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THE UNIVERSITY OF ALBERTA

A TAXONOMIC SURVEY OF AGROMYZID FLIES OF ALBERTA AND A STUDY OF HOST-PLANT RELATIONSHIPS OF AN OLIGOPHAGOUS SPECIES *PHYTOMYZA MATRICARIAE* HENDEL (DIPTERA : AGROMYZIDAE)

BY

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entited A TAXONOMIC SURVEY OF AGROMYZID FLIES OF ALBERTA AND A STUDY OF HOST-PLANT RELATIONSHIPS OF AN OLIGOPHAGOUS SPECIES *PHYTOMYZA MATRICARIAE* HENDEL (DIPTERA : AGROMYZIDAE) submitted by Vinod Kumar Sehgal in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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External Examiner

Date Spring 1970

AUTOBIOGRAPHICAL SKETCH

Born on 19th October, 1941 at Jagraon, Punjab, India, I passed matriculation examination of the Panjab University, India in the year 1955. I obtained the degrees of B.Sc. (Hons.) in Zoology in 1960 and M.Sc. (Hons.) in Zoology-Entomology in 1961 from the Panjab University, Chandigarh, India.

I worked for about two years, 1962-1964, at the Entomology Division, Indian Lac Research Institute, Namkum, Ranchi, Bihar, India, on lepidopterous predators of lac insect. For about one year, 1964-1965, I worked at the Department of Zoology-Entomology, Punjab Agricultural University, Ludhiana, Punjab, India on a problem of agromyzid flies.

I came to Canada in September 1965. Since then I worked at the Department of Entomology, University of Alberta, Edmonton, Alberta, Canada in a programme leading to Ph.D. degree in Entomology. During most of this period, I also worked as a Graduate Teaching Assistant involved in the teaching of Introductory Entomology and Invertebrate Zoology courses at the University of Alberta, Edmonton, Alberta, Canada.

ABSTRACT

Thirty-two new species are described and eleven further have been recorded from Alberta. This brings the total of Albertan Agromyzidae to 171 and that for Canada and Alaska to 322 species. The male genitalia of almost all new species are illustrated. Keys to Albertan genera and species are given. Information on larval host-plants and biology wherever available is also given. Host-plant relationships are discussed.

Host-plant relationships of an oligophagous species *Phytomyza matricariae* Hendel were studied in adults and larvae. The members of this species feed in nature around Edmonton only on the representatives of the plant genera *Achillea, Chrysanthemum, Matricaria* and *Tanacetum*, belonging to the tribe Anthemideae, family Compositae. Observations on natural incidence, mating, adult and larval feeding, oviposition and life cycle were made on one of its natural host-plants *Tanacetum vulgare* L. Thirty-eight plant species belonging to 17 families were tested for acceptability to gravid females for feeding and oviposition. Comparison of index of acceptability for feeding and oviposition with the index of plant relationship show that only plants closely related phylogenetically to the natural host-plant were acceptable for feeding and oviposition. This ovipositional preference by adult females is probably due to host-specific substances present only in selected plants. Studies on the feeding and ovipositional preference by adult females when offered a choice of six acceptable plants show that maximum number of feeding punctures were on the plant from which flies were obtained. Other preferred plants also served as hosts in nature.

Two plants *Artemisia* and *Helianthus*, though acceptable but not preferred in these studies also do not serve as hosts in nature. Larva being completely internal plant feeder is unable to select a more suitable food plant which might be available in its geographical range. First instar larvae were manually transferred from the natural host-plants to various test plant species. Comparison of the index of suitability of test plants for larval development with the index of plant relationship show that plants widely removed phylogenetically were nutritionally adequate for completion of larval development, if they lacked substances which are toxic or otherwise inhibitory.

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I am grateful to Dr. B. Hocking, Chairman, Department of Entomology, University of Alberta, for providing the opportunity and necessary support to carry out this project in Alberta, Canada. I also express my most sincere thanks to him, for his supervision and guidance, helpful criticism of the manuscript, and keen interest throughout this study. I am grateful to Dr. G. E. Ball, Department of Entomology, University of Alberta, for his ever available help, supervision and valuable criticism of the manuscript. I am also grateful to Dr. K. A. Spencer (10, Willow Road, Hampstead, London, England) and Mr. G. C. D. Griffiths, Department of Entomology, University of Alberta, for numerous useful discussions and valuable suggestions during this study. I would like to thank Dr. D. A. Craig and Dr. W. G. Evans, Department of Entomology, University of Alberta, for various suggestions and helpful criticism of the results.

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INTRODUCTION

This taxonomic survey of the family Agromyzidae in Alberta was started in the summer of 1966, at a time when this was one of the most poorly known families of cyclorrhaphous Diptera in Canada. Strikland (1938, 1946) listed 20 species as occurring in Alberta. The only comprehensive treatment for North American Agromyzidae was by Frick (1959) who also included all those known in Canada. Since the publication of Frick's synopsis, the concept of certain genera of Agromyzidae had been revised by Nowakowski (1962) on the basis of his studies of male genitalia. As new characters of male genitalia were discovered, it became necessary to confirm all determinations of species, which were previously based on external morphology and sometimes only on female specimens. One of the main objectives of the present study was to collect, determine, and describe as many species as possible in order to assess the position of the family Agromyzidae in Alberta and in Canada, and to provide keys for the determination of various genera and species. This investigation in Alberta was started parallel to that of Spencer's which appeared in his 1969 synopsis of the Agromyzidae of Canada and Alaska. As a preliminary report on these investigations I described 13 new species from Alberta (Sehgal 1968). Spencer (1969) examined all previously known records of Canadian and Alaskan Agromyzidae and confirmed a total of 290 species.

Among the Canadian species Spencer (1969) recorded 128 described species as occurring in Alberta. As a result of this study 32 new species are described from Alberta and 11 further species have been recorded as occurring in Alberta. This brings the total of Albertan Agromyzidae to 171 and that of Canadian and Alaskan Agromyzidae to 322 described species (see Table 1.). The male genitalia of almost all Albertan species have been examined. Any record of Albertan Agromyzidae outside the present work must be considered tentative, until confirmation is made with studies based on the examination of characters of male genitalia.

Table 1.

Agromyzid species known from Alberta, and Canada and Alaska.

Genus	Species known (Spencer 1969)		New spp. Alberta	New Alta. records	Species now known from	
	Can. and Alaska	Alberta			Can. and Alaska	Alberta
Agromyza	34	13	2	2	36	17
Melanagromyza	17	6	3	-	20	9
Hexomyza	2	1	-	-	2	1
Ophiomyia	26	16	1	-	27	17
Phytobia	8	2	-	1	8	3
Cerodontha						
Dizygomyza	18	5	-	2	18	7
Poemyza	8	5	-	-	8	5
Icteromyza	6	2	-	-	6	2
Cerodontha	3	2	-	-	3	2
Calycomyza	13	1	-	1	13	2
Amauromyza	3	-	2	-	5	2
Nemorimyza	1	1	-	-	1	1
Liriomyza	36	20	6	1	42	27
Lemurimyza	3	1	-	-	3	1
Metopomyza	3	1	1	-	4	2
Praspedomyza	1	1	-	-	1	1
Haplomyza	1	1	-	-	1	1
Phytoliriomyza	2	1	-	-	2	1
Paraphytomyza	6	4	1	-	7	5
Pseudonapomyza	2	2	-	-	2	2
Napomyza	9	3	-	-	9	3
Phytomyza	83	40	16	4	99	60
Other genera	5	-	-	-	5	-
TOTAL	290	128	32	11	322	171

MATERIALS AND METHODS

As a part of this study I made intensive collections of agromyzid specimens from the province of Alberta, Canada, including the Alberta Rockies. Some specimens collected by other collectors, especially G. C. D. Griffiths, K. A. Spencer, the late Professor E. H. Strickland, and B. Hocking, from Alberta localities were also examined. All specimens collected by others are acknowledged in the list of material examined.

Attempts were made to rear adults from immature stages as far as possible. This permitted me to clarify the biology of many species.

During this study I studied approximately 1200 specimens and examined the genitalia preparations of 620 specimens. Male genitalia of representatives of all new species and few other species wherever necessary for their specific determination have been illustrated. Reference is made to good earlier illustrations of male genitalia.

The holotypes and allotypes of all new species will be deposited in the Canadian National Collection, Ottawa.

The terminology used in describing new species is that employed by Spencer (1969) and other workers in Agromyzidae. The frons width and eye width are measured at the level of the median front ocellus from above. The term gena here means the area below the eyes including the lower orbits. The ratio of genal and eye heights are measured mid-way between vibrissal and posterior margins. The terminology of the aedeagus is that used by Frick (1952) and Spencer (1969).

ABBREVIATIONS

acr, acrostichal hair; Adap, aedeagal apodeme; Ar, arista; As3, third antennal article; Bsph, basiphallus; C, costa; dc, dorsocentral bristles; Dph, distiphallus; Ejap, ejaculatory apodeme; Ejb, ejaculatory bulb; Ejd, ejaculatory duct; Hypa, hypandrium; m-m, medial crossvein; M_{1+2} and M_{3+4}, median veins; Mph, mesophallus; oc, ocellar bristles; Ori, lower orbital bristles; Ors, upper orbital bristles; os, orbital setulae; Pgo, postgonites; Phph, phallophore; Prgo, pregonites; Pvt, postvertical bristles; R_1, R_{2+3} and R_{4+5}, radial veins; r-m radiomedial crossvein; Sc, subcosta; Vi, Vibrissa; *Vte*, outer vertical bristle; *Vti*, inner vertical bristle.

CHARACTERISTICS OF THE FAMILY AGROMYZIDAE

The main distinguishing characters of the members of this family are as follows:

Head.-Postvertical bristles divergent; distinct orbital bristles present, normally two strong upper orbital bristles, *Ors*, directed upwards and two lower orbital bristles, *Ori*, directed inwards and upwards; orbital setulae present; distinct vibrissal hair always present, represented by a bunch of fused hairs or 'vibrissal' horn in some males of the genus *Ophiomyia* Braschnikov; centre of frons without bristles or setulae.

Mesonotum.-Distinct dorsocentral bristles present, normally 3+1, sometimes a few anterior bristles get reduced or lost; variable number of acrostichals present; scutellum normally with four scutellar bristles, sometimes only two as in subgenus *Cerodontha* Rondani.

Wing.-Costa broken at end of subcosta, extended to apex of vein R_{4+5} or M_{1+2}; subcosta weakly developed distally, adjacent to, and either joined or independent from R_1 distally; crossvein r-m present; anal vein shortened, not reaching the wing margin.

Male genitalia.-Hypandrium large and well developed; pregonites and postgonites normally well differentiated, the former sometimes fused with hypandrium; epandrium large and conspicuous; surstyli and cerci normally well developed and with diagnostic setae or setulae; aedeagus complex; aedeagal apodeme large and darkly sclerotized; aedeagal hood conspicuous; aedeagus with distinct basal section consisting of basiphallus and phallophore and distal section consisting of various sclerites forming mesophallus, paraphallus, and distiphallus; terminal section of ejaculatory duct inside the distiphallus normally bifid; ejaculatory apodeme normally well developed, sometimes reduced, bulb conspicuous.

Female postabdomen.-Seventh segment completely sclerotized, forming a conical ovipositor sheath; eighth segment elongate, retractable into the seventh, bearing numerous anteriorly directed denticles; pair of egg guides present around gonopore; anus situated well beyond the gonopore; two spermathecae.

Larvae.-Anterior spiracles on first abdominal segment approximate; posterior spiracles on last or eight abdominal segment approximate or widely separated; mouth hooks well developed and almost vertical in relation to labial sclerite; paraclypeal phragma normally with a dorsal and a ventral arm; muscle scars and tubercle bands are strongly developed along lateral portions of abdominal segments.

Biology.- Larvae feed inside the living tissue of angiosperms (except those of *Pteridomyza* Nowakowski which feed on ferns and few representatives of the genus *Liriomyza* Mik feeding on horsetails and liver mosses). Larvae show varying degree of host-plant specificity, but normally feed on one plant organ. Most species feed as leaf miners, but quite a few feed inside the stems and seeds and other parts of plants; a few also feed in galls (such as genus *Hexomyza* Enderlein).

TAXONOMIC TREATMENT

The generic concept used in this study is the one which has come to be generally accepted (Spencer 1969), but is certainly not final in agromyzid classification. As recent studies progress on the male genitalia, the need for defining some of the larger genera on a monophyletic basis becomes more apparent. No attempt is made in this study to undertake any generic revision of the existing classification.

According to the biological species concept (Mayr 1963), species are defined to be groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups. I accept this species definition. The application of this species concept presents many practical difficulties and some of these have been discussed by Mayr (1969). The reproductive isolation of a population is usually inferred indirectly from comparisons of external morphology. In Agromyzidae, besides the evidence of external morphology, various other evidences are also helpful. The majority of agromyzid species are restricted feeders, either monophagous or oligophagous, confined to botanically related plant species. It seems highly unlikely that significant gene interchange occurs between populations restricted to unrelated host-plants, even if the morphological differences between them are minor. In such case one can assume with reasonable certainty that the populations are distinct species, so long as the observed differences are shown consistently. Often other evidence such as larval morphology, shape of leaf mine, etc. are available to support this assumption.

Spencer (1969) discussed briefly the significance of various taxonomic characters currently in use in agromyzid taxonomy; the same criteria have been accepted here for this work. The characters of male genitalia have been used as far as possible in order to provide a basis for more accurate determination of species. Information on Albertan host-plants and biology, wherever available, has been included. The following key represents a further development of that originally produced by Hendel (1931) and modified by Frick (1952, 1959) and Spencer (1969).

Key to genera of Albertan Agromyzidae

1(0). Subcosta developed throughout its length, coalesced with R_1 before contact with costa..2

\- Subcosta weakly developed distally, joined with costa independent of R_1..........................5

2(1). Prescutellars absent; Dorsocentrals, two, three or four pairs, if three or four pairs halteres black......................................3

\- Prescutellars present; at least three pairs of dorsocentrals; halteres yellow.......*Agromyza* Fallén p.13

3(2). Mesonotum or abdomen normally with greenish, bluish or coppery metallic sheen; antennae not separated by a conspicuous keel; aedeagus with basiphallus U-shaped; larvae normally with conspicuous horn in centre of posterior spiracles; larvae feed inside stems or seeds........................*Melanagromyza* Hendel p.33

\- Mesonotum and abdomen black; aedeagus with basiphallus having long side arms; posterior spiracles of larva without central horn...................4

4(3). Antennae separated by conspicuous raised facial keel (absent from *pulicaria* group); male with or without distinct vibrissal horn; larval posterior spiracles with more than three bulbs; larva feeds below stem epidermis or as leaf miner...*Ophiomyia* Braschnikov p. 51

\- Antennae approximate; male without vibrissal horn; larval posterior spiracles with three bulbs; larva gall producer ....*Hexomyza* Enderlein p. 49

5(1). Orbital setulae erect or reclinate, rarely absent...6

\- Orbital setulae distinctly proclinate.....................18

6(5). Costa extended to apex of vein M_{1+2}, if only to R_{4+5} then either crossvein m-m absent (*Phytobia confessa* Spencer) or lunule broad, distinctly higher than semicircle (*Cerodontha (Dizygomyza) frankensis* Spencer)................................7

\- Costa extended to apex of vein R_{4+5}...17

7(6). Scutellum normally dark, concolourous with mesonotum...8

\- Scutellum yellow; vein M_{1+2} ending nearest wing tip...14

8(7). Halteres with knob white or yellow........................9

\- Halteres with knob black or partially darkened, if yellow distiphallus with numerous spinules..................*Amauromyza* Hendel p.92

9(8). Crossvein m-m absent.................*Haplomyza* Hendel p.140

-Crossvein m-m present..10

10(9). Vein R_{4+5} ending nearest the wing tip;

larvae cambium miners...................*Phytobia* Lioy p.67

-Vein M_{1+2} ending nearest wing tip.........................11

11(10). Third antennal article with conspicuous

spine anterodorsally, scutellum with

only two bristles; or lunule higher than

semicircle, narrow or triangular; or

lunule broad, antennal bases widely

separated, third antennal segment in

male distinctly enlarged..........*Cerodontha* Rondani p.71

-Not so..12

12(11). Fore-tibia with lateral bristle;

abdomen in male yellowish; larva make

characteristic blotch mine with

concentric rings on *Aster* and *Solidago*

in *Nemorimyza posticata* (Meigen)......*Nemorimyza* Frey p.98

-Fore-tibia without lateral bristle;

leaf mine not as above.....................................13

13(12). Frons dark; orbits raised above the

plane of frons......................*Praspedomyza* Hendel p.138

-Frons yellow, orbits in same plane

as frons............................*Calycomyza* Hendel p.89

14(7). Frons yellow; orbits in the plane

of frons...15

- Frons dark; orbits raised above plane of frons......................*Metopomyza* Hendel p.134

15(14). Crossvein m-m absent; one *Ors*.........*Haplomyza* Hendel p.140

- Crossvein m-m present (absent in *Liriomyza singula* Spencer); two *Ors*..16

16(15). Prescutellar area yellow; orbital setulae normally erect; aedeagus with sclerotized paired tubules in the distiphallus, epandrium with conspicuous black spines...........*Lemurimyza* Spencer p. 133

- Prescutellar area normally dark, sometimes yellow; orbital setulae reclinate; aedeagus variable, but never as in the genus *Lemurimyza* Spencer.................................*Liriomyza* Mik p.100

17(6). Crossvein m-m either absent, or if present well beyond r-m.......*Paraphytomyza* Enderlein p. 143

- Crossvein m-m basal to r-m.......*Pseudonapomyza* Hendel p. 152

18(5). Crossvein m-m present, basal to or at the same level as r-m...........*Napomyza* Westwood p. 154

- Crossvein m-m absent..................*Phytomyza* Fallén p.156

Genus *Agromyza* Fallén

Agromyza Fallén 1810 : 21.

The main distinguishing characters of this genus are subcosta developed throughout its length and coalesced with R_1 before contact with costa; at least three pairs of dorsocentrals; prescutellars present and halteres yellow.

This genus is represented in Alberta by 17 species, of which two are described as new. The species in this genus form a very diverse assemblage of many groups. The species in the *ambigua* group, *albertensis* Sehgal, *aprilina* Malloch and *kincaidi* Malloch; as well as species in the *nigripes* group, *albipennis* Malloch, *brevispinata* new species, *hockingi* Spencer and *nigripes* Meigen; like other members of the *ambigua/nigripes* groups (Griffiths 1963) form a single group of grass mining species with similarity in shape of the distiphallus. Members of the *ambigua* group differ from those of the *nigripes* group only by a shortened costa, not extended beyond the apex of vein R_{4+5}, and longer distiphallus.

The *Urtica* miner, *pseudoreptans* Nowakowski, belongs to the *reptans* group, while the *Mertensia* miner, *canadensis* Malloch, belongs to the *rufipes* group.

The species in the *spiraeae* group, *populoides* Spencer, *vockerothi* Spencer, *fragariae* Malloch, *masculina* Sehgal and *spiraeae* Kaltenbach, are believed to be closely related due to similarities in the male genitalia. This concept was first proposed by Sasakawa (1961). The species in this group have asymmetric sclerotization of the basiphallus and mesophallus.

A. aristata Malloch, whose larvae mine the leaves of *Ulmus americana* L., family Ulmaceae, is probably close to the *rubi/spiraeae* group of Sasakawa (1961).

Another group of species whose members are characterized by 3+1 strong dorsocentrals and yellow frons is represented in Alberta by *nearctica* new species. Three further females belonging to this group cannot be identified, as males are necessary for this purpose.

The leaf mines on members of *Geum allepicum* Jacq., *Potentilla* sp., and *Rosa acicularis* Lindl., of the family Rosaceae probably represent those of the members of the *spiraeae* group, but no flies have been bred from these hosts.

Key to Alberta species of the genus *Agromyza* Fallén

1(0). Dorsocentrals 3-6, decreased significantly in size anteriorly; presuturals as well as anterior postsutural dorsocentrals usually not distinguishable from acrostichals....................2

\- Dorsocentrals 3+1, strong and distinct..................12

2(1). Wing tip near the apex of vein M_{1+2}..............................*sulfuriceps* Strobl p.31

\- Wing tip near the apex of vein R_{4+5} or midway between R_{4+5} and M_{1+2}..3

3(2). Legs largely yellowish..................................4

–	Legs largely black or brown	5
4(3).	Antennae yellow, smaller specimens, wing length 2.2 to 2.7 mm; larvae leaf miner on *Ulmus americana* L.	*aristata* Malloch p.19
–	Antennae dark brown; larger specimens, wing length about 3.0 mm	*canadensis* Malloch p.21
5(3).	Costa extended to apex of vein R_{4+5}	6
–	Costa extended to apex of vein M_{1+2}	8
6(5).	Squamal fringe brown or black; larger specimens, wing length about 2.7 to 3.5 mm	*kincaidi* Malloch p.24
–	Squamal fringe pale or whitish, smaller specimens	7
7(6).	Third antennal article with distinct angle or point anterodorsally; eyes upright, normal	*albertensis* Sehgal p.17
–	Third antennal article rounded at end; eye distinctly slanted	*aprilina* Malloch p.18
8(5).	Mesonotum at least weakly shining black; mesophallus and distiphallus a single S-shaped sclerotization	9
–	Mesonotum distinctly mat black; mesophallus and distiphallus separate sclerotizations	*pseudoreptans* Nowakowski p.29

9(8). Third antennal article with distinct
angle anterodorsally......................................10

- Third antennal article rounded at tip....................11

10(9). Squamal fringe pale or whitish;
ejaculatory bulb very broad..........*albipennis* Meigen p.18

- -Squamal fringe dark or brown;
ejaculatory bulb narrower.............*nigripes* Meigen p.28

11(9). Surstyli with 3-6 distinctly large
spines (Fig. 6).......................*hockingi* Spencer p.23

- Surstyli with smaller spines
(Fig. 5); aedeagus as in Figs. 3, 4...*brevispinata* n. sp. p.20

12(1). Frons reddish yellow; orbits black;
second and third antennal articles
black; aedeagus as in Fig. 10.........*nearctica* n. sp. p.25

- Frons dark, brown or black................................13

13(12). Squamal fringe pale...............*populoides* Spencer p.29

- Squamal fringe darker, brown or black....................14

14(13). Mid-tibia with a strong bristle
posteriorly.......................*vockerothi* Spencer p.32

- Mid-tibia without a distinct
bristle...15

15(14). Frons distinctly brown..............*fragariae* Malloch p.23

- Frons distinctly mat black................................16

16(15). Gena narrow one-eighth to one-
tenth eye height; basiphallus and
mesophallus with sclerotized strips...*masculina* Sehgal p.25

- Gena broader, about one-fifth eye height; distiphallus separated from basiphallus by a long membranous section................*spiraeae* Kaltenbach p.30

Agromyza albertensis Sehgal

Agromyza albertensis Sehgal 1968 : 57, Spencer 1969 : 32.

Comparisons and diagnostic characters.-The members of this species differ from those of similar species, *kincaidi* Malloch, in having smaller size, wing length 2.0-2.7 mm and pale squamal fringe, and from those of *ambigua* Fallén in having frons less projected above eyes in profile. The main distinguishing characters are the conspicuous angle on the third antennal article and distinct male genitalia. Sehgal (1968) illustrated the head, wing and male genitalia characteristic of this species. Spencer (1969) also figured the aedeagus.

Biology.-Not confirmed, but larvae probably mine leaves of grasses (Gramineae).

Geographical distribution.-Known only from Alberta, from the following localities:

CANADA. Alberta : Banff, Blairmore, Elkwater.

Agromyza albipennis Meigen

Agromyza albipennis Meigen 1830 : 171; Spencer 1969 : 32.

Diagnostic characters.-The members of this species may be recognised by the combination of characters given in the key. The distinctive aedeagus and ejaculatory bulb are as illustrated (Figs. 1, 2). Sasakawa (1961) and Griffiths (1963) described in detail and illustrated significant diagnostic characteristcs of this species.

Biology.-Larvae are known to mine the leaves of grasses (Gramineae) (Sasakawa 1961, Griffiths 1963).

Geographical distribution.-The members of this species are Holarctic in distribution, known from numerous localities in Europe (Griffiths 1963), Japan (Saskawa 1961) and Canada (Spencer 1969). I have examined three specimens from the following localities:

CANADA. Alberta : 1 ♀ Cypress Hills, near Elkwater Lake, 24.vi.1966; 1 ♂ Devon, University of Alberta Botanical Garden, 22.vi.1966; 1 ♂ Edmonton, Rainbow Valley, 14.vi.1968.

Agromyza aprilina Malloch

Agromyza aprilina Malloch 1915b : 359; Spencer 1969 : 36.

Comparison and diagnostic characters.-The members of this species resemble closely those of *A. kincaidi* Malloch and can be reliably separated only by examination of the characters of male genitalia. Other external differences are pale squamal fringe, smaller size and distinctly slanting eyes. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Not confirmed, but the larvae probably mine the leaves of grasses (Gramineae).

Geographical distribution.-The members of this species are Nearctic in distribution and are known from United States and Canada. The known Alberta locality is:

CANADA. Alberta : Banff (Spencer 1969).

Agromyza aristata Malloch

Agromyza aristata Malloch 1915a : 13; Spencer 1969 : 38.
Agromyza ulmi Frost 1924 : 54. Frick 1957 : 199.

Diagnostic characters.-The members of this species may be recognized by the combination of characters given in the key. Spencer (1969) illustrated the distinctive aedeagus.

Biology.-Larvae make elongated blotch mines on the upper surface of the leaves of *Ulmus americana* L., family Ulmaceae. The leaf mines appear in great numbers around Edmonton during the second week of June. The members of this species have only one generation a year in Alberta.

Geographical distribution.-The members of this species are widespread in United States (Frick 1959) and are also known from Canada (Spencer 1969). I have examined the following material from Alberta:

CANADA. Alberta : 2 ♀♀ Edmonton, University of Alberta campus from leaf mines on *Ulmus americana* L., coll. 6.vi.1968, em. 20-27.v.

1969, coll. G. C. D. Griffiths; 1 ♀ same locality, swept over same host, 3.vi.1969; Numerous leaf mines on *Ulmus americana* L., same locality, 9.vi.1966, 5.vi.1967, 10.vi.1968.

Agromyza brevispinata new species

Comparison and diagnostic characters.-The male of this species differs from those of the similar species *hockingi* Spencer and *lucida* Hendel in having weakly shining or somewhat mat mesonotum and distinct male genitalia. This species is included in Spencer's (1969) key to Canadian species of the genus *Agromyza* Fallén by amending and extending the couplet 26 as follows:

26. Third antennal segment distinctly cut away below (Spencer 1969, Fig. 5)....................................*nigripes* Meigen
   -Third antennal segment rounded at tip......................26a

26a. Mesonotum somewhat mat or weakly shining black; surstyli with 8-10 small spines; aedeagus as in Figs. 3, 4...................................*brevispinata* n. sp.
   -Mesonotum entirely shining black..........................27

Description.-Head. Frons slightly wider than width of eye at level of front ocellus, not projected in front of eye margin in profile; two strong *Ors* directed upwards; two *Ori* directed inwards and upwards; orbital setulae reclinate; eyes oval, approximately 1.3 times higher than their length; gena deepest at rear, approximately one-fifth eye height midway between vibrissal and posterior margins;

third antennal article rounded at tip; arista long and pubescent.

Mesonotum. Two strong dorsocentrals; *acr* in about nine irregular rows.

Wing. Length in male about 2.8 mm; costa extended to apex of vein M_{1+2}; wing tip nearest to vein R_{4+5} ; crossvein r-m approximately at centre of discal cell.

Male genitalia (Figs. 3-5). Hypandrium with short apodeme and broad pregonites; surstyli (Fig. 5) with 8-10 small spines; aedeagus as illustrated (Figs. 3,4).

Colour. Frons and orbits mat black; ocellar triangle weakly shining black; mesonotum weakly shining mat black; squamae yellow, fringe dark brown.

Derivation of the specific name.-The name *brevispinata* is given in view of the small spines on surstyli.

Biology.-Not confirmed, but larvae probably mine leaves of grasses (Gramineae).

Geographical distribution.-This species is known from a single male collected at the following locality:

CANADA. Alberta : Holotype ♂ St. Albert near Edmonton, 18.vi.1967.

Agromyza canadensis Malloch

Agromyza canadensis Malloch 1913a : 299; Spencer 1969 : 39.

Comparison and diagnostic characters.-The members of this spec es are large flies, wing length approximately 3.0 mm and are distinctive in having yellowish brown legs and dark antennae.

They have male genitalia which appear indistinguishable from those of *A. pseudorufipes* Nowakowski. The two previously known Canadian specimens of this species are brownish flies (Shewell 1953) while the members of European *A. pseudorufipes* are darker in colour. This was the basis of Spencer's (1969) accepting them as different species. The bred male from Yukon Territory, Canada, however, is darker in colour. The discovery of this dark specimen casts doubt on the separation of these two species on the basis of colour. The name *A. pseudorufipes* Nowakowski will probably prove to be a junior synonym of *A. canadensis* Malloch.

Biology.-Larvae make blotch mines on the leaves of *Mertensia paniculata* (Ait.) G. Don, family Boraginaceae. Pupation takes place outside the leaf mine.

Geographical distribution.-The members of this species are known from Western and Eastern Canada (Frick 1959, Spencer 1969). I have examined the following material referable to this species:

CANADA. Alberta : Numerous leaf mines on *Mertensia paniculata* (Ait.) G. Don, Edmonton, River Bed near University of Alberta campus; White Mud Creek Park, July to September 1968; Yukon Territory : 1 ♂ Dawson City, from leaf mines on *Mertensia paniculata* (Ait.) G. Don, 5.viii.1968, emerged 22.vi.1969, coll. G. C. D. Griffiths.

Agromyza fragariae Malloch

Agromyza fragariae Malloch 1913a : 307; Spencer 1969 : 42.

Comparisons and diagnostic characters.-The members of this species resemble closely those of *A. spiraeae* Kaltenbach and *A. masculina* Sehgal but differ in having distinctly brownish frons and distinctive aedeagus. The aedeagus has a characteristic sclerotization in the mesophallus as illustrated by Spencer (1969).

Biology.-Larvae are known to mine the leaves of *Fragaria virginiana* Duchesne, family Rosaceae in United States.

Geographical distribution.-The members of this species are known from United States and Canada (Spencer 1969). From Alberta, Canada they are known from the following localities:

CANADA. Alberta : Blairmore; Onefour (Spencer 1969).

Agromyza hockingi Spencer

Agromyza hockingi Spencer 1969 : 44.

Diagnostic characters.-The members of this species are small shining black flies, having pale or slightly brownish squamal fringe and distinct male genitalia. Spencer (1969) illustrated the aedeagus. The number of bristles on surstyli (Fig. 6) is variable, from three to six.

One male collected from Edmonton, White Mud Creek Park, 13.vi.1966 is tentatively referred here as it has the aedeagus very similar to that of *hockingi* Spencer, but have distinctive surstyli (Fig. 7) with two very long spines and a small indistinguishable bristle. This probably represents a further species, but more material is necessary to confirm this opinion.

Biology.-Larvae probably mine leaves of grasses (Gramineae).

Geographical distribution.-Known from Alberta, New Brunswick, Ontario and Quebec (Spencer 1969). I have examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, White Mud Creek Park, 6.vii.1966; 1 ♂ same locality, viii.1968; 2 ♀♀ same locality, 29.vi.1966; 1 ♂ Elk Island Park, 2.viii.1966; 1 ♀ same locality, 31.vii.1966; 1 ♂ George Lake near Busby, 21.viii.1966.

Agromyza kincaidi Malloch

Agromyza kincaidi Malloch 1913a : 285; Spencer 1969 : 45.

Comparisons and diagnostic characters.-The members of this species are large shining black flies, wing length about 3.0 mm, with costa extended to vein R_{4+5} and dark squamal fringe. The aedeagus (Figs. 8, 9) and surstyli are also very distinctive.

Hendel (1931) synonymised the name *kincaidi* Malloch with *ambigua* Fallén. Frick (1952, 1959) also accepted it synonymous with *ambigua* Fallén. Spencer (1965d) concluded that specimens of *ambigua* Fallén *sensu* Hendel represented *nigrella* Rondani and not the true *ambigua* Fallén. He later (1969) rejected Hendel's synonymy and established this species.

Biology.-Larvae probably mine leaves of grasses (Gramineae).

Geographical distribution.-Known from Alaska and widespread in Canada (Spencer 1969). I have examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Cypress Hills, Elkwater Lake, 24.vi.1966; 1 ♂ Edmonton, White Mud Creek Park, 10.vi.1966, 1 ♂ same locality, 6.vii.1966, 1 ♂ same locality, viii.1968; 1 ♂ Edmonton, 110 St. 84 Ave., 15.vi.1968; 1 ♂ 2 ♀♀ Jasper, 17.vi.1966.

Agromyza masculina Sehgal

Agromyza masculina Sehgal 1968 : 59.

Comparisons and diagnostic characters.-The members of this species resemble externally those of *spiraeae* Kaltenbach and *vockerothi* Spencer, are reliably recognized by examination of the male genitalia. Sehgal (1968) illustrated the head, wing and aedeagus characteristic of this species.

Geographical distribution.-Known only from Alberta from the following localities:

CANADA. Alberta : Blairmore, Okotoks.

