *s.n.*!-0%);
Gul. Oakes s.n. (PENN 12530!-0%);
C.G. Pringle s.n. (UC 178527!-0%);
C.G. Pringle s.n. (MT *s.n.*!-0%);
C.G. Pringle s.n. (ND 011138!, NDG 062487/G 45952!-0%, PENN 12529!, PH 709126!);
Oakes s.n. (UC 380285!-0%);
Anon. (CAN 372717!-0%);
Anon. (UC 380286!-0%);
Gul. Oakes 38327 (CAN 191113!-0%);
Ezra Bramend & C.S. Williamson s.n (PH s.n.!-0%).

Arnica longifolia D.C. Eaton

CANADA: Alberta.
A.E. Porsild & Johannes Lid 1957[illegible] (CAN 293158!-0%);
A.E. Porsild & A.J. Breitung 14247 (CAN 109813!-0%).

U.S.A.: California.
L.S. Smith 1055 (JEPS 35892!-**16%**, **19%**, RM 471054!-**14%**);
W.L. Jepson 7974 (JEPS 35867!-**6%**, JEPS 35868!-**9%**, **13%**);
Leland S. Smith 1041 (JEPS 35880!-**16%**, RM 471055!);
Annie M. Alexander & Louise Kellogg 5110 (UC 936275!-0%);
Wm. Bridge Cooke 15427 (ND 011130!-20%);
Joseph P. Tracy 14655 (UC 582486!-20%);
A. A. Heller 7191 (PH 507083!, RM 46659!-0%, UC 57884!);
G. Thomas Robbins 3712 & L.R. Heckard (JEPS [illegible]5569!-0%);
C.F. Sonne 191 (JEPS 20970!-**18%**, PH 548682!);
C.F. Sonne s.n. (UC 29640!-0%);
C.F. Sonne s.n. (UC 197284!-0%);
Miss Helen D. Geis 43 (UC 468975!-0%);
W.C. Blasdale s.n. (UC 467703!-**7%**);
Miss Helen D. Geis 77 (UC 468974!-**5%**);
H.M. Hall 8815 (UC 148993!-0%);
H.M. Hall s.n. (RM 73167!-**5%**);
C.G. Albertus 328 (RM 470719!-0%, UC M-119287!);
Rimo Bacigalupi 6052 & C. Fletcher Talbot (JEPS 19839!-0%);
Annie M. Alexander & Louise Kellogg 3882 (JEPS 35875!-**23%**, UC 703409!);
Annie M. Alexander & Louise Kellogg 4228 (JEPS 35874!-0%, WS 256348!-0%);
T.M. Hendrix 568 (UC 577909!-**2%**);
A.R. Kruckeberg 3574 (RM 259292!-0%, WS 235988!);
Richard S. Mitchell 2254 (UC M-299868!-0%);
Philip A. Munz 20014 (RM 245268!-0%);
W.A. Peterson 559 (UC M-119297!-0%);
Carl W. Sharsmith 2788 (UC 712186!-0%);
Rimo Bacigalupi 8009, P.C. Hutchison & L. Heckard (JEPS 28091!-0%);
Mary DeDecker 4875 (UC I-445380!-0%);
C.A. Purpus s.n. (UC 134167!-**15%**);
Ralph Hopping 181 (UC 467695!-**16%**).

Colorado.
Leslie N. Goodding 1914 (PH 523769!, RM 52151!-**20%**, RM 169628!);
Jean H. Langenheim 4045 (RM 257231!-0%, UC M-080031!-**1%**);
W.A. Weber & Sam Shushan 9380 (RM 248530!-0%, UC M-049909!, WS 221896!-**1%**);
C.F. Baker 726 (NDG 062481!/G 45943!-**7%**, RM 169626!, RM 33183!-[illegible]%, UC 29638!-10%, WS 26623!-0%).

Idaho.
R.T. Bingham & C.J. Miller 351 (WS 286806!-**27%**);
John N. Kinney 341 (RM 470971!-**97%**);
J.F. Macbride & Edwin B. Payson 3278 (RM 86112!-**97%**);
Aven Nelson & J.F. Macbride 1443 (CAN 191099!, RM 71133!-**10%**);
J. William Thompson 13959 (PH 768291!, UC 609841!-**97%**);
C.L. Hitchcock & C.V. Muhlick 10663 (CAN 191102!, PH 838659!, RM 198595!-**40%**, WS 155997!);
Herman Work 431 (RM 470979!-**18%**);
Beverly Albee 30 (BRY 111196!-**45%**);
F.J. Hermann 20216 (RM 470981!-**11%**);
William Sm. Gruezo WM11425 (ALTA 92178!-**24%**, WGRZ!);
William Sm. Gruezo WM11430 (ALTA 92177!-**19%**, WGRZ!);
William Sm. Gruezo WM11433 (ALTA 91433!-**12%**, WGRZ!);
William Sm. Gruezo WM11435 (ALTA 91434!-**28%**, WGRZ!);
C.L. Hitchcock & C.V. Muhlick 10113 (RM 197898!-**82%**, UC 968526!);
R.B. Johnson RBJ-175 (RM 471037!-**6%**);
J. Francis Macbride 699 (RM 67433!-**57%**, WS 44689!);
Charles Piper Smith 2285 (RM 67767!-**95%**);
Dieffenbach, Glennon, Holte, Mel, Pearson & Vieth TNF 937 (RM 470970!-**89%**);
Aven Nelson & Ruth A. Nelson 2978 (RM 177952!-**9%**, UC 614298!);
Ray Pickett 91 (RM 82198!-**93%**);
C.N. Woods 91 (RM 470973!-**94%**);
Carl J. Kriley 85 (RM 470972!-**90%**).

Montana.
D.C. Pashusta 86 (RM 470983!-**92%**);
J.W. Blankinship 711 (CAN 191101!-**77%**, RM 470992!);
C.H. Hurst 77 (RM 470990!-**42%**);
C.L. Hitchcock & C.V. Muhlick 13360 (CAN 191096!, PH 836534!, RM 203760!-**20%**, UC 757571!, WS 159583!);
C.E.G. Sewing 17 (RM 470993!-**32%**);
Aven Nelson 4219 (RM 10611!-**37%**);
Jean G. Witt 1763 (WS 228545!-**33%**);
James C. Whitham 1707 (RM 470984!-**50%**);
C.L. Hitchcock 16951 (CAN 191090!-**52%**, WS 175076!);
James C. Whitham 1426 (RM 470985!-**16%**);
Lincoln Ellison & R.A. Robinson 3346 (RM 470986!-**22%**);
Thomas D. Howe 54 (RM 470987!-**93%**);
P.A. Rydberg & Ernst A. Bessey 5226 (CAN 191100!; NDG 062511!/G 45971!, PH 709100!, RM 21638!-**36%**);
L.M. Umbach 338 (RM 169976!-**13%**);
E. Knox 21 p.p. ['B'](RM 146394!-**55%**);
F.J. Ryder 212 (RM 81399!-**74%**);
Arthur Buckingham 123 (RM 470659!-**99%**).

Nevada.
A.A. Heller 9961 (JEPS 22843!-**50%**, MT *s.n.*!- 2 herb. sheets, PH 537121!, UC 174558!);
Percy Train 4367 (UC 892100!-**0%**);
Frank E. Gray 335 (RM 470647!-**37%**).