Agromyza nearctica new species

Comparison and diagnostic characters.-The specimen of this species is distinctive in having reddish frons and 3+1 strong dorsocentrals. It is distinguished in Spencer's (1969) key to Canadian species of the genus *Agromyza* Fallén by amending and extending couplet 29 as below:

29. Third antennal segment yellow..................................30

– Third antennal segment black.................................29a

29a. Second and third antennal segments completely black; orbits black; frons distinctly projected in profile; aedeagus as in Fig. 10.........................*nearctica* n. sp.

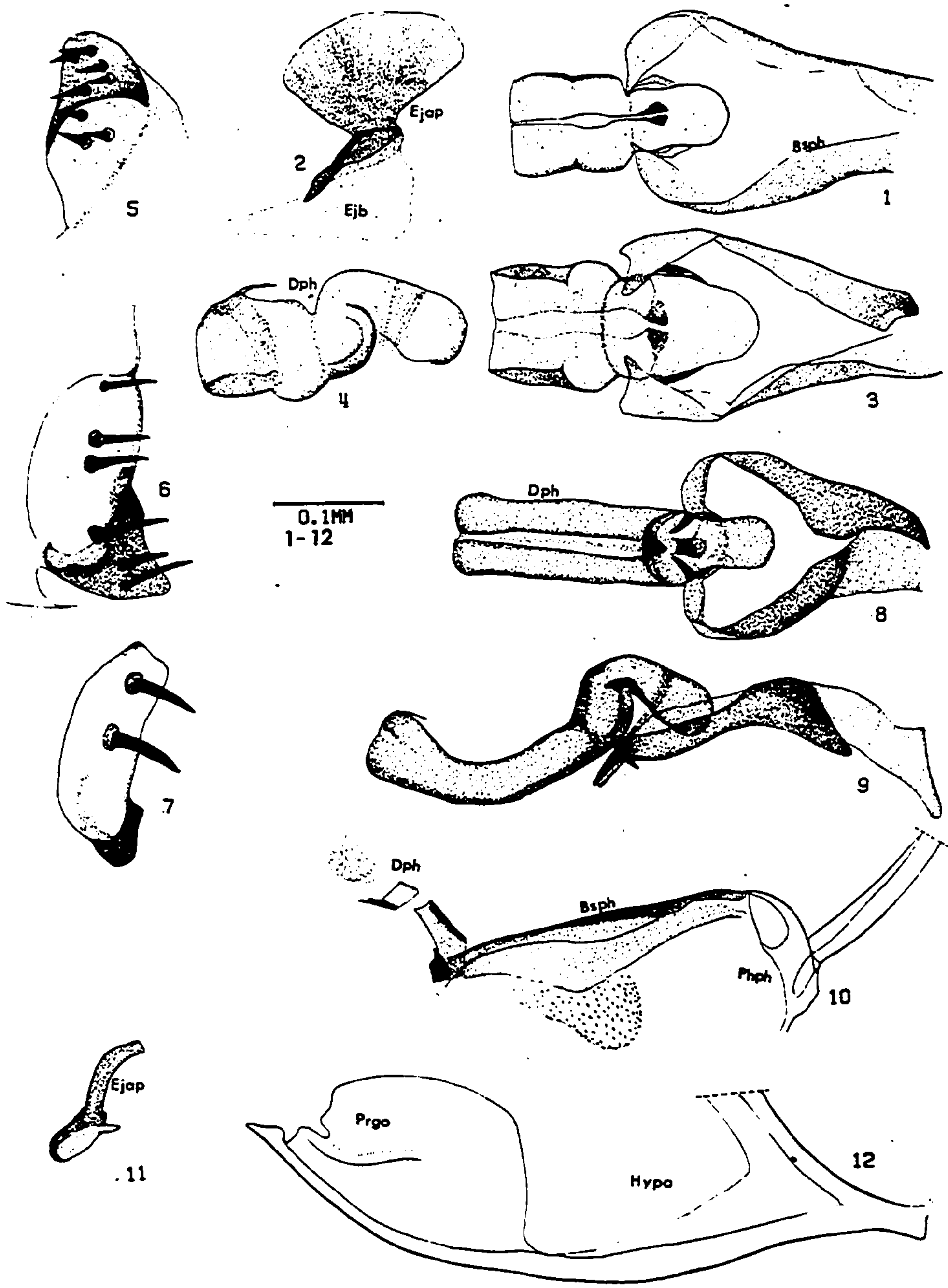
– Third antennal segment black..............sp. indet. (Spencer)

Description.-Head. Frons approximately twice width of eye at level of front ocellus, distinctly projected in front of eye margin in profile. Two strong *Ors* directed upwards; three *Ori* directed inwards and upwards; orbital setulae numerous, reclinate. Orbits broad, each approximately one-fifth frons width. Eyes oval, 1.2 times higher than their length, bare; ocellar triangle small. Gena appoximately one-fourth eye height. Third antennal article rounded at tip, with normal pubescence; arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* numerous, approximately in six rows; strong prescutellars present.

Wing. Length in male approximately 2.5 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.22 : 0.21; crossvein m-m present; basal portion of M_{3+4} slightly longer than distal (1 : 0.9).

Male genitalia (Figs. 10-12). Hypandrium (Fig. 12) V-shaped, with narrow side arms and short but distinct apodeme; pregonites broad; postgonites elongate; surstyli with approximately 8 spinnules placed anteriorly; cerci long; aedeagus (Fig. 10) characteristic with



Figs. 1 - 2. *Agromyza albipennis*. 1. aedeagus, ventral view. 2. ejaculatory apodeme. Figs. 3 - 5. *A. brevispinata*. 3. aedeagus, ventral view. 4. distiphallus, lateral view. 5. surstylus. Fig. 6. *A. hockingi*, surstylus. Fig. 7. *A. ? hockingi*, surstylus. Figs. 8 - 9. *A. kincaidi*. 8. aedeagus, ventral view. 9. aedeagus, lateral view. Figs. 10 - 12. *A. nearctica*. 10. aedeagus, lateral view. 11. ejaculatory apodeme. 12. hypandrium.

bag of spinules between two arms of basiphallus as illustrated; ejaculatory apodeme (Fig. 11) small and narrow, bulb small, membranous.

Colour. Frons reddish; orbits black; gena paler; lunule reddish; ocellar triangle weakly shining black; both *Vt's* on dark ground; first antennal article reddish; second and third antennal articles black; mesonotum, scutellum and pleura mat black; legs black, only distal tips of femora yellow; squamae yellow, fringe light brown; halteres yellow.

Derivation of the specific name.-The name *nearctica* indicates that the members of this species are Nearctic in distribution.

Geographical distribution.-This species is known from a single male from the following locality:

CANADA. Alberta : Holotype ♂ Edmonton, Mayfair Park, 1.vi.1969.

Agromyza nigripes Meigen

Agromyza nigripes Meigen 1830 : 170; Shewell 1953 : 462; Spencer 1969 : 50

Comparison and diagnostic characters.-The members of this species resemble closely those of *A. albipennis* Meigen and are separated reliably by examination of the characters of male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-In Europe the larvae are known to mine the leaves of various genera belonging to the tribes Glycerieae, Aveneae and Agrosteae of the family Gramineae (Griffiths 1963).

Geographical distribution.-The members of this species are known from Europe and Canada (Spencer 1969). From Alberta, Canada they are known from the following localities:

CANADA. Alberta : Red Deer, St. Albert near Edmonton, Spencer (1969).

Agromyza populoides Spencer

Agromyza populoides Spencer 1969 : 52.

Diagnostic characters.-The members of this species are very distinctive in having pale squamal fringe, characteristic aedeagus (Spencer 1969, Fig. 53) and biology.

Biology.-Larvae make large black blotch mines on *Populus* spp., family Salicaceae.

Geographical distribution.-Known from United States, and Alberta, Ontario, Quebec and Saskatchewan in Canada. I have examined the following material from Alberta:

CANADA. Alberta : Paratype 1 ♂ Edmonton, University of Alberta campus, near Aberhart Hospital, 1.vi.1966; 1 ♂ Edmonton, White Mud Creek Park, from leaf mines on *Populus tremuloides* Michx., coll. 4.ix.1968, em. 15.iii.1969; 1 ♀ same data, em. 3.vi.1969.

Agromyza pseudoreptans Nowakowski

Agromyza urticae Nowakowski 1964 ; 192 (Preoccupied).
Agromyza pseudoreptans Nowakowski 1967 : 658; Spencer 1969 : 54.

Agromyza reptans; Frick 1952 : 373 (not Fallén 1823a).

Diagnostic characters.-The members of this species had previously been confused with *reptans* Fallén, but possess very distinct male genitalia. Nowakowski (1964) illustrated the distinctive male genitalia of a specimen of this species under the name *urticae* Nowakowski. Frick (1952) also illustrated the characteristics of this species under the name *reptans*.

Biology.-Larvae make irregular blotch mines on the leaves of *Urtica* spp., family Urticaceae.

Geographical distribution.-Known from Europe, Japan, United States and Canada (Spencer 1969). I have examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Blairmore, 4.ix.1966, det. K. A. Spencer.

Agromyza spiraeae Kaltenbach

Agromyza spiraeae Kaltenbach 1867 : 104; Spencer 1969 : 55.

Comparisons and diagnostic characters.-The diagnostic characters of the members of this species are: frons mat black, not projected in front of eye margin in profile; mesonotum and scutellum weakly shining black; wing length approximately 2.4 mm; costa extended to vein M_{1+2}. Spencer (1969) figured the distinctive aedeagus.

The adults resemble those of *A. vockerothi* Spencer and *A. masculina* Sehgal and are separated by examination of male genitalia. The Japanese description of *A. spiraeae* Kaltenbach indicates a probable further species because of slight differences in the structure of distiphallus as figured by Sasakawa (1961).

Biology.-Larvae mine leaves of various members of the subfamily Rosoideae, family Rosaceae (Hering 1954).

Geographical distribution.-The members of this species are widespread in North America and Central Europe (Hering 1954, Spencer 1969). I have examined the following material from Alberta:

CANADA. Alberta : 1 ♂, 1 ♀ Jasper, 19.vi.1966.

Agromyza sulfuriceps Strobl

Agromyza sulfuriceps Strobl 1898 : 270; Spencer 1969 : 58.

Diagnostic characters.-The members of this species are small flies, wing length approximately 2.4 mm (Spencer 1969). The main distinguishing characters are: antennae yellow, frons yellowish below and darker above, orbits black; mesonotum mat gray, legs black, costa extended to vein M_{1+2}, wing tip near the apex of vein M_{1+2}; aedeagus as illustrated by Spencer (1969).

Biology.-Larvae mine leaves of various members of the family Rosaceae in Europe and United States.

Geographical distribution.-The members of this species are Holarctic in distribution and are known from North America, Europe and Mongolia (Spencer 1969). From Alberta, Canada they are known from the following locality:

CANADA. Alberta : Wabamun (Spencer 1969).

Agromyza vockerothi Spencer

Agromyza vockerothi Spencer 1969 : 60.

Comparison and diagnostic characters.-The members of this species resemble those in the *spiraeae* group and differ only in having a mid-tibial bristle. The examination of male genitalia is necessary for correct identification. Spencer (1969) illustrated the aedeagus, characteristic of this species.

Geographical distribution.-Known from Alberta, British Columbia, Ontario and Nova Scotia (Spencer 1969). I have examined the following material from Alberta:

CANADA. Alberta : Paratypes 2 ♂♂ Elk Island Park, 31.vii.1966.

Genus *Melanagromyza* Hendel

Melanagromyza Hendel 1920 : 126

The distinguishing characters of the genus *Melanagromyza* Hendel are: subcosta developed throughout its length and coalesced with R_1 before contact with costa; normally two to three pairs of dorsocentrals, four only in *setifrons* (Melander); halteres black; prescutellars lacking; antennal bases approximate; conspicuous facial keel lacking; aedeagus with basiphallus U-shaped; posterior puparial spiracles normally with black horn or scar in centre.

This genus is represented in Alberta by nine species. Three new species are described in this treatment. The members of this genus are mostly stem borers as shown by the known life histories of four Albertan species: *achilleana* n. sp. and *bidenticola* n. sp. feed on Compositae; *martini* Spencer on Urticaceae, and *actaeae* n. sp. on Ranunculaceae. Three further males tentatively discussed here as *Melanagromyza* sp. might represent a new species. But as the males of a closely related species *actaeae* n. sp. have not been bred these specimens cannot be definitely determined for the time being.

Key to Alberta species of the genus *Melanagromyza* Hendel.

1(0). Squamal fringe pale or white..............................2

\- Squamal fringe dark, black or brown........................5

2(1). Orbits distinctly projected
above eyes in profile......................................3

- Orbits not significantly projected above eyes in profile....................................4

3(2). Posterior puparial spiracles widely separated, each with approximately 30 bulbs; larva stem borer in *Actaea*...................................*actaeae* n. sp. p.39

- Posterior puparial spiracles approximate, each with 15-18 bulbs; larva stem borer in *Urtica*............*martini* Spencer p.46

4(2). Orbits about one-fourth the width of frons, not projected above eyes in profile; orbital setulae numerous, in three irregular rows; aedeagus as in Fig. 27.........................*bidenticola* n. sp. p.41

- Orbits about one-fifth the width of frons, slightly projected above eyes in profile; orbital setulae fewer, in two rows; aedeagus as in Fig. 14....*achilleana* n. sp. p.35

5(1). Dorsocentrals 3 or 4; larger specimens, wing length 3.2 mm.....*setifrons* (Melander) p.47

- Dorsocentrals 2, at most 3; smaller specimens.......................................6

6(5). Frons strongly projected....................................7

- Frons not significantly projected.*occidentalis* Spencer p.47

7(6). Abdomen greenish, broad, low keel separating base of antennae.........*shewelli* Spencer p.48

- Abdomen black, facial keel normal.........................8

8(7). Orbits and ocellar triangle distinctly
shining black.........................*fastosa* Spencer p.45

\- Orbits and ocellar triangle not
shining black.......................*laetifica* Spencer p.45

Melanagromyza achilleana new species

Comparisons.-The members of this species differ from those of a similar species *M. matricarioides* Spencer in having proclinate orbital setulae and distinct male genitalia (Fig. 14). *M. achilleana* and *M. bidenticola* n. sp. described below are distinguished in Spencer's (1969) key to Canadian species of the genus *Melanagromyza* Hendel by amending and extending the couplet 8 as below:

8. Orbits conspicuously broad, each
almost one-third width of frons............................9

\- Orbits narrower, at most one-
quarter width of frons..................................8a

8a. Orbital setulae proclinate,
with few reclinate hairs below...........................8b

\- Orbital setulae erect or reclinate,
not proclinate above....................................10

8b. Orbits about one-quarter width of
frons, not projected above eyes in
profile; orbital setulae numerous,
in three irregular rows, aedeagus
as in Fig. 27..........................*bidenticola* n. sp.

-Orbits about one-fifth width of frons, slightly projected above eyes in profile; orbital setulae fewer, in two rows; aedeagus as in Fig. 14.............................. *achilleana* n. sp.

Description.- Head (Fig. 13). Frons slightly broader than width of eye (1.0 : 0.9) at level of front ocellus, slightly projected above eye margin in profile; orbits broad, approximately one-fifth of frons width; ocellar triangle small; lunule almost semicircular above; eyes oval approximately 1.3 times higher than their length, hairy; gena almost deepest at middle, approximately one-fifth of eye height; two strong *Ors* directed upwards; two *Ori* directed inwards; distance between *Ori* approximately three times distance between upper *Ori* and lower *Ors*; orbital setulae numerous, in two irregular rows, largely proclinate, with few reclinate hairs below; antennal bases approximate; third antennal article rounded at tip; arista long and pubescent.

Mesonotum. Two strong postsutural dc; *acr* numerous, in 10-11 irregular rows.

Leg. Mid-tibia with two strong bristles medially.

Wing. Length 2.2 mm in ♂♂, 2.6 mm in ♀♀; costa extending strongly to vein M_{1+2}; wing tip nearest to apex of vein R_{4+5}; crossvein r-m beyond middle of discal cell; distal section of M_{3+4} approximately 0.7 times basal section.

Male genitalia (Figs. 14-17). Hypandrium (Fig. 16) with distinct apodeme, side arms and pregonites broad; surstyli (Fig. 17) with group of conspicuous spines anteriorly; aedeagus (Fig. 14) with basiphallus U-shaped and close to distiphallus complex; ejaculatory apodeme (Fig. 15) broad, bulb small and well sclerotized.

Colour. Frons mat black; orbits and ocellar triangle weakly shining black; antennae black; mesonotum, scutellum and abdomen shining black with greenish lustre; halteres and legs black; squamal fringe and margin pale or white.

Description of immature stages.-Puparium creamish yellow, elongate and cylindrical in shape, measures 3.0 mm x 1.3 mm.

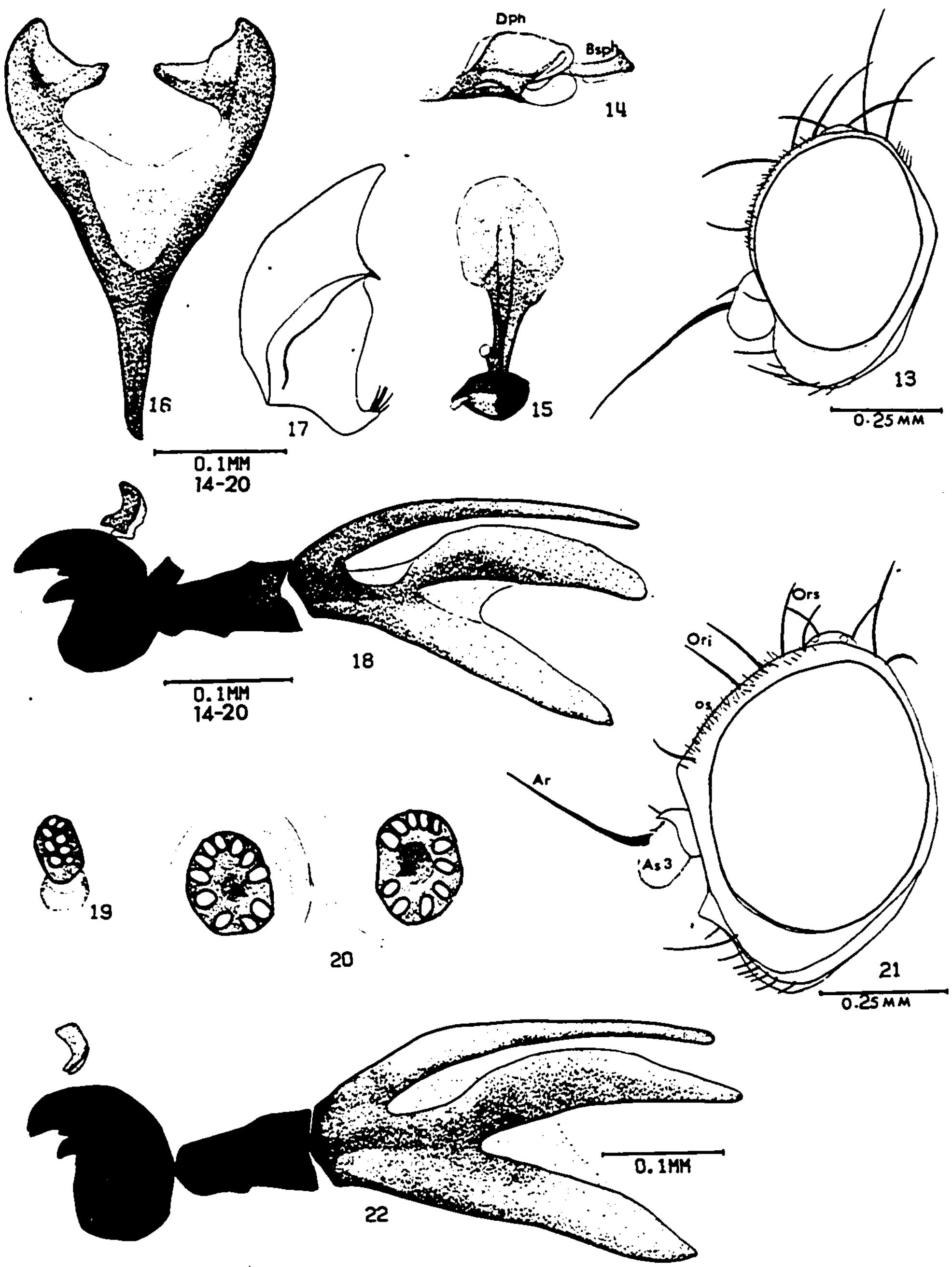
Larval mouth parts obtained from puparium are illustrated (Fig. 18). Mandibles sickle-shaped, left larger than right, each with large apical and small second tooth; short U-shaped sclerite present above the mandibles; lateral sclerites at base of mandibles well developed; labial sclerite short and darkly sclerotized; paraclypeal phragmata approximately 2.5 times length of labial sclerite, weakly sclerotized.

Muscle scars on abdominal segments elongate anteroposteriorly; tubercles small and scattered.

Anterior spiracles (Fig. 19) short, with 8 small bulbs arranged in two rows; posterior spiracles (Fig. 20) widely separated, with almost complete circlet of 10-11 bulbs; small black horn present in centre of posterior spiracles.

Derivation of the specific name.-This species is named after the genus of its larval food plant, *Achillea sibirica* Ledeb.

Biology.-Larva feed inside the stem of *Achillea sibirica* Ledeb., family Compositae. Pupation occurs inside the stem during August-September.



Figs. 13 - 20. *Melanagromyza achilleana*. 13. head, lateral view. 14. aedeagus, lateral view. 15. ejaculatory apodeme. 16. hypandrium. 17. surstylus. 18. cephalopharyngeal skeleton of larva. 19. anterior spiracle. 20. posterior spiracles. Figs. 21 - 22. *M. actaeae*. 21. head, lateral view. 22. cephalopharyngeal skeleton of larva.

Geographical distribution.-The members of this species are known only from type locality:

CANADA. Alberta : Holotype ♂ Elk Island Park, from stems of *Achillea sibirica* Ledeb., emerged 12.viii.1967; Paratypes 2 ♀♀ same data.

Melanagromyza actaeae new species

Comparisons.-The members of this species resemble those of *M. martini* Spencer in external morphology, but have distinct biology and larval morphology. This species is distinguished in Spencer's (1969) key to Canadian species of the genus *Melanagromyza* Hendel by amending and extending couplet 6 as below:

6. Orbits shining black, very strongly projected; large species, wing length 3.4 mm in male.............................*miranda* Spencer

\- Orbits weakly shining; smaller species, wing length 2.5–3.0 mm...........................6a

6a. Posterior puparial spiracles widely separated, each with approximately 30 bulbs; larva stem borer in *Actaea*..........*actaeae* n. sp.

\- Posterior puparial spiracles approximate, each with 15–18 bulbs; larva stem borer in *Urtica*...........*martini* Spencer

Description.-Head (Fig. 21). Frons broad, approximately twice width of eye at level of front ocellus, distinctly projected in front of eye margin in profile; orbits narrow, each about one-sixth of frons width; ocellar triangle small; lunule higher than semicircle along upper margin; eyes oval, approximately 1.2 times higher than their length, almost bare or with very fine pubescence; gena deepest at middle, approximately one-fourth of eye height; two *Ors* directed upwards; 3 *Ori* directed inwards, distance between lower and middle *Ori* about three times distance between middle and upper *Ori*; orbital setulae numerous, in two to three rows, erect or reclinate below and proclinate above; antennal bases approximate; third antennal article rounded at tip.

Mesonotum. Two distinct postsutural *dc; acr* numerous, in 10-12 irregular rows.

Leg. Mid-tibia with one or two small bristles medially.

Wing. Length 3.0 mm in ♀♀, costa extended to vein M_{1+2}; apex of vein R_{4+5} nearest wing tip; crossvein r-m slightly beyond the middle of discal cell; distal portion of M_{3+4} approximately 0.7 times basal portion.

Colour. Frons mat black, orbits and ocellar triangle weakly shining black; lunule and antennae black; mesonotum, scutellum and abdomen shining black with slight greenish lustre; legs and halteres black; squamal margin and fringe pale or white.

Description of immature stages.-Puparium yellow, elongate and cylindrical in shape, measures 4.0 mm x 1.5 mm.

Larval mouth parts obtained from puparium are illustrated (Fig. 22). Mandibles sickle shaped, left larger than right, each with large apical and small lower tooth; short U-shaped sclerite present above the mandibles; labial sclerite small and darkly sclerotized; paraclypeal phragmata approximately 3.0 times labial sclerite, weakly sclerotized.

Muscle scars (Fig. 23) on abdominal segments elongate anteroposteriorly; tubercles small and scattered.

Anterior spiracles (Fig. 24) short with 16 small bulbs arranged in two rows; posterior spiracles (Fig. 25) widely separated, each with approximately 30 small scattered bulbs, distinct horn present in the centre of each spiracle.

Derivation of the specific name.-This species is named after the genus of its larval food plant.

Biology.-The larvae feed inside the stems of *Actaea rubra* (Ait.) Willd, family Ranunculaceae. The host plant, commonly known as Red and White Baneberry, is fairly common in moist places in forests near Edmonton. This is the first *Melanagromyza* species to be recorded whose members feed on plants of the family Ranunculaceae.

Geographical distribution.-Known only from the locality of type specimens as below:

CANADA. Alberta : Holotype ♀ Edmonton, White Mud Creek Park, from stems of *Actaea rubra* (Ait.) Willd., coll. 4.ix.1968, emerged 27.x.1968; Paratypes 3 ♀♀ same data, coll. 4-6.ix.1968, em. 18-23.x.1968. One paratype female presented to K. A. Spencer.

Melanagromyza bidenticola new species

Comparison.-The members of this species differ from those of a similar species *M. virens* (Loew) in having narrower orbits and distinct male genitalia. This species is distinguished in Spencer's (1969) key to Canadian species of the genus *Melanagromyza* Hendel as shown earlier at the beginning of the description of *M. achilleana* n. sp.

Description.-Head (Fig. 26). Frons slightly broader than width of eye (1 : 0.9) at level of front ocellus, not projected in front of eye margin in profile; orbits broad, approximately one-fourth of frons width; ocellar triangle small; lunule higher than semicircle along upper margin; eyes oval, approximately 1.2 times higher than their length, hairy; gena almost deepest at middle, approximately one-seventh of eye height; two strong *Ors* directed upwards; two *Ori* directed inwards; orbital setulae numerous, in about 3 irregular rows, largely proclinate, with erect or reclinate hairs below; antennal bases approximate; third antennal article rounded at tips, arista pubescent.

Mesonotum. Two strong postsutural *dc; acr* numerous, in 12-15 irregular rows.

Leg. Mid-tibia with two strong bristles medially.

Wing. Length 2.5-2.8 mm; costa extended to vein M_{1+2}; wing tip near the apex of vein R_{4+5}; crossvein r-m slightly beyond middle of discal cell; distal portion of M_{3+4} approximately 0.7 times basal portion.

Male genitalia (Figs. 27, 28). Hypandrium (Fig. 28) with short, broad apodeme, side arms and pregonites broad; surstyli with small spines at base; aedeagus (Fig. 27) with basiphallus U-shaped and close to distiphallus complex; distiphallus as illustrated, ejaculatory apodeme broad, bulb small and well sclerotized.

Colour. Frons and orbits mat black; ocellar triangle weakly shining black; lunule and antennae black; mesonotum, scutellum and abdomen shining black with distinct greenish and coppery lustre; halteres and legs black; squamal margin and fringe pale or white.

Description of immature stages.-Puparium pale yellow, elongate and cylindrical in shape, measures 3.4 mm x 1.3 mm.

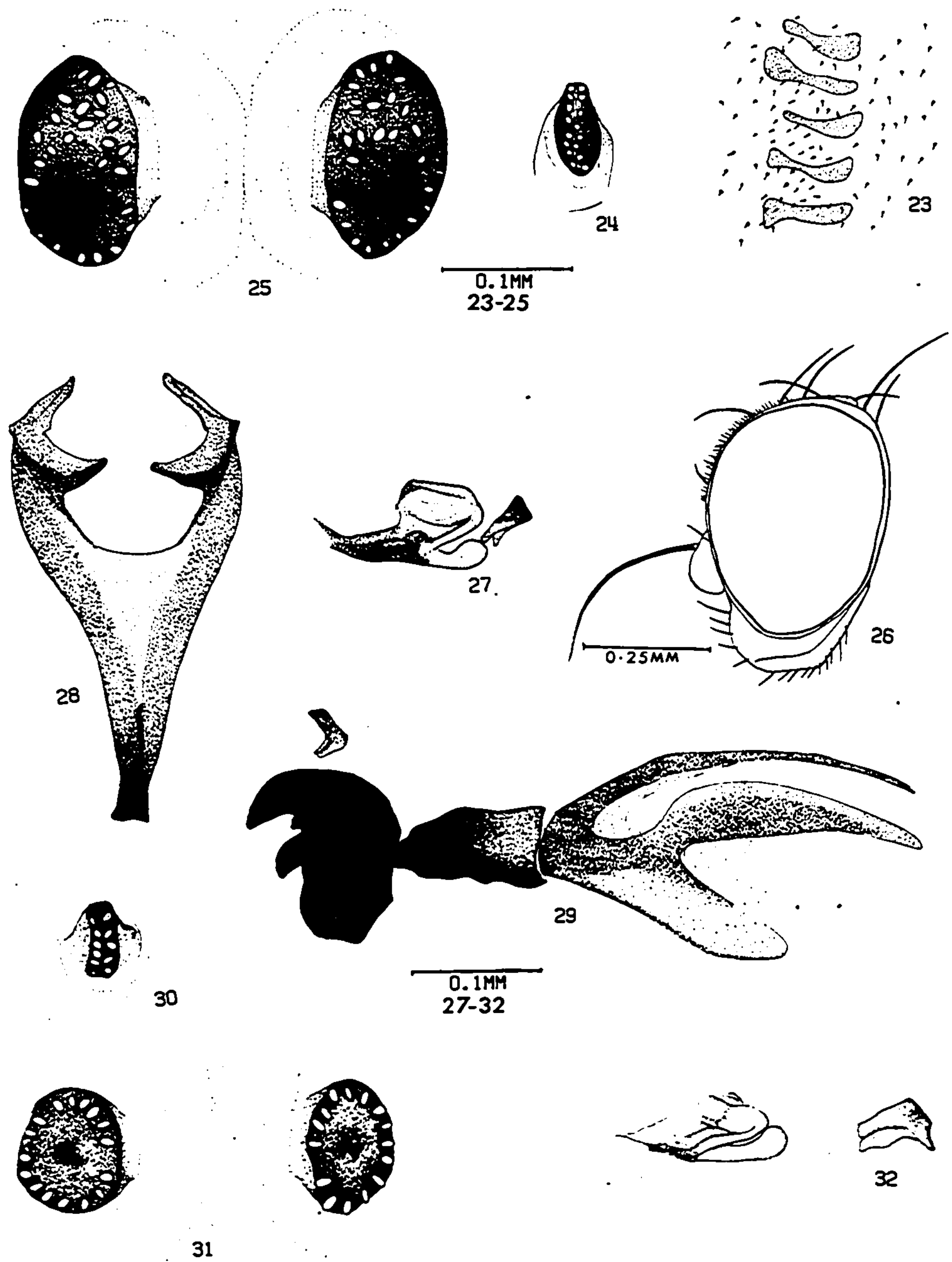
Larval mouth parts obtained from puparium are illustrated (Fig. 29). Mandibles sickle shaped, left larger than right, each with large apical and small lower tooth; short U-shaped sclerite present above mandibles; labial sclerite short and more darkly sclerotized along lower margins; paraclyeal phragmata approximately 3.0 times length of labial sclerite, weakly sclerotized.

Muscle scars on abdominal segments elongate anteroposteriorly; tubercles small and scattered.

Anterior spiracles (Fig. 30) short with about 10-11 bulbs arranged in two rows; posterior spiracles (Fig. 31) widely separated, each with almost complete circlet of 15-17 small bulbs, small distinct horn present in centre of each spiracle.

Derivation of the specific name.-This species is named after the genus of its larval food plant.

Biology.-Larvae feed and pupate inside the stems of *Bidens cernua* L., family Compositae. Puparia are found inside the stems during August-September. Puparia remain inside the stems during winter and the flies emerge towards the end of June. Specimens of *Bidens cernua* L. are fairly abundant around Edmonton along stream banks.



Figs. 23 - 25. *Melanagromyza actaeae*. 23. muscle scars and tubercles band from lateral portion of first abdominal segment of larva. 24. anterior spiracle. 25. posterior spiracles. Figs. 26 - 31. *M. bidenticola*. 26. head, lateral view. 27. aedeagus, lateral view. 28. hypandrium. 29. cephalopharyngeal skeleton of larva. 30. anterior spiracle. 31. posterior spiracles. Fig. 32. *Melanagromyza sp.* ?, aedeagus, lateral view.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Holotype ♂ Edmonton, Rainbow Valley, from stems of *Bidens cernua* L., coll. 9.x.1967, emerged 25.xi.1967; Allotype ♀ same locality and host, coll. 9.x.1967, emerged 22.xi.1967; Paratypes 21 ♂♂ and 9 ♀♀ same locality and host, coll. 9.x.1967, emerged 16-25.xi.1967; 3 ♂♂ and 1 ♀ same data, emerged x.1967.

Melanagromyza fastosa Spencer

Melanagromyza fastosa Spencer 1969 : 67.