Oregon.
L. Constance & C.D. Jacobs 1373 (MT *s.n.*!, WS 69148!-**0%**);
C.W. Sharsmith 3892 (UC 604481!, WS 91104!-**17%**);
C.E. Fleming 154 (RM 471048!, RM 471049!-**30%**);
Wm. C. Cusick 1774 (NDG 062510!/HG 45972!, UC 29639!, WS 26640!-**0%**);

Bassett Maguire & Arthur H. Holmgren 26849 (CAN 191097!, UC 739042! WS 170005!-**44%**);
William H. Baker 6365 (UC 922892!-**25%**);
A.A. Heller 12621 (PH/PENN 68056!-**37%**, PH 598789!, UC 726628!);
William Sm. Gruezo WM11471 (ALTA 91435!-**33%**, WGRZ!);
William Sm. Gruezo WM11475 (ALTA 91436!-**26%**, WGRZ!);
L.R. Abrams 9827 (RM 100188!-**35%**).

Utah.
Bassett Maguire, Dean A. Hobson & Ruth R. Maguire 14209 (CAN 191106!-**95%**, PH 781119!, RM 180249!);
R.S. Snell 1017 (CAN 191093!-**85%**, WS 170191!);
Bassett Maguire 16153 (CAN 191092!-**98%**, PH 810064!);
John Thieret & Mildred Thieret 206 (UC M-010949!, WS 216257!-**95%**);
Bassett Maguire & Arthur H. Holmgren 22187 (CAN 191098!, PH 813499!, PH 824361!, UC 711480!-**29%**);
Wallace M. Saling WMS-105 (RM 470982!-**13%**);
A. Taye & B. Wall 1172 (BRY 218650!-**0%**);
William Sm. Gruezo WM11444 (ALTA 92175!-**19%**);
B. Welsh & S.L. Welsh 711 (BRY 221873!
p.p. mag.-**4%**);
Decker 638 (BRY 15881!-**11%**);
R. Foster 6729 (BRY 185007!-**0%**, RM 314437!-**0%**);
Edwin B. Payson & Lois B. Payson 4103 (RM 102250!-**0%**, UC 275312!-**10%**);
N.D. Atwood 3043 (BRY 102239!-**0%**);
Marcus E. Jones 5900 (RM 14269!-**24%**, RM 64002!);
H.M. Christensen C-67 (RM 470614!-**25%**);
A. Taye 2743 (BRY 277383!-**14%**);
Frank W. Gould 1905 (ND 011135!, PH 824753!, RM 197008!-**0%**, WS 156712!-**12%**);
P.A. Rydberg & C. Carlton 7736 (CAN 191105!, RM 59893!-**31%**).

Washington.
Ralph & Dorothy Naas 2546 (RM 470621!-**17%**);
Ralph & Dorothy Naas 2736 (RM 470620!-**13%**);
J. William Thompson 14349 (ALTA 16939!, CAN 272383! *p.p.*, PH 832811! *p.p.*, UC 748824!, WS 152604!, WS 230550! *p.p. mag.*-**29%**, CAN 191103! consists of *Arnica lanceolata* Nutt. subsp. amplexicaulis (Nutt.) Gruezo, and so with the remainder of the specimens on those herbarium sheets marked with *pro parte/pro parte magna*);
J. William Thompson 8103 (PH 692754!, UC 470859!-**5%**);
Wilhelm N. Suksdorf 6097 (WS 79775!-**42%**).

Wyoming.
Aven Nelson 8499 (RM 37039!-**17%**);
Ronald L. Hartman 10256 (RM 347748!-**44%**);
B.E. Nelson 4343 (RM 347754!-**21%**);
William Sm. Gruezo WM11380 (ALTA 91425!-**12%**, WGRZ!);
William Sm. Gruezo WM11385 (ALTA 91426!-**22%**, WGRZ!);
B.E. Nelson 4596 (RM 347753!-**32%**);
B.E. Nelson 4638 (RM 347752!-**49%/37%**);
B.E. Nelson 4671 (RM 347751!-**29%**);
Frank Tweedy 3023 (RM 38406!-**34%**, WS 26639!);
William Sm. Gruezo WM11373 (ALTA 91424!-**27%**, WGRZ!);
Leslie N. Goodding 390 (RM 37041!-**39%**, UC 892061!);
Neland A. Kissinger Jr K-36 (RM 227284!, RM 402841!-**31%**);
William Sm. Gruezo WM11391 (ALTA 91428!-**24%**, WGRZ!);
William Sm. Gruezo WM11395 (ALTA 91429!-**14%**, WGRZ!);

William Sm. Gruezo WM11396 (ALTA 91430!-**9%**, WGRZ!);
William J. Cochran C-142 (RM 402840!-**38%**);
Gael Fonken 1013 (RM 347679!-**31%**);
B.E. Nelson 4588 (RM 347689!-**32%**);
B.E. Nelson 6535 (RM 347750!-**33%**);
Louis O. Williams & Rua Williams 3256 (RM 177550!-**39%**);
Thomas Nelson 141 (BRY 115135!-**47%**);
Jean G. Witt 1389 (BRY 142234!-**23%**, MT *s.n.*!, WS 184745!);
C.L. Porter & Marjorie N. Porter 5925 (PH 856801!, RM 222699!-**24%**, UC 937427!);
Aven Nelson & Elias Nelson 6279 (RM 20773!-**17%**, RM 169625!);
H.S. Conard 1583 (RM 101391!-**60%/66%**);
William Sm. Gruezo WM11404 (ALTA 91427!-**43%**, WGRZ!);
William Sm. Gruezo WM11408 (ALTA 91431!-**27%**, WGRZ!);
Loran C. Anderson 576 (RM 254213!-**85%**, UC M-249242!);
A. Nelson 4219 (RM 10611!-**43%**);
Claud C. Shannon 1 (RM 402981!-**81%**);
Robert Lichvar 574 (RM 315780!-**96%**);
Robert Lichvar 591 (RM 315616!-**87%**);
Robert Lichvar 991 (RM 315627!-**93%**);
John Merkle 63-48 (RM 273966!-**51%**);
John Merkle 65-29 (RM 280106!-**43%**);
O.J. Munie 12 (RM 130057!-**76%**);
Aven Nelson 957 (RM 4832!-**79%**);
Louis Williams 1022 (PH 682728!, RM 169923!-**81%**);
Louis Williams 1404 (RM 135278!-**21%**, RM 142442!);
Louis Williams 1705 (RM 169924!-**24%**, WS 72560!);
C.L. Porter 5216 (RM 215261!-**25%**);
John F. Reed, Beetle & Mildred S. Reed 2590 (RM 211626!-74%);
Louis Williams 1368 (RM 135277!-**92%**);
Richard W. Scott 327 (RM 275199!-**0%**);
Arthur H. Holmgren 16596 (RM 319218!-**33%**);
John S. Shultz 374 (RM 313150!-**90%**);
Geo. J. Goodman 5134 (RM 215556!-**91%**);
Orval C. Harrison 190 (RM 305058!-**81%**);
Edwin B. Payson & Lois B. Payson 2301 (RM 88558!**56%**);
C.H. McDonald & A. Gardiner Mc & G-12 (RM 402839!-74%);
Aven Nelson 2356 (RM 7632!-**36%**);
Richard W. Scott 311A (RM 275279!-**2%**).

Ex Hortus
I. Merfort et al. s.n. (Univ. Dusseldorf Inst. Pharm. Biol. Herb. *s.n.*!-**26%**).