Comparison and diagnostic characters.-The members of this species differ from those of a similar species *laetifica* Spencer in having shining black orbits and ocellar triangle and deep gena, about one-fourth to two-fifth eye height. Spencer (1969) has figured the distinctive aedeagus.

Geographical distribution.-Known only from Alberta and Quebec. Known Alberta locality is as follows:

CANADA. Alberta : Onefour (Spencer 1969).

Melanagromyza laetifica Spencer

Melanagromyza laetifica Spencer 1969 : 68.

Diagnostic characters.-The main diagnostic characters of the members of this species are: strongly projected frons, dark squamal fringe and abdomen. Spencer (1969) has illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known only from Alberta and Manitoba in Canada (Spencer 1969). Alberta localities are:

CANADA. Alberta : Manyberries, Mountain View.

Melanagromyza martini Spencer

Melanagromyza martini Spencer 1969 : 70.

Comparison and diagnostic characters.-The members of this species resemble those of *M. actaeae* n. sp. but have different biology and larval morphology as shown in the key. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae feed inside the stems of *Urtica,* family Urticaceae.

Geographical distribution.-The members of this species are known from Alberta, British Columbia, Ontario and Saskatchewan in Canada (Spencer 1969). I have examined the following material from Alberta:

CANADA. Alberta : Paratype 1 ♂ Blairmore, 26.vi.1966; 1 ♀ same data; 1 ♂ and 1 ♀ Edmonton, Rainbow Valley, from stems of *Urtica gracilis* Ait. (Urticaceae), em. 24.iii.1968; 1 ♀ Edmonton, White Mud Creek Park, 23.vi.1966; Paratype 1 ♂ George Lake, near Busby, 1.vii.1966; 2 ♀♀ same locality, 1-5.vii.1966.

Melanagromyza occidentalis Spencer

Melanagromyza occidentalis Spencer 1969 : 73

Diagnostic characters.-The main distinguishing characters of the members of this species are dark squamal fringe, frons normally not projected, mat black mesonotum and greenish abdomen. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from Alberta, British Columbia and Saskatchewan in Canada. Spencer (1969). The Alberta localities are:

CANADA. Alberta : Banff, Elkwater and Jasper.

Melanagromyza setifrons (Melander)

Agromyza setifrons Melander 1913 : 260.

Melanagromyza setifrons (Melander) Frick 1959 : 366; Spencer 1969 : 75.

Diagnostic characters.-The main distinguishing characters of the members of this species are dark squamal fringe and 3 or 4 dorsocentrals. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from United States, and Alberta and British Columbia in Canada. The Alberta locality is as below:

CANADA. Alberta : Blairmore (Spencer 1969).

Melanagromyza shewelli Spencer

Melanagromyza shewelli Spencer 1969 : 75.

Diagnostic characters.-The main distinguishing characters of the members of this species are: dark squamal fringe, distinctly projected orbits, facial keel and deep gena. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from Alberta and British Columbia in Canada (Spencer 1969). The Alberta localities are:

CANADA. Alberta : Frank and Mountain View.

Melanagromyza sp. ?

Comparisons and diagnostic characters.-The males resemble externally those of *M. actaeae* n. sp., but as the males of the latter species have not been bred, these males cannot be definitely associated. The aedeagus (Fig. 32) has a characteristic gap between basiphallus and distiphallus. Such a gap is also characteristic of *Melanagromyza* sp. (Steyskal) (Spencer 1969) and *M. angelicae* (Frost), but the adults differ from them in having narrower orbits and smaller size. The wing length in male is about 2.5 mm.

Geographical distribution.-I examined three males from the following localities:

CANADA. Alberta : 1 ♂ Edmonton, Emily Murphy Park, 11.vi.1968; 2 ♂♂ George Lake, near Busby, 22.v.1968.

Genus *Hexomyza* Enderlein

Hexomyza Enderlein 1936 : 182.

The members of this small genus are similar to those of the genus *Melanagromyza* Hendel in external morphology. Hendel (1931) included all known species in the genus *Melanagromyza* Hendel. Frick (1952) combined the members of the genus *Hexomyza* Enderlein with those of the large genus *Melanagromyza* Hendel. Later Spencer (1966a) in view of distinct male genitalia and larval biology resurrected this genus to include gall causing species.

Of the two species known in Canada only one, *H. schineri* (Giraud), has been confirmed in Alberta. The other species, *H. albicula* Spencer, gall producer on *Salix* twigs, probably also occurs in Alberta.

Hexomyza schineri (Giraud)

Agromyza schineri Giraud 1861 : 484.

Melanagromyza schineri (Giraud), Hendel 1920 : 128; Frick 1952 : 379.

Hexomyza schineri (Giraud), Spencer 1966a : 42, 1969 : 81.

Comparison and diagnostic characters.-The members of this species differ from those of *H. albicula* Spencer in having costa extended to apex of vein M_{1+2}, and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae produce twig galls on *Populus tremuloides* Michx., family Salicaceae.

Geographical distribution.-The members of this species are known from Western Europe, U. S. A. and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : Empty galls on *Populus tremuloides* Michx. Edmonton, August-September 1967; 1 larva, Elk Island Park, same host, November 1969, coll. G. C. D. Griffiths; 1 larva, George Lake, from same host, 29.iv.1967.

Genus *Ophiomyia* Braschnikov

Agromyza Fallén, subgenus *Ophiomyia* Braschnikov 1897 : 40.

Ophiomyia Braschnikov; Hendel 1920 : 128.

The main distinguishing characters of the genus *Ophiomyia* Braschnikov are: subcosta developed throughout its length and coalesced with R_1 before contact with costa; two to three pairs of dorsocentrals; halteres black; prescutellars lacking; antennal bases usually separated by distinct, bulbous facial keel; aedeagus with bashiphallus elongate, with two distinct side arms.

The species in this genus are extremely difficult to separate on the basis of external morphology alone. Recent examination of characters of the male genitalia of most of North American species (Spencer 1969) has greatly facilitated the identification of closely related species. The species in the *pulicaria* group, *decima* Spencer, *pulicaria* (Meigen) and *pulicarioides* Sehgal resemble externally those in the genus *Melanagromyza* Hendel, but possess aedeagus typical of the genus *Ophiomyia* Braschnikov. Spencer (1964c) transferred species in the *pulicaria* group from the genus *Melanagromyza* Hendel to the genus *Ophiomyia* Braschnikov due to similarities in the characters of the male genitalia.

The genus is represented in Alberta by 17 species. The members of this genus usually mine below the stem epidermis of various herbaceous plants, but a few mine the tissue in the leaf. Biology of most of species in Alberta remains to be determined as information is available about host-plants of only four species.

Key to Alberta species of the genus *Ophiomyia* Braschnikov.

1(0). Antennal bases separated by distinct, swollen facial keel or male with vibrissal horn or both....................................4

– Antennal bases not separated by distinct keel; vibrissa normal; aedeagus with basiphallus elongate, with two distinct side arms..............................2

2(1). Peristomal hairs long, conspicuous.....*decima* Spencer p.55

– Peristomal hairs normal....................................3

3(2). Aedeagus as in Fig. 35............*pulicaria* (Meigen) p.60

– Aedeagus as illustrated (Fig. 12, Sehgal 1968)....................*pulicarioides* Sehgal p.61

4(1). Orbital setulae proclinate, upper orbital bristles lacking in male; three pairs of postsutural dorsocentrals..........................*nasuta* (Melander) p.57

– Orbital setulae reclinate.................................5

5(4). Costa extended to apex of vein R_{4+5}, male without vibrissal fasciculus.........................6

– Costa extended to apex of vein M_{1+2}, male with vibrissal fasciculus...........................7

6(5). Squamae pale, margin slightly darker, facial keel narrow...............*banffensis* Spencer p.54

– Squamae darker grey, margin dark brown; facial keel broader...........*monticola* Sehgal p.57

7(5). Vibrissal angle at most 60°..................................8

\- Vibrissal angle between 70° and 90°.........................13

8(7). Gena deep, one-fourth to one-
third eye height...9

\- Gena narrower, one-tenth to one-sixth
eye height...10

9(8). Vibrissal fasciculus broad at base
incompletely fused....................*praecisa* Spencer p.59

\- Vibrissal fasciculus long and
compact.............................*stricklandi* n. sp. p.63

10(8). Large specimens, wing length
2.5 mm; aedeagus as illustrated
by Spencer (1969)......................*secunda* Spencer p.61

\- Smaller specimens, wing length
2.2 mm. or less..11

11(10). Squamal fringe brownish, last and
penultimate segments of M_{3+4} equal....*undecima* Spencer p. 66

\- Squamal fringe black...12

12(11). Facial keel broad, aedeagus as
illustrated by Spencer (1969)............*nona* Spencer p.59

\- Facial keel narrow, aedeagus as
illustrated by Spencer (1969)..........*septima* Spencer p.62

13(7). Frons conspicuously projected above
eyes in profile, gena deep approximately
one-third eye height, 3 *Ori*............*sexta* Spencer p.62

– -Frons not projected, gena narrower at most one-fifth eye height, 2 *Ori*......................14

14(13). Gena one-fifth eye height, vibrissal fasciculus with distinct curvature at end............................*labiatarum* Hering p.55

– -Gena narrower one-sixth to one-eighth eye height...15

15(14). Facial keel conspicuously raised below antennae, broader, aedeagus as in Fig. 34.........................*maura* (Meigen) p.56

– -Facial keel narrower.......................................16

16(15). Mesonotum mat greyish............*wabamunensis* Spencer p.66

– -Mesonotum shining black..................*prima* Spencer p.60

Ophiomyia banffensis Spencer

Ophiomyia banffensis Spencer 1969 : 83.

Comparison and diagnostic characters.-The members of this species resemble closely those of *O. monticola* Sehgal, but differ in having narrower facial keel, pale squamae and distinctive aedeagus. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known only from the locality of the type specimens as follows:

CANADA. Alberta : Banff (Spencer 1969).

Ophiomyia decima Spencer

Ophiomyia decima Spencer 1969 : 85

Comparison and diagnostic characters.-The members of this species resemble those in the *pulicaria* group in lacking a distinct vibrissa in male and distinct facial keel. The facial keel is only weakly developed. The main distinguishing characters are the conspicuous peristomal hairs and distinctive aedeagus. Spencer (1969) illustrated the distinctive aedeagus.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Cypress Hills (Spencer 1969).

Ophiomyia labiatarum Hering

Ophiomyia labiatarum Hering 1937 : 509; Spencer 1964c : 793, 1969 : 87.

Diagnostic characters.-The main distinguishing characters of the members of this species are dark squamal fringe, broad gena, reclinate orbital setulae and a distinct curvature in the vibrissal fasciculus. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Not confirmed in Alberta, but larvae are known to mine below the stem epidermis of various genera of the family Labiatae in Europe and United States (Spencer 1969).

Geographical distribution.-The members of this species are known in Europe, United States and Alberta, Ontario and Quebec in Canada (Spencer 1969). The Alberta localities are:

CANADA. Alberta : Edmonton, White Mud Creek Park; Elk Island Park; George Lake near Busby; Wabamun Lake near Sundance.

Two additional Alberta specimens listed below are only provisionally referred here as they are not separable externally, but the aedeagus (Fig. 33) has slight differences in the shape of the distiphallus.

CANADA. Alberta : 1 ♂ Edmonton, White Mud Creek Park, viii.1968; 1 ♂ George Lake near Busby, 7.vi.1968, coll. G. C. D. Griffiths.

Ophiomyia maura (Meigen)

Agromyza maura Meigen 1838 : 399.

Ophiomyia maura (Meigen); Hendel 1920 : 129; 1931 : 188;
Sasakawa 1961 : 358.

Comparison and diagnostic characters.-The adults of this species differ from those of similar species *O. labiatarum* Hering having narrower gena and distinct aedeagus. The aedeagus of this species (Fig. 34) resembles that of *O. asterivora* Spencer and differs only in very minor details as the central circular area and deeper concavity on dorsal side. *O. asterivora* Spencer has a different larval mine. Sasakawa (1961) illustrated this species in detail. Spencer (1964c, 1969) also discussed this species and illustrated the aedeagus.

Biology.-The larvae make long, narrow linear mines with widely spaced frass granules on *Aster* and *Solidago*, family Compositae. Sasakawa (1961) illustrated the characteristic leaf mine.

Geographical distribution.-The members of this species are Holarctic in distribution, known from Japan (Sasakawa 1961), Europe, North America and Canada (Spencer 1964c, 1969). I have examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, White Mud Creek Park, 16.vii.1966; Leaf mines on *Solidago* around Edmonton, ix.1968.

Ophiomyia monticola Sehgal

Ophiomyia monticola Sehgal 1968 : 60.

Comparison and diagnostic characters.-The members of this species differ from those of a closely related species *O. banffensis* Spencer in having darker squamae and broad facial keel. Sehgal (1968) illustrated the head, wing and male genitalia characteristic of this species. Spencer (1969) also illustrated the aedeagus.

Geographical distribution.-The members of this species are known from numerous localities from Western Canada and also from Alaska (Sehgal 1968). The Alberta localities are:

CANADA. Alberta : Banff; Cypress Hills, Elkwater; Jasper.

Ophiomyia nasuta (Melander)

Agromyza maura var. *nasuta* Melander 1913 : 260.

Agromyza youngi Malloch 1914a: 312.

Ophiomyia madizina Hendel 1920 : 130.

Tylomyza madizina (Hendel); Hendel 1931 : 185; Frick 1952: 385;
Sasakawa 1961 : 359.

Siridomyza madizina (Hendel); Enderlein 1936 : 179.

Tylomyza nasuta (Melander); Frick 1957 : 201, 1959 : 372.

Ophiomyia nasuta (Melander); Spencer 1964c : 798.

Comparison and diagnostic characters.-The members of this species differ from those of a closely related Palaearctic species *O. pinguis* (Fallén) by having three dosocentrals and absence of upper orbital bristles in male. The proclinate orbital setulae are numerous in male while there are only few in female. Frick (1959) illustrated the characteristic head and wing of this species as *Tylomyza nasuta* (Melander). Sasakawa (1961) illustrated this species as *Tylomyza madizina* (Hendel). Spencer (1964c, 1969) illustrated the aedeagus characteristic of this species.

Biology.-Not confirmed in Alberta, but larvae are known to mine the leaves of *Taraxacum officinale* Weber, family Compositae, in United States (Frick 1959).

Geographical distribution.-The members of this species are Holarctic in distribution and are known from numerous localities in Europe (Spencer 1964c), Japan (Sasakawa 1961), North America (Frick 1959) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 3 ♂♂ and 2 ♀♀ Blairmore, 26-27.vi.1966; 6 ♂♂ and 5 ♀♀ Cypress Hills, Elkwater Lake, 24.vi.1966; 2 ♂♂ Edmonton, Parliament grounds, 19.vi.1967; 1 ♂ Edmonton, Rainbow Valley, 14.vi.1968; 1 ♀ Edmonton White Mud Creek Park, 20.viii.1966, 1 ♀ same locality, 8.vi.1967, 1 ♀ same locality, 30.viii.1968 (coll. G. C. D. Griffiths); 1 ♀ Edmonton, University of Alberta Campus, 11.vi.1966; 1 ♂ Edmonton, 26.v.1946 (coll. R. M. Mason); 1 ♂ Elk Island Park, 31.vii.1966; 3 ♀♀ George Lake, near Busby, 21.vi.1966; 8 ♂♂ and 5 ♀♀ Jasper, 16-19.vi.1966.

Ophiomyia nona Spencer

Ophiomyia nona Spencer 1969 : 92.

Diagnostic characters.-The main distinguishing characters of the members of this species are acute vibrissal fasciculus, narrow gena, dark squamal fringe and broad facial keel. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Cypress Hills, Elkwater (Spencer 1969).

Ophiomyia praecisa Spencer

Ophiomyia praecisa Spencer 1969 : 92.

Comparison and diagnostic characters.-The members of this species belong to the group having acute vibrissal angle and deeper gena. They differ from those of a similar species, *O. stricklandi* n. sp., in having broad and incompletely fused vibrissal fasciculus. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from the localities of their type specimens as below:

CANADA. Alberta : Banff-Jasper Highway, 13 miles North of Banff, Cypress Hills, Elkwater.

Ophiomyia prima Spencer

Ophiomyia prima Spencer 1969 : 93.

Diagnostic characters.-The main distinguishing characters of the members of this species are the vibrissal angle of about 80°, frons not projected, narrow facial keel and shining black mesonotum. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Elk Island Park (Spencer 1969).

Ophiomyia pulicaria (Meigen)

Agromyza pulicaria Meigen 1830 : 170.

Melanagromyza pulicaria (Meigen); Hendel 1920 : 127, 1931 : 171.

Ophiomyia pulicaria (Meigen); Spencer 1964c : 802, 1969 : 93.

Comparisons and diagnostic characters.-The members of this species resemble externally those of *O. decima* Spencer and *O. pulicarioides* Sehgal, and are reliably separated only by characteristics of male genitalia. The aedeagus of an Alberta specimen has been illustrated (Fig. 35). Spencer (1969) also illustrated the aedeagus.

Biology.-Not confirmed in Alberta, but larvae are known to mine along the leaf midrib of various Compositae in Europe (Spencer 1969).

Geographical distribution.-The members of this species are widespread in Europe and are known from Alberta and British Columbia in Canada (Spencer (1969). I examined the following further material from Alberta:

CANADA. Alberta : 1 ♂ Wabamun, 1.vii.1940, coll. E. H. Strickland.

Ophiomyia pulicarioides Sehgal

Ophiomyia pulicarioides Sehgal 1968 : 61.

Comparisons and diagnostic characters.-The members of this species resemble externally those of *O. decima* Spencer and *O. pulicaria* (Meigen), and are separated reliably only by examination of the characters of the male genitalia. Sehgal (1968) illustrated the head, wing and male genitalia. Spencer (1969) also figured the aedeagus.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Cypress Hills, Elkwater (Spencer 1969).

Ophiomyia secunda Spencer

Ophiomyia secunda Spencer 1969 : 96.

Comparison and diagnostic characters.-The members of this species differ from those of a closely related species, *O. septima* Spencer, in having larger size, wing length 2.5 mm, and distinct aedeagus. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from the type locality:

CANADA. Alberta : Elk Island Park (Spencer 1969).

Ophiomyia septima Spencer

Ophiomyia septima Spencer 1969 : 96.

Diagnostic characters.-The main distinguishing characters of the members of this species are acute vibrissal angle of about 45°, narrow gena, wing length about 1.9 mm and narrow facial keel. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from Alberta and Ontario in Canada. The Alberta locality is:

CANADA. Alberta: Jasper (Spencer 1969).

Ophiomyia sexta Spencer

Ophiomyia sexta Spencer 1969 : 98.

Diagnostic characters.-The main distinguishing characters of the members of this species are vibrissal angle of about 80°, wing length about 2.3 mm in male, conspicuously projected frons and three lower orbital bristles. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from Alberta, Northwest Territory, Manitoba and Quebec in Canada (Spencer 1969). The Alberta locality is:

CANADA. Alberta : Cypress Hills (Spencer 1969).

Ophiomyia stricklandi new species

Comparison.-The members of this species differ from those of a similar species *O. praecisa* Spencer in having long and compact vibrissal fasciculus and distinct aedeagus. They may be included in Spencer's (1969) key to Canadian species of the genus *Ophiomyia* Braschnikov by extending couplet 10 as below:

10. Lower orbits conspicuously projected above eyes in profile....................................10a

- Orbits not projected...11

10a. Vibrissal fasciculus broad at base, incompletely fused; aedeagus as illustrated (Spencer 1969)..................*praecisa* Spencer

- Vibrissal fasciculus long and compact; aedeagus as in Figure 37.................*stricklandi* n. sp.

Description.-Head (Fig. 36). Frons approximately one and half times width of eye at level of front ocellus; lower orbits strongly projected in front of eye margin in profile; ocellar triangle small; facial keel broad; eyes oval, approximately 1.2 times higher than their length, bare; gena strongly projected anteriorly, approximately one-fourth eye height; vibrissal angle acute; vibrissal fasciculus strong, compact and with normal curvature; two strong *Ors* directed upwards; two *Ori* directed inwards and upwards; orbital setulae few, reclinate; third antennal article rounded at tip.

Mesonotum. Two strong postsutural *dc; acr* numerous, in six rows.

Wing. Length 1.6 mm in male; costa extended strongly to vein M_{1+2}; costal segments 2-4 in the ratio of 1 : 0.3 : 0.22; wing tip between R_{4+5} and M_{1+2}; crossvein r-m beyond the middle of discal cell; distal section of M_{3+4} approximately equal to its basal section.

Male genitalia (Figs. 37-39). Hypandrium (Fig. 39) with narrow side arms and short apodeme, darkly sclerotized; surstyli with very small spinules anteriorly; aedeagus (Fig. 37) with basiphallus elongate and more sclerotized towards its base, distiphallus elongate, well sclerotized, with conspicuous bulb below; ejaculatory apodeme (Fig. 38) broad, bulb small and darkly sclerotized.

Colour. Frons mat black; lunule, facial keel and lower orbits dark brown, mesonotum, scutellum and abdomen shining black; legs and halteres black; squamae pale, margin and fringe brown.

Derivation of the specific name.-This species is named in honour of the late Professor E. H. Strickland, Department of Entomology, University of Alberta, Edmonton, Canada.

Geographical distribution.-I examined a single male specimen from the following locality:

CANADA. Alberta : Holotype ♂ Medicine Hat, 8.viii.1939, coll. E. H. Strickland.

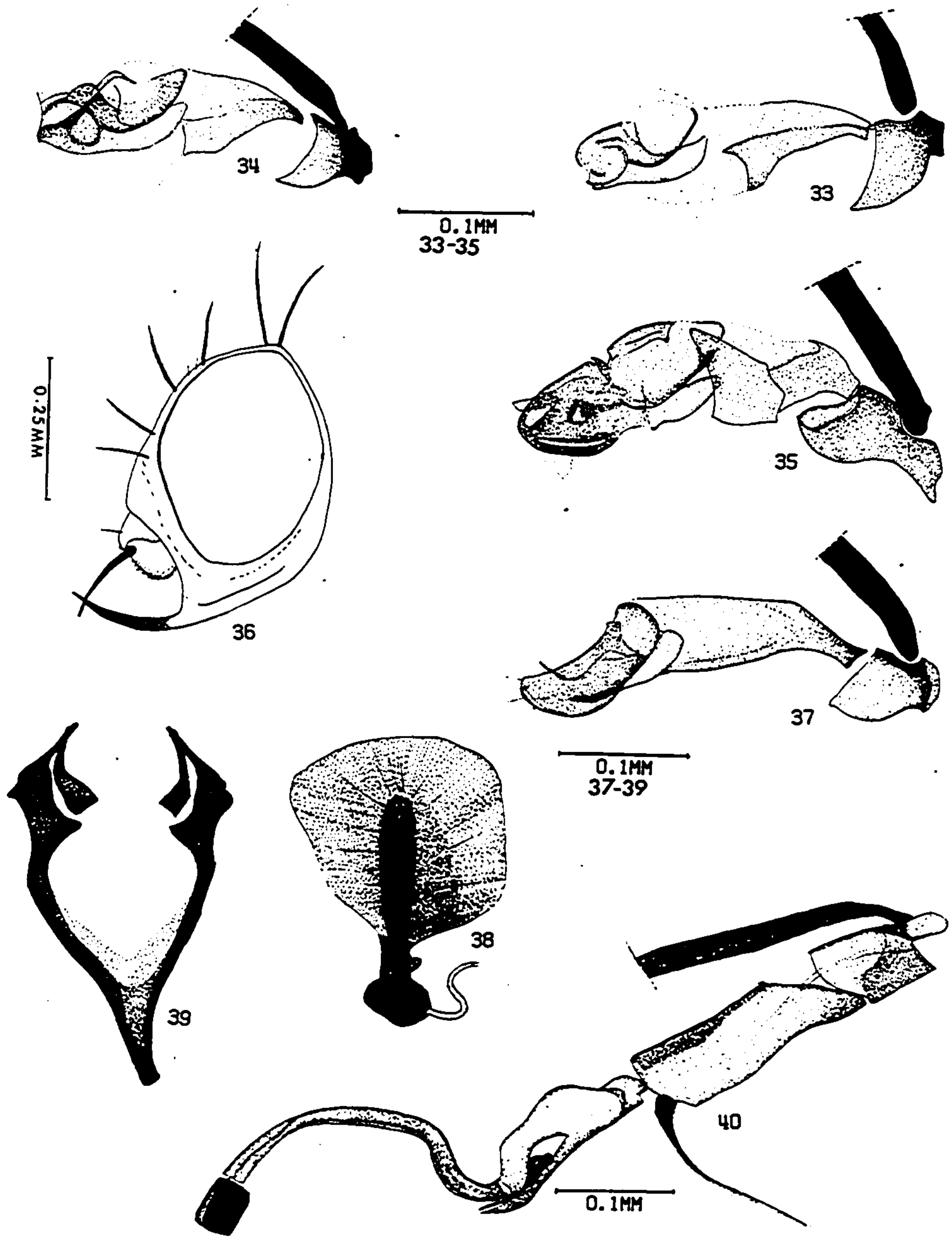


Fig. 33. *Ophiomyia labiatarum*, aedeagus, lateral view. Fig. 34. *O. maura*, aedeagus, lateral view. Fig. 35. *O. pulicaria*, aedeagus, lateral view. Figs. 36 - 39. *O. stricklandi*. 36. head, lateral view. 37. aedeagus, lateral view. 38. ejaculatory apodeme. 39. hypandrium. Fig. 40. *Cerodontha ? occidentalis*, aedeagus, lateral view.

Ophiomyia undecima Spencer

Ophiomyia undecima Spencer 1969 : 99.

Diagnostic characters.-The main distinguishing characters of the members of this species are acute vibrissal angle of about 60°, narrower gena, wing length about 2.2 mm, last and penultimate sections of M_{3+4} equal and slightly brownish squamal fringe. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from the type locality:

CANADA. Alberta : Banff, 20 miles towards Calgary (Spencer 1969).

Ophiomyia wabamunensis Spencer

Ophiomyia wabamunensis Spencer 1969 : 101.

Comparisons and diagnostic characters.-The members of this species differ from those of the similar species *O. maura* (Meigen) and *O. prima* Spencer in having mat greyish mesonotum and distinct aedeagus. Spencer (1969) illustrated the distinctive aedeagus.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Wabamun Lake (Spencer 1969).

Genus *Phytobia* Lioy

Phytobia Lioy 1864 : 1313.

Dizygomyza (Dendromyza) Hendel 1931 : 22.

Phytobia (Phytobia) Frick 1952 : 390; 1959 : 374.

Shizukoa Sasakawa 1963 : 38; Spencer 1965a : 8.

The main distinguishing characters of the members of this genus are: subcosta fold-like distally, joined to costa independent of R_1; orbital setulae erect or reclinate; costa normally extended to apex of vein M_{1+2}, if only to R_{4+5} (*P. confessa* Spencer) then notopleural areas dark, larger specimens wing length at least 3.0 mm. scutellum dark, concolourous with mesonotum; halteres with knob white or yellow; second crossvein normally present and wing tip near the apex of vein R_{4+5}.

Nowakowski (1962) on the basis of his studies on the male genitalia restricted the genus *Phytobia* Lioy to the species placed in the subgenus *Dendromyza* Hendel and in the subgenus *Phytobia* Lioy.

The larvae of various members of this genus bore inside the cambium of many trees. Of the three species known in Alberta information about biology is available of only one, *amelanchieris* (Greene).

Key to Alberta species of the genus *Phytobia* Lioy

1(0). Costa extended to apex of vein R_{4+5}..................................*confessa* Spencer p.69

-Costa extended to apex of vein M_{1+2}...2

2(1). Mesonotum with humeral and notopleural areas partly yellow; four orbital bristles, upper two reclinate....*flavohumeralis* Sehgal p.69

-Sides of thorax black; five or six orbital bristles, only one upper orbital bristle reclinate.......*amelanchieris* (Greene) p.68

Phytobia amelanchieris (Greene)

Agromyza amelanchieris Greene 1917 : 314.

Phytobia (Phytobia) amelanchieris (Greene); Frick 1952 : 390, 1959 : 375.

Diagnostic characters.-The main distinguishing characters of the members of this species are mesonotum, scutellum and pleura distinctly mat grey and five or six orbital bristles, only upper one reclinate. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Not confirmed in Alberta, but larvae are known to mine the cambium of *Amelanchier canadensis* (L.), family Rosaceae (Frick 1959).

Geographical distribution.-The members of this species are known from United States and British Columbia, Manitoba, Ontario, Quebec and Saskatchewan in Canada (Spencer 1969). I examined single male from the following locality:

CANADA. Alberta : 1 ♂ Edmonton, White Mud Creek Park, 6.v.1969.

Phytobia confessa Spencer

Phytobia confessa Spencer 1969 : 105.

Diagnostic characters.-The main distinguishing characters of the members of this species are costa extended to apex of vein R_{4+5}; conspicuously projected frons; shining black gena and orbits; gena deep, about one-third to one-fifth eye height and wing length about 3.3 mm in male. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from Alberta, Manitoba and Saskatchewan in Canada (Spencer 1969). The Alberta localities are as below:

CANADA. Alberta : Jumping Pond Creek, 20 miles west of Calgary; Medicine Hat.

Phytobia flavohumeralis Sehgal

Phytobia flavohumeralis Sehgal 1968 : 62.

Diagnostic characters.-The main distinguishing characters of the members of this species are yellow ring around humeral areas on mesonotum; mat greyish black mesonotum and four orbital bristles, two upper orbital bristles reclinate. Sehgal (1968) illustrated the head, wing and male genitalia characteristic of this species. Spencer (1969) also figured the aedeagus.

Geographical distribution.-The members of this species are known from Alberta, British Columbia, Manitoba, Ontario and Saskatchewan in Canada. I examined the following additional material from Alberta:

CANADA. Alberta : 2 ♂♂ George Lake, near Busby, University of Alberta, Department of Entomology, 22.v.1968, coll. G. C. D. Griffiths; 1 ♂ same locality, 22.v.1968.

Genus *Cerodontha* Rondani

Cerodontha Rondani 1861 : 10; Hendel 1932 : 265; Frick 1952 : 397; 1959 : 395; Nowakowski 1962 : 100; 1967 : 633-661.

This genus was previously restricted to a small group of species having two scutellar bristles and a conspicuous spine on the third antennal segment anterodorsally. Nowakowski (1962) on the basis of his studies of the genitalia discovered marked similarities between the genus *Cerodontha* Rondani *sensu stricto* and Hendel's subgenera *Dizygomyza*, *Poemyza* and *Icteromyza*. He proposed the enlarged concept for the genus *Cerodontha* Rondani and included above-mentioned subgenera. Spencer (1963, 1969) and other workers in the family Agromyzidae accepted this concept. Nowakowski (1967) in his recent revision of the genus *Cerodontha* Rondani proposed two new subgenera: *Butomomyza* and *Crastemyza*. The characters used to define these subgenera overlap with those in the subgenus *Dizygomyza* Hendel. Spencer (1969) included the species belonging to these subgenera in the subgenus *Dizygomyza* Hendel. The Albertan species falling in Nowakowski's subgenus *Butomomyza* are *angulata* (Loew), *eucaricis* Nowakowski, *gibbardi* Spencer, *scirpi* (Karl) and in the subgenus *Crastemyza*, *frankensis* Spencer. The above-mentioned species are included here in the subgenus *Dizygomyza* Hendel, pending further clarification of Nowakowski's subgenera *Butomomyza* and *Crastemyza*.

The members of this genus feed exclusively on monocotyledons: Gramineae, Cyperaceae, Juncaceae and Iridaceae.

The main distinguishing characters of this genus are: subcosta joined to costa independent of R_1; costa normally extended to apex of vein M_{1+2}, if only to R_{4+5} then lunule broad and higher than semicircle (*Cerodontha (Dizygomyza) frankensis* Spencer); vein M_{1+2} usually near wing tip; crossvein m-m normally present; halteres with knob white or yellow; scutellum dark and concolourous with mesonotum. Either third antennal article with conspicuous spine anterodorsally and scutellum with only two bristles (subgenus *Cerodontha* Rondani); or frons normally yellow and prescutellars absent (subgenus *Icteromyza* Hendel); or lunule broad, in the form of semicircle or slightly higher, but still broad, prescutellars usually present, antennal bases widely separated, third antennal segment normally greatly enlarged in male (subgenus *Dizygomyza* Hendel); or lunule substantially higher than semicircle, but conspicuously narrow (subgenus *Poemyza* Hendel).

This genus is represented in Alberta by 16 species, two in the subgenus *Cerodontha* Rondani, 7 in the subgenus *Dizygomyza* Hendel, 5 in the subgenus *Poemyza* Hendel and 2 in the subgenus *Icteromyza* Hendel.

Key to Alberta species of the genus *Cerodontha* Rondani

1(0). Third antennal article with conspicuous spine anterodorsally (subgenus *Cerodontha* Rondani)..2

\- Third antennal article without such spine..3

2(1). Scutellum and adjoining mesonotum with variable yellow spot; aedeagus with distiphallus comparatively short, but with elongated apical bulbs (Fig. 18c, Sehgal 1968)................*dorsalis* (Loew) p.86

\- Scutellum and adjoining mesonotum mat black; aedeagus with long distiphallus, but with short apical bulbs (Fig. 18a, Sehgal 1968)...........*occidentalis* Sehgal p.87

3(1). Lunule broad, in form of semicircle, or slightly higher but still broad.........................4

\- Lunule conspicuously higher than semicircle (subgenus *Poemyza* Hendel).....................11

4(3). Frons normally yellow; prescutellars absent (subgenus *Icteromyza* Hendel)......................15

\- Frons normally dark; prescutellars usually present (subgenus *Dizygomyza* Hendel)...5

5(4). Lunule broad, in form of semicircle; third antennal article in male enlarged....................6

\- Lunule broad, but conspicuously higher....................7

6(5). All femora distally yellow; frons not projected; smaller specimens, wing length about 2.2 mm....................*ultima* Spencer p. 79

\- Only fore femora yellow distally; frons at most slightly projected; orbits and lunule yellowish.....*chaixiana* (Groschke) p. 76

7(5). Costa extended to apex of vein
R_{4+5} ....*frankensis* Spencer p. 77

– Costa extended to apex of vein
M_{1+2} 8

8(7). Frons conspicuously projected
above eyes..........................*gibbardi* Spencer p.78

– Frons not projected...9

9(8). Squamal fringe dark; lower *Ors*
incurved...............................*scirpi* (Karl) p.78

– Squamal fringe normally yellow; *Ors*
parallel or lower one directed
slightly outwards...10

10(9). *Ors* parallel; wing length 2.4-3.0 mm;
aedeagus with distiphallus short and
less sinuate.........................*angulata* (Loew) p.76

– Lower *Ors* directed slightly outwards;
wing length 3.0-3.2 mm; aedeagus with
distiphallus long and more
sinuate........................*eucaricis* Nowakowski p.77

11(3). Orbits or frons yellow...................................12

Orbits and frons dark.....................................14

12(11). Femora yellow only distally;
notopleural area yellow..........*lateralis* (Macquart) p.83

– Femora yellow, at least in apical one-
third; notopleural areas dark...........................13

13(12). Aedeagus short and rotated...........*muscina* (Meigen) p. 83

- Aedeagus with long and thread-like distiphallus...............*calamagrostidis* Nowakowski p. 80

14(11). All femora yellow distally.......*inconspicua* (Malloch) p. 82

- Only fore femora yellow distally.......*incisa* (Meigen) p. 80

15(4). Palps black; larger specimens, wing length up to 3.5 mm........*capitata* (Zetterstedt) p. 85

- Palps yellow.......................*longipennis* (Loew) p. 85

Subgenus *Dizygomyza* Hendel

Dizygomyza Hendel 1920 : 130.

Phytobia (Dizygomyza) Frick 1952 : 396, 1959 : 383.

Cerodontha (Dizygomyza) Nowakowski 1962 : 102, 1967 :638.

This subgenus is represented in Alberta by 7 known species. Biology of various species have not been confirmed in Alberta, but some information about host-plants is known for 5 Albertan species.

Cerodontha (Dizygomyza) angulata (Loew)

Agromyza angulata Loew 1869 : 47.

Phytobia (Poemyza) angulata (Loew), Frick 1957 : 202, 1959 : 380.

Cerodontha (Butomomyza) semiposticata (Hendel), Nowakowski 1967 : 634.

Cerodontha (Dizygomyza) angulata (Loew), Spencer 1969 : 113.

Comparison and diagnostic characters.-The members of this species differ from those of a closely related species *eucaricis* Nowakowski in having upper orbital bristles parallel and short and less sinuate distiphallus. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae are known to mine the leaves of *Carex* spp., family Cyperaceae, in Europe. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are known from Europe, United States and Alberta and Ontario in Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Vègreville, 22.vi.1968.

Cerodontha (Dizygomyza) chaixiana (Groschke)

Phytobia (Dizygomyza) chaixiana Groschke, Hering 1956 : 264.
Phytobia (Dizygomyza) chaixiana Groschke 1957 : 116
Cerodontha (Dizygomyza) chaixiana (Hering), Nowakowski 1967 : 643.
Cerodontha (Dizygomyza) chaixiana (Groschke), Spencer 1969 : 115.

Diagnostic characters.-The main distinguishing characters of the members of this species are the enlarged third antennal articles, yellowish orbits and lunule and distally yellow fore femora. Spencer (1969) illustrated the aedeagus characteristic of this species. The distiphallus has characteristic swelling distally.

Biology.-The members of this species are know to mine the leaves of *Poa* sp., family Gramineae, in Europe. Hering (1956) described the larval morphology.

Geographical distribution.-The members of this species are known from Europe, and Alberta and Ontario in Canada. I examined the following additional material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, 20.viii.1936, coll. E. H. Strickland; 1 ♂ Edmonton, White Mud Creek Park, 6.vi.1966; 3 ♂♂ same locality, 28.v.-19.vi.1967; 1 ♂ same locality, 10.vi.1968, coll. G. C. D. Griffiths; 1 ♂ same locality, 7.v.1969.

Cerodontha (Dizygomyza) eucaricis Nowakowski

Cerodontha (Butomomyza) eucaricis Nowakowski 1967 : 636.

Cerodontha (Dizygomyza) eucaricis (Nowakowski), Spencer 1969 : 116.

Diagnostic characters.-The main distinguishing characters of the members of this species are the larger size, wing length about 3.0 mm; prescutellars present, yellow squamal fringe and lower *Ors* directed slightly outwards. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-The members of this species are known to mine the leaves of *Carex* sp., family Cyperaceae, in Europe.

Geographical distribution.-The members of this species are known from Europe, Alaska, and Alberta, Manitoba and Ontario in Canada (Spencer 1969). The known Alberta locality is as follows:

CANADA. Alberta : Banff (Spencer 1969).

Cerodontha (Dizygomyza) frankensis Spencer

Cerodontha (Dizygomyza) frankensis Spencer 1969 : 119.

Comparison and diagnostic characters.-The members of this species are distinctive in having costa extended to apex of vein R_{4+5}. They resemble externally those of *C. (Dizygomyza) flavocingulata* (Strobl), but differ in having darker squamal fringe. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from Alberta, British Columbia and Yukon Territories in Canada. I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ (Paratype) Banff, 28.vi.1966, coll. V. K. Sehgal.

Cerodontha (Dizygomyza) gibbardi Spencer

Cerodontha (Dizygomyza) gibbardi Spencer 1969 : 119.

Diagnostic characters.-The main distinguishing characters of the members of this species are broad, but distinctly higher lunule and conspicuously projected frons. Spencer (1969) illustrated the aedeagus and head characteristic of this species.

Geographical distribution.-The members of this species are known from Alberta, British Columbia, Manitoba and Saskatchewan in Canada. The known Alberta locality is as follows:

CANADA. Alberta : Onefour (Spencer 1969).

Cerodontha (Dizygomyza) scirpi (Karl)

Dizygomyza scirpi Karl 1926 : 137.

Cerodontha (Butomomyza) scirpi (Karl), Nowakowski 1967 : 638.

Cerodontha (Dizygomyza) scirpi (Karl), Spencer 1969 : 123

Diagnostic characters.-The members of this species are distinctive in having incurved lower *Ors*, and slightly darker squamal fringe. Spencer (1969) illustrated the aedeagus characteristic of this species. There is no membranous gap between meso- and distiphallus.

Biology.-Larvae mine the leaves of *Scirpus* spp., family Cyperaceae, in Europe. Pupation occurs towards the base of the leaf sheath. Similar mines seen around Edmonton probably were made by members of this species.

Geographical distribution.-The members of this species are known from Europe, and British Columbia and Quebec in Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂ Edmonton, Rainbow Valley, 14.vi.1968; 3 ♂♂ Edmonton, White Mud Creek Park, 10.vi.1968.

Cerodontha (Dizygomyza) ultima Spencer

Cerodontha (Dizygomyza) ultima Spencer 1969 : 125.

Diagnostic characters.-The members of this species are distinctive in having enlarged third antennal article and all femora distally yellow. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae mine the leaves of family Cyperaceae, *Scirpus* or *Carex* sp. (Spencer 1969).

Geographical distribution.-The members of this species are known from Ontario, Canada. I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂ Edmonton, White Mud Creek Park, 8.vi.1967 and 11.v.1969; 1 ♂ Glynde, 30.iv.1946, E. H. Strickland.

Subgenus *Poemyza* Hendel

Dizygomyza (Poemya) Hendel 1931 : 35.

Phytobia (Poemyza), Frick 1952 : 391, 1959 : 379.

Cerodontha (Poemyza), Nowakowski 1962 : 102, 1967 : 645.

This subgenus is represented in Alberta by five species.

Cerodontha (Poemyza) calamagrostidis Nowakowski

Cerodontha (Poemyza) calamagrostidis Nowakowski 1967 : 648.

Comparison and diagnostic characters.-The members of this species can only be reliably separated from those of *C. (Poemyza) muscina* (Meigen) by examination of the characters of male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae mine the leaves of *Calamagrostis* spp., family Gramineae, in Europe.

Geographical distribution.-The members of this species are known from Europe, and Alberta in Canada. I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, White Mud Creek Park, 23.vi.1966.

Cerodontha (Poemyza) incisa (Meigen)

Agromyza incisa Meigen 1830 : 182.

Dizygomyza (Poemyza) incisa (Meigen), Hendel 1931 : 38.

Phytobia (Poemyza) incisa (Meigen), Frick 1959 : 381.

Cerodontha (Poemyza) incisa (Meigen), Nowakowski 1967 : 651.

Comparison and diagnostic characters.-The members of this species differ from those of *C. (Poemyza) inconspicua* (Malloch) in having slightly higher lunule and only fore-femora distally yellow. The distiphallus is long and narrow with apical bulb. Spencer (1969) illustrated the aedeagus.

Biology.-Larvae mine the leaves of plants belonging to various genera in the family Gramineae. The known genera from Canada are *Agropyron, Phalaris, Phleum* and *Zizania*. Several larvae mine and pupate together inside the leaf.

Geographical distribution.-The members of this species are Holarctic in distribution, being known from Europe, Asia, United States and Canada. I examined the following material from Alberta:

CANADA. Alberta : 1 ♂, 1 ♀ Edmonton, 114 Street, 76 Avenue, from leaf mines on *Agropyron repens* (L.) Beauv., coll. 21.vii.1966, emerged 19-24.ii.1967; 1 ♂ Edmonton, River Bed near University of Alberta Campus, from leaf mines on grass, coll. 26.vi.1966, emerged 5.viii.1966; 2 ♂♂, 2 ♀♀ same locality, from leaf mines on grass, coll. 22.vi.1968, emerged 4.vii.1968; 1 ♂ Edmonton, University of Alberta Campus, from leaf mines on *Phalaris arundinacea* L., coll. 24.ix.1966, emerged 15.i.1967; 3 ♀♀ same locality and host, coll. 10.x.1966, emerged 11.iii.1967; 1 ♀ same locality and host, coll. 24.ix.1966, emerged 11.iii.1967; 1 ♀ Elk Island Park, 7.vi.1966.

Cerodontha (Poemyza) inconspicua (Malloch)

Agromyza inconspicua Malloch 1913a : 310.

Phytobia (Poemyza) inconspicua (Malloch), Frick 1959 : 381.

Cerodontha (Poemyza) inconspicua (Malloch), Spencer 1969 : 129.

Diagnostic characters.-The members of this species are distinctive in having all femora yellow on distal tips, both sections of M_{3+4} almost equal and dark frons and orbits. Spencer (1969) illustrated the distinctive aedeagus. The distal tips of distiphallus are slightly dilated at apex.

Biology.-Larvae mine the leaves of *Agropyron*, family Gramineae.

Geographical distribution.-The members of this species are known from United States and Canada. I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂, 3 ♀♀ Banff, 28.vi.1966; 2 ♂♂, 3 ♀♀ Blairmore, 26.vi.1966; 3 ♂♂, 6 ♀♀ Edmonton, White Mud Creek Park, 6-29.vi.1966; 1 ♂ same locality, 16.vii.1966; 2 ♂♂ same locality, viii.1968 and 31.v.1969; 2 ♂♂, 2 ♀♀ same locality, 10-18.vi.1968, coll. G. C. D. Griffiths; 1 ♂, 3 ♀♀ Elk Island Park, 31.vii.1966; 1 ♂ same locality, 2.viii.1966; 3 ♂♂, 2 ♀♀ George Lake near Busby, 21.vi.1966; 1 ♀ same locality, 5.vii.1966; 1 ♀ same locality, 7.vi.1968, coll. G. C. D. Griffiths; 3 ♂♂, 4 ♀♀ Jasper, 16-19.vi.1966; 1 ♂ St. Albert, 14.vi.1966; 2 ♂♂ same locality, 18.vi.1967; 1 ♂, 4 ♀♀ Vegreville, 22.vi.1968; 2 ♀♀ Vermilion, 22.vi.1968.

Cerodontha (Poemyza) lateralis (Macquart)

Agromyza lateralis Macquart 1835 : 609

Dizygomyza (Poemyza) lateralis (Macquart), Hendel 1931 : 40

Phytobia (Poemyza) lateralis (Macquart), Frick 1953 : 70; 1959 : 381.

Cerodontha (Dizygomyza) lateralis (Macquart), Nowakowski 1967 : 650.

Cerodontha (Poemyza) lateralis (Macquart), Spencer 1969 : 131.

Diagnostic characters.-The members of this species are distinctive in having yellowish frons, orbits and notopleural areas. All femora are also yellow on distal tips.

Biology.-Larvae mine the leaves of various Gramineae. Known host genera are *Agropyron, Avena, Elymus, Hordeum, Triticum* and *Zea*.

Geographical distribution.-The members of this species are Holarctic in distribution, being known from United States, Europe, Japan, Canada and Alaska. I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, White Mud Creek Park, 23.v.1967; 1 ♀ Edmonton, 114 Street, 76 Avenue, from leaf mine on *Triticum aestivum* L., coll. 13.viii.1966, emerged 23.viii.1966.

Cerodontha (Poemyza) muscina (Meigen)

Agromyza muscina Meigen 1830 : 177

Dizygomyza (Poemyza) muscina (Meigen), Hendel 1931 : 44.

Phytobia (Poemyza) muscina (Meigen), Frick 1959 : 382.

Cerodontha (Poemyza) muscina (Meigen), Nowakowski 1967 : 649.

Comparison and diagnostic characters.- The members of this species differ from those of a closely related species, *C. (Poemyza) calamagrostidis* Nowakowski, only in having short and twisted distiphallus. Spencer (1969) illustrated the distinctive aedeagus.

Biology.-Larvae mine leaves of many Gramineae. Known host genera in North America are *Agropyron*, *Ehrharta* and *Hordeum*.

Geographical distribution.-The members of this species are known from Europe, United States and Canada. I examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Edmonton, Parliament Hill, 19.vi.1967; 1 ♀ Edmonton, Rainbow Valley, 14.vi.1968; 4 ♀♀ Edmonton, White Mud Creek Park, 6-23.vi.1966; 1 ♂, 1 ♀ same locality, 16.vii.1966; 1 ♀ same locality, 16.viii.1966; 1 ♂ same locality, from leaf mine on grass, coll. 7.viii.1966, emerged 5.iii.1967; 1 ♂, 3 ♀♀ same locality, 28.vi.1967; 1 ♂ same locality, 8.vi.1967; 1 ♂ same locality, 10.vi.1968, coll. G. C. D. Griffiths, 2 ♂♂ Elk Island Park, 31.vii.1966; 1 ♀ same locality, 4.vi.1967; 1 ♀ George Lake near Busby, 7.vi.1968, coll. G. C. D. Griffiths; 1 ♀ Red Deer, 28.vi.1966; 1 ♂ Vègreville, 22.vi.1968.

Subgenus *Icteromyza* Hendel

Dizygomyza (Icteromyza) Hendel 1931 : 51.

Phytobia (Icteromyza), Frick 1952 : 392, 1959 : 385.

Cerodontha (Icteromyza), Nowakowski 1962 : 102, 1967 : 654.

This subgenus is represented in Alberta by only two species discussed below.

Cerodontha (Icteromyza) capitata (Zetterstedt)

Agromyza capitata Zetterstedt 1848 : 2750.

Dizygomyza (Icteromyza) capitata (Zetterstedt), Hendel 1931 : 52.

Phytobia (Icteromyza) capitata (Zetterstedt), Frick 1959 : 386.

Cerodontha (Icteromyza) capitata (Zetterstedt), Nowakowski 1967 : 654.

Diagnostic characters.- The members of this species are distinctive in having larger size, wing length 2.5-3.5 mm and black palps. Spencer (1969) illustrated the distinctive aedeagus.

Biology.-Larvae feed inside the stems of *Juncus* spp., family Juncaceae (Spencer 1969).

Geographical distribution.-The members of this species are known from Europe, United States, Alaska and Canada. Known Alberta localities are:

CANADA. Alberta : Banff, Jasper, Mount Eisenhower, near Banff, Nordegg (Spencer 1969).

Cerodontha (Icteromyza) longipennis (Loew)

Agromyza longipennis Loew 1869 : 48; Shewell 1953 : 466.

Phytobia (Icteromyza) longipennis (Loew), Frick 1959 : 386.

Cerodontha (Icteromya) longipennis (Loew), Spencer 1969 : 140.

Diagnostic characters.-The members of this species are distinctive in having yellow palpi, yellow femora distally and bare eyes. Spencer

(1969) illustrated the distinctive aedeagus.

Biology.-Larvae mine the leaves of *Juncus* spp., family Juncaceae in United States.

Geographical distribution.-The members of this species are known from United States and Canada. The Alberta locality is:

CANADA. Alberta : Lethbridge (Spencer 1969).

Subgenus *Cerodontha* Rondani

Cerodontha Rondani 1861 : 10.

Cerodontha (Cerodontha), Nowakowski 1962 : 100; 1967 : 656.

This subgenus is represented in Alberta by two species, *dorsalis* (Loew) and *occidentalis* Sehgal. Sehgal (1968) and Spencer (1969) discussed the male genitalia differences between these two species.

Cerodontha (Cerodontha) dorsalis (Loew)

Odontocera dorsalis Loew 1863 : 54.

Cerodontha dorsalis (Loew), Melander 1913 : 249; Frick 1959 : 396.

Cerodontha (Cerodontha) dorsalis (Loew), Spencer 1969 : 143.

Comparison and diagnostic characters.-The main distinguishing characters of the members of this species are scutellum and adjoining mesonotum with variable yellow spot and slightly smaller size. The aedeagus (Fig. 18c, Sehgal 1968) is two-third, the size of that of a closely related species *occidentalis* Sehgal, and have distinctly elongated apical bulbs.

Biology.-Larvae mine the leaf sheaths of grasses (Gramineae).

Geographical distribution.-The members of this species are known from Mongolia, South America, United States and Canada. Material examined is as follows:

CANADA. Alberta : 1 ♂ Banff, 3.ix.1966; 2 ♂♂ Blairmore, 4.ix.1966; 1 ♂ Crowsnest, 5.ix.1966; 1 ♀ Medicine Hat, 16.vi.1928, coll. F. S. Carr. British Columbia : 1 ♂ Chilliwack, 14.x.1938, coll. J. K. Jacob; 1 ♂ Crowsnest, 26.ii.1926, coll. A. A. Dennys; 1 ♂ Shuswap Lake, 22.vii.1926, coll. J. M. Dunnough; Manitoba : 1 ♂ Aweme, 27.viii.1917, coll. N. Criddle.

UNITED STATES. Indiana : 1 ♂ Lafayette, date ?, coll. J. M. Aldrich.

Cerodontha (Cerodontha) occidentalis Sehgal

Cerodontha (Cerodontha) occidentalis Sehgal 1968 : 64; Spencer 1969 : 144.

Comparison and diagnostic characters.-The members of this species can be reliably separated from those of a similar species, *dorsalis* (Loew), only by examination of the characters of male genitalia. The aedeagus (Fig. 18a Sehgal 1968) is about one and a half times as long as in *dorsalis* (Loew). The apical bulbs on distiphallus are relatively short.

Three males collected from Banff, Alberta on June 28, 1966, are only tentatively referred here, as these most likely represent a further species. They are not separable externally from those of *occidentalis*, but the aedeagus (Fig. 40) shows conspicuous differences in the shape of mesophallus. Since these specimens are collected from the same locality as for *occidentalis*, I prefer not to treat them as distinct species, until the range of variation in the aedeagus is more clearly defined for *occidentalis*.

Biology.-Larvae probably mine the leaves of Gramineae.

Geographical distribution.-The members of this species are known from United States, Alaska and Canada. Known Alberta localities (Sehgal 1968) are as below:

CANADA. Alberta : Canmore near Banff; Blairmore (Sehgal 1968).

Genus *Calycomyza* Hendel

Dizygomyza (Calycomyza) Hendel 1931 : 65.

Phytobia (Calycomyza), Frick 1952 : 394, 1956 : 284, 1959 : 387.

Calycomyza Hendel, Nowakowski 1962 : 97; Spencer 1969 : 144.

The main distinguishing characters of this genus are subcosta joined to costa independent of R_1; costa extended to apex of vein M_{1+2}; vein M_{1+2} near wing tip; crossvein m-m present, halteres with knob white or yellow; scutellum dark and concolorous with mesonotum; lunule and antennae normal; orbital setulae erect or reclinate; orbits in same plane as frons; frons yellow; notopleural areas yellow; presutural dorsocentral absent and mid-tibia sometimes with lateral bristle.

The members of this genus are difficult to separate, because of variations in colour characters. Recent studies by Spencer (1969) have indicated constant differences in male genitalia.

This genus is so far represented in Alberta by two species, *menthae* Spencer and *sonchi* Spencer. I am aware of two further species: one mines the leaves of *Solidago* and the other of *Artemisia*. These probably represent *solidaginis* (Kaltenbach) and *artemisiae* (Kaltenbach) respectively, but this would need confirmation by examination of male genitalia.

Key to Alberta species of the genus *Calycomyza* Hendel.

1. Orbits shining black....................*sonchi* Spencer p.91

- Orbits paler at least in lower regions..............................*menthae* Spencer p.90

Calycomyza menthae Spencer

Calycomyza menthae Spencer 1969 : 152.

Comparison and diagnostic characters.-The members of this species resemble closely those of *althaeae* Spencer and *cynoglossi* Frick and can be reliably separated only by examination of characters of male genitalia. Spencer (1969) illustrated the distinctive aedeagus. The colour of squamal fringe is from pale to dark brown.

Biology.-Larvae make brownish blotch mines on the leaves of *Mentha* and *Monarda*, family Labiatae.

Geographical distribution.-The members of this species are known from Ontario and Alberta. I examined the following material from Alberta:

CANADA. Alberta : 1 ♂, 1 ♀ Edmonton, Fort Road, from leaf mines on *Mentha arvensis* L., coll. 9.viii.1969, emerged 22-25.viii. 1969; 1 ♂ Edmonton, Mayfair Park, 17.v.1969.

Calycomyza sonchi Spencer

Calycomyza sonchi Spencer 1969 : 155.

Diagnostic characters.-The members of this species are distinctive in having shining black orbits and pale squamal fringe. Spencer (1969) illustrated the distinctive aedeagus.

Biology.-Larvae mine the leaves of *Sonchus* and *Taraxacum*, family Compositae.

Geographical distribution.-The members of this species are known from Alberta and Manitoba in Canada. Known Alberta localities are as below:

CANADA. Alberta : Edmonton, University of Alberta Campus, Red Deer.

Genus *Amauromyza* Hendel

Dizygomyza (Amauromyza), Hendel 1931 : 59.

Phytobia (Amauromyza), Frick 1952 : 393, 1959 : 377.

Amauromyza Hendel, Nowakowski 1962 : 97.

Dizygomyza (Cephalomyza) Hendel: Spencer 1969 : 157.

The main distinguishing characters of the members of this genus are subcosta joined to costa independent of R_1; costa extended to apex of vein M_{1+2}; orbital setulae reclinate; mesonotum and scutellum black; halteres with knob black or partially paler or whitish, if yellow, aedeagus with numerous spinules on distiphallus.

This genus is represented in Alberta by two new species, *riparia* and *shepherdiae*, described below. Three species known from eastern Canada (Spencer 1969) have not been discovered from the west.

Key to Alberta species of the genus *Amauromyza* Hendel.

1. Two lower orbital bristles; gena approximately one-third eye height; aedeagus as in Figures 43, 44.......*shepherdiae* n. sp. p.94

-Three lower orbital bristles; gena approximately one-fourth eye height; aedeagus as in Figure 41...............*riparia* n. sp. p.93

Amauromyza riparia new species

Comparison and diagnostic characters.-The members of this species differ from those of a similar species *subinfumata* (Malloch) in having smaller size and distinct male genitalia. They may be included in Spencer's (1969) key to Canadian species of the genus *Amauromyza* Hendel as shown below at the beginning of the description of *shepherdiae* n. sp.

Description.-Head. Frons approximately twice width of eye at level of front ocellus, not projected in front of eye margin in profile. Three strong *Ori* directed inwards and upwards, two *Ors* directed upwards; orbital setulae few, approximately 8, reclinate. Eyes oval, 1.1 times higher than their length. Gena approximately one-fourth eye height. Vibrissa normal. Third antennal article rounded at tip; arista short, thickened at base.

Mesonotum. Three strong *dc; acr* in about 5 irregular rows.

Wing. Length 1.5 to 1.6 mm in ♂♂; costa extended to apex of vein M_{1+2}; costal segments 2-4 in the ratio of 1.0 ; 0.3 : 0.2; crossvein m-m present; last section of M_{3+4} approximately twice length of penultimate.

Male genitalia. Hypandrium without apodeme, postgonites elongate; aedeagus and ejaculatory apodeme as illustrated (Figs. 41,42). Ejaculatory bulb large.

Colour. Frons, gena and face dark brown; orbits and ocellar triangle weakly shining black. Mesonotum, scutellum and pleura mat black, squamae grey, fringe black; halteres with stalk black, and knob distinctly whitish or paler.

Derivation of the specific name.-The members of this species are named *riparia* as the type specimens were caught along the river bank in Edmonton.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Holotype ♂ Edmonton, River Bed near University of Alberta Campus, 18.v.1969; Paratypes 4 ♂♂ same locality, 18-24.v.1969; 1 ♂ Edmonton, White Mud Creek Park, along river bed, 23.v.1967.

Amauromyza shepherdiae new species

Comparisons.-The members of this species differ from those of *riparia* n. sp. in having only two lower orbital bristles and distinct male genitalia. This species and *riparia* n. sp. are distinguished in Spencer's (1969) key to Canadian species of the genus *Amauromyza* Hendel, by extending his key as shown below:

2. Halteres entirely black; larger specimens; wing length 2.2 to 3.2mm................*abnormalis* (Malloch)

\- Halteres with stalk black, knob whitish or yellowish grey; smaller specimens......................3

3. Three lower orbital bristles..............................4

\- Two lower orbital bristles; larvae leaf miner on *Shepherdia*..................*shepherdiae* n. sp.

4. Larger specimens, wing length 1.9-2.2 mm............................*subinfumata* (Malloch)

- Smaller specimens, wing length 1.5-1.6 mm in male...........................*riparia* n. sp.

Description.-Head. Frons almost equal to width of eye at level of front ocellus, not projected in front of eye margin in profile. Two strong *Ors* directed upwards, two *Ori* directed inwards and upwards; orbital setulae few, approximately 9-10 reclinate hairs. Eyes oval, approximately 1.1 times higher than their length. Gena deep, approximately one-third eye height. Vibrissa normal. Third antennal article rounded at tip, arista conspicuously thickened at base, bare.

Mesonotum. Three strong *dc; acr* in 5-6 irregular rows.

Wing. Length in male 1.5 mm; costa extended to apex of vein M_{1+2}; costal segments 2-4 in the ratio of 1.0 : 0.3 : 0.3; crossvein m-m present; last section of M_{3+4} approximately twice penultimate.

Male genitalia. Hypandrium without distinct apodeme; postgonites elongate; aedeagus as illustrated (Figs. 43,44); ejaculatory apodeme (Fig. 45) with large bulb.

Colour. Frons. gena and face dark brown; orbits and ocellar triangle weakly shining black; mesonotum, scutellum and pleura mat black, weakly shining; antennae black; squamae grey, fringe dark brown; legs black; haltere with stalk black, knob whitish.

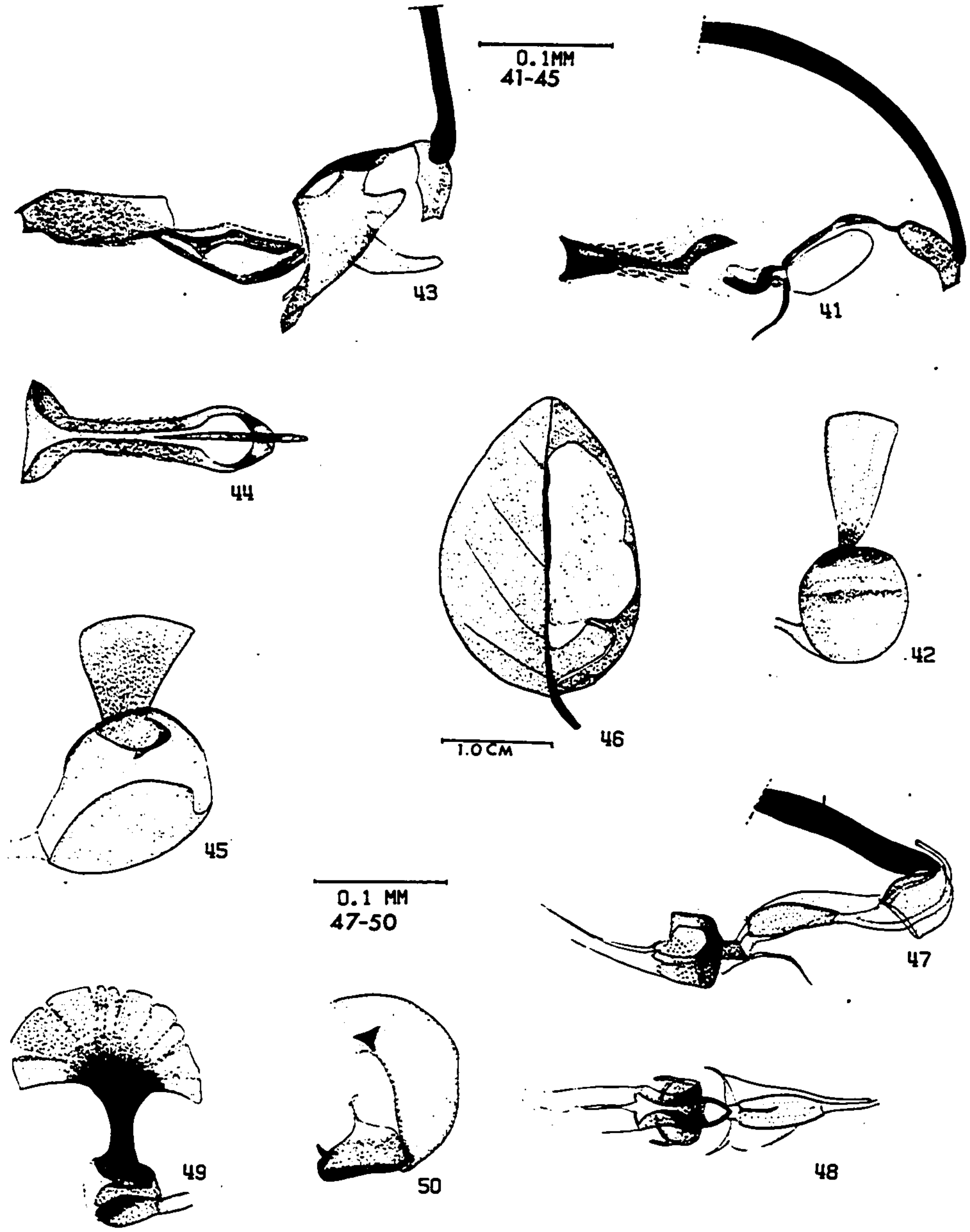
Derivation of the specific name.-The members of this species are named after the generic name of their food plant *Shepherdia.*

Biology.-Larvae make blotch mines (Fig. 46) on the leaves of

Shepherdia canadensis (L.) Nutt., family Elaeagnaceae. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are known from the type locality:

CANADA. Alberta : Holotype ♂ Edmonton, University of Alberta Campus, from leaf mines on *Shepherdia canadensis* (L.) Nutt., coll. 5.vii.1968, emerged 25.v.1969. Numerous leaf mines, same data.



Figs. 41 - 42. *Amauromyza riparia*. 41. aedeagus, lateral view. 42. ejaculatory apodeme. Figs. 43 - 46. *A. shepherdiae*. 43. aedeagus, lateral view. 44. distiphallus, ventral view. 45. ejaculatory apodeme. 46. leaf mine on *Shepherdia canadensis* (L.) Nutt. Figs. 47 - 50. *Liriomyza balcanicoides*. 47. aedeagus, lateral view. 48. aedeagus, ventral view. 49. ejaculatory apodeme. 50. surstylus.

Genus *Nemorimyza* Frey

Nemorimyza Frey 1946 : 42.

Nemorimyza Frey was erected as a monotypic subgenus of a large genus *Dizygomyza* Hendel *sensu lato*. Frick (1952) synonymized *Dizygomyza* Hendel with *Phytobia* Lioy *sensu lato*. Later (1953, 1959) he treated *Nemorimyza* Frey as a subgenus of *Phytobia* Lioy. Nowakowski (1962) in view of differences in the structure of male genitalia and larval biology restricted *Phytobia* Lioy to cambium miners and raised *Nemorimyza* Frey to full generic rank.