Arnica ovata Greene

CANADA: **Alberta.**
L.R. Hettinger 420 (ALTA 45572!-**19%**);
L.R. Hettinger 392 (CAN 40982!-**14%**);
T. Mosquin 3353 (UC M-287590!-**10%**);
J.M. Macoun Geol. Surv. Can 96054 (CAN 109683!-7%);
J.M. Macoun Geol. Surv. Can. 96055 (CAN 109688!-**17%**);
J.M. Macoun Geol. Surv. Can. 96065 (CAN 109684!-**15%**);
William Sm. Gruezo WM11550 (ALTA 91296!-**11%**, WGRZ!);
William Sm. Gruezo WM11552 (ALTA 91293!-**5%**, WGRZ!);
J.M. Macoun Geol. Surv. Can. 96066 (CAN 109687!-**4%**);
J.M. Macoun Geol. Surv. Can. 96071 (CAN 109685!-3%);
A.E. Porsild 21147 (CAN 288120!-**11%**);

A.E. Porsild & A.J. Breitung 14485 (CAN 109694!-**19%**);
William Sm. Gruezo WM11555 (ALTA 91294!-**12%**, WGRZ!);
William Sm. Gruezo WM11558 (ALTA 91295!-**5%**, WGRZ!);
G.H. Turner 5245 (ALTA 65875!-**10%**);
G.H. Turner 5437 (ALTA 65872!- **9%**);
G.H. Turner 5109 (ALTA 65873! *p.p. mag.*-**12%**);
T.D. Lee & W.M. Peterson s.n. (ALTA 56116! *p.p.min.*-**7%**);
R.M. Anderson s.n. (CAN 109626!--**15%**);
J.M. Macoun Geol. Surv. Can. 96053 (CAN 109686!-**11%**);
William Sm. Gruezo WM11559 (ALTA 91305!-**15%**, WGRZ!);
William Sm. Gruezo WM11568 (ALTA 91307!-**7%**, WGRZ!);
A.E. Porsild & A.J. Breitung 16353 (CAN 109689!-**2%**);
William Sm. Gruezo WM11571 (ALTA 91308!-**16%**, WGRZ!);
William Sm. Gruezo WM11579 (ALTA 91309!-**10%**, WGRZ!);
William Sm. Gruezo WM11580 (ALTA 91311!-**3%**, WGRZ!);
P. Kuchar 529 (ALTA *s.n.*!-**12%**);
P. Kuchar 530 (ALTA 49259! *p.p.*-**17%**);
P. Kuchar 532 (ALTA 49259! *p.p.*-**5%**);
P. Kuchar 577 (ALTA *s.n.*!-**16%**);
P. Kuchar 581 (ALTA 49246!-**14%**);
William Sm. Gruezo WM11583 (ALTA 91312!-**16%**, WGRZ!);
William Sm. Gruezo WM11584 (ALTA 91313!-**11%**, WGRZ!);
William Sm. Gruezo WM11586 (ALTA 91314!-**6%**, WGRZ!);
William Sm. Gruezo WM11591 (ALTA 91315!-**17%**, WGRZ!);
William Sm. Gruezo WM11593 (ALTA 91316!-**14%**, WGRZ!);
A.E. Porsild & A.J. Breitung 14931 (CAN 109690!-**10%**);
A.E. Porsild & A.J. Breitung 13506 (CAN 109702!-**25%**);
A.E. Porsild & A.J. Breitung 14013 (CAN 109693!-**17%**);
William Sm. Gruezo WM11595 (ALTA 91317!-**10%**, WGRZ!);
William Sm. Gruezo WM11536 (ALTA 91302!-**4%**, WGRZ!);
William Sm. Gruezo WM11538 (ALTA 91303!-**16%**, WGRZ!);
A.E. Porsild & A.J. Breitung 15969 (CAN 109701!-**13%**);
F.J. Hermann 13195 (ALTA 16892!-**10%**);
A.E. Porsild & Johannes Lid 19682 (CAN 293149!-**17%**);
A.E. Porsild & A.J. Breitung 14158 (CAN 109696!-**17%**);
A.E. Porsild & A.J. Breitung 13363 (CAN 109698!-**19%**);
A.E. Porsild & A.J. Breitung 13390 (CAN 109699!-**8%**);
A.E. Porsild & Johannes Lid 19569 (CAN 293147!-**22%**);
A.E. Porsild & A.J. Breitung 14575 (CAN 109695!-**19%**);
A.E. Porsild & A.J. Breitung 16115 (CAN 109624!-**12%**);
M.O. Malte s.n. (CAN 197182!-**9%**);
M.O. Malte & W.R. Watson 1129 (CAN 291695!-**3%**);
A.E. Porsild & A.J. Breitung 12822 (CAN 109691!-**15%**);
Aven Nelson & Ruth A. Nelson 3056 (RM 177974!-**8%**);
J.M. Macoun Geol. Surv. Can. 14744 (CAN 109704!-**13%**);
J.M. Macoun Geol. Surv. Can. 65527 (CAN 109708!-**4%**);
P. Mortimer 474 (ALTA 75213!-**12%**);
William Sm. Gruezo WM11504 (ALTA 91299!-**10%**, WGRZ!);
William Sm. Gruezo WM11511)ALTA 91300!-**7%**, WGRZ!);
William Sm. Gruezo WM11516 (ALTA 91301!-**11%**, WGRZ!);
P. Mortimer 447 (ALTA 75214-B!-**18%**);
P. Mortimer 423 (ALTA 75214-A!-**12%**);
P. Achuff & L. Allen 1412 (Ref. no. 9396) (CAN 465849!-**1%**);
G. Ringius 1376 (ALTA 85848!-**5%**);
W.C. McCalla 7233 (ALTA 68726!-**10%**);
P. Kuchar 2920b (ALTA 46078!-**26%**);

M.O. Malte & W.R. Watson 2724 (CAN 291696!-**12%**);
Keith Shaw 2300 (BRY 126741!-**16%**);
August J. Breitung 16371 (ALTA 16921!-**5%**);
G. Armstrong & J. Nagy 4976 (ALTA 82474!-**8%**, CAN 346920!);
G. Armstrong & J. Nagy 5109 (CAN 346910!-**4%**);
William Sm. Gruezo WM11608 (ALTA 91318!-**7%**, WGRZ!);
William Sm. Gruezo & S.R. Downie WM11619 (ALTA 11619!-**1%**, WGRZ!);
William Sm. Gruezo WM11622 (ALTA 91320!-**12%**, WGRZ!);
William Sm. Gruezo WM11667 (ALTA 91726!-**4%**, WGRZ!);
J. Kuijt, G. Armstrong & J. Nagy 4935 (ALTA 82478!-**7%**, CAN 346908!, WTON 3421!);
J. Nagy 2483 & W. Blais (ALTA 82470! *p.p.mag.* -**15%**);
John Macoun Geol. Surv. Can. 11605 (ALTA 76787!-**18%**);
Macoun Geol. Surv. Can. 11604 (CAN 109630! *p.p.min.*-**2%**);
J. Kuijt, G. Armstrong & J. Nagy 5165 (ALTA 82459!-**12%**);
J. Kuijt, M. Gadd, G. Armstrong & J. Nagy 4398 (ALTA 82468!-**4%**, CAN 346909!).