Nemorimyza posticata (Meigen)

Agromyza posticata Meigen 1830 : 172; Frost 1924 : 50.
Dizygomyza (Dendromyza) posticata (Meigen); Hendel 1931 : 30.
Dizygomyza (Nemorimyza) posticata (Meigen); Frey 1946 : 42.
Phytobia (Phytobia) posticata (Meigen); Frick 1952 : 390.
Phytobia (Nemorimyza) posticata (Meigen); Frick 1953 : 69, 1959 : 377.
Nemorimyza posticata (Meigen); Nowakowski 1962 : 97; Spencer 1969 : 161.

Diagnostic characters.-The members of this species are large shining black flies, wing length approximately 3.0 mm. Other diagnostic characters are: orbits in the same plane as frons; mesonotum shining black; dorsocentrals 3+0; acrostichals approximately in six rows; prescutellars present and squamal fringe pale whitish. Sasakawa (1961) and Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-The larvae make blotch mines on the leaves of *Solidago* spp. in Alberta. The larvae are also known to mine the leaves of *Aster* spp. in United States (Frick 1959). Frost (1924) and Sasakawa (1961) illustrated the leaf mine characteristic of this species. The leaf mine is characteristic in having concentric feeding marks. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are Holarctic in distribution and are known from Japan (Sasakawa 1961), Europe (Hendel 1931), United States and Canada (Frick 1959, Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Edmonton, River-bed, near University of Alberta Campus, from leaf mines on *Solidago* sp., coll. 26.vii.1966, emerged 20.viii.1966; 1 ♀ same locality and host, coll. 15.vi.1969, emerged 8.vii.1969; numerous leaf mines around Edmonton; 1 ♀ Jasper, 18.vi.1966.

Genus *Liriomyza* Mik

Liriomyza Mik 1894 : 289.

The main distinguishing characters of the genus *Liriomyza* Mik are: subcosta fold-like distally, joined to costa independent of R_1; orbital setulae erect or reclinate; costa extended to vein M_{1+2}; vein M_{1+2} nearest wing tip; scutellum yellow at least centrally; orbits largely in plane of frons; frons usually yellow; crossvein m-m normally present, but absent in *L. singula* Spencer; aedeagus variable in shape, without sclerotized paired tubules as in the genus *Lemurimyza* Spencer.

The genus is represented in Alberta by 27 species. The species in this genus are extremely difficult to separate from external characteristics alone. The characters of male genitalia are necessary for confirmation of the specific identity of most of the species. Many species very similar in external adult characteristics often belong to very different groups when their male genitalia are studied; e.g., *L. taraxaci* Hering, *L. veluta* Spencer and *L. lathyri* new species are extremely similar in external characters; but the structure of their male genitalia suggests that they belong to entirely different groups.

Six new species described in this treatment are: *L. balcanicoides*, *L. bifurcata*, *L. lathyri*, *L. senecionivora*, *L. sinuata* and *L. sylvatica*. Necessary amendments to include these species in Spencer's (1969) key to Canadian species of the genus *Liriomyza* Mik are given.

Key to Alberta species of the genus *Liriomyza* Mik.

1(0). Mesonotum with yellow central
area adjoining scutellum..................................2

\- Mesonotum without such yellow area.......................3

2(1). Larger specimens, wing length 2.8-
3.5 mm; *acr* in about 5 irregular
rows, scutellum with dark areas
laterally............................*conspicua* Sehgal p.109

\- Smaller specimens, wing length
approximately 2.0 mm; *acr* in two
rows; scutellum entirely yellow.........*viciae* Spencer p.132

3(1). Crossvein m-m present......................................4

\- Crossvein m-m absent..................*singula* Spencer p.123

4(3). Femora mostly dark...5

\- Femora mostly yellow, some specimens
with dark spots or streaks.................................9

5(4). Third antennal article black..............................6

\- Third antennal article yellow or
slightly darkened at base of arista.......................7

6(5). Antennae entirely black; *acr* in
four rows...........................*baptisiae* (Frost) p.106

\- First and second antennal article
yellow; *acr* in two rows..................*eboni* Spencer p.110

7(5). Mesonotum shining black; *acr* in four
rows; femora black with yellow distal tips................8

- Mesonotum black grey; *acr* in two rows; femora with some yellow spots on lines..............................*socialis* Spencer p.127

8(7). Orbits mostly yellow; aedeagus with ejaculatory duct conspicuously swollen between basiphallus; distiphallus lightly sclerotized............*septentrionalis* Sehgal p.122

- Orbits slightly darkened; aedeagus with ejaculatory duct not so swollen, distiphallus darkly sclerotized....*cordillerana* Sehgal p.110

9(4). Third antennal article with conspicuously long pubescence............................10

- Third antennal article with normal pubescence...12

10(9). *vte* on black and *vti* on margin of black and yellow areas on vertex........*sinuata* n. sp. p.124

- *vte* and *vti* both on yellow areas........................11

11(10). Surstyli long and narrow; larva leaf miner on *Achillea*..............*millefolii* Hering p.117

- Surstyli shorter and broader..........*pilosa* Spencer p. 120

12(9). Squamal fringe pale yellow...............*lima* (Melander) p.117

- Squamal fringe brown or black..........................13

13(12). Mesonotum brilliantly shining black......................14

- Mesonotum dull or mat, black or grey...15

14(13). *vte* and *vti* on yellow areas on vertex, separated by narrow dark band..................................*montana* Sehgal p.118

\- *vte* on dark and *vti* on margin of dark and yellow areas; aedeagus as illustrated (Figs. 55,56).......*eupatorii* (Kaltenbach) p.111

15(13). *vte* on black and *vti* on margin of dark and yellow areas on vertex..........................16

\- *vte* and *vti* both on yellow areas..........................21

16(15). Upper orbits partially darkened..........................17

\- Orbits yellow...18

17)16). Distiphallus with two circular lobes in ventral view.................*edmontonensis* Spencer p.111

\- Distiphallus as illustrated (Figs. 68, 69)......................*sylvatica* n. sp. p.128

18(16). Acrostichals in four rows..............................19

\- Acrostichals in two rows................................20

19(18). Femora blackish.......................*nordica* Spencer p.119

\- Femora normal yellow; aedeagus as in Figs. 60, 61................*senecionivora* n. sp. p.120

20(18). Aedeagus with distal processes divergent as in Figs. 52, 53..........*bifurcata* n. sp. p.107

\- Aedeagus without such distal processes.............................*kenti* Spencer p.113

21(15). Acrostichals in two rows................................22

\- Acrostichals in 3-4 irregular rows.......................23

22(21). Aedeagus with distiphallus oval,
disc shaped in ventral view............*fricki* Spencer p.113

- Aedeagus as in Figs. 47, 48.......*balcanicoides* n. sp. p.104

23(21). One *Ors* and two to three *Ori*...............................24

- Two *Ors* and two *Ori*......................................25

24(23). Last section of M_{3+4} approximately
two times the penultimate; larva
leaf miner on *Smilacina*............*smilacinae* Spencer p.127

- Last section of M_{3+4} two and a half
to three times the penultimate; aedeagus
with long undulating process
distally..............................*undulata* Spencer p.131

25(23). Mesonotum black, not grey............*taraxaci* Hering p.130

- Mesonotum grey...26

26(25). Frons slightly projected in front
of eye margin in profile...............*veluta* Spencer p.131

- Frons not projected in front of eye
margin in profile......................*lathyri* n. sp. p.115

Liriomyza balcanicoides new species

Comparisons.-A member of this species resembles that of *L. fricki* Spencer in external characteristics and can be reliably separated only by examination of male genitalia. The aedeagus (Figs. 47, 48) characteristic of this species is of same general type as that of the Palaearctic species *L. balcanica* (Strobl) as figured by Spencer

(1966c), but is quite distinctive. Besides, the adult differs in having cross-vein m-m present. This species may be included in Spencer's (1969) key to Canadian species of the genus *Liriomyza* Mik by amending and extending couplet 39 as below:

39. *acr* in two rows..................................39a

- *acr* in three to four rows...............................40

39a. Aedeagus as illustrated (Spencer 1969).....*fricki* Spencer

- Aedeagus as in figures 47, 48.......*balcanicoides* n. sp.

Description.-Head. Frons approximately one and a half times width of eye at level of front ocellus, projected in front of eye margin in profile; eyes oval, 1.25 times higher than their length; gena little less than one-third of eye height midway between vibrissal and posterior margins; ocellar triangle small; lunule high; two strong *Ors* directed upwards; two *Ori*, lower one directed inwards, upper one directed upwards; orbital setulae few, 3-4, reclinate; third antennal article rounded at tip, with normal pubescence; arista pubescent.

Mesonotum. Dorsocentrals 3+1; *acr* in two rows.

Wing. Length in male approximately 1.5 mm; costa extended to vein M_{1+2}; costal segments 2-4 in the ratio of 1 : 0.27 : 0.3; crossvein m-m present; last segment of M_{3+4} approximately two and a half times the penultimate.

Male genitalia (Figs. 47-50). Hypandrium U-shaped with slender side arms; pregonites broad; postgonites elongated; surstylus (Fig. 50) with characteristic spine placed anteriorly and a small spine dorsally on epandrium; aedeagal apodeme darkly sclerotized; phallophore small; basiphallus with swollen ejaculatory duct; distiphallus as illustrated with two characteristic processes at distal end; ejaculatory apodeme (Fig. 49) broad, with darkly sclerotized stem, bulb small, sclerotized along lower margin.

Colour. Frons, orbits, lunule, gena and antennae yellow; *vte* and *vti* on yellow areas; mesonotum mat greyish black; humeral area yellow, with a dark spot anteriorly; notopleural area yellow; scutellum yellow, with dark areas at its basal corners; mesopleuron yellow with slight dark area anteroventrally; pteropleuron yellow; sternopleuron black, with a narrow yellow band dorsally; femora essentially yellow; tibiae and tarsi brown; squamal fringe dark brown, halteres yellow.

Derivation of the specific name.-The name *balcanicoides* is given in view of the fact that this species belong to the same group as *L. balcanica* (Strobl).

Geographical distribution.-A male of this species is known only from type locality:

CANADA. Alberta : Holotype ♂ St. Albert, near Edmonton, 18.vi.1967.

Liriomyza baptisiae (Frost)

Agromyza baptisiae Frost 1931 : 275.

Liriomyza baptisiae (Frost), Frick 1952 : 402, 1959 : 402; Spencer 1969 : 169.

Comparisons and diagnostic characters.-The members of this species are small black flies, approximately 1.7 mm in wing length. The adults resemble closely those of *L. quadrisetosa* (Malloch) in external morphology but differ in having only four orbital bristles. The adults differ from those of another similar species *L. eboni* Spencer in having all three antennal articles black. Spencer (1969) illustrated the distinctive aedeagus.

Biology.-The larvae form linear blotch mines on leaves of *Baptisia tinctoria* (L.), family Leguminosae, in Pennsylvania, U. S. A. (Frick 1959). The larvae probably have some other food plant in Alberta.

Geographical distribution.-The members of this species are known from Pennsylvania, U. S. A. (Frick 1959) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 4 ♂♂ and 3 ♀♀ Cypress Hills, near Elkwater Lake, 24.vi.1966.

Liriomyza bifurcata new species

Comparisons.-A member of this species resembles closely that of *L. kenti* Spencer in external characteristics and can be separated reliably only by the examination of male genitalia. It differs from those of similar species *L. nordica* Spencer and *L. senecionivora* new species in having two rows of acrostichals and distinct male genitalia. *L. bifurcata* is included in Spencer's (1969) key to the Canadian species of the genus *Liriomyza* Mik as shown at the beginning of the description of *L. senecionivora* new species described later in this treatment.

Description.-Head (Fig. 51). Frons wide, approximately two times width of eye at level of front ocellus, slightly projected in front of eye margin in profile; eyes oval, approximately 1.3 times higher than their length; gena approximately one-fifth of eye height midway between vibrissal and posterior margins; ocellar triangle small, lunule almost semicircular above; two strong *Ors* directed upwards, one *Ori* directed inwards; orbital setulae 3, reclinate; antennal bases approximate; third antennal article rounded at tip, with normal pubescence; arista long and pubescent.

Mesonotum. Dorsocentrals 3+1; *acr* in two rows.

Wing. Length in male 1.25 mm; costa extended to vein M_{1+2}; costal segments 2-4 in the ratio of 1 : 0.4 : 0.24; wing tip at M_{1+2}; last segment of M_{3+4} approximately three times penultimate.

Male genitalia (Figs. 52-54). Hypandrium U-shaped with slender side arms. pregonites small; postgonites elongated; surstylus small, with a short spine anteriorly and a cone-like projection dorsally on epandrium; aedeagal apodeme lightly sclerotized; phallophore small; basiphallus with a thick swollen ejaculatory duct; hypophallus small narrow process; distiphallus with two divergent tubules distally and small filamentous hair ventrally; ejaculatory apodeme broad, bulb small and sclerotized along the lower margin.

Colour. Frons, orbits, lunule, gena and antennae yellow; ocellar triangle black; *vte* and *vti* on dark areas; mesonotum greyish black; humeral area yellow, with dark spot anteriorly; notopleural area yellow; scutellum yellow with lateral dark areas, mesopleuron yellow with small dark area anteroventrally; sternopleuron dark, with a narrow yellow band along upper margin; femora yellow, slightly brownish at base; tibiae and tarsi brownish; squamal fringe brown, squamae yellow; halteres yellow.

Derivation of the specific name.-The name *bifurcata* is given in view of two divergent tubular processes on the distiphallus.

Geographical distribution.-A member of this species is known only from the type locality:

CANADA. Alberta : Holotype ♂ Edmonton, White Mud Creek Park, 29.vi.1966.

Liriomyza conspicua Sehgal

Liriomyza conspicua Sehgal 1968 : 66.

Diagnostic characters.-The members of this species are large flies, wing length 2.8-3.5 mm, with characteristic prescutellar yellow, yellow third antennal segment, scutellum slightly darkened at basal corners and distinct male genitalia. Sehgal (1968) illustrated the head, wing and male genitalia characteristic of this species.

Geographical distribution.-The members of this species are known from various localities in Alberta, Manitoba, Ontario and Saskatchewan in Canada (Sehgal 1968). I examined the following further material from Alberta:

CANADA. Alberta : 2 ♂♂ and 3 ♀♀ Vegreville, 22.vi.1968.

Liriomyza cordillerana Sehgal

Liriomyza cordillerana Sehgal 1968 : 69.

Comparison and diagnostic characters.-The members of this species resemble closely those of *L. septentrionalis* Sehgal in external morphology and can be reliably separated only by the examination of the characters of the male genitalia. The colour of third antennal article is variable from complete yellow to slightly darkened at the base of arista; the orbits are usually darkened. Sehgal (1968) illustrated the head, wing and the distinctive aedeagus. Spencer (1969) also figured the aedeagus.

Biology.-Larvae mine the leaves of *Deschampsia caespitosa* (L.) Beauv., family Gramineae.

Geographical distribution.-The members of this species are known from various localities in the Rockies in Alberta, Canada (Sehgal 1968). I examined the following further material from Alberta:

CANADA. Alberta : 1 ♂ Banff, from leaf mine on grass, 13-23.ix.1966; 1 ♂ Blairmore, 26.vi.1966; 1 ♂ Jasper, from leaf mines on *Deschampsia caespitosa* (L.) Beauv., family Gramineae; 1 ♂ same locality, 1.ix.1966.

Liriomyza eboni Spencer

Liriomyza eboni Spencer 1969 : 173.

Comparison and diagnostic characters.-The members of this species differ from those of the similar species *L. baptisiae* (Frost) in having first and second antennal article yellow and acrostichals in two rows. The aedeagus has been illustrated by Spencer (1969).

Geographical distribution.-The members of this species are known only from Alberta, from the type locality:

CANADA. Alberta : Blairmore (Spencer 1969).

Liriomyza edmontonensis Spencer

Liriomyza edmontonensis Spencer 1969 : 174.

Comparison and diagnostic characters.-The members of this species resemble closely those of *L. sylvatica* new species in external morphology and can be reliably separated only by comparison of the characters of male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known from Alberta and British Columbia in Canada. Known Alberta locality is as follows:

CANADA. Alberta : Edmonton, University of Alberta Campus (Spencer 1969).

Liriomyza eupatorii (Kaltenbach)

Agromyza eupatorii Kaltenbach : 1874 : 320.

Liriomyza eupatorii (Kaltenbach), Hendel 1920 : 143; Spencer 1969 : 174.

Comparison and diagnostic characters.-The members of this species are very close to those of *L. montana* Sehgal in external characteristics and are reliably separated only by examination of male genitalia. Spencer (1969) figured the distinctive aedeagus of this species. The aedeagus of a caught specimen from Alberta is illustrated in figures 55,56. The distiphallus of this species is very close the that of *L. pictella* (Thompson) and *L. munda* Frick, from which it differs only in minor details. Spencer (1965c) illustrated the aedeagus characteristic of *L. pictella* (Thompson) and of *L. munda* Frick.

Biology.-Larvae mine the leaves of members of the genera *Solidago*, *Helianthus*, *Eupatorium*, *Aster*, and *Lampsana*, family Compositae, and *Galeopsis*, family Labiatae, in Europe (Hering 1957).

Geographical distribution.-The members of this species are widespread in Europe and are known from Canada (Spencer 1969). Frick's (1953, 1959) description of *L. eupatorii* (Kaltenbach) refers to *L. munda* Frick (Stegmaier 1966, 1968). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, Aberhart Hospital lawns, 13.vi.1967.

Liriomyza fricki Spencer

Liriomyza trifolii; Frick 1959 : 410 (not Burgess 1879).
Liriomyza fricki Spencer 1965c : 35.

Comparison and diagnostic characters.-The members of this species are very close to those of *L. balcanicoides* new species in external characteristics, but the male genitalia are very different. Spencer

(1965c, 1969) illustrated the distinctive aedeagus of this species.

Biology.-Larvae mine the leaves of various species of the genera *Medicago, Melilotus, Trifolium* and *Vigna* of the family Leguminosae (Stegmaier 1968). The flies were also bred from two other genera *Lathyrus* and *Vicia* of the family Leguminosae. The leaf mine is a small blotch with a short linear beginning.

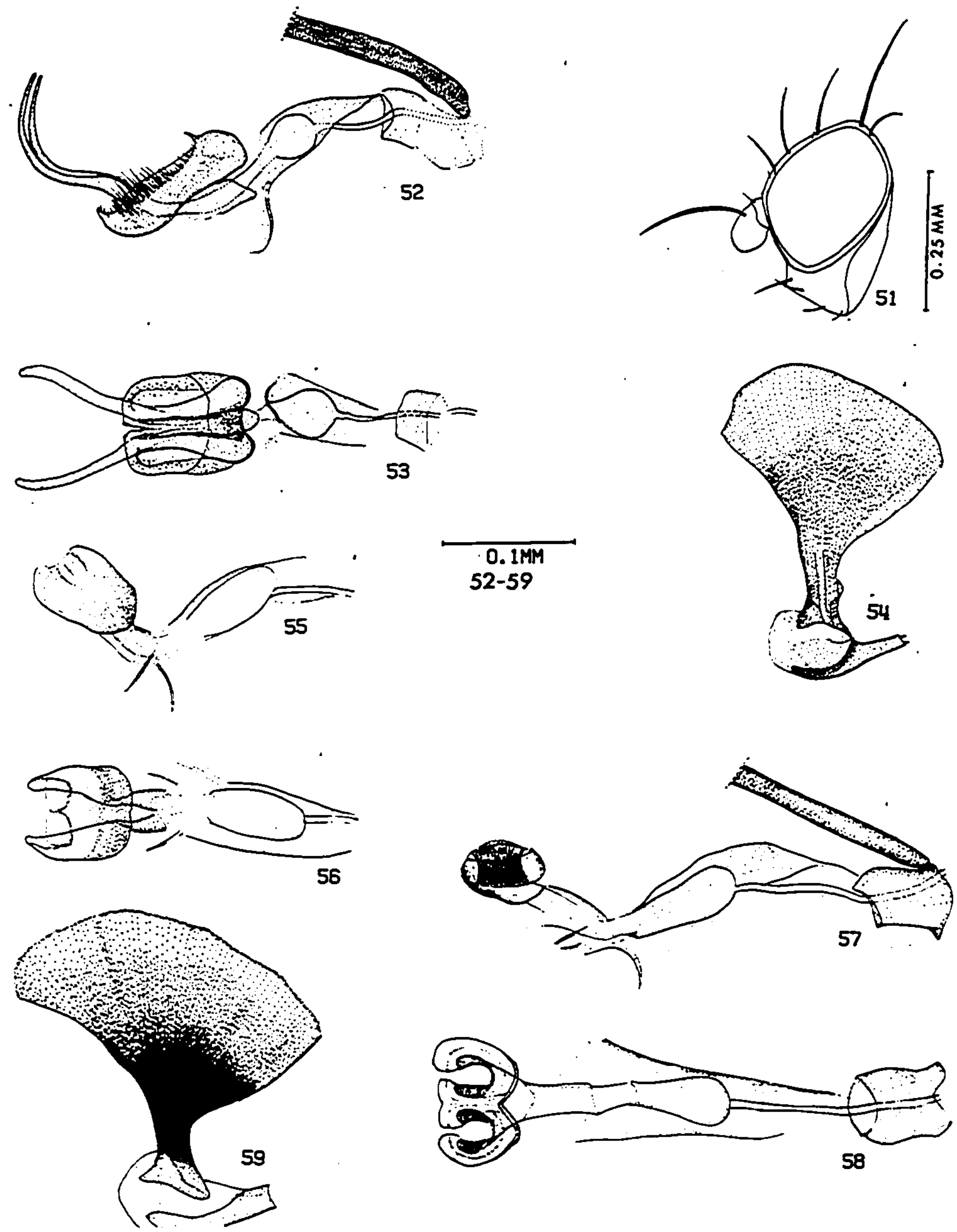
Geographical distribution.-*L. fricki* Spencer is a Nearctic species whose members are known from Northern United States and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Banff, 28.vi.1966; 1 ♂ Edmonton, 12.vi.1937, coll. E. H. Strickland; 1 ♂ and 1 ♀ Elk Island Park, from leaf mines on *Trifolium repens* L., coll. 31.vii.1966, emerged 14-15.viii.1966; 2 ♂♂ same locality, from leaf mines on *Vicia americana* Muhl., 31.vii.-11. viii.1966; 1 ♀ same locality, from leaf mines on *Lathyrus ochroleucus* Hook., viii.1967; 5 ♂♂, same locality, 31.vii.1966; 2 ♂♂, same locality, 7.vi. and 2.viii.1966; 2 ♂♂, Jasper, 18.vi. and 23.vii.1966.

Liriomyza kenti Spencer

Liriomyza kenti Spencer 1969 : 176.

Comparisons and diagnostic characters.-The members of this species resemble closely those of *L. bifurcata* new species and are separated reliably only by examination of the characters of male genitalia. The adults differ from those of similar species *L. senecionivora* new species and *L. nordica* Spencer in having only two rows of acrostichals. Spencer (1969) illustrated the distinctive aedeagus.



Figs. 51 - 54. *Liriomyza bifurcata*. 51. head, lateral view. 52. aedeagus, lateral view. 53. aedeagus, ventral view. 54. ejaculatory apodeme. Figs. 55 - 56. *L. eupatorii*. 55. aedeagus, lateral view. 56. aedeagus, ventral view. Figs. 57 - 59. *L. lathyri*. 57. aedeagus, lateral view. 58. aedeagus, ventral view. 59. ejaculatory apodeme.

Geographical distribution.-The members of this species are known only from the localities of its type series (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Blairmore, 26.vi.1966; 1 ♂ Edmonton, Emily Murphy Park, 11.vi.1968; 1 ♂ Edmonton Mayfair Park, 17.v.1969; Paratype 1 ♂ Edmonton, White Mud Creek Park, 13.vi.1966; 2 ♂♂ same locality, 19.v.1968; 1 ♂ same locality; 10.vi.1968; 10 ♂♂, same locality. 25.v.1969; 5 ♂♂ Jasper, 19.vi.1966.

Liriomyza lathyri new species

Comparisons.-The members of this species resemble closely those of *L. veluta* Spencer, *L. trifolii* (Burgess) and *L. taraxaci* Hering in external morphology and can be separated reliably only by examination of the characters of the male genitalia. This species is included in Spencer's (1969) key to Canadian species of the genus *Liriomyza* Mik by amending couplet 43 and adding couplet 44 as below:

43. Aedeagus as in Figs. 57, 58..................*lathyri* n. sp.
 -Aedeagus not so..44
44. Aedeagus as illustrated (Spencer 1969)...*trifolii* (Burgess)
 -Aedeagus as illustrated (Spencer 1969)........*veluta* Spencer

Description.-Frons approximately 1.8 times width of eye at level of front ocellus, not projected in front of eye margin in profile; eyes oval, approximately 1.25 times higher than their length; gena approximately one-fifth of eye height midway between vibrissal and posterior margins; ocellar triangle small; two *Ors* directed upwards; two *Ori* directed inwards; orbits narrow; orbital setulae approximately six, reclinate; third antennal article rounded at tip, with normal pubescence; arista pubescent.

Mesonotum. Dorsocentrals 3+1; *acr* in 3 irregular rows.

Wing. Length in male approximately 1.7 mm; costa extended to vein M_{1+2}; costal segments 2-4 in the ratio of 1 : 0.27 : 0.27; crossvein m-m present; last segment of M_{3+4} approximately two and a half times the penultimate.

Male genitalia (Figs. 57-59). Hypandrium U-shaped with slender side arms; pregonites broad; postgonites elongated; surstylus typical with a conspicuous spine placed anteriorly; small cone-like projection present on epandrium; phallophore and aedeagus (Figs. 57, 58) as illustrated; ejaculatory apodeme (Fig. 59) broad, darkened at its stem, bulb small, sclerotized along lower margin.

Colour. Frons, orbits, lunule, gena and antennae all yellow or reddish; *vte* and *vti* on yellow areas; mesonotum mat greyish black; humeral area yellow, with a dark spot anteriorly; notopleural area yellow; mesopleura essentially yellow, with dark area centrally and along ventral half; sternopleura black, with a narrow yellow band along its dorsal margin, femora essentially yellow; tibiae and tarsi brownish; squamal fringe dark brown; halteres yellow.

Derivation of the specific name.-This species is named *lathyri* after the name of its larval food plant.

Biology.-Larvae make large blotch mine with a small linear beginning on the leaflets of *Lathyrus ochroleucus* Hook., family

Leguminosae. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are known only from the localities of its type series:

CANADA. Alberta, Holotype ♂ Edmonton, White Mud Creek Park, from blotch mines on leaflets of *Lathyrus ochroleucus* Hook., coll. 4.ix.1968, emerged 7.ii.1969; Paratypes 13 ♂♂ Elk Island Park, 31.vii.-2.viii.1966.

Liriomyza lima (Melander)

Agromyza lima Melander 1913 : 265.

Liriomyza lima (Melander), Frick 1952 : 404, 1959 :406.

Diagnostic characters.-The main distinguishing characters are mat black mesonotum, yellow femora and third antennal article. The pale squamal fringe differentiates this from other species in this group. Spencer (1969) illustrated the distinctive aedeagus.

Geographical distribution.-Members of this species are known from United States and Canada. The Alberta locality is:

CANADA. Alberta : Edmonton (Spencer 1969).

Liriomyza millefolii Hering

Liriomyza millefolii Hering 1927 : 185; Spencer 1969 : 178.

Comparison and diagnostic characters.-The members of this species can be easily recognised by the presence of conspicuously long whitish pubescence on the third antennal article and the presence of vertical bristles on yellow areas. The adults resemble closely those of

L. sinuata new species in external morphology, but the male genitalia are distinct. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae mine the leaves of *Achillea millefolium* L. and *A. sibirica* Ledeb., family Compositae. Larvae also mine the leaves of *Tanacetum vulgare* L. in the laboratory.

Geographical distribution.-The members of this species are known from Germany (Hendel 1931) in Europe, and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂ and 3 ♀♀ Edmonton, River Bed near University of Alberta Campus, from leaf mines on *Achillea sibirica* Ledeb., Coll. 26.vii.1966, emerged 10-13.viii.1966; 3 ♂♂ and 1 ♀ Edmonton, White Mud Creek Park, same host, 6-20.x.1968; 6 ♂♂ and 3 ♀♀ Elk Island Park, same host, coll. 31.vii.1966, emerged 15-20. viii.1966; 3 ♂♂ same locality, 31.vii.1966; 1 ♂ same locality, viii.1967.

Liriomyza montana Sehgal

Liriomyza montana Sehgal 1968 : 67.

Comparison and diagnostic characters.-The members of this species resemble closely those of *L. eupatorii* (Kaltenbach) in external morphology. The positon of vertical bristles on yellow areas used to differentiate the adults of this species from those of *L. eupatorii* (Kaltenbach) is variable as the area of vertical bristles in some specimens is darkened. The male genitalia are however quite distinct.

Sehgal (1968) illustrated the head, wing and male genitalia characteristic of this species. Spencer (1969) also figured the distinctive aedeagus.

Biology.-Larvae probably mine the leaves of grasses (Gramineae).

Geographical distribution.-The members of this species are known from various localities in the Rockies in Alberta, Canada, (Sehgal 1968).

Liriomyza nordica Spencer

Liriomyza nordica Spencer 1969 : 179.

Comparisons and diagnostic characters.-The members of this species are very similar to those of *L. senecionivora* new species and differ only in having femora blackish. The male genitalia are however very distinct. The adults differ from those of other similar species *L. bifurcata* new species and *L. kenti* Spencer in having darker mesopleura and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known only from the locality of its type series from Canada. I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, Rainbow Valley, 31.v.1969; 2 ♂♂ Edmonton, White Mud Creek Park, 25.v.1969.

Liriomyza pilosa Spencer

Liriomyza pilosa Spencer 1969 : 182.

Comparison and diagnostic characters.-The members of this species resemble closely those of *L. millefolii* Hering in having long pubescence on third antennal article and can be reliably separated only by examination of male genitalia. Surstyli in this species are shorter and broader than in *millefolii* Hering. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-The members of this species are known only from Alberta from the locality of type specimen as follows:

CANADA. Alberta : Edmonton, University of Alberta Campus (Spencer 1969).

Liriomyza senecionivora new species

Comparisons.-The adults of this species resemble closely those of *L. nordica* Spencer in external characteristics and can be reliably separated only by the examination of male genitalia. *L. senecionivora* and *L. bifurcata* new species described earlier are included in Spencer's (1969) key to Canadian species of the genus *Liriomyza* Mik by amending and extending the couplet 38 as below:

38. *acr* in four rows..38a
    -*acr* in two rows..38b

38a. Aedeagus as illustrated (Spencer 1969).......*nordica* Spencer

-Aedeagus as in figures 60, 61............*senecionivora* n. sp.

38b. Aedeagus as illustrated (Spencer 1969).........*kenti* Spencer

-Aedeagus as in figures 52, 53..............*bifurcata* n. sp.

Description.-Head. Frons wide, approximately 1.8 times width of eye at level of front ocellus, slightly projected in front of eye margin in profile; eyes oval, 1.3 times higher than their length; gena approximately one-fifth of eye height midway between vibrissal and posterior margins; ocellar triangle small; lunule high, almost flat above; two strong *Ors* directed upwards, three *Ori* directed inwards and upwards; orbital setulae few, approximately 7, reclinate; antennal bases approximate; third antennal article rounded at tip, with normal pubescence; arista long and pubescent.

Mesonotum. Dorsocentrals 3+1; *acr* in four irregular rows.

Wing. Length in male 2.0 mm; costa extended to vein M_{1+2}; costal segments 2-4 in the ratio of 1 : 0.23 : 0.26; wing tip at vein M_{1+2}; crossvein m-m present; last segment of M_{3+4} approximately three times the penultimate.

Male genitalia (Figs. 60-63). Hypandrium U-shaped with slender side arms; pregonites broad and membranous; postgonites long and narrow; sustyli (Fig. 63) small, with two spines placed anteriorly, small spine on epandrium anteriorly also present; phallophore small and darkly sclerotized; basiphallus and distiphallus lightly sclerotized; ejaculatory duct swollen between basiphallus; distiphallus small; ejaculatory apodeme (Fig. 62) narrow and darkly sclerotized at base, bulb membranous.

Colour. Frons, orbits, lunule, gena and antennae all yellow; ocellar triangle black; *vte* on black and *vti* on margin of black and yellow areas; mesonotum mat black; humeral area yellow, with a dark spot anteriorly; notopleural area yellow; scutellum yellow with dark areas at its basal corners; mesopleuron and sternopleuron black with narrow yellow band along upper margins; femora mainly yellow, with slight brownish area towards their base; tibiae and tarsi dark brown; squamal fringe brown, squamae slightly dark; halteres yellow.

Derivation of the specific name.-This species is named *senecionivora* after the name of its food plant.

Biology.-The larvae make linear mines on the leaves of *Senecio pauciflorus* Pursh. Pupation occurs outside the leaf mine.

Geographical distribution.-The members of this species are known only type localities:

CANADA. Alberta : Holotype ♂ Jasper National Park, near Medicine Lake, from leaf mines on *Senecio pauciflorus* Pursh, coll. 16.vii.1969, emerged 30.vii.1969, coll G. C. D. Griffiths. Paratype 1 ♂ Blairmore, 26.vi.1966.

Liriomyza septentrionalis Sehgal

Liriomyza septentrionalis Sehgal 1968 : 70.