British Columbia.
D.R. Lubin 082 (ALA V75361!-**6%**);
Alice Eastwood 896 (CAN 109664!, UC 892095!-**12%**);
T.T. McCabe 566 (UC 542857!-**8%**);
G.W. Douglas 7980 (BRY 127522!-**17%**);
G.W. Argus & E. Haber 10148 (CAN 410884!-**24%**);
J.H. Soper 12495, M.J. Shchepanek & A.F. Szczawinski (CAN 342318!-**7%**);
H.M. Lang 688 (CAN 205453!-**20%**);
C.L. Hitchcock & J.S. Martin 7690 (WS 113104!, *p.p.*-**23%**);
Viljo Kujala & Aarno Cajander s.n. (CAN 394051!-**14%**);
Macoun Geol. Surv. Can. 65515 (CAN 109713!-**19%**);
Macoun Geol. Surv. Can. 65518 (CAN 109709!-**2%**);
Macoun Geol. Surv. Can. 14748 (CAN 109707!-**0%**);
Stewardson Brown 535 (PH 529822!-**6%**);
G.H. Turner 3899 (ALTA 16868!, ALTA 65869!-**6%**);
Edith Scamman 6721 (CAN 245390!-**22%**);
Macoun Geol. Surv. Can. 14745 (CAN 109717!-**5%**);
Macoun Geol. Surv. Can. 14747 (CAN 109715!-**8%**);
Charles H. Shaw 993 (PH/PENN 43874!-**12%**);
J.M. Macoun Geol. Surv. Can. 69335 (WS 31390!-**14%**);
J.M. Macoun Geol. Surv. Can. 69333 (CAN 109714!-**16%**);
J.M. Macoun Geol. Surv. Can. 69335 (CAN 109711!-**10%**);
M.O. Malte s.n. (CAN 197181!-**6%**);
Charles Schaffer s.n. (PENN 37773! *p.p. mag.*-**17%**);
Erich Haber 1467 & M.J. Shchepanek (CAN 363168!-**18%**);
J.M. Macoun Geol. Surv. Can. 26932 (CAN 109710!-**11%**);
W. Spreadborough Geol. Surv. Can. 77005 (CAN 109712!-**20%**);
J.K. Henry s.n. (NDG 062532/G 45899!-**12%**);
G.W. & G.G. Douglas 4704 (BRY 207799!, BRY 207937!-**14%**);
T.T. McCabe 4980 (UC 576255!-**4%**).

Yukon.
G.W. & G.G. Douglas 10567 (BRY 177581!-**4%**);
R. Rosie 524 (CAN 412628!-**13%**);
A.M. Pearson 67-337 (CAN 316856!-**6%**).

U.S.A.: Alaska.
William Sm. Gruezo & Aida BG. Gruezo WM11946 (ALTA!-**5%**, WGRZ!);
Olav Gjaerevoll 1315 (CAN 225194!-**13%**);
Galen Smith 2049 (ALA 10626!, UC M-076867!-**4%**);

Jack Winters Jr. 407 (ALA 84195!-**12%**);
R. Backer 85 (ALA 95293!-**0%**);
G.M. Frohne s.n. (ALA 21808!-**4%**);
G.M. Frohne 54-140 (ALA 21868!-**19%**);
G.M. Frohne s.n. (ALA 23834!-**11%**);
Les & Teri Viereck 2069 (ALA 8506!-**5%**);
Bee Cumby 282 (ALA V071646!-**0%**);
D. Jaques 1442 BRY 105907! *p.p.*-**2%**).

California.
C.A. Ground 763 (RM 470845!-**0%**);
Gilbert Muth 476 (JEPS 82425!-**5%**);
Frederick W. Oettinger 1441 (UC I-409369!-**2%**);
Eleanor Burks Hart 915 (UC 609312!-**14%**);
Annie M. Alexander & Louise Kellogg 5463 (UC 933431!-**7%**);
Joseph P. Tracy 14624 (UC M-199249!-**13%**);
Joseph P. Tracy 14654 (UC 582491!-**17%**);
Joseph P. Tracy 14439 (UC 582490!--**6%**);
A.A. Heller 7029 (PH 506993!-**3%**, RM 46658!, UC 57885!);
C.F. Sonne s.n. (UC 91024!-**2%**);
H.M. Hall & H.P. Chandler 688 (UC 29590!-**7%**);
C.F. Sonne s.n. (UC 193561!-**6%**);
Annie M. Alexander & Louise Kellogg 3494 (UC M-03803!-**12%**);
G.L. Stebbins Jr. 2031 (UC 593472!-**17%**);
A.A. Heller 12544 (PH/PENN 70750!, PH 598772!, UC 195384!, UC 726616!,-**10%** UC 892139!);
G. Thomas Robbins 1341 (UC 747151!-**15%**);
T.M. Hendrix 482 (UC 577718!, UC M-119303!-**3%**);
Alex Hawkes 5208 (UC I-328177!-**13%**);
C.W. Hanks 348 (UC M-119307-**7%**);
F.G. Anderson s.n. (UC 892184!-**5%**);
Ruby Van Deventer 264 (JEPS 35903! *p.p. mag.*-**11%**).

Colorado.
Leslie N. Goodding 1635 (PH 523856!-**7%**, RM 52140!-**14%**, RM 169623!);
Leslie N. Goodding 1765 (RM 52143!-**16%**);
I.W. Clokey 3499 (RM 169769!, UC 892194!-**16%**);
George E. Osterhout 1319 (RM 169926!-**4%**);
Geo. E. Osterhout 3809 (RM 169850!-**8%**);
George E. Osterhout 3837 (RM 169981!-**12%**);
I.W. Clokey 3116 (RM 95443!, RM 169824!-**14%**);
I.W. Clokey 3958 (WS 37741!-**10%**);
H.D. Harrington 1708 (RM 200451!-**11%**);
I.W. Clokey 4384 (RM 90094!-**4%**);
K.H. Lancaster, C.W. Doran & V.L. Bunderson 47 (RM 471116!-**8%**);
K.H. Lancaster, C.W. Doran & V.L. Bunderson 67 (RM 471115!-**13%**);
G.E. Osterhout 5229 (RM 169925!-**14%**);
Aven Nelson & Ruth A. Nelson 4474 (RM 191946!-**15%**);
Ruth E. Ashton 70-8-3 (RM 116154!-**9%**).

Idaho.
R.F. Daubenmire 44359 (WS 260931!-**12%**;
R.F. Daubenmire 43164 (WS 181724!-**7%**);
A.A. Heller 753 (NDG 062403/G 46816!-**3%**);
A.A. Heller 753 (PH *s.n.*-**1%**);
J.H. Christ 12585 (WS 261668!-**11%**);

A.R. Kruckeberg 3194 (CAN 249681!, RM 239528!, UC M-013180!-**6%**, WS 213269!);
~~*Ray J. Davis 1693* (WS 100099 *p.p.mag.*-**8%**);~~
C.L. Hitchcock & C.V. Muhlick 10899 (UC 968678!-**17%**);
J.F. Macbride & Edwin B. Payson 3691 (RM 86114! *p.p.mag.*-0%);
R.B. Johnson RBJ-181 (RM 471102!-0%);
Ray J. Davis 720 (WS 97375!, WS 291513!-5%);
J.H. Sandberg s.n. (RM 9408!-**12%**).

Montana.
Bassett Maguire & George Piranian 15366 (PH 781128!-**6%**);
Fred Zwickel 101 (WS 200574!-**12%**);
L.M. Umbach 591/01 (PH 769902!-**1%**);
W.A. Laycock SR-110 (RM 471077!-**4%**).

Nevada.
Rodd V. Hardy 814 (BRY 224037!-3%).