Comparison and diagnostic characters.-The members of this species resemble closely those of *L. cordillerana* Sehgal in external morphology, and can be reliably separated only by the examination of the characters of male genitalia.

The third antennal article is variable in colour from complete yellow to slightly darkened at the base of arista; orbits are usually yellow. Sehgal (1968) figured the head, wing and the characteristic aedeagus.

Biology.-Larvae mine the leaves of grasses (Gramineae).

Geographical distribution.-The members of this species are known from various localities in the Rocky Mountains and Cypress Hills in Alberta and from British Columbia (Sehgal 1968).

Liriomyza singula Spencer

Liriomyza singula Spencer 1969 : 184.

Diagnostic characters.-The members of this species are distinct in the absence of crossvein m-m; the third antennal segment is only lightly darkened at the base of arista. Spencer (1969) figured the distinctive aedeagus.

Geographical distribution.-The members of this species are known only from its type series in Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : Paratype 1 ♂ Blairmore, 20.vi.1966.

Liriomyza sinuata new species

Comparisons.-The members of this species resemble those of *L. millefolii* Hering in having long pubescence on third antennal article but differ in having both vertical bristles on dark areas and distinct male genitalia. This species is included in Spencer's (1969) key to Canadian species of the genus *Liriomyza* Mik by amending and extending the couplet 26 as below:

26. Orbits shining black; mesopleura black in lower three-quarters; femora distinctly darkened......................sp. (Constance Bay)

\- Orbits yellow; femora yellow............................26a

26a. *vte* on black and *vti* on margin of black and yellow grounds.....................*sinuata* n. sp.

\- Both *vt* on yellow grounds...............................27

Description.-Head. Frons wide, approximately twice width of eye at level of front ocellus, projected in front of eye margin in profile; eyes oval, slightly slanted, 1.25 times higher than their length; gena deep, approximately one-third of eye height midway between vibrissal and posterior margins; ocellar triangle small; lunule high, narrow at top; two strong *Ors* directed upwards; two *Ori*, lower one directed inwards and upper one directed upwards; orbital setulae 1-2, reclinate; antennal bases approximate; third antennal article rounded at tip, with conspicuous pubescence; arista pubescent.

Mesonotum. Dorsocentrals 3+1; *acr* in two rows.

Wing. Length in male approximately 1.5 mm; costa extended to vein M_{1+2}; costal segments 2-4 in the ratio of 1 : 0.35 : 0.25; wing tip at M_{1+2}; crossvein m-m present; last segment of M_{3+4} approximately two and a half times penultimate.

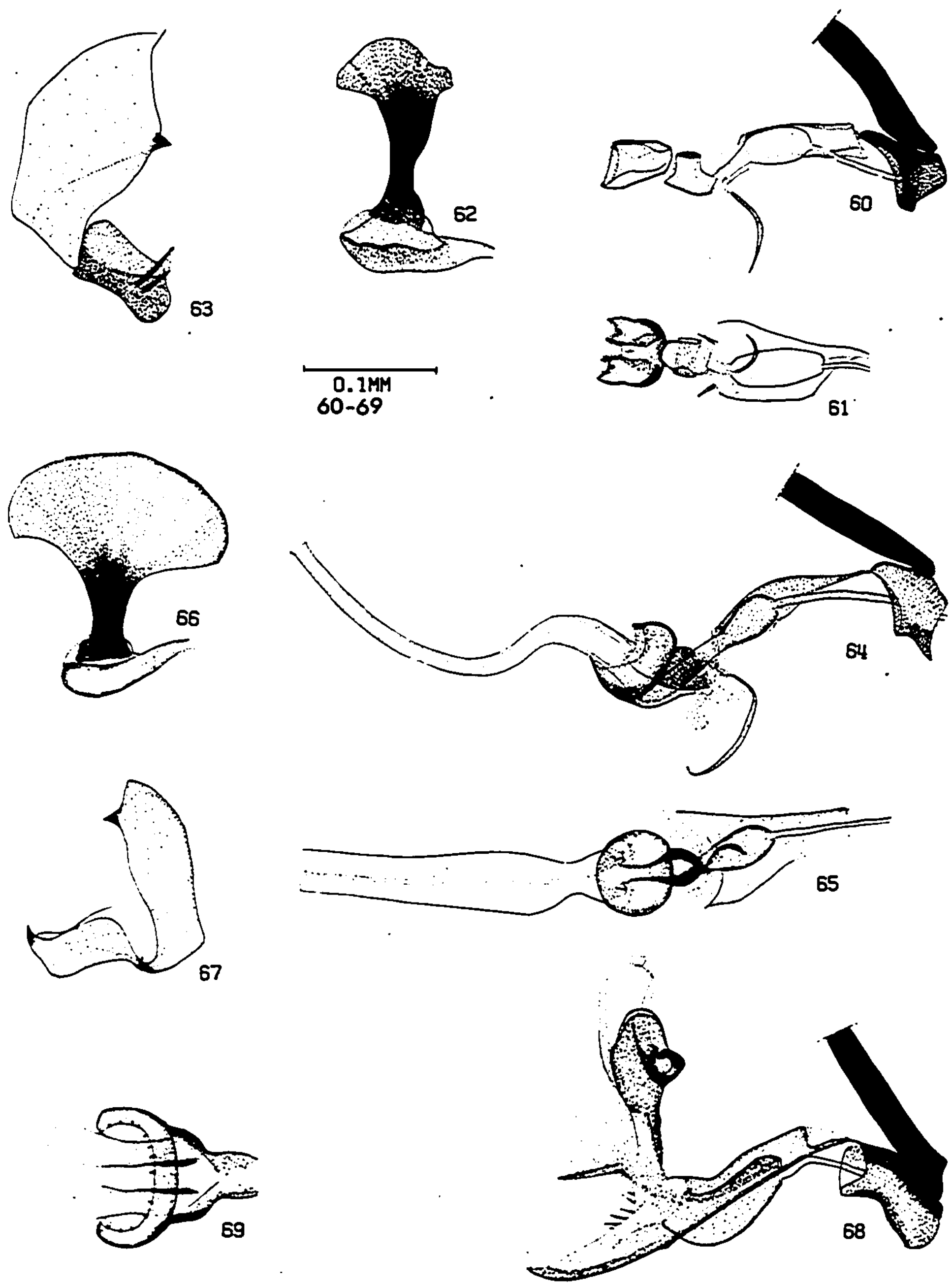
Male genitalia (Figs. 64-67). Hypandrium U-shaped with slender side arms; pregonites broad; postgonites elongated; surstylus (Fig. 67) small with a short spine anteriorly and a small spine dorsally on epandrium; aedeagal apodeme darkly sclerotized; phallophore small; ejaculatory duct swollen between basiphallus; distiphallus two long tubular S-shaped processes; ejaculatory apodeme (Fig. 66) broad, bulb small and sclerotized along lower margin.

Colour. Frons, orbits, lunule, gena and antennae all yellow; *vte* on black and *vti* on the margin of dark and yellow areas; mesonotum mat black; humeral area yellow, with a dark spot anteriorly; notopleural area yellow; scutellum yellow, with dark area along its basal corners; mesopleuron yellow with slight dark area anteroventrally; sternopleuron black, with a narrow yellow band dorsally; femora mainly yellow; tibiae and tarsi brown, squamal fringe dark brown; halteres yellow.

Derivation of the specific name.-The name *sinuata* is given in view of the sinuate or wavy distiphallus.

Geographical distribution.-The members of this species are known only from the localities of its type specimens:

CANADA. Alberta : Holotype ♂ Banff, 28.vi.1966; Paratype 1 ♂ Cypress Hills, Elkwater, 24,vi.1966.



Figs. 60 - 63. *Liriomyza senecionivora*. 60. aedeagus, lateral view. 61. aedeagus, ventral view. 62. ejaculatory apodeme. 63. surstylus. Figs. 64 - 67. *L. sinuata*. 64. aedeagus, lateral view. 65. aedeagus, ventral view. 66. ejaculatory apodeme. 67. surstylus. Figs. 68 - 69. *L. sylvatica*. 68. aedeagus, lateral view. 69. aedeagus, ventral view.

Liriomyza smilacinae Spencer

Liriomyza smilacinae Spencer 1969 : 186.

Comparison and diagnostic characters.-The members of this species are close to those of *L. undulata* Spencer in external morphology and are separated only by examination of the characters of male genitalia. Spencer (1969) illustrated the characteristic aedeagus.

Biology.-Larvae form linear leaf mines on the leaves of *Smilacina stellata* (L.) Desf., family Liliaceae. Spencer (1969) illustrated the leaf mine characteristic of this species.

Geographical distribution.-The members of this species are known only from the localities of its type series in Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : Paratype 1 ♂ Edmonton, White Mud Creek Park, 13.vi.1966; 1 ♂ same locality, 18.vi.1968, leg. G. C. D. Griffiths; 4 ♂♂ and 5 ♀♀ same locality, from leaf mines on *Smilacina stellata* (L.) Desf., coll. 10.vi.1968, leg. G. C. D. Griffiths; 1 ♂ same locality and host, 10.vi.1968-2.ii.1969; 1 ♂ and 1 ♀ same locality and host, 28.vi.-14.vii.1968.

Liriomyza socialis Spencer

Liriomyza socialis Spencer 1969 : 186.

Diagnostic characters.-The main distinguishing characters of the members of this species are mat grey mesonotum and two rows of acrostichals. The colour of third antennal article varies from pale to dark brown (Spencer 1969). Spencer (1969) illustrated the distinctive aedeagus.

Geographical distribution.-The members of this species are known only from Alberta, Canada. The Alberta localities are as follows:

CANADA. Alberta : Blairmore, Elk Island Park, Jasper (Spencer 1969).

Liriomyza sylvatica new species

Comparisons.-A male of this species is very similar to that of *L. edmontonensis* Spencer in external characteristics and is reliably separated only by examination of male genitalia, which however are very distinct. This species is included in Spencer's (1969) key to Canadian *Liriomyza* species by amending and extending the couplet 37 as below:

37. Femora partially darkened................................37a

\- Femora almost entirely bright yellow........*arcticola* Spencer

37a. Aedeagus as illustrated (Spencer 1969)................................*edmontonensis* Spencer

\- Aedeagus as in figures 68, 69...............*sylvatica* n. sp.

Description.-Head. Frons approximately 1.3 times wider than the width of eye at level of front ocellus; slightly projected in front of eye margin in profile; eyes oval, 1.4 times higher than their length; gena little less than one-fourth of eye height midway between vibrissal and posterior margins; ocellar triangle small; lunule high; two *Ors* directed upwards; two *Ori* directed inwards and upwards; orbital setulae 3-4, reclinate; antennal bases approximate; third antennal article with a slight angle anterodorsally, with normal pubescence; arista pubescent.

Mesonotum. Dorsocentrals 3+1; *acr* in four irregular rows.

Wing. Length in male 1.7 mm; costa extended to vein M_{1+2}; costal segments 2-4 in the ratio of 1 : 0.26 : 0.18; wing tip at vein M_{1+2}; crossvein m-m present; last segment of M_{3+4} approximately three and a half times the penultimate.

Male genitalia. (Figs. 68, 69). Hypandrium U-shaped with slender side arms; pregonites broad; postgonites elongated; surstylus small and lightly sclerotized; aedeagal apodeme darkly sclerotized; phallophore elongate; ejaculatory duct swollen between basiphallus; distiphallus as illustrated; ejaculatory apodeme broad, bulb small and sclerotized along lower margin.

Colour. Frons, gena, lunule and antennae yellow; upper orbits partially darkened up to lower *Ors*; *vte* on black and *vti* on the margin of dark and yellow areas; mesonotum mat greyish black; humeral area yellow, with a dark spot anteriorly; notopleural area yellow; scutellum yellow, with slight dark at its basal corners; mesopleuron black with a narrow yellow band dorsally; sternopleuron black; femora yellow, darkened towards base, tibiae and tarsi dark brown; squamal fringe brownish; halteres yellow.

Derivation of the specific name.-The name *sylvatica* indicates that the species is woodland-inhabiting.

Geographical distribution.-This species is known only from the type locality:

CANADA. Alberta : Holotype ♂ St. Albert, near Edmonton, 18.vi.1967.

Liriomyza taraxaci Hering

Liriomyza taraxaci Hering 1927 : 184; Spencer 1969 : 188.

Comparisons and diagnostic characters.-The members of this species resemble closely those of *L. veluta* Spencer, *L. trifolii* (Burgess), *L. lathyri* new species, and differ only in having mesonotum black and not grey. The male genitalia are however entirely different. Spencer (1969) illustrated the aedeagus distinctive of this species.

Biology.-Larvae form elongate blotch mines on the leaves of *Taraxacum officinale* Weber, family Compositae. Hering (1927) illustrated the characteristic leaf mine.

Geographical distribution.-The members of this species are known from various localities in Europe (Hendel 1931) and from Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Banff, 28.vi.1966; 1 ♂ Blairmore, 26.vi.1966; 1 ♀ Edmonton, 110 Street, 84 Avenue, from leaf mines on *Taraxacum officinale* Weber, 15-29.vi.1968; 2 ♂♂ Edmonton, University of Alberta Campus, same host, 27.vii.-11.viii.1966; 1 ♂ Edmonton, White Mud Creek Park, 28.v.1967.

Liriomyza undulata Spencer

Liromyza undulata Spencer 1969 : 190.

Comparison and diagnostic characters.-The members of this species resemble closely those of *L. smilacinae* Spencer in external morphology, but have distinct male genitalia. Spencer (1969) illustrated the characteristic aedeagus. The distiphallus is distinctive in having a long undulating process distally.

Geographical distribution.-The members of this species are known only from the localities of its type series from Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂ Blairmore, 26.vi.1966; Paratype 1 ♂ Edmonton, White Mud Creek Park, 23.vi.1966, coll. V. K. Sehgal; 11 ♂♂ same locality, 23-29.vi.1966.

Liriomyza veluta Spencer

Liriomyza veluta Spencer 1969 : 190.

Comparisons and diagnostic characters.-The members of this species resemble closely those of *L. lathyri* new species and *L. trifolii* (Burgess) in external morphology and can be separated only by examination of the characters of male genitalia. The adults differ from those of another similar species *L. taraxaci* Hering in having mesonotum grey and not black. Spencer (1969) illustrated the distinctive aedeagus.

Geographical distribution.-The members of this species are known from various localities of its type series from Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Blairmore, 26.vi.1966; 1 ♂ Edmonton, White Mud Creek Park, viii.1968; 2 ♂♂ and 1 ♀ George Lake, near Busby, 21.vi.1966.

Liriomyza viciae Spencer

Liriomyza viciae Spencer 1969 : 191.

Comparison and diagnostic characters.-The members of this species resemble closely those of *L. melampyga* (Loew) in external morphology and differ only in having acrostichals in two rows and distinctive male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species as well as that of *L. melampyga* (Loew).

The adults are small flies, wing length approximately 2.0 mm, with characteristic prescutellar yellow and yellow antennae.

Biology.-Larvae form blotch mines on the leaflets of *Vicia americana* Muhl., family Leguminosae.

Geographical distribution.-The members of this species are known only from the type series from Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Banff, 28.vi.1966; Paratype 1 ♂ Blairmore, 27.vi.1966; 1 ♀ Edmonton, University of Alberta Campus, from leaf mines on *Vicia americana* Muhl., 21.ix.1968-13.ii.1969; 1 ♂ Elk Island Park, 31.vii.1966; 3 ♀♀ Jasper, 17-23.vi.1966.

Genus *Lemurimyza* Spencer

Lemurimyza Spencer 1965b : 26.

The main distinguishing characters of the genus *Lemurimyza* Spencer are: subcosta weakly developed distally, joined to costa independent of R_1; costa extended to vein M_{1+2}; orbital setulae normally erect or slightly proclinate; scutellum yellow; mesonotum with yellow central area adjoining scutellum, epandrium normally with comb-like arrangement of dark spines; aedeagus typical of the genus, with paired sclerotized tubules.

The genus *Lemurimyza* Spencer is represented in Alberta by only one species, *L. pallida* Sehgal. The members of this genus are extremely similar to those of the genus *Liriomyza* Mik in external characteristics, but possess very distinct male genitalia.

Lemurimyza pallida Sehgal

Lemurimyza pallida Sehgal 1968 : 72.

Comparisons and diagnostic characters.-The members of this species differ from those of two other species *L. dorsata* (Siebke) and *L. pacifica* (Melander) known from Canada (Spencer 1969), in having third antennal article yellow and distinctive male genitalia. Sehgal (1968) illustrated the head, wing and male genitalia characteristic of this species. Spencer (1969) also illustrated the aedeagus.

Geographical distribution.-The members of this species are known only from the type locality (Sehgal 1968).

Genus *Metopomyza* Enderlein

Metopomyza Enderlein 1936 : 180.

The main distinguishing characters of this genus are subcosta fold like distally and joined to costa independent of R_1; orbital setulae reclinate; costa extended to apex of vein M_{1+2}; scutellum yellow; orbits broad and raised above the plane of frons; aedeagus typical of the genus.

The members of this genus are very similar to those of the genus *Liriomyza* Mik in external morphology, but the male genitalia are very distinct.

This genus is represented in Alberta by two species, *interfrontalis* (Melander) and *griffithsi* new species.

Key to Alberta species of the genus *Metopomyza* Enderlein.

1. Squamal fringe yellow; larger specimens, wing length 2.0-2.3 mm.......*interfrontalis* (Melander) p.136

\- Squamal fringe brown, smaller specimens, wing length 1.5 mm in male..........*griffithsi* n. sp. p.134

Metopomyza griffithsi new species

Comparisons and diagnostic characters.-A member of this species differs from that of *interfrontalis* (Melander) in having smaller size and brown squamal fringe. It resembles that of a Palaearctic species *flavonotata* (Haliday), but possesses distinct male genitalia. This species is distinguished in Spencer's (1969) key to Canadian species of the genus *Metopomyza* Enderlein by amending and extending the couplet 1 as below:

1. Notopleural areas black..1a

\- Notopleural areas yellow..2

1a. Larger specimens, wing length 2.0-2.3 mm; squamal fringe yellow..........*interfrontalis* (Melander)

\- Smaller specimens, wing length 1.5 mm in male; squamal fringe brown.......................................*griffithsi* n. sp.

Description.-Head. Frons approximately 1.8 times width of eye at level of front ocellus, slightly projected in front of eye margin in profile; orbits broad, slightly raised above the plane of frons; eyes oval, strongly slanted along posteroverntral margin, vertical height is almost equal to their length; ocellar triangle small; gena deep, approximately 0.3 times vertical height of eye. Two strong *Ors* directed upwards; two strong *Ori* directed inwards; orbital setulae numerous, reclinate; third antennal article slightly angulate antero-dorsally and rounded below, pubescent.

Mesonotum. Dorsocentrals 3+1 decreasing in length anteriorly, *acr* in 3-4 irregular rows.

Wing. Length in male 1.5 mm; costa extended to vein M_{1+2}; costal segments 2-4 in the ratio of 1 : 0.33 : 0.26; vein M_{1+2} at the wing tip; crossvein m-m present; last segment of M_{3+4} approximately 0.4 times the penultimate.

Male genitalia (Figs. 70-72). Hypandrium with narrow side arms; surstyli (Fig. 70) with two rows of conspicuous spines as illustrated; phallophore long; aedeagus (Fig. 71) typical of the genus; basiphallus broad and sclerotized; mesophallus long and slender; distiphallus as small diverging tubules distally; ejaculatory apodeme (Fig. 72) small and narrow, bulb small, membranous.

Colour. Frons darker below and yellowish above, orbits black; lunule dark; gena greyish black; antennae black; mesonotum mat black, slightly brownish; scutellum almost entirely yellow; mesopleura, sternopleura and pteropleura all black; femora black, with distal tips yellow; tibiae and tarsi brownish black; squamae pale, fringe brownish; halteres yellow.

Derivation of the specific name.-This species is named in honour of G. C. D. Griffiths of the Department of Entomology, University of Alberta, Canada.

Geographical distribution.-A member of this species is known only from the type locality:

CANADA. Alberta : Holotype ♂ Edmonton, White Mud Creek Park, 18.vi.1968, coll. G. C. D. Griffiths.

Metopomyza interfrontalis (Melander)

Agromyza interfrontalis Melander 1913 : 263.

Liriomyza interfrontalis (Melander), Frick 1952 : 403.

Metopomyza interfrontalis (Melander), Frick 1957 : 204, 1959 : 412; Spencer 1969 : 198.

Comparison and diagnostic characters.-The members of this species differ from those of *griffithsi* new species in having larger size and pale squamal fringe. Spencer (1969) illustrated the distinctive aedeagus.

Geographical distribution.-The members of this species are known from Canada and United States. The Alberta locality is:

CANADA. Alberta : Elkwater (Spencer 1969).

Genus *Praspedomyza* Hendel

Dizygomyza (Praspedomyza) Hendel 1931 : 77.

Phytobia (Praspedomyza), Frick 1952 : 395, 1959 : 394.

Praspedomyza Hendel, Spencer 1966b : 146.

Nowakowski (1962) on the basis of his studies on male genitalia proposed that this genus should be merged with the genus *Liriomyza* Mik. Later Spencer (1966b, 1969) in view of the dark colouration, raised orbits and distinct male genitalia justified the retention of *Praspedomyza* Hendel as a distinct genus.

This genus is represented in Canada by only one species, *galiivora* Spencer, the common leaf miner on *Galium*.

Praspedomyza galiivora Spencer

Praspedomyza galiivora Spencer 1969 : 199.

Diagnostic characters.-The members of this species are quite distinctive in having yellow third antennal article and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species. The colour of third antennal article vary slightly from bright yellow to reddish.

Biology.-Larvae mine the leaves of *Galium boreale* L., family Rubiaceae.

Geographical distribution.-The members of this species are known from Europe and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Banff, 28.vi.1966; 1 ♂, 3 ♀♀ Edmonton, White Mud Creek Park, 13-23.vi.1966; 3 ♀♀ same locality, from leaf mines on *Galium boreale* L., coll. 28.vi.1968, emerged 11-12.vii.1968; 1 ♂ same locality and host, coll. 4.ix.1968, emerged 16.ix.1968, coll. G. C. D. Griffiths; 1 ♂ Edmonton River bank near University of Alberta Campus, 14.vi.1969; 4 ♂♂, 1 ♀ Elk Island Park, 31.vii.-2.viii.1966.

Genus *Haplomyza* Hendel

Antineura Melander 1913 : 219.

Haplomyza Hendel 1914 : 73, new name for *Antineura* Melander, not Osten Sacken 1881.

The members of this genus resemble externally those of a large genus *Liriomyza*, but possess distinct male genitalia. They are represented in Alberta by only one species *togata* (Melander).

Haplomyza togata (Melander)

Antineura togata Melander 1913 : 250.

Haplomyza togata (Melander), Frick 1953 : 73, 1959 : 413; Spencer 1969 : 201.

Diagnostic characters.-The main distinguishing characters of the members of this species are wing length 1.75-2.2 mm, costa extended to vein M_{1+2}; crossvein m-m absent; one *Ors* and three *Ori*; eyes slanted; frons, gena, face and antennae yellow; mesonotum mat grey, few acrostichals and distinct male genitalia. The ninth sternite is greatly elongate.

Biology.-Larvae are known to make irregular blotch mines on the leaves of *Amaranthus* spp., family Amaranthaceae, in United States (Frick 1959).

Geographical distribution.-The members of this species are known from United States, and Alberta and Saskatchewan in Canada (Spencer 1969). The Alberta locality is:

CANADA. Alberta : Drumheller.

Genus *Phytoliriomyza* Hendel

Liriomyza (Phytoliriomyza) Hendel : 1921 : 203.

Phytoliriomyza Hendel, Frey 1941 : 19; Frick 1952 : 410; Spencer 1964b : 662.

Xyraeomyia Frick, Spencer 1964b : 662.

The members of this genus differ from those of the genus *Liriomyza* Mik in having dark scutellum and proclinate orbital setulae. They are represented in Alberta by only one species, *arctica* (Lundbeck).

Phytoliriomyza arctica (Lundbeck)

Agromyza arctica Lundbeck 1900 : 304.

Odinia immaculata Coquillett 1902 : 185.

Agromyza formosensis Malloch 1914b: 315.

Dizygomyza (Icteromyza) arctica (Lundbeck); Hendel 1931 : 57.

Phytoliriomyza arctica (Lundbeck); Shewell 1953 : 469; Frick 1959 : 414.

Diagnostic characters.-The main distinguishing characters of the members of this species are: eyes oval, slanted, slightly pilose; acrostichals present; wing length approximately 2.0 mm; costa strongly extended to vein M_{1+2}; crossvein m-m present; and aedeagus with characteristic two long, membranous coiled tubules. Spencer (1963, 1964b, 1969) discussed in detail and illustrated the male genitalia of members of this species.

Biology.-Larvae feed as stem miners on *Sonchus asper* L., family Compositae in Germany (Spencer 1963). No host plant is yet known in

North America.

Geographical distribution.-The members of this species are most widely distributed being known from Europe; Formosa; Canada, United States and South America (Spencer 1963). I examined the following material from Alberta:

CANADA. Alberta : 4 ♂♂ Cypress Hills; near Elkwater Lake; 24.vi.1966.

Genus *Paraphytomyza* Enderlein

Paraphytomyza Enderlein 1936 : 180; Nowakowski 1962 : 102; Spencer 1969 : 203.

Rubiomyza Nowakowski 1962 : 102.

The name *Phytagromyza* Hendel which has long been used (Hendel 1920, 1932; Frick 1952, 1959) for members of this genus, cannot be used now as its type *P. flavocingulata* (Strobl.) is now referred to the genus *Cerodontha* Rondani (Nowakowski 1962, 1967).

The main distinguishing characters of the genus *Paraphytomyza* Enderlein are: subcosta weakly developed distally, joined to costa independent of R_1; orbital setulae erect or reclinate or absent; costa extended to vein R_{4+5}; crossvein m-m usually absent, if present, always beyond the crossvein r-m.

This genus is represented in Alberta by five species. All Alberta species discussed here probably form a single group within the genus *Paraphytomyza* Enderlein, whose members feed on the representatives of the family Caprifoliaceae and other related families of the order Rubiales. Nowakowski (1962) proposed a new genus *Rubiomyza* for this group of flies, which later proved to be synonymous with *Paraphytomyza* Enderlein.

Another group of leaf miners on Salicaceae is probably also represented in Alberta. Linear leaf mines on the under surface of the leaves of *Populus tremuloides* Michx., quite common around Edmonton, are very similar to those of *Paraphytomyza tremulae* (Hering) in Europe on *Populus tremula* L. Since no flies have yet been bred, their identity cannot be confirmed.

Key to Alberta species of the genus *Paraphytomyza* Enderlein

1(0).	Crossvein m-m present..	2
-	Crossvein m-m absent...	4
2(1).	Dorsocentrals two; mouthparts elongate............... .... *nitida* (Malloch) p.145	
-	Dorsocentrals three or more; mouthparts normal.........	3
3(2).	Notopleural areas yellow....... *plagiata* (Melander) p.148	
-	Notopleural areas brownish black..................... ....*lonicerae* (Robineau-Desvoidy) p.144	
4(1).	Small specimens, wing length 1.6-1.8 mm in males; aedeagus as illustrated (Fig. 76)........... *spenceri* n. sp. p.148	
-	Larger specimens, wing length up to 2.4 mm........... ....*orbitalis* (Melander) p.146	

Paraphytomyza lonicerae (Robineau-Desvoidy)

Phytomyza lonicerae Robineau-Desvoidy 1851 : 396.

Phytagromyza lonicerae (Robineau-Desvoidy), Hering 1951 : 36; Frick 1953 : 74.

Paraphytomyza lonicerae (Robineau-Desvoidy), Spencer 1969 : 205.

Comparison and diagnostic characters.-The members of this species are very close to those of *P. orbitalis* (Melander) in the general shape of aedeagus, but differ in lacking crossvein m-m. Spencer (1969) illustrated the aedeagus characteristic of this species. The posterior spiracles on the puparium are distinctive in having a dark spine in centre.

Biology.-Larvae mine the leaves of various members of the genera *Lonicera* and *Symphoricarpos*, family Caprifoliaceae. Frick (1953) reared this species from *Lonicera involucrata* (Richards) Banks and *Symphoricarpos albus* (L.). I observed the leaf mines of this species in Alberta on *Lonicera dioica* L., *L. tartarica* L. and *Symphoricarpos albus* (L.). The leaf mine is whitish, linear with distinct frass granules disposed alternately along the mine. Hering (1951) illustrated the characteristic leaf mine. This species is the first to appear in early spring and there is only one generation a year.

Geographical distribution.-The members of this species are known from Europe, United States and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂ Edmonton, White Mud Creek Park, 19.v.1968. 2 ♂♂, same locality, 7.v.1969.

Paraphytomyza nitida (Malloch)

Agromyza nitida Malloch 1913a : 288, Frick 1952 : 373.
Phytagromyza nitida (Malloch); Frick 1953 : 74; 1959 : 417.
Paraphytomyza nitida (Malloch); Spencer 1969 : 207.

Diagnostic characters.-The members of this species are distinctive in having elongate mouth parts and absence of crossvein m-m. Spencer (1969) illustrated the distinctive aedeagus.

Biology.-Not confirmed. Spencer (1969) noted the similarity between this species and *P. orphana* (Hendel) a stem miner on *Galium* in Europe and has suggested as host one of the *Galium* species occuring in Alberta.

Geographical distribution.-The members of this species are known from United States (Frick 1953, 1959) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Elk Island Park, 7.vi.1966.

Paraphytomyza orbitalis (Melander)

Phytomyza orbitalis Melander 1913 : 271.

Phytagromyza orbitalis (Melander), Frick 1952 : 416, 1959 : 417.

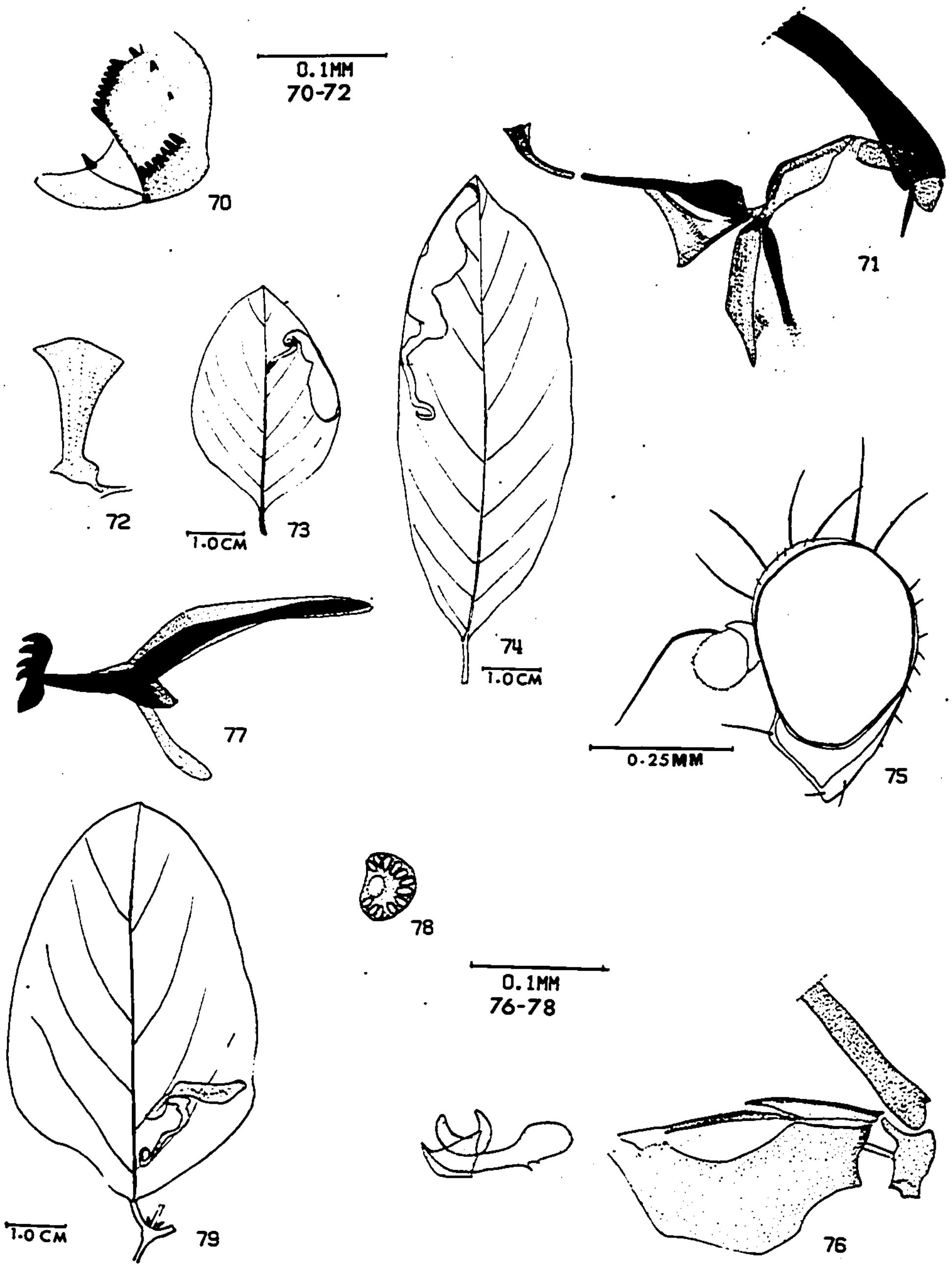
Paraphytomyza orbitalis (Melander), Spencer 1969 : 207.