Oregon.
L. Constance & C.D. Jacobs 1357 (WS 69132!-6%);
Lewis S. Rose 36541 (ND 011128!-2%);
William Sm. Gruezo WM-1474 (ALTA 91297!-**11%**, WGRZ!);
Bassett Maguire & Arthur H. Holmgren 27104 (UC 739038!-5%);
Bassett Maguire & Arthur H. Holmgren 27047 (UC 739041!-**11%**, WS 169999!);
Wm.C. Cusick 2488 (JEPS 20956!, NDG 062465/G 46776!, NDG 062467/G 46777!, RM 31435!-0%, UC 29619!, WS 26576!);
Wm.C. Cusick 2463 (JEPS 2095[illegible] NDG 062468!, RM 31437!, UC 29585!,-**3%** WS 26519!);
Thomas Howell s.n. (PH/PENN 1[illegible]42! *p.p.*-2%);
Bassett Maguire & Arthur H. Holmgren 26963 (PH 824342!-**4%**, WS 169998! *p.p.*, UC 739035! *p.p.*; CAN 191034! & CAN 453260! are determined here as *Arnica latifolia* Bong.);
A.A. Heller 12578 (PH/PENN 68061!-**1%**, PH 598654!, WS 150238!).

Utah.
Bassett Maguire 16102 (CAN 191035!, UC 738815!-**3%**);
Bassett Maguire 16141 (UC 738813! *p.p.*-**8%**);
E. Neese & J.L. Neese 9851 (BRY 218710!, RM 340588!-**6%**);
E. Neese & J.L. Neese 10790 (BRY 225708!-7%);
A.O. Garrett 1670 (RM 52685!-**9%**);
A.O. Garrett 1975 (RM 56655!-**11%**);
A.O. Garrett 1386 (RM 54079!-**4%**);
B. Albee 5139 (BRY 228828!-**2%**);
P.A. Rydberg 6843 (RM 59718!-**2%**);
Bassett Maguire 17419 (UC 738649!-7%, WS 170183!);
Sherel Goodrich 6456 (BRY 164117!-**6%**);
Sherel Goodrich 6457 (BRY 164113!-**4%**);
Sherel Goodrich 6472 (BRY 214498!-**12%**);
S. Goodrich 14738 (BRY 216603!-**15%**);
S. Goodrich 14753 (BRY 216667!-**18%**);
K. Allred 972 (BRY 125693!-**6%**);
V.N. West 8 (RM 470843!-**2%**);
Cottam 1395 (BRY 15861!-**6%**);
A.O. Garrett 3456 (RM 106891!-3%);
R. Collins & K. Harper 500 (BRY 204913!-7%);
R. Collins & K. Harper 581 (BRY 204996!-**11%**);
K. Thorne & J. Chandler 3411 (BRY 268012!-**9%**);
R. Foster & J. Henriod 7031 (BRY 186737!-**13%**);
Bassett Maguire 26166 (UC 738647!-**12%**);

Edwin B. Payson & Lois B. Payson 4036 (RM 102252!-0%, UC 275311!);
Mont E. Lewis 4960 (BRY 178894!-3%);
S. Welsh & J. Henriod 18145 (BRY 187676!-6%);
S. Welsh, M. Welsh & J. Henriod 17897 (BRY 186660!-8%);
B.F. Harrison 12500 (BRY 36282!-2%);
Orange A. Olsen 0-122 (RM 470844!-8%).

Washington.
A.D.E. Elmer 693 (WS 26528!-3%);
Chas. B. Fiker 1374 (WS 68838!-7%);
R. & D. Naas 3915 (WS 285435!-4%);
R. & D. Naas 3941 (WS 285470!-9%);
R. & D. Naas 3457 (RM 470842!-3%);
R. & D. Naas 2591 (RM 471094!-5%).
J. William Thompson 15138 (CAN 191037!, UC 749375!-3%, WS 152638!);
L. Constance, J.F.G. Clarke, W. Staats & G. Van Vleet 1258 (WS 69426!-6%);
Ralph & Dorothy Naas 2691 (RM 471081!-13%);
J. William Thompson 7723 (PH 692782!-10%);
W.C. Muenscher 8025 (PH 781136!-4%);
J. William Thompson 8031 (PH 692177!-8%);
J. B. Flett 818 (WS 26532!, *p.p. mag.*-2%);
C.V. Piper 738 (WS 26527!-7%).

Wyoming.
Richard W. Scott 720 (RM 279825!, UC M-312195!-4%);
Leslie N. Goodding 1950 (RM 52141!, UC 70509!-5%);
William Sm Gruezo WM11350 (ALTA 91297!-9%, WGRZ!);
Aven Nelson 7848 (RM 41754!-7%);
Leslie N. Goodding 2065 (RM 52146!-2%);
Frank H. Rose 98 (RM 402836!-9%);
Frank Tweedy 3019 (RM 38402!-3%);
Leslie N. Goodding 1950 (UC 70509!-7%).

Appendix 6. Cluster Membership Index of Subgenus Chamissonis using CLUSTAN Ward method of Cluster Analysis

Cluster Number	OTUs*
Cluster 1	1, 8, 14, 28, 41, 26, 47, 31.
Cluster 2	6, 149, 7, 39, 40, 42.
Cluster 3	117, 139, 160, 164, 176, 165.
Cluster 4	24, 25, 50, 156, 163.
Cluster 5	27, 51, 36, 38, 45, 140, 167, 58, 55, 72, 141, 154, 173, 200, 142.
Cluster 6	23, 29, 34, 46.
Cluster 7	61, 77, 62, 67, 69, 79, 74, 81.
Cluster 8	63, 73, 152, 177, 188, 180, 187, 183, 189, 196, 194, 145, 158, 171, 182, 185, 190, 193, 199.
Cluster 9	11, 21, 30, 129, 162.
Cluster 10	44, 198, 148, 157, 186, 195, 197.
Cluster 11	99, 100.
Cluster 12	161, 170, 166, 169, 175, 181.
Cluster 13	2, 9, 17.
Cluster 14	5, 171, 15, 32, 59, 12, 174.
Cluster 15	93, 178, 179, 130, 110, 112, 115, 143, 114, 124, 128, 132, 116, 133, 131, 121, 123, 125, 122, 184, 119, 136, 127.
Cluster 16	3, 60, 76, 80, 57.
Cluster 17	4, 43, 146, 159, 10, 16, 37.
Cluster 18	13, 48, 54, 64, 65, 70, 153, 144.
Cluster 19	56, 71, 75, 68.
Cluster 20	126, 192, 138, 150, 191, 151.
Cluster 21	52, 111, 168.
Cluster 22	85, 91, 102, 101, 96, 106, 90, 98, 87, 95, 89, 86, 92, 104, 108, 103, 97, 109.
Cluster 23	18, 33, 35, 49.
Cluster 24	22, 134, 135, 113, 120, 137.
Cluster 25	82, 83.
Cluster 26	88, 94, 105, 107.
Cluster 27	19, 20, 147, 155.
Isolated OTUs	84, 53, 66, 78, 118.

*Listed in chronological order starting from left hand side of dendrogram.

Appendix 7. Comparison between chromosome numbers and percent pollen stainability determined for members of Arnica L. subgenus Chamissonis Maguire.

Taxon	2n=	Locality and voucher-Percent Pollen Stainability
A. parryi	76	**U.S.A., Idaho**: Blaine Co., *Wm. Gruezo WM11431* (ALTA 91401!-**6%**, WGRZ!). **Montana**: Glacier Co., *Wm. & Aida Gruezo WM12000* (ALTA 93005!-**36%**, WGRZ!); *Wm. & Aida Gruezo WM11682* (ALTA 93006!-**39%**, WGRZ!). **Wyoming**: Albany Co., *Wm. Gruezo WM11323* (ALTA 92174!-**11%**, WGRZ!); *Wm. Gruezo WM11405* (ALTA!-**20%**, WGRZ!); *Wm. Gruezo WM11406* (ALTA 91400!-**15%**, WGRZ!). **Oregon**: Klamath Co., *Wm. Gruezo WM11472* (ALTA!-**13%**, WGRZ!); *Wm. Gruezo WM11476* (ALTA 91403!-**16%**, WGRZ!).
A. ovata	57	**U.S.A., Alaska**: Denali Hwy (Hwy 8), *Wm. & Aida Gruezo WM11946* (ALTA!-**5%**, WGRZ!). **Oregon**: Klamath Co., *Wm. Gruezo WM11474* (ALTA 91298!-**11%**, WGRZ!). **Wyoming**: Carbon Co., *Wm. Gruezo WM11349* (ALTA 91217!-**13%**, WGRZ!).
		Canada, Alberta: Jasper National Park, *Wm. Gruezo WM11550* (ALTA 91296!-**11%**, WGRZ!), *Wm. Gruezo WM11552* (ALTA 91293!-**5%**, WGRZ!), *Wm. Gruezo WM11555* (ALTA 91294!-**12%**, WGRZ!), *Wm. Gruezo WM11558* (ALTA 91295!-**5%**, WGRZ!), *Wm. Gruezo WM11559* (ALTA 91305!-**15%**, WGRZ!); *Wm. Gruezo WM11568* (ALTA 91307!-**7%**, WGRZ!), *Wm. Gruezo WM11571* (ALTA 91308!-**16%**, WGRZ!); *Wm. Gruezo WM11580* (ALTA 91311!-**3%**, WGRZ!), *Wm. Gruezo WM11579* (ALTA 91309-**10%**!, WGRZ!); *Wm. Gruezo WM11583* (ALTA 91312!-**16%**, WGRZ!); *Wm. Gruezo WM11584* (ALTA 91313!-**11%**, WGRZ!); *Wm. Gruezo WM11586* (ALTA 91314!-**6%**, WGRZ!), *Wm. Gruezo WM11591* (ALTA 91315!-**17%**, WGRZ!), *Wm. Gruezo WM11593* (ALTA 91316!-**14%**, WGRZ!); *Wm. Gruezo WM11595* (ALTA 91317!-**10%**, WGRZ!); *Wm. Gruezo WM11536* (ALTA 91302!-**4%**, WGRZ!), *Wm. Gruezo WM11538* (ALTA 91303!-**16%**, WGRZ!), *Wm. Gruezo WM11504* (ALTA 91299!-**10%**, WGRZ!), *Wm. Gruezo WM11511* (ALTA 91300!-**7%**, WGRZ!), *Wm. Gruezo WM11516* (ALTA 91301!-**11%**, WGRZ!). Waterton Lakes National Park, *Wm. Gruezo WM11608* (ALTA 91318!-**7%**, WGRZ!); *Wm. Gruezo & S.R. Downie WM11619* (ALTA 91319!-**1%**, WGRZ!); *Wm. Gruezo WM11622* (ALTA 91320!-**12%**, WGRZ!);

	76	**U.S.A.**, **Wyoming**: Carbon Co., *Wm. Gruezo WM11350* (ALTA 91297!-**9%**, WGRZ!).
		Canada, **Alberta**: Waterton Lakes National Park, *Wm. Gruezo WM11667* (ALTA 91726!-**4%**, WGRZ!). **British Columbia**: Mount Assiniboine Provincial Park, *Wm. Gruezo WM11588* (ALTA 91304!-**18%**, WGRZ!).
A. longifolia	57	**U.S.A.**, **Idaho**: Blaine Co., *Wm. Gruezo WM11425* (ALTA 92178!-**24%**, WGRZ!), *Wm. Gruezo WM11430* (ALTA 92177!-**19%**, WGRZ!); *Wm. Gruezo WM11433* (ALTA 91433!-**12%**, WGRZ!); *Wm. Gruezo WM11435* (ALTA 91434!-**28%**, WGRZ!). **Oregon**: Klamath Co., *Wm. Gruezo WM11471* (ALTA 91435!-**33%**, WGRZ!); *Wm. Gruezo WM11475* (ALTA 91436!-**26%**, WGRZ!). **Utah**: Wasatch Co., *Wm. Gruezo WM11444* (ALTA 92175!-**19%**, WGRZ!). **Wyoming**: Johnson Co., *Wm. Gruezo WM11373* (ALTA 91424!-**27%**, WGRZ!). *Wm. Gruezo WM11380* (ALTA 91425!-**12%**, WGRZ!); Sheridan Co., *Wm. Gruezo WM11385* (ALTA 91426!-**22%**, WGRZ!). Big Horn Co., *Wm. Gruezo WM11391* (ALTA 91428!-**24%**, WGRZ!), *Wm. Gruezo WM11395* (ALTA 91429!-**14%**, WGRZ!); *Wm. Gruezo WM11396* (ALTA 91430!-**9%**, WGRZ!). Yellowstone National Park, *Wm. Gruezo I1404* (ALTA 91427!-**43%**, WGRZ!); *Wm. Gruezo WM11408* (ALTA 91431!-**27%**, WGRZ!).
		Canada, **Alberta**: Waterton Lakes National Park, *Wm. Gruezo WM11666* (ALTA 91724!-**7%**, WGRZ!); *Wm. Gruezo WM11668* (ALTA 91727!-**11%**, WGRZ!).
A. mollis	57	**U.S.A.**, **Nevada**: Elko Co., *Wm. Gruezo WM11450* (ALTA 91344!-**24%**, WGRZ!).
	76	**U.S.A.**, **Wyoming**: Albany Co., *Wm. Gruezo WM11316* (ALTA 91321!-**15%**, WGRZ!); *Wm. Gruezo WM11328* (ALTA 91322!-**27%**, WGRZ!); *Wm. Gruezo WM11337* (ALTA 91339!-**43%**, WGRZ!); *Wm. Gruezo WM11338* (ALTA 91323!-**23%**, WGRZ!). Carbon Co., *Wm. Gruezo WM11343* (ALTA 91325!-**7%**, WGRZ!); *Wm. Gruezo WM11344* (ALTA 91328!-**19%**, WGRZ!); *Wm. Gruezo WM11349* (ALTA 92171!-**17%**, WGRZ!); *Wm. Gruezo WM11351* (ALTA 91324!-**34%**, WGRZ!); *Wm. Gruezo WM11353* (ALTA 91326!-**19%**, WGRZ!); *Wm. Gruezo WM11359* (ALTA 91327!-**30%**, WGRZ!); *Wm. Gruezo WM11360* (ALTA 91329!-**15%**, WGRZ!), *Wm. Gruezo WM11361* (ALTA 91330!-**27%**, WGRZ!), *Wm. Gruezo WM11362* (ALTA 91341!-**20%**, WGRZ!). *Wm. Gruezo WM11368* (ALTA!-**35%**, WGRZ!); Johnson Co., *Wm. Gruezo WM11369* (ALTA!-**0%**, WGRZ!); *Wm. Gruezo WM11371* (ALTA 91332!-**8%**, WGRZ!).