Comparison and diagnostic characters.-The members of this species resemble externally those of a sympatric species *P. spenceri* new species, but differ in having a distinct aedeagus and larval leaf mine (Fig. 73). The aedeagus has been illustrated by Spencer (1969). The females unless represented by bred series cannot be determined definitely.

Biology.-Larvae mine the leaves of *Lonicera dioica* L. and *Symphoricarpos albus* (L.), family Caprifoliaceae. The leaf mine (Fig. 73) is broad, linear in shape. Pupation occurs outside the leaf mine.

Geographical distribution.-*P. orbitalis* (Melander) is a Nearctic species, whose members are known from United States (Frick 1952, 1959) and Canada (Spencer 1969). I examined 10 males and one female from Alberta:

CANADA. Alberta : 1 ♂ Blairmore, 27.vi.1966; 1 ♂ Edmonton, 24.v.1946, Coll. E.H. Strickland; 1 ♂ Edmonton, University of Alberta Campus, from leaf mines on *Lonicera dioica* L., 29.v.-22.vi.1966; 1 ♀ Edmonton, White Mud Creek Park from leaf mines on *Symphoricarpos*



Figs. 70 - 72. *Metopomyza griffithsi*. 70. surstylus. 71. aedeagus, lateral view. 72. ejaculatory apodeme. Fig. 73. *Paraphytomyza orbitalis*, leaf mine on *Lonicera dioica* L. Fig. 74. *P. plagiata*, leaf mine on *Lonicera involucrata* (Richards) Banks. Figs. 75 - 79. *P. spenceri*. 75. head, lateral view. 76. aedeagus, lateral view. 77. cephalopharyngeal skeleton of larva. 78. posterior spiracle. 79. leaf mine on *Lonicera dioica* L.

albus (L.), coll. 10.vi.1966; 3 ♂♂ same locality, 12-19.vi.1966; 2 ♂♂ same locality, 16.vii.1966; 1 ♂ Edmonton, Mayfair Park, 4.v.1969; 1 ♂ Elk Island Park, 4.vi.1967; 1 ♂ St. Albert, near Edmonton, 14.vi.1966.

Paraphytomyza plagiata (Melander)

Napomyza plagiata Melander 1913 : 273.

Agromyza plagiata (Melander), Malloch 1918 : 130.

Phytagromyza plagiata (Melander), Frick 1952 : 416, 1959 : 417.

Paraphytomyza plagiata (Melander), Spencer 1969 : 208.

Diagnostic characters.-The members of this species can be easily recognised by the characters given in the key.

Biology.-Larvae mine the leaves of *Lonicera involucrata* (Richards) Banks, family Caprifoliaceae. The leaf mine (Fig. 74) is linear and light greenish in colour.

Geographical distribution.-The members of this species are known from United States (Frick 1952) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ George Lake,near Busby, from leaf mines on *Lonicera involucrata* (Richards) Banks, 7.vi.1968 em. 30.iv.1969, coll. G. C. D. Griffiths; 1 ♀ St. Albert, near Edmonton, same host, 14.vi.1966-5.iii.1967; 1 ♀ same locality, 14.vi.1966.

Paraphytomyza spenceri new species

Comparisons and diagnostic characters.-The members of this species resemble externally those of a sympatric species *P. orbitalis* (Melander) and can only be reliably differentiated by the examination of the characters of male genitalia. The females unless from bred series are very difficult to determine definitely. The linear leaf mine of this species (Fig. 79) is similar to that of *P. luteoscutellata* (de Meijere) illustrated by Spencer (1969), but the adults are distinct in having completely black scutellum. This species is distinguished in Spencer's (1969) key to Canadian species of the genus *Paraphytomyza* Enderlein by extending the couplet 5 as below:

5. Scutellum yellow, at least between basal scutellar bristles.. ....*luteoscutellata* (de Meijere)

\- Scutellum entirely dark................................ 5a

5a. Wing length up to 2.0 mm; aedeagus as in Fig. 76....... .... *spenceri* n. sp.

\- Larger species... 6

Description.-Head (Fig. 75). Frons almost equal to width of eye at level of front ocellus; upper orbits slightly projected in front of eye margin in profile; eyes oval, 1.3 times higher than their width, bare; ocellar triangle small; gena deepest posteriorly, approximately one-sixth of eye height mid-way between vibrissal and posterior margins; two strong *Ors* directed upwards; two *Ori* directed inwards; orbital setulae 4-6, reclinate; third antennal article rounded at tip, arista long and pubescent.

Mesonotum. Dorsocentrals 3+1; *acr* numerous in approximately four rows.

Leg. Mid-tibiae without any differentiated bristle medially.

Wing. Length in ♂♂ 1.6-1.8 mm, in ♀♀ approximately 2.0 mm; costa extended to vein R_{4+5}; wing tip between R_{4+5} and M_{1+2}; crossvein m-m absent; costal segments 2-4 in the ratio of 1.0 : 0.23 : 0.28.

Male genitalia (Fig. 76). Hypandrium U-shaped with slender side arms and no apodeme; surstyli broad and rounded, without spines; pregonites broad; postgonites elongate; phallophore short and darkly sclerotized; basiphallus consisting of broad arms; distiphallus removed from basiphallus by a short membranous gap, consisting of two distinctive curved tubes; aedeagal apodeme weakly sclerotized; ejaculatory apodeme small and fan shaped, bulb small and membranous.

Colour. Frons darker above the lunule; orbits yellow; ocellar triangle black; antennae, gena and lunule yellowish brown; mesonotum and scutellum mat grayish black; humeral and notopleural areas yellow; femora dark brown; tibiae and tarsi mostly yellowish or slightly brownish; squame yellow, fringe slightly brownish; halteres yellow.

Description of immature stages.-Puparium brownish yellow, oval and deeply segmented, measures approximately 1.5 mm x 0.8 mm.

Larval mouth parts obtained from puparium are illustrated (Fig. 77). Right mandible larger than left, each with two distinct teeth alternating with one another; labial sclerite short and darkly sclerotized; paraclypeal phragmata with darkly sclerotized dorsal and weakly sclerotized ventral arms.

Muscle scars on abdominal segments small and oval; tubercles numerous in approximately 6-8 rows.

Anterior spiracles small, each with about 6-8 bulbs; posterior spiracles (Fig. 78) small and rounded, each with about 11-12 bulbs.

Derivation of the specific name.-This species is named in honour of Dr. K. A. Spencer, who has contributed greatly to the knowledge of world Agromyzidae.

Biology.-Larvae mine the leaves of *Lonicera dioica* L. and *Symphoricarpos occidentalis* Hook. family Caprifoliaceae. The leaf mine (Fig. 79) is linear, greenish black, without discrete frass granules. Pupation occurs outside the mine.

Geographical distribution.-I examined the members of this species only from the province of Alberta:

CANADA. Alberta : Holotype ♂ Edmonton, White Mud Creek Park, from leaf mine on *Lonicera dioica* L., 21.ix.-10.x.1968; allotype ♀ same locality and host, 21.ix.-22.x.1968; paratypes 2 ♀♀ same locality and host, 21.ix-10.x.1968; 1 ♂ same locality and host, 6.ix.1968-7.ii.1969; 1 ♀ same locality and host, 6.ix.-22.x.1968; 1 ♂, 1 ♀, same locality and host, coll. 6.ix.1968, em, 2.vi.1969; 2 ♂♂ same locality, from leaf mines on *Symphoricarpos occidentalis* Hook., coll. 10.ix.1966, 25.iii.1967 and 2.vi.1967; 4 ♂♂ same locality, 6-23.vi.1966; 1 ♂ same locality, 8.vi.1967; 2 ♂♂, Edmonton, MayFair Park, 17.v.1969; 1 ♂ Drumheller, 14.vi.1946, coll. W. R. M. Mason.

Genus *Pseudonapomyza* Hendel

Pseudonapomyza Hendel 1920 : 115.

The members of this genus differ from those in the genus *Phytomyza* Fallén in having crossvein m-m basal to r-m and reclinate orbital setulae. They are represented in Alberta by two species, *atra* (Meigen) and *lacteipennis* (Malloch).

Key to Alberta species of the genus *Pseudonapomyza* Hendel

1. Mesonotum weakly shining black; tarsi dark brown; wings normal......................... *atra* (Meigen) p.152

– Mesonotum mat gray; tarsi yellow; wings whitish....... ....*lacteipennis* (Malloch) p.153

Pseudonapomyza atra (Meigen)

Phytomyza atra Meigen 1830 : 191.
Pseudonapomyza atra (Meigen); Hendel 1932 : 302; Spencer 1969 : 209.

Comparison and diagnostic characters.-The members of this species are quite distinctive in having angulate third antennal articles. The adults differ from those of similar species *P. lacteipennis* (Malloch) in having dark tarsi and weakly shining black mesonotum.

Biology.-Larvae mine the leaves of grasses (Gramineae).

Geographical distribution.-The members of this species are Holarctic in distribution known from Europe (Hendel 1932), United States

(Frick 1959) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Edmonton, 26.v.1946, coll. R. M. Mason; 1 ♀ Edmonton, University of Alberta Campus from leaf mine on grass; coll. 22.vi.1968, em. 12.vii.1968.

Pseudonapomyza lacteipennis (Malloch)

Phytomyza lacteipennis Malloch 1913b : 152.

Pseudonapomyza lacteipennis (Malloch), Frick 1952 : 419, 1959 : 419; Spencer 1969 : 210.

Diagnostic characters.-The main distinguishing characters are mat greyish mesonotum, yellow tarsi and whitish wings.

Biology.-Larvae probably mine the leaves of grasses (Gramineae).

Geographical distribution.-The members of this species are known from United States and Canada. The Alberta localities are as follows:

CANADA. Alberta : Elkwater; Medicine Hat; Orion (Spencer 1969).

Genus *Napomyza* Westwood

Napomyza Westwood 1840 : 152.

The members of this genus differ from those in the large genus *Phytomyza* Fallén in the presence of crossvein m-m. Male genitalia are, however, distinct. This genus is represented in Alberta by three species.

Key to Alberta species of the genus *Napomyza* Westwood

1(0). Third antennal article with conspicuous pubescence...... .... *plumea* Spencer p.155

– Third antennal article almost bare...................... 2

2(1). Smaller specimens, wing length about 2.5-3.1 mm; distiphallus paler.................. *nugax* Spencer p.155

– Larger specimens, wing length about 3.5-4.5 mm; distiphallus darkly sclerotized.....*immanis* Spencer p.154

Napomyza immanis Spencer

Napomyza immanis Spencer 1969 : 212.

Comparison and diagnostic characters.-The members of this species differ from those of a similar species *nugax* Spencer in larger size, wing length 3.5-4.5 mm; third antennal article slightly less quadrate and aedeagus with darker distiphallus. Spencer (1969) illustrated the distinctive aedeagus.

Geographical distribution.-Known from Alaska, Alberta, Northwest Territories and Yukon Territory. The Alberta locality is as follows:

CANADA. Alberta : Edmonton, White Mud Creek Park (Spencer 1969).

Napomyza nugax Spencer

Napomyza nugax Spencer 1969 : 215.

Comparison and diagnostic characters.-The members of this species differ from those of a similar species *immanis* Spencer in having smaller size, wing length 2.5-3.1 mm; quadrate third antennal segment and paler distal process on the distiphallus. Spencer (1969) illustrated the distinctive aedeagus. They also differ from *lateralis* (Fallén) in having distinct aedeagus.

Geographical distribution.-Known from Alberta, British Columbia, Ontario and Quebec in Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂, 1 ♀ Blairmore, 26.vi.1966.

Napomyza plumea Spencer

Napomyza plumea Spencer 1969 : 217.

Diagnostic characters.-The main distinguishing characters are the pubescent third antennal article and distinct male genitalia. The aedeagus has been illustrated by Spencer (1969).

Geographical distribution.-Known from Alaska, Alberta, British Columbia, Manitoba and Quebec. The Alberta locality is as follows:

CANADA. Alberta : Banff, Mt. Eisenhower (Spencer 1969).

Genus *Phytomyza* Fallén

Phytomyza Fallén 1810 : 21.

The main distinguishing characters of this genus are subcosta weakly developed distally and joined to costa independent of R_1; orbital setulae proclinate; costa extended vein R_{4+5} and crossvein m-m normally absent.

The members of this genus as defined presently on the basis of the direction of orbital setulae and shortened costa, form a very diverse assemblage of many groups. The discovery and use of the characters of male genitalia in agromyzid taxonomy have proved beyond doubt that species extremely similar in external characteristics may have very conspicuous differences in genitalic structures. A close look at any of the recent keys show that many species and even sometimes genera can be distinguished by examination of characters of male genitalia only. Attempts to divide this genus into various groups have not been successful as characters of male genitalia were not taken into consideration. It is not possible to undertake the full scale revision of this genus as at present the phallic structures of numerous species have not been illustrated.

This is the largest genus of agromyzid flies with about 400 described species in the world. Spencer (1969) reported 83 species for Canada, of which he recorded 41 as occurring in Alberta. Sixteen new species are described in this genus here and four additional species are recorded as new to Alberta. *P. flavicornis* Fallén which has been reported as occurring in Alberta (Spencer 1969) is not considered here as the Alberta specimens collected from the same locality as those of Spencer's proved to be a new species *luteiceps* described here, distinguishable from *flavicornis* Fallén in the characters of the male genitalia. This genus is now represented in Alberta by 60 described species and in Canada by 99 species. Necessary amendments to include the further new species in Spencer's (1969) key to Canadian species are given.

Key to Alberta species of the genus *Phytomyza* Fallén

1(0). Frons basically pale, yellow, orange or reddish.......... 2

– Frons basically dark, brown or black.................... 41

2(1). Scutellum all or partially yellow...................... 3

– Scutellum dark, grey or black.......................... 5

3(2). Third antennal article black or dark brown............. 4

– Third antennal article yellow........ *major* Malloch p.201

4(3). Upper *Ors* shorter than lower; aedeagus with up to 8 coils......................... *ranunculi* (Schrank) p.218

– Two *Ors* equal................. *clematiphaga* Spencer p.181

5(2). Femora mostly yellow.................................. 6

– Femora mostly dark, at most with yellow distal tips..... 7

6(5). Third antennal article black....... *miranda* Spencer p.207

– Third antennal article yellow; aedeagus as in Fig. 106.... ....*luteiceps* n. sp. p.198

7(5). Sides of thorax including humeral and notopleural areas yellow.. 8

– Sides of thorax dark, at most upper margins of mesopleura with narrow yellow band................................ 12

8 (7). Third antennal article with normal pubescence.......... 9

– Third antennal article with conspicuously long pubescence.. .... *riparia* n. sp. p.219

9 (8). Upper *Ors* shorter than lower or lacking................ 10

– Two *Ors* equal; hypopleuron and sternopleuron largely yellow.........................*petasiti* Spencer p.214

10(9). Second costal segment two and a half to three times length of fourth.. 11

– Second costal segment longer, approximately four times length of fourth.................. *spondylii* R.-D. p.226

11(10). Second antennal article black; hind margins of eyes black...................... *solidaginivora* Spencer p.224

– Second antennal article yellow; hind margins of eyes yellow........................ *matricariae* Hendel p.202

12(7). Upper *Ors* shorter than lower or lacking................ 13

– Two *Ors* equal.. 19

13(12). Frons partly darkened................*prava* Spencer p.216

– Frons almost entirely yellow........................... 14

14(13). Second costal segment more than three and a half times length of fourth.. 15

– Second costal segment less than three and a half times length of fourth.. 17

15(14). Upper *Ors* present; aedeagus as in Figs. 81, 82........... .... *aquilegioides* n. sp. p.167

– Upper *Ors* invariably lacking; larvae leaf miner on *Heracleum*.. 16

16(15). Second costal segment three and a half times length of fourth............................ *lanati* Spencer p.196

\- Second costal segment four to four and a half times length of fourth.......................... *spondylii* R.-D. p.226

17(14). Upper *Ors* normally lacking.................................. 18

\- Upper *Ors* present; aedeagus as in Figs. 93, 94.. *columbinae* n. sp. p.184

18(17). Second costal segment more than three times length of fourth, approximately 3.3 times; notopleural areas dark; larvae make linear leaf mines on *Aster conspicuus* Lindl................................. *asterophaga* Spencer p.175

\- Second costal segment less than three times length of fourth; notopleural areas yellowish; larvae make linear leaf mines on *Aster ciliolatus* Lindl.. *ciliolati* Spencer p.180

19(12). Third antennal article with conspicuously long pubescence; aedeagus as in Fig. 104............. *lactuca* Frost p.194

\- Third antennal article with normal pubescence............ 20

20(19). Broad epistoma present; gena deeply extended........... 21

\- Mouth margin normal.................................... 24

21(20). Second antennal article black........................... 22

\- Second antennal article yellowish....................... 23

22(21). Larger specimens, wing length 3.0-3.4 mm.. *illustris* Spencer p.192

\- Smaller specimens, wing length about 2.4 mm in male; aedeagus as in Figs. 88, 89... *blairmorensis* n. sp. p.

23(21). Mesonotum light gray................. *lupini* Sehgal p.196

\- Mesonotum darker, blackish gray.. *aquilegiophaga* Spencer p.169

24(20). Acrostichals in 3-6 rows.............................. 25

– Acrostichals at most in 2 rows......................... 31

25(24). Frons slightly darkened above, lunule; aedeagus as in Fig. 126.................. *solidaginophaga* n. sp. p.224

– Frons entirely pale.................................... 26

26(25). Gena deep, approximately one-third to one-half eye height.. 27

– Gena narrower, one-sixth to one-fifth vertical eye height.. 29

27(26). Orbits yellow; third antennal article distinctly elongate....................... *banffensis* Spencer p.175

– Orbits black; third antennal article not so elongate..... 28

28(27). Mesonotum paler grey; frons entirely yellow............. .... *urbana* Spencer p.233

– Mesonotum darker grey; frons slightly brownish yellow.... .... *subtilis* Spencer p.231

29(26). Fore-tibia yellowish; gena approximately one-fifth eye height; aedeagus as in Fig. 133.....*timida* Spencer p.233

– Fore-tibia dark; gena approximately one-sixth eye height; larvae blotch-miners on leaves of *Aquilegia* and *Thalictrum*... 30

30(29). Aedeagus as in Figs. 81, 82...... *aquilegioides* n. sp. p.167

– Aedeagus as figured by Spencer (1969).................... .... *aquilegiana* Frost p.166

31(24). Acrostichals lacking or at most 3-4 isolated hairs present.... 32

– Acrostichals in two rows.............................. 36

32(31). Squamal fringe dark; second costal segment about twice length of fourth.. 34

33(32). Aedeagus with distiphallus distinctly curved (Fig. 123)..... .... *senecionella* n. sp. p.221

– Aedeagus with distiphallus paler and not so curved, as figured by Spencer (1969).........*syngenesiae* (Hardy) p.231

34(32). Second antennal article black; larva leaf miner on *Penstemon*........................ *penstemonis* Spencer p.213

– Second antennal article yellow or slightly brownish...... 35

35(34). Fore-coxae bright yellow; second antennal article yellow............................ *plantaginis* R.-D. p.215

– Fore-coxae dark; second antennal article brownish; aedeagus as in Fig. 91...........*colemanensis* n. sp. p.182

36(31). Fore-coxae dark.. 37

– Fore-coxae yellow....................................... 39

37(36). Squamal fringe dark..................................... 38

– Squamal fringe pale; aedeagus as in Figs. 130, 131......... .... *subalpina* n. sp. p.228

38(37). Aedeagus with distiphallus membranous, as figured by Spencer (1969).................... *fuscula* Zetterstedt p.190

– Aedeagus with distiphallus darkly sclerotized as in Fig. 84; larva leaf miner on *Arnica*.........*arnicivora* n. sp. p.172

39(36). Frons distinctly projected above eyes in profile.........40

– Frons not so projected; aedeagus as in Fig. 114........... .... *misella* Spencer p.207

40(39). Gena deep, about two-third eye height; aedeagus as illustrated (Spencer 1969).......... *subtenella* Frost p.230

– Gena narrower, about one-third eye height; aedeagus as in Fig. 102..................... *jasperensis* n. sp. p.193

41(1). Upper *Ors* shorter than lower or absent................. 42

– Two *Ors* equal.. 50

42(41). Upper *Ors* present.. 43

– Upper *Ors* absent... 48

43(42). Second costal segment more than three times length of fourth... 44

– Second costal segment less than three times length of fourth... 45

44(43). Larva leaf miner on *Aralia*..........*aralivora* Spencer p.171

– Larva leaf miner on *Angelica*.... sp. indet. *(Angelica)* p.234

45(43). Acrostichals in two rows; larvae leaf miner on *Delphinium*...................... *delphinivora* Spencer p.186

– Acrostichals in approximate four irregular rows.......... 46

46(45). Frons partly yellowish.................................. 47

– Frons darker; aedeagus as in Figs. 110, 111; larvae leaf miner on *Mertensia*............. *mertensiae* n. sp. p.203

47(46). Third antennal article small; acrostichals strong......... .... *sehgali* Spencer p.221

– Third antennal article larger, oval; acrostichals normal; larvae blotch-miners on leaves of *Anemone canadensis* L..... .... *prava* Spencer p.216

48(42). Second costal segment more than three times length of fourth; larger specimens, wing length about 2.4 mm; tibiae and tarsi yellowish brown; aedeagus as in Fig. 97.. *edmontonensis* n. sp. p.186

\- Second costal segment less than three times length of fourth; smaller specimens, wing length about 1.6-1.9 mm; tibiae and tarsi dark.. 49

49(48). Frons slightly paler; acrostichals absent; aedeagus with distiphallus straight........*aquilegivora* Spencer p.170

\- Frons darker; acrostichals present; aedeagus with distiphallus wavy................*thalictrivora* Spencer p.232

50(41). Tarsi yellowish brown; larva leaf miner on *Cornus*........ .... *agromyzina* Meigen p.165

\- Tarsi dark brown...51

51(50). Second costal segment at least three times length of fourth...52

\- Second costal segment less than three times length of fourth... 53

52(51). Larger specimens, wing length 2.8-3.3 mm; mesonotum greyish; third antennal article elongate................ .... *involucratae* Spencer p.192

\- Smaller specimens, wing length about 2.7 mm; mesonotum blackish; third antennal article rounded................ .... *milii* Kaltenbach p.206

53(51). Mesonotum brilliantly shining black.........................54

\- Mesonotum distinctly mat, greyish or black................55

54(53). Orbits normal in width; only fore-femur with yellow distal tip.............................. *canadensis* Spencer p.178

– Orbits broad; distal tips of femora variable from yellow to almost black; wing base yellow; aedeagus as in Fig. 116........................... *multifidae* n. sp. p.208

55(53). Third antennal article elongate; frons distinctly projecting above eyes................*cineracea* Hendel p.180

– Third antennal article normal, rounded at tip............ 56

56(55). Acrostichals in two rows................................. 57

– Acrostichals in approximately four irregular rows........ 58

57(56). Second costal segment about one and a quarter times length of fourth; orbits dark.......*lupinivora* Sehgal p.197

– Second costal segment almost equal to fourth; aedeagus as in Fig. 119................... *oxytropidis* n. sp. p.210

58(56). Mesonotum black... 59

– Mesonotum paler, greyish................................. 60

59(58). Gena deep, about one-half of eye height; broad rings below eyes formed by orbits............ *merula* Spencer p.206

– Gena narrower at most one-fourth eye height; aedeagus as in Fig. 99......................... *gregaria* Frick p.191

60(58). Frons distinctly projected; orbits well differentiated..... .... *evanescens* Hendel p.189

– Frons not projected; orbits normal.....................61

61(60). Frons slightly pale above; distiphallus with distinctly curved distal processes, as figured by Spencer (1969)....... .... *queribunda* Spencer p.217

– Frons entirely black..................................62

62(61). Smaller specimens, wing length about 1.75-2.0 mm; aedeagus as figured by Spencer (1969).. *caprifoliae* Spencer p.179

– Larger specimens, wing length 2.0-2.3 mm; aedeagus with smaller hypophallus and stouter distiphallus, as figured by Spencer (1969)..............*periclymeni* de Meijere p.213

Phytomyza agromyzina Meigen

Phytomyza agromyzina Meigen 1830 : 191.

Comparison and diagnostic characters.-The members of this species belong to the group having dark frons and two *Ors* equal. The adults are quite distinctive in having brownish yellow tibiae and tarsi. They resemble those of *P. notopleuralis* Spencer from whom they may be separated by having predominantly dark pleura and distinct male genitalia. Spencer (1969) illustrated the distinctive aedeagus. Other distinguishing characters of the adults are: wing length a approximately 2.0 mm; mesonotum with slight yellow on humeral and notopleural areas; antennae dark; third antennal article rounded apically, with normal pubescence; and dark femora.

Biology.-Larvae make linear mines in the leaves of *Cornus stolonifera* Michx. and *C. canadensis* L., family Cornaceae.

Geographical distribution.-Known from Europe (Hendel 1935) and in the United States from California and Washington (Frick 1959) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, White Mud Creek Park, 19.v.1968; 2 ♂♂ same locality, 10.vi.1968, coll. G.G.D. Griffiths; 2 ♂♂ same locality, 4.v. and 8.vi.1969. Numerous leaf mines around Edmonton on *Cornus stolonifera* Michx.

Phytomyza aquilegiana Frost

Phytomyza aquilegiana Frost 1930 : 459.

Comparison and diagnostic characters.-The members of this species belong to the group having yellow frons; dark scutellum and pleura; third antennal article black, with normal pubescence; two *Ors* equal. The adults resemble those of a sympatric species *P. aquilegioides* new species in external characteristics and can be reliably separated only by examination of male genitalia. Spencer (1969) illustrated the distinctive aedeagus.

Biology.-Larvae make blotch mines in the leaves of *Aquilegia spp*. and *Thalictrum spp*., family Ranunculaceae.

Geographical distribution.-Known from United States (Frick 1959) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Edmonton, University of Alberta Campus, from blotch leaf mines on *Aquilegia sp*. (cultivated), coll. 16-18.vii. 1966, em. 14.iii.1967; numerous leaf mines around Edmonton on *Aquilegia sp*., Yukon Territory : 1 ♂ Lake Teslin from leaf mines on *Aquilegia brevistyla* Hock., coll. 11.viii.1968, em. 10.v.1969, coll. G.C.D. Griffiths.

Phytomyza aquilegioides new species

Comparisons and diagnostic characters.—The members of this species belong to the group characterized by yellow frons; normal mouth margin; dark scutellum; mostly dark femora and pleura; and 3-6 rows of acrostichals. The upper orbital bristles vary in length from almost equal to two-third the length of lower. Therefore, this species has been included in two couplets in Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén as amended below:

19. Only 1 *Ors* present; second costal section at most 3 1/3 times length of fourth................ *asterophaga* Spencer

– Both *Ors* present; second costal section 3½ to 4 times length of fourth.. 19a

19a. Lower *Ors* only slightly weaker than upper; aedeagus as in figures 81, 82...................*aquilegioides* n. sp.

– Invariably small upper *Ors* present; aedeagus not so..... 20

36. Jowls deep, almost ½ eye height; third antennal segment distinctly elongate; aedeagus as illustrated (Spencer (1969)............................... *banffensis* Spencer

– Jowls narrower, about one-sixth eye height; third antennal segment rounded................................ 36a

36a. Aedeagus as illustrated (Spencer 1969)...*aquilegiana* Frost

– Aedeagus as in figures 81, 82........ *aquilegioides* n. sp.

Description.—Head. Frons approximately one and a half times width of eye at level of front ocellus, not projected in front of eye margin in profile. Mouth margin normal; lunule high. Two *Ors*, directed upwards, length of upper *Ors* varies from equal to two-third the length or lower; two *Ori*, directed inwards and upwards, almost equal in size; orbital setulae few 6-7, proclinate. Eyes oval, approximately 1.35 times higher than their length, bare; ocellar triangle small. Gena approximately one-sixth vertical eye height. Third antennal article rounded at tip, with normal pubescence; arista normal, with slightly long pubescence.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* 4-5 irregular rows.

Wing. Length approximately 2.1-2.5 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.28 : 0.27; crossvein m-m absent.

Male genitalia (Figs. 80-82). Hypandrium (Fig. 80) V-shaped, with narrow side arms and short, broad apodeme; pregonites broad; postgonites elongate; surstyli normal; aedeagus (Figs. 81, 82) as illustrated; ejaculatory apodeme small, fan shaped, with small bulb.

Colour. Frons varies from bright yellow to orange; orbits and gena yellow; ocellar triangle weakly shining black; both vertical bristles on dark ground; antennae black; mesonotum, scutellum and pleura mat greyish black; humeral areas with slight yellow; coxae black; femora dark, with yellow on distal tips; tibiae and tarsi yellowish brown; squamae and fringe pale; halteres yellow..

Derivation of the specific name.-The name *aquilegioides* indicates that the members of this species have similar biology to those of *P. aquilegiae* Hardy.

Biology.-Larvae make blotch mines on the leaves of *Aquilegia formosa*

Fisch. and *Thalictrum venulosum* Trel., family Ranunculaceae. Pupation takes place outside the mine. The dark brown puparia measure approximately 1.75 mm x 0.8 mm, and are covered all over with conspicuous tubercles and spines, as in the palaearctic species *P. thalictricola* Hendel.

Geographical distribution.-The members of this species are known only from the localities of their type specimens as below:

CANADA. Alberta : Holotype ♂ Edmonton, White Mud Creek Park, from leaf mines on *Thalictrum venulosum* Trel., coll. 5.ix.1968, em. 5.xii.1968; paratypes 1 ♂ same data, em. 29.xi.1968.

ALASKA. Paratypes 1 ♂, 2 ♀♀ Chilkat, near Haines, from leaf mines on *Aquilegia formosa* Fisch., coll. 29.vi.1968, em. 22.vii.1968, 12.x.1968 and 21.v.1968, coll. G.C.D. Griffiths.

Phytomyza aquilegiophaga Spencer

Phytomyza aquilegiophaga Spencer 1969 : 227.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; mostly dark pleura and femora; third antennal article black, with normal pubescence and broad epistoma. The adults resemble those of *P. lupini* Sehgal but differ in having darker or blackish grey mesonotum and distinct male genitalia. They differ from other related species *P. affinalis* Frost, *P. blairmorensis* new species and *P. illustris* Spencer in having second antennal article yellowish brown. Spencer (1969) illustrated the distinctive aedeagus.

Biology.-Larvae bore inside the stems of *Aquilegia sp.* (cultivated), family Ranunculaceae, and pupate at the stem base. The dark brown pupae can be found during late summer.

Geographical distribution.-The members of this species are known from Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, Aberhart Hospital, University of Alberta, from stem-base of *Aquilegia sp*. (cultivated), coll. 4.ix.1968, em. 3.x.1968; 1 ♂, 3 ♀♀ same locality, swept over *Aquilegia sp*., 1.vi.1967; 2 ♂♂, 1 ♀ same locality, from stem-base of *Aquilegia sp*., coll. 3.ix.1968, em. 26.ix.-26.x.1968, coll. G.C.D. Griffiths.

Phytomyza aquilegivora Spencer

Phytomyza aquilegivora Spencer 1969 : 229.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by dark frons, mesonotum and scutellum; upper *Ors* lacking; essentially dark femora and pleura and second costal segment less than three times length of fourth. The adults resemble those of *P. thalictrivora* Spencer but differ in having yellowish frons and lacking acrostichals. They also differ from the similar species *P. minuscula* Goureau in having very different male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae make linear mines on the leaves of *Aquilegia sp*. (cultivated), family Ranunculaceae. Pupation takes place outside the mine.

Geographical distribution.-The members of this species are known only from the locality of its type series from Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 5 ♂♂ Edmonton, Aberhart Hospital, University of Alberta Campus, swept over *Aquilegia sp.* (cultivated), 25.vi.1969; 1 ♂ same locality, 1.vi.1967; 3 ♂♂ same locality, from leaf mines on *Aquilegia sp.*, coll. 4.ix.1968, em. 16-19.ix.1968, 30.x.1968; 2 ♂♂ Edmonton, Garneau, from same host, coll. 3.ix.1968, em. 15-17.ix. 1968.

Phytomyza aralivora Spencer

Phytomyza aralivora Spencer 1969 : 230.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by dark frons, mesonotum and scutellum; upper *Ors* shorter than lower; and second costal segment more than three times fourth. The adults resemble those of *P. osmorhizae* Spencer but differ in having yellow tarsi and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae make linear mines on the leaves of *Aralia nudicaulis* L., family Araliaceae. Pupation takes place outside the mine.

Geographical distribution.-The members of this species are known only from Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, river bed near University of

Alberta campus, 14.vi.1969; numerous leaf mines around Edmonton and in Elk Island Park on *Aralia nudicaulis* L.

Phytomyza arnicivora new species

Comparison and diagnostic characters.-The main distinguishing characters of the members of this species are pale frons; two equal *Ors*; third antennal article normal; mouth margin normal; mesonotum, pleura and scutellum all mat greyish black; femora black, with slight yellow on distal tips and squamal fringe dark. The adults resemble those of *P. fuscula* Zetterstedt and can be reliably distinguished only by examination of male genitalia. The members of this species are included in Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén by extending the couplet 50 as below:

50. Mesopleura entirely grey.............................. 50a

\- Mesopleura with upper margin narrowly yellow........... 51

50a. Aedeagus with distiphallus membranous, as illustrated (Spencer 1969)...................... *fuscula* Zetterstedt

\- Aedeagus with distiphallus sclerotized, as in figure 84..... .... *arnicivora* n. sp.