Sheridan Co., *Wm. Gruezo WM11378* (ALTA 91333!-**21%**, WGRZ!); *Wm. Gruezo WM11382* (ALTA!-**54%**, WGRZ!); *Wm. Gruezo WM11384* (ALTA!-**1%**, WGRZ!).
Big Horn Co., *Wm. Gruezo WM11387* (ALTA 91336!-**9%**, WGRZ!); *Wm. Gruezo WM11397* (ALTA 91338!**2%**, WGRZ!).
Yellowstone National Park, *Wm. Gruezo WM11407* (ALTA 91342!-**24%**, WGRZ!); *Wm. Gruezo WM11410* (ALTA 91343!-**30%**, WGRZ!).

Canada, Alberta: Jasper National Park, *Wm. Gruezo WM11549* (ALTA 91503!, ALTA 91504!-**23%**, WGRZ!), *Wm. Gruezo WM11557* (ALTA 91349!-**12%**, WGRZ!), *Wm. Gruezo WM11560* (ALTA!-**7%**, WGRZ!), *Wm. Gruezo WM11561* (ALTA 91306!-**28%**, WGRZ!); *Wm. Gruezo WM11572* (ALTA 91353!-**5%**, WGRZ!), *Wm. Gruezo WM11574* (ALTA 91354!-**32%**, WGRZ!), *Wm. Gruezo WM11577* (ALTA 91356!-**17%**, WGRZ!); *Wm. Gruezo WM11578* (ALTA 91357!-**14%**, WGRZ!); *Wm. Gruezo WM11581* (ALTA 91358!-**11%**, WGRZ!); *Wm. Gruezo WM11582* (ALTA 91360!-**26%**, WGRZ!); *Wm. Gruezo WM11569* (ALTA 91351!-**34%**, WGRZ!).
Banff National Park, *Wm. Gruezo WM11534* (ALTA 91345!-**36%**, WGRZ!), *Wm. Gruezo WM11537* (ALTA 91346!-**20%**, WGRZ!), *Wm. Gruezo WM11539* (ALTA 91347!-**40%**, WGRZ!), *Wm. Gruezo WM11541* (ALTA!-**15%**, WGRZ!); *Wm. Gruezo WM11592* (ALTA 91362!-**23%**, WGRZ!); *Wm. Gruezo WM11594* (ALTA 91363!-**23%**, WGRZ!); *Wm. Gruezo WM11596* (ALTA 91364!-**35%**, WGRZ!), *Wm. Gruezo WM11597* (ALTA 91365!-**37%**, WGRZ!); *Wm. Gruezo WM11598* (ALTA 91366!-**44%**, WGRZ!):
Waterton Lakes National Park, *Wm. Gruezo WM11605* (ALTA 91367!, WGRZ!); *Wm. Gruezo WM11607* (ALTA 91368!-**27%**, WGRZ!); *Wm. Gruezo WM11609* (ALTA 91369!-**32%**, WGRZ!); *Wm. Gruezo WM11611* (ALTA 91370!-**3%**, WGRZ!). *Wm. Gruezo & S.R. Downie WM11618*(ALTA 91359!-**12%**, WGRZ!).
British Columbia: Mount Assiniboine Provincial Park, *Wm. Gruezo WM11590* (ALTA 91361!-**27%**, WGRZ!).

A. chamissonis 38 **U.S.A., Oregon**: Klamath Co., *Wm. Gruezo WM11467* (ALTA 91412!-**96%**, WGRZ!).

Canada, Alberta: Waterton Lakes National Park, *Wm. Gruezo WM11600* (ALTA 92164!-**99%**, WGRZ!).

57 **U.S.A., Alaska**: Richardson Hwy (Hwy 4), *Wm. & Aida Gruezo WM11881* (ALTA 91947!-**20%**, ALTA 91948!, WGRZ!); *Wm. & Aida Gruezo WM11883* (ALTA 91950!-**26%**, ALTA 91951!, WGRZ!).

Glenn Hwy (Hwy 1), *Wm. & Aida Gruezo WM11915* (ALTA!-25%, WGRZ!); *Wm. & Aida Gruezo WM11916* (ALTA!-27%, WGRZ!); *Wm. & Aida Gruezo WM11918* (ALTA!-16%, WGRZ!); *Wm. & Aida Gruezo WM11919* (ALTA!-29%, WGRZ!); *Wm. & Aida Gruezo WM11920* (ALTA!-12%, WGRZ!); *Wm. & Aida Gruezo WM11921* (ALTA!-15%, WGRZ!); *Wm. & Aida Gruezo WM11922* (ALTA!-21%, WGRZ!); *Wm. & Aida Gruezo WM11923* (ALTA!-35%, WGRZ!).
Hwy 9, Moose Pass proper, *Wm. Gruezo WM11925* (ALTA!-14%, WGRZ!), *Wm. & Aida Gruezo WM11926* (ALTA!-37%, WGRZ!); *Wm. & Aida Gruezo WM11928* (ALTA!-66%, WGRZ!).
Glenn Hwy (Hwy 1, E), *Wm. & Aida Gruezo WM11931* (ALTA!-31%, WGRZ!).
Kenai Township, Hwy 1, *Wm. & Aida Gruezo WM11932* (ALTA!-36%, WGRZ!).
Hwy 1(S), *Wm. & Aida Gruezo WM11934* (ALTA!-28%, WGRZ!);
Hwy 1(S), Ninilchik proper, *Wm. & Aida Gruezo WM11935* (ALTA!-39%, WGRZ!).
Sterling Hwy (Hwy 1, S), *Wm. & Aida Gruezo WM11936* (ALTA!-45%, WGRZ!); *Wm. & Aida Gruezo WM11937* (ALTA!-24%, WGRZ!); *Wm. & Aida Gruezo WM11939* (ALTA!-49%, WGRZ!); *Wm. & Aida Gruezo WM11940* (ALTA!-55%, WGRZ!).
Ninilchik proper, *Wm. & Aida Gruezo WM11941* (ALTA 92048!-23%, ALTA 92049!, ALTA 92050!, ALTA 92055!, ALTA 92056!, WGRZ!).
Idaho: Blaine Co., *Wm. Gruezo WM11424* (ALTA!-42%, WGRZ!).
Oregon: Klamath Co., Hwy 31 *Wm. Gruezo WM11468* (ALTA 91413!-60%, WGRZ!);
Klamath Co., *Wm. Gruezo WM11469* (ALTA 92160!-56%, WGRZ!). Hwy 22, Ochoco National Forest, *Wm. Gruezo WM11479* (ALTA 91423!-35%, WGRZ!).
Umatilla Co., Hwy 244, Blue Mountains, *Wm. Gruezo WM11485* (ALTA!-26%, WGRZ!); *Wm. Gruezo WM11486* (ALTA!-19%, WGRZ!).
Grant Co., Hwy 26, *Wm. Gruezo WM11480* (ALTA!-13%, WGRZ!).
Utah: Wasatch Co., *Wm. Gruezo WM11442* (ALTA 91411!-30%, WGRZ!).
Wyoming: Albany Co., *Wm. Gruezo WM11315* (ALTA 91408!-36%, WGRZ!); *Wm. Gruezo WM11322* (ALTA 92179!-37%, WGRZ!).
Johnson Co., *Wm. Gruezo WM11375* (ALTA!-22%, WGRZ!); *Wm. Gruezo WM11377* (ALTA!-30%, WGRZ!).
Sheridan Co., *Wm. Gruezo WM11381* (ALTA 91409!-43%, WGRZ!). Big Horn Co., *Wm. Gruezo WM11388* (ALTA!-26%, WGRZ!).
Park Co., *Wm. Gruezo WM11403* (ALTA 91410!-70%, WGRZ!).

Canada, Alberta: Hwy 40, *Wm. Gruezo WM11494* (ALTA 91414!-3%, WGRZ!).

Hwy 940 (= Forestry Trunk Road), *Wm. Gruezo* ***WM11495*** (ALTA!-**4%**, WGRZ!).

Hwy 940 (= Forestry Trunk Road), *Wm. Gruezo* ***WM11496*** (ALTA 91416!-**0%**, WGRZ!); *Wm. Gruezo* ***WM11497*** (ALTA 91417!-**5%**, WGRZ!), *Wm. Gruezo* ***WM11498*** (ALTA 91418!-**10%**, WGRZ!), *Wm. Gruezo* ***WM11499*** (ALTA 91419!-**7%**, WGRZ!), *Wm. Gruezo* ***WM11500*** (ALTA 91420!-**13%**, WGRZ!).
Mountain Park, *Wm. Gruezo* ***WM11532*** (ALTA 91432!-**17%**, WGRZ!).
Waterton Lakes National park, *Wm. Gruezo* ***WM11617*** (ALTA 91422!-**12%**, WGRZ!).
British Columbia: Hwy 97, S of Fort Nelson, *Wm. Gruezo* ***WM11267*** (ALTA 91406!-**72%**, WGRZ!). Hwy 97, inside Buckinghorse Provincial Campground, *Wm. Gruezo* ***WM11268*** (ALTA!-**25%**, WGRZ!).
John Hart Hwy (Hwy 97), *Wm. & Aida Gruezo* ***WM11281*** (ALTA 91407!-**7%**, WGRZ!). Cassiar Hwy (Hwy 37), *Wm. Gruezo* ***WM11981*** (ALTA 92119!-**40%**, ALTA 92120!, WGRZ!);
Cassiar Hwy (Hwy 37), *Wm. & Aida Gruezo* ***WM11982*** (ALTA 92121!-**0%**, ALTA 92122!, WGRZ!). Yellowhead Trail (Hwy 16), *Wm. & Aida Gruezo* ***WM11983*** (ALTA 92124!-**12%**, ALTA 92123!, WGRZ!); *Wm. Gruezo* ***WM11986*** (ALTA 92127!-**0%**, ALTA 92128!, ALTA 92129!, WGRZ!); *Wm. & Aida Gruezo* ***WM11987*** (ALTA 92130!-**6%**, ALTA 92131!, WGRZ!); *Wm. & Aida Gruezo* ***WM11988*** (ALTA 92132!-**4%**, ALTA 92133!, ALTA 92134!, WGRZ!); *Wm. & Aida Gruezo* ***WM11989*** (ALTA 92135!-**0%**, ALTA 92136!, ALTA 92137!, WGRZ!).

		Yukon: Johnsons Crossing, *Wm. Gruezo WM11153* (ALTA!-**10%**, WGRZ!); *Wm. & Aida Gruezo WM11972* (ALTA 92101!-**22%**, ALTA 92102!, ALTA 92103!, ALTA 92104!, WGRZ!). *Wm. Gruezo WM11245* (ALTA!-**11%**, WGRZ!); *Wm. Gruezo WM11250* (ALTA!-**17%**, WGRZ!);
		Wm. Gruezo WM11251 (ALTA!-**7%**, WGRZ!). *Wm. Gruezo WM11253* (ALTA!-**16%**, WGRZ!), *Wm. Gruezo WM11254* (ALTA!-**20%**, WGRZ!); *Wm. Gruezo WM11257* (ALTA!-**5%**, WGRZ!). *Wm. & Aida Gruezo WM11788* (ALTA 91850!-**24%**, ALTA 91851!, ALTA 91852!, WGRZ!). *Wm. & Aida Gruezo WM11822* (ALTA 91890!-**21%**, WGRZ!). *Wm. & Aida Gruezo WM11953* (ALTA 92068!, ALTA 92069!-**45%**, WGRZ!); *Wm. & Aida Gruezo WM11961* (ALTA 92077!-**16%**, ALTA 92078!, WGRZ!). *Wm. & Aida Gruezo WM11963* (ALTA 92080!-**22%**, ALTA 92081!, WGRZ!); *Wm. & Aida Gruezo WM11964* (ALTA 92082!-**12%**, ALTA 92083!, WGRZ!);
		Wm. & Aida Gruezo WM11965 (ALTA 92084!-**21%**, ALTA 92085!, WGRZ!); *Wm. & Aida Gruezo WM11967* (ALTA 92087!-**6%**, ALTA 92088!, ALTA 92089!, WGRZ!); *Wm. & Aida Gruezo WM11968* (ALTA 92090!-**23%**, ALTA 92091!, ALTA 92092!, WGRZ!); *Wm. & Aida Gruezo WM11970* (ALTA 92093!, ALTA 92094!-**16%**, ALTA 92095!, ALTA 92096!, WGRZ!); *Wm. & Aida Gruezo WM11971* (ALTA 92097!-**29%**, ALTA 92098!, ALTA 92099!, ALTA 92100!, WGRZ!); *Wm. & Aida Gruezo WM11973* (ALTA 92105!-**37%**, ALTA 92106!, ALTA 92107!, WGRZ!); *Wm. & Aida Gruezo WM11977* (ALTA 92110!, ALTA 92111!-**30%**, ALTA 92112!, WGRZ!); *Wm. & Aida Gruezo WM11980* (ALTA 92116!-**18%**, ALTA 92117!, ALTA 92118!, WGRZ!).
	76	U.S.A., **Alaska**: Seward proper, *Wm. & Aida Gruezo WM11927* (ALTA!-**46%**, WGRZ!).
A. lanceolata Nutt. subsp. *amplexicaulis* (Nutt.) Gruezo	57	U.S.A., **Alaska**: Glenn Hwy (Hwy 1 SE). *Wm. & Aida Gruezo WM11917* (ALTA 91986!-**5%**, ALTA 91987!, ALTA 91988!, WGRZ!); *Wm. & Aida Gruezo WM11944* (ALTA 92052!-**12%**, ALTA 92053!, ALTA 92054!, ALTA 92057!, WGRZ!). **Nevada**: Elko Co., *Wm. Gruezo WM11448* (ALTA 91371!-**0%**, WGRZ!); *Wm. Gruezo WM11460* (ALTA 91372!-**13%**, WGRZ!); *Wm. Gruezo WM11462* (ALTA 91374!-**13%**, WGRZ!); *Wm. Gruezo WM11463* (ALTA 91373!-**17%**, WGRZ!). *Wm. Gruezo WM11465* (ALTA 91375!-**13%**, WGRZ!).

Canada, Alberta: Waterton Lakes National Park, *Wm. Gruezo WM11603* (ALTA 91376!-**1%**, WGRZ!); *Wm. Gruezo WM11604* (ALTA 91377!-**9%**, WGRZ!); *Wm. Gruezo WM11616* (ALTA 91378!-**4%**, WGRZ!). *Wm. Gruezo 11669* (ALTA 91728!-**8%**, WGRZ!); *Wm. Gruezo WM11673* (ALTA 91732!-**10%**, WGRZ!); *Wm. Gruezo WM11674* (ALTA 91733!-**7%**, WGRZ!); *Wm. Gruezo WM11675* (ALTA 91734!-**13%**, WGRZ!).