Description.-Head. Frons approximately twice width of eye at level of front ocellus, not projected in front of eye margin in profile. Mouth margin normal. Two *Ors*, equal in size, directed upwards; one large *Ori* and a small hair below, directed inwards and upwards; orbital setulae few, approximately 8-9, proclinate. Eyes oval, almost equal in height to their length; ocellar triangle small. Gena approximately one-fourth vertical eye height. Third antennal article rounded at tip, with normal pubescence, arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* in two rows.

Wing. Length in male 2.4 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.3 : 0.5; crossvein m-m absent.

Male genitalia (Figs. 83-85). Hypandrium (Fig. 83) small, side arms broad, no apodeme; pregonites broad; postgonites elongate; surstyli normal; aedeagus complex as illustrated in figure 84; ejaculatory apodeme (Fig. 85) small, bulb small and membranous.

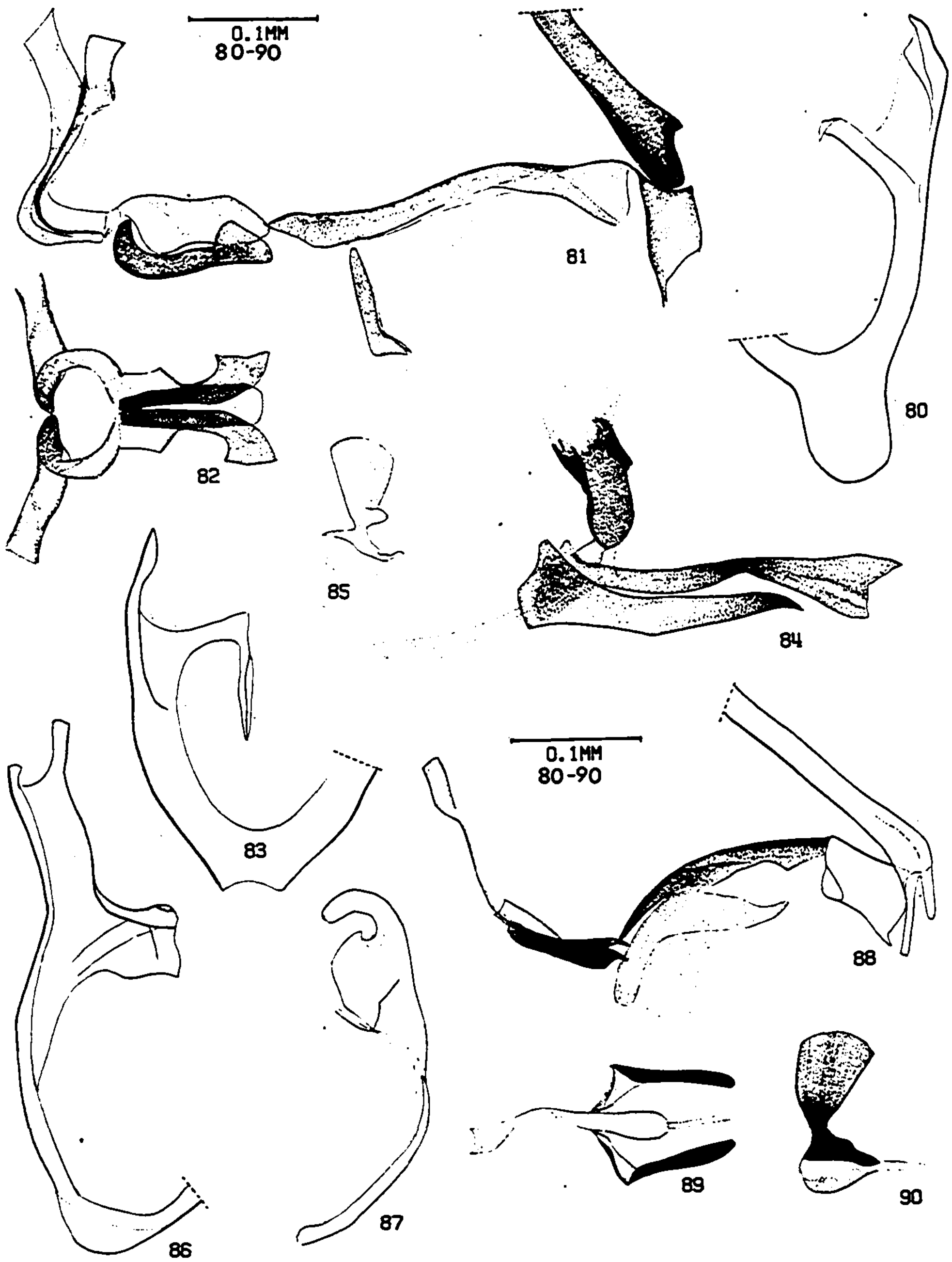
Colour. Frons pale whitish, slightly darkened at centre; orbits pale; gena yellowish; ocellar triangle weakly shining black; *vte* on black and *vti* on margin of dark and yellow grounds; antennae black; mesonotum, scutellum and pleura mat greyish black; coxae black; femora black, with slight yellow on distal tips; tibiae and tarsi black; squamae pale, fringe dark; halteres pale.

Derivation of the specific name.-The members of this species are named after the generic name of their food plant.

Biology.-Larvae make linear leaf mines on *Arnica cordifolia* Hook., family Compositae. Pupation occurs inside the leaf mine and the whitish puparia can be collected during July and August.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Holotype ♂ Jasper National Park, near Medicine Lake; from leaf mines on *Arnica cordifolia* Hook., coll. 16.vii.1969, em. 24.vii.1969, coll. G.C.D. Griffiths; numerous leaf mines on the same host around Jasper.



Figs. 80 - 82. *Phytomyza aquilegioides*. 80. hypandrium. 81. aedeagus, lateral view. 82. distiphallus, ventral view. Figs. 83 - 85. *P. arnicivora*. 83. hypandrium. 84. aedeagus, lateral view. 85. ejaculatory apodeme. Figs. 86 - 90. *P. blairmorensis*. 86. hypandrium. 87. postgonite. 88. aedeagus, lateral view. 89. aedeagus, ventral view. 90. ejaculatory apodeme.

Phytomyza asterophaga Spencer

Phytomyza asterophaga Spencer 1969 : 230.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; essentially dark femora and pleura and upper *Ors* lacking. The adults resemble those of *P. ciliolati* Spencer and differ in having a darker notopleural area and different biology. Spencer (1969) illustrated the aedeagus and leaf mine distinctive of this species.

Biology.-Larvae make linear mines on the leaves of *Aster conspicuus* Lindl., family Compositae. The leaf mines are distinctive in having frass disposed in the form of discrete granules alternately in the mine. Pupation occurs outside the mine.

Geographical distribution.-The members of this species were previously known only from the locality of type series from Western Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Blairmore, 26.vi.1966; 1 ♂ Edmonton, White Mud Creek Park, from leaf mines on *Aster conspicuus* Lindl., coll. 10.ix.1966, em. 8.iii.1967; 2 ♂♂ Elk Island Park, same host, em. 4.vi.1967.

Phytomyza banffensis Spencer

Phytomyza banffensis Spencer 1969 : 231.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; essentially dark scutellum, pleura and femora; acrostichals in 3-6 rows and third antennal article with normal pubescence. The adults resemble those of *P. aquilegiana* Frost and *P. aquilegioides* new species but differ in having deeper gena, approximately one-half of vertical eye height, elongate third antennal segment and distinct male genitalia. Spencer (1969) illustrated the distinctive aedeagus.

Geographical distribution.-The members of this species were previously known only from the locality of its type series from western Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂ Jasper, 17.vi.1966.

Phytomyza blairmorensis new species

Comparison and diagnostic characters.-A member of this species belongs to the group characterized by yellow frons; two equal *Ors*; broad epistoma; normal third antennal segment; dark scutellum and mostly dark femora and pleura. The adult resembles those of *P. lupini* Sehgal and *P. aquilegiophaga* Spencer but differs in having second antennal article black and distinct male genitalia. It also resembles other similar species *P. illustris* Spencer and *P. affinalis* Frost and may be separated from them as shown below in extension to Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén:

29a. Large specimens, wing length 3.0-3.4 mm; normally one *Ors*.................................... *illustris* Spencer

\- Smaller specimens, wing length at most 2.4 mm in male; two *Ors*.. 29b

29b. Frons entirely yellow; aedeagus as illustrated (Spencer 1969).................................. *affinalis* Frost

- Frons slightly darkened; aedeagus as in figures 88, 89 .... *blairmorensis* n. sp.

Description.-Head. Frons approximately two and a half times width of eye at level of front ocellus; orbits broad, distinctly projected in front of eye margin in profile; broad epistoma. Two equal *Ors*, directed upwards; two *Ori*, directed inwards and upwards, lower one weaker than upper; orbital setulae few, 6-7, proclinate. Eyes oval, slightly slanted, their vertical height being approximately 1.25 times their length; ocellar triangle small. Gena approximately 1.25 times their length; ocellar triangle small. Gena approximately one-third vertical eye height. Third antennal article large, circular, with normal pubescence; arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* approximately 8-9, in two rows.

Wing. Length in male approximately 1.75 mm; costa extended to vein R_{4+5}; costal segments 2-4 in ratio of 1 : 0.35 : 0.65; crossvein m-m absent.

Male genitalia (Figs. 86-90). Hypandrium (fig. 86) V-shaped, narrow side arms, no distinct apodeme; pregonites broad; postgonites (Fig. 87) long, with hook-like process anteriorly; aedeagus (Figs. 88, 89) as illustrated; ejaculatory apodeme (Fig. 90) small, well sclerotized, bulb small, membranous.

Colour. Frons yellow, very slightly darkened above; orbits yellow, with slight dark near upper *Ors*; gena and lunule yellow; ocellar triangle weakly shining black; both *Vt's* on dark ground; antennae black; mesonotum, scutellum and pleura mat grey; legs black, only distal tips of femora with slight yellow; squamae pale, fringe brown; halteres yellow.

Derivation of the specific name.-This species is named after the locality of its type specimen.

Geographical distribution.-A member of this species is known only from the type locality:

CANADA. Alberta : Holotype ♂ Blairmore, 26.vi.1966.

Phytomyza canadensis Spencer

Phytomyza canadensis Spencer 1969 : 231.

Comparison and diagnostic characters.-The main distinguishing characters of the members of this species are: dark frons; two equal *Ors*; brilliantly shining black mesonotum and scutellum; acrostichals in approximately two rows; dark tarsi and second costal segment less than three times length of fourth. The adults resemble those of very similar species *P. multifidae* new species but differ in having narrower orbits and different puparia.

Biology.-The larvae were stated by Spencer (1969) to make linear mines in the leaves of *Anemone canadensis* L., family Ranunculaceae. The characteristic leaf mines have been illustrated by Spencer (1969). However a confusion seems to have arisen, since the leaf figured by Spencer is clearly not of this species. Mr. Griffiths and myself have found similar leaf mines only on *Anemone riparia* Fern., never on *A. canadensis* L. The mined leaf figured by Spencer was probably also of *A. riparia* Fern.

Geographical distribution.-The members of this species are known only from Canada from the type locality (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : Numerous empty leaf mines on *Anemone riparia* Fern., Edmonton, White Mud Creek Park, 5-6.ix.1968, and in Elk Island Park.

Phytomyza caprifoliae Spencer

Phytomyza caprifoliae Spencer 1969 : 233.

Comparison and diagnostic characters.-The main distinguishing characters of the members of this species are: frons black, not projected; two equal *Ors*; normal third antennal article; mat grey mesonotum, scutellum and pleura; approximately four rows of *acr*; black tarsi and second costal segment less than three times length of fourth. The adults resemble those of *P. periclymeni* de Meijere and can be reliably separated only by examination of male genitalia. Spencer (1969) illustrated the distinctive aedeagus.

Biology.-Larvae mine the leaves of *Symphoricarpos sp.*, family Caprifoliaceae.

Geographical distribution.-The members of this species are known only from the locality of its type series from Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂, 6 ♀♀ Edmonton, White Mud Creek Park, from leaf mines on *Symphoricarpos sp.*, coll. 10.ix.1966, em. 9.i. 1967 to 7.iii.1967; 2 ♂♂ same locality, 14.v.1968 and 8.vi.1967.

Phytomyza ciliolati Spencer

Phytomyza ciliolati Spencer 1969 : 234.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; essentially dark femora and pleura and upper *Ors* absent. The adults resemble those of *P. asterophaga* Spencer but differ in having yellow on notopleural areas and different biology.

Biology.-Larvae make linear mines on the leaves of *Aster ciliolatus* Lindl., family Compositae. The leaf mines are distinctive in having frass disposed in continuous streaks. Pupation occurs outside the mine. Spencer (1969) illustrated the characteristic leaf mine.

Geographical distribution.-The members of this species are known only from the type locality (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : Numerous leaf mines on *Aster ciliolatus* Lindl. around Edmonton during July and August.

Phytomyza cineracea Hendel

Phytomyza cineracea Hendel 1920 : 160.

Comparison and diagnostic characters.-The main diagnostic characters of the members of this species are: yellowish brown frons; mat grey mesonotum and scutellum; black tarsi and second costal segment approximately two times the length of the fourth. The adults are distinctive in having elongate third antennal article. They differ from those of similar species *P. erigerontophaga* Spencer in having frons distinctly projected above eyes and distinct male genitalia. Griffiths (1968) and Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae of this species feed inside the stems of *Ranunculus spp*., Ranunculaceae (Griffiths 1968).

Geographical distribution.-The members of this species are known from Europe, Iceland (Griffiths 1968) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 8 ♂♂ Blairmore, swept over *Ranunculus acris* L., family Ranunculaceae, 26.vi.1966; 3 ♂♂ Jasper, 16-19.vi.1966.

Phytomyza clematiphaga Spencer

Phytomyza clematiphaga Spencer 1969 : 236.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by yellow frons and partially yellow scutellum. The adults differ from those of *P. major* Malloch in having darker body and black third antennal segment. They differ from those of *P. ranunculi* (Schrank) in having both *Ors* of equal length and distinct male genitalia. Spencer (1969) illustrated the distinctive aedeagus.

Biology.-Larvae make linear mines on the leaves of *Clematis verticellaris* DC, family Ranunculaceae. Pupation occurs inside the leaf mine.

Geographical distribution.-The members of this species are known from Canada only from the type locality. I examined the following material from Alberta:

CANADA. Alberta : Holotype ♂ (in K.A. Spencer's collection) Edmonton, River bed near University of Alberta campus, from leaf mines on *Clematis verticellaris* DC, coll. 26.vii.1966, em. 7.viii. 1966, coll. B. Hocking; paratype 1 ♀ (in K.A. Spencer's collection) Edmonton, University of Alberta campus, from same host, coll. 24. ix.1966, em. 9.x.1966; 2 ♂♂, 4 ♀♀ Edmonton, river bed near University of Alberta campus, same host, coll. 26.vii.1966, em. 6-12.viii.1966, coll. B. Hocking; 4 ♀♀ Edmonton, University of Alberta campus, same host, coll. 23.ix.1966, em. 1.x.1966, 4.ii.1967 and 11.iii.1967.

Phytomyza colemanensis new species

Comparison and diagnostic characters.-A member of this species belongs to the group characterized by yellow frons; two equal *Ors*; mouth margin normal; third antennal article with normal pubescence; dark scutellum; mostly dark femora and pleura; and acrostichals approximately 3-4 scattered hairs. The adult resembles those of *P. penstemonis* Spencer and *P. plantaginis* R.-D. from which it may be separated as shown below in extension to Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén:

41. Fore-coxae essentially dark............................ 41a

\- Fore-coxae conspicuously yellow......... *plantaginis* R.-D.

41a. First and second antennal segment black; aedeagus as illustrated (Spencer 1969)........... *penstemonis* Spencer

\- First and second antennal segment yellowish brown; aedeagus as in figures 91............ *colemanensis* n. sp.

Description.-Head. Frons almost twice the width of eye at level of front ocellus, slightly projected in front of eye margin in profile. Mouth margin normal. Two equal *Ors* directed upwards; one strong *Ori* incurved, one small hair present below *Ori*; orbital setulae only 2, proclinate. Eyes slightly slanted, their vertical height being 1.2 times their length, bare; ocellar triangle small. Gena approximately one-third vertical eye height. Third antennal article with slight angle anterodorsally, with normal pubescence; arista normal, pubescent.

Mesonotum. Dorsocentral 3+1 strong bristles; *acr* few, 3-4 scattered hairs.

Wing. Length in male 1.6 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.3 : 0.7; crossvein m-m absent.

Male genitalia (Fig. 91). Hypandrium U-shaped, with broad side arms; pregonites broad; postgonites elongate, with curved process anteriorly; surstyli normal; aedeagus (Fig. 91) with distinctive hypophallus; ejaculatory apodeme broad, bulb small and membranous.

Colour. Frons, orbits and gena yellow; ocellar triangle weakly shining black; *Vte* on black and *Vti* on margin of dark and yellow ground; first and second antennal articles yellowish brown; third antennal article black; legs black; mesonotum, scutellum and pleura mat greyish; squamae and fringe pale.

Derivation of the specific name.-This species is named *colemanensis* after the name of the type locality.

Geographical distribution.-A member of this species is known only from the type locality:

CANADA. Alberta : Holotype ♂ Coleman, 27.vi.1966.

Phytomyza columbinae new species

Comparison and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; upper *Ors* shorter than lower; dark scutellum; essentially dark femora and pleura. The adults differ from those of the similar species *P. timida* Spencer and may be separated as shown below in extension to Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén:

24. Jowls narrow, 1/5 to ¼ vertical eye height.............. 24a

– Jowls deeper, 1/3 to ½ vertical eye height.............. 25

24a. Fore-tibia yellowish; aedeagus as illustrated (spencer 1969).................................... *timida* Spencer

– Fore-tibia dark; aedeagus as in figures 93, 94............ .... *columbinae* n. sp.

Description.-Head. Frons approximately twice width of eye at level of front ocellus, not projected in front of eye margin in profile. Mouth margin normal; lunule high. Two *Ors*, directed upwards, upper one shorter than lower; two *Ori*, directed inwards and upwards; orbital setulae few 5-6, proclinate. Eyes oval, approximately 1.2 times higher than their width, bare; ocellar triangle small. Gena approximately 0.22 times vertical eye height. Third antennal article rounded at tip, with normal pubescence; arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* in 4-5 irregular rows.

Wing. Length 1.5-1.8 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.33 : 0.4; crossvein m-m absent; wing tip at M_{3+4}.

Male genitalia (Figs. 92-95). Hypandrium (Fig. 92) V-shaped, with small apodeme; pregonites broad; postgonites elongate; surstyli normal; aedeagus (Figs. 93, 94) as illustrated; ejaculatory apodeme (Fig. 95) small, fan-shaped, bulb small, membranous.

Colour. Frons and gena pale; orbits slightly darkened lunule dark; ocellar triangle shining black; antennae black; both *Vt's* on dark ground; mesonotum, scutellum and pleura mat greyish black; legs black; squamae pale, fringe brown; halteres yellow.

Derivation of the specific name.-The members of this species are named *columbinae* after the common name of their food plant Columbine (*Aquilegia*).

Biology.-Larvae make blotch mines in the leaves of *Aquilegia sp.* (cultivated) and *Thalictrum venulosum* Trel., family Ranunculaceae. Pupation occurs outside the mine. The dark brown puparium measures approximately 1.5 mm x 0.75 mm and is densely covered with small spinnules.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Holotype ♂ Edmonton, White Mud Creek Park, from blotch mines on *Thalictrum venulosum* Trel., coll. 6.ix.1968, em. 19.ix.1968; paratypes 2 ♂♂ Edmonton, Aberhart Hospital, University of Alberta campus, from leaf mines on *Aquilegia sp.* (cultivated), coll. 4.ix.1968, em. 18.ix.1968 and 2.ii.1969; 2 ♂♂ same locality, swept over *Aquilegia sp.* , 25.vi.1969; 1 ♂ Edmonton, University of Alberta campus, from leaf mines on *Aquilegia sp.*, coll. 13.vi.1969, em. 17.vi.1969; 2 ♂♂ Edmonton, Rainbow Valley, from leaf mines on *Thalictrum venulosum* Trel., coll. 14.vi.1968.

Phytomyza delphinivora Spencer

Phytomyza delphinivora Spencer 1969 : 238.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by dark frons, mesonotum and scutellum; essentially dark femora and pleura; upper *Ors* shorter than lower and second costal segment less than three times length of fourth. The adults differ from those of the similar species *P. mertensiae* new species and *P. prava* Spencer in having only two rows of acrostichals and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae mine the leaves of *Delphinium sp*. (cultivated), family Ranunculaceae. Spencer (1969) illustrated the characteristic linear mine. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are known only from the type locality (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂ Edmonton, White Mud Creek Park, 28.v. 1967; numerous leaf mines around Edmonton on *Delphinium sp*. (cultivated).

Phytomyza edmontonensis new species

Comparisons and diagnostic characters.-A member of this species belongs to the group characterized by dark frons; upper *Ors* absent; essentially dark femora and pleura; mat greyish black mesonotum and scutellum; and second costal segment more than three times length of fourth. The adult resembles that of *P. modica* Spencer from which it may be separated as shown below in an extension to Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén:

78. Second costal section long, five times length of fourth.................................. *pallipes* Spencer

\- Second costal section shorter, up to three and a half times length of fourth.................................. 78a

78a. Second costal section slightly over three times length of fourth; veins pale; aedeagus as illustrated (Spencer (1969).................................. *modica* Spencer

\- Second costal section three and a half times length of fourth; veins brownish; aedeagus as in figure 97.......... .... *edmontonensis* n. sp.

Description.-Head. Frons approximately twice the width of eye at level of front ocellus, not projected in front of eye margin in profile. One *Ors*, curved upwards; three strong *Ori* directed inwards; orbital setulae numerous, proclinate. Eyes almost circular, their vertical height being 1.1 times their length; ocellar triangle small. Gena narrow, approximately 0.3 times eye height midway between vibrissal and posterior margins. Third antennal article slightly enlarged, rounded at tip, with normal pubescence; arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* in three irregular rows.

Wing. Length in male 2.4 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.26 : 0.3; crossvein m-m absent.

Male genitalia (Figs. 96-98). Hypandrium (Fig. 96) U-shaped, with broad side arms, pregonites elongate; postgonites broad anteriorly and with a small hook; surstyli small; aedeagus (Fig. 97) darkly

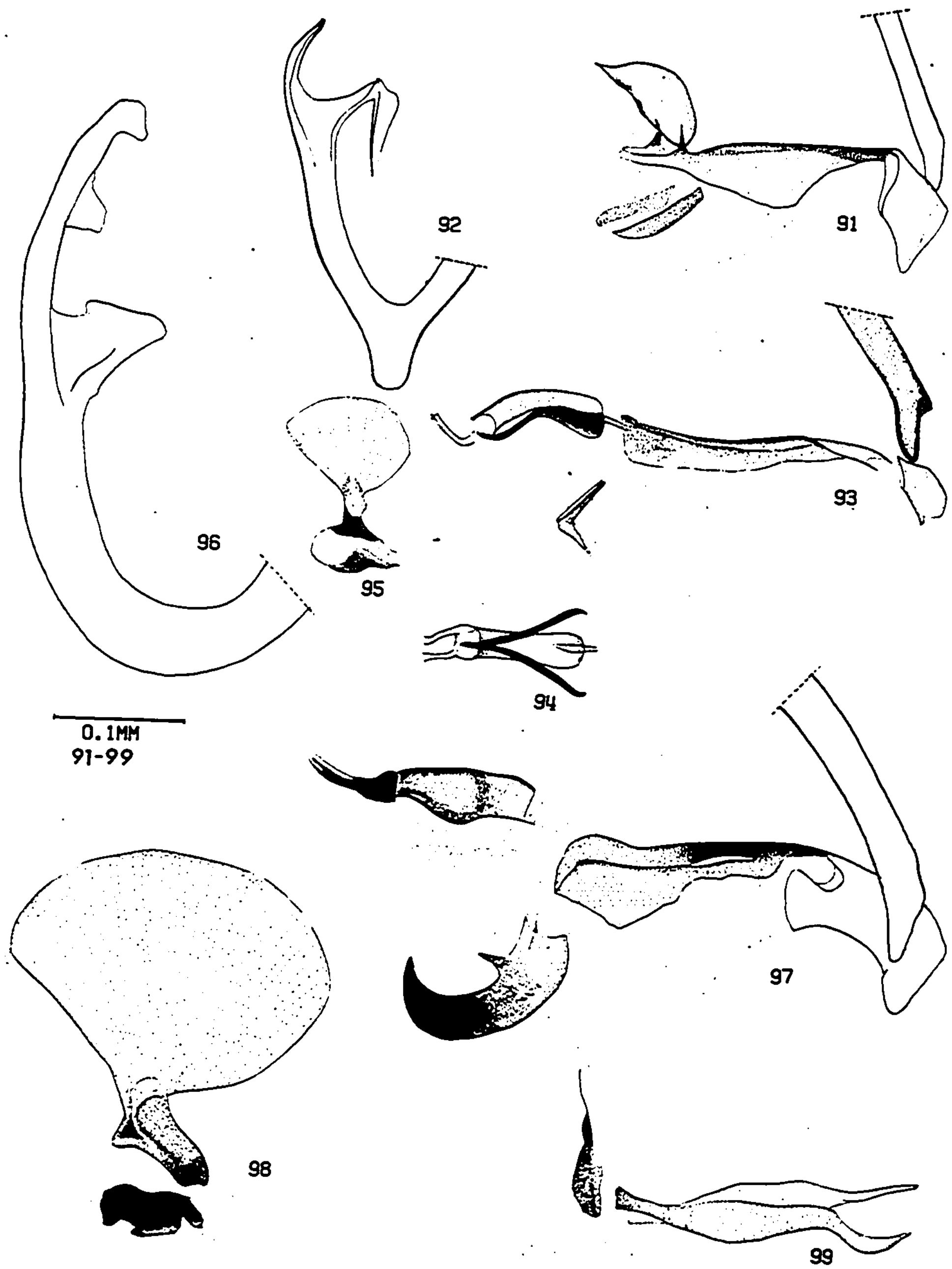


Fig. 91. *Phytomyza colemanensis*, aedeagus, lateral view. Figs. 92 - 95. *P. columbinae*. 92. hypandrium. 93. aedeagus, lateral view. 94. distiphallus, ventral view. 95. ejaculatory apodeme. Figs. 96 - 98. *P. edmontonensis*. 96. hypandrium. 97. aedeagus, lateral view. 98. ejaculatory apodeme. Fig. 99. *P. gregaria*, aedeagus, lateral view.

sclerotized and as illustrated; ejaculatory apodeme (Fig. 99) very broad, bulb small and membranous, the latter with darkly sclerotized areas.

Colour. Frons, orbits and gena brown; ocellar triangle black; mesonotum, scutellum and pleura mat black; femora black, tibiae and tarsi yellowish brown; wing veins brownish; squamae and fringe pale; halteres yellow.

Derivation of the specific name.-This species is named after the type locality.

Geographical distribution.-A member of this species is known only from the type locality:

CANADA. Alberta : Holotype ♂ Edmonton, White Mud Creek Park, 18.vi.1968, coll. G.C.D. Griffiths.

Phytomyza evanescens Hendel

Phytomyza evanescens Hendel 1920 : 167.

Comparisons and diagnostic characters.-The diagnostic characters of the members of this species are: dark frons; two equal *Ors*; normal third antennal article; mat grey mesonotum, scutellum and pleura; dark tarsi; second costal segment less than three times length of fourth and acrostichals in approximately four rows. The adults differ from those of similar species *P. caprifoliae* Spencer, *P. periclymeni* de Meijere and *P. queribunda* Spencer in having frons distinctly projected and characteristic male genitalia. The surstyli have long wing-like processes. Griffiths (1964) illustrated the male genitalia characteristic of this species. Spencer (1969) also figured the aedeagus.

Biology.-Larvae feed inside the stems of *Ranunculus spp.*, family Ranunculaceae (Griffiths 1968).

Geographical distribution.-The members of this species are known from Europe, Iceland, Faroes (Griffiths 1968) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Blairmore, 26.vi.1966; 2 ♂♂ Jasper, 16-19.vi.1966.

Phytomyza fuscula Zetterstedt

Phytomyza fuscula Zetterstedt 1848 : 2831; Spencer 1969 : 242.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; essentially dark femora and pleura; mouth margin normal; third antennal article black, with normal pubescence; two *Ors* equal; *acr* in two well-defined rows and dark fore-coxae.

Spencer (1969) groups this species both under yellow frons and dark frons. The Alberta specimens correspond to the colour form having yellow frons. The aedeagus of Alberta specimens corresponds exactly to that figured by Spencer (1969) including the weakly sclerotized membranous processes in the distiphallus. Griffiths' (1966) description of *fuscula* Zett. from Greenland refers to *puccinelliae* Spencer (see Spencer 1969).

Biology.-Larvae of this species mine the leaves of grasses (Gramineae) in Canada (Spencer 1969).

Geographical distribution.-The members of this species are known from Europe (Hendel 1935) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, University of Alberta campus, 6.vi.1968; 1 ♂ Elk Island Park, 31.vii.1966.

Phytomyza gregaria Frick

Phytomyza gregaria Frick 1954 : 371.

Comparison and diagnostic characters.-The distinguishing characters of the members of this species are: dark frons; two equal *Ors*; normal third antennal article; mat black mesonotum, scutellum and pleura; acrostichals in approximately 4 rows; dark tarsi and second costal segment less than three times length of fourth. The adults resemble those of the similar species *P. periclymeni* de Meijere but differ in having darker mesonotum; narrower gena, approximately one-fourth eye height and distinct male genitalia. The aedeagus of an Alberta specimen is illustrated in figure 99. Spencer (1969) also illustrated the aedeagus.

Biology.-The larvae mine the leaves of *Lonicera involucrata* (Richards) Banks, family Caprifoliaceae.

Geographical distribution.-The members of this species are known from United States (Frick 1959) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ St. Albert, near Edmonton, 18.vi.1967; numerous leaf mines on *Lonicera involucrata* (Richards) Banks around Edmonton.

Phytomyza illustris Spencer

Phytomyza illustris Spencer 1969 : 247.

Comparison and diagnostic characters.- The members of this species differ from those of similar species *blairmorensis* new species and *affinalis* Frost in larger size, wing length 3.0-3.4 mm and normally only one *Ors*. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-Known from Alberta, British Columbia and Yukon Territory. The Alberta locality is:

CANADA. Alberta : Blairmore (Spencer 1969).

Phytomyza involucratae Spencer

Phytomyza involucratae Spencer 1969 : 249.

Comparison and diagnostic characters.-The members of this species differ from those of a similar species *milii* Kaltenbach in having larger size, wing length 2.8-3.3 mm, grey mesonotum and third antennal article large and elongate. Spencer (1969) illustrated the distinctive aedeagus.

Geographical distribution.-Known from Alberta and British Columbia. The Alberta locality is:

CANADA. Alberta : Frank; St. Albert.

The following type specimen was examined:

CANADA. British Columbia : Paratype 1 ♂, Prince George, 17.vi. 1966, coll. K.A. Spencer.

Phytomyza jasperensis new species

Comparisons and diagnostic characters.-A member of this species belongs to the group characterized by yellow frons; normal mouth margin and third antennal article; two equal *Ors*; dark scutellum; mostly dark femora and pleura and acrostichals in two rows. The adult resembles that of *P. pedicularicaulis* Spencer and can be reliably separated only by examination of male genitalia. This species may be included in Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén by amending couplet 43 and extending 44 as below:

43. Frons strongly projected above eyes; jowls conspicuously deep, two-third eye height.............. *subtenella* Frost

\- Frons less projected; jowls at most one-half eye height..44

44. Arista conspicuously thickened basally...................44a

\- Arista more slender, normal..............................45

44a. Aedeagus as illustrated (Spencer 1969)...................... .... *pedicularicaulis* Spencer

\- Aedeagus as in figure 102............. *jasperensis* n. sp.

Description.-Head. Frons approximately two and a half times width of eye at level of front ocellus, projected in front of eye margin in profile. Mouth margin normal. Two equal *Ors* directed upwards; two *Ori*, lower one smaller than upper, incurved; orbital setulae few, approximately 8, proclinate. Eyes oval, their vertical height being 1.3 times their length, bare; ocellar triangle small. Gena approximately one-third eye height. Third antennal article rounded at tip, with normal pubescence; arista slightly thickened at base, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* in two rows.

Wing. Length in male 2.6 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.27 : 0.45; crossvein m-m absent.

Male genitalia (Figs. 100-103). Hypandrium (Fig. 100) V-shaped, with narrow side arms; pregonites broad; postgonites (Fig. 101) long, with hook-like process anteriorly; surstyli normal; aedeagal apodeme exceptionally long; aedeagus (Fig. 102) relatively short and as illustrated; ejaculatory apodeme (Fig. 103) broad, bulb small and membranous.

Colour. Frons, orbits and gena bright yellow; maxillary palpi black; ocellar triangle weakly shining black; lunule yellow; both *Vt's* on dark ground; first antennal article yellowish, second and third articles black; mesonotum, scutellum and pleura mat grey; only mesopleura with narrow yellow band along upper margin; legs with fore-coxae yellowish, femora dark with yellow on distal tips, tibiae and tarsi black; squamae yellow, fringe brownish; halteres yellow.

Derivation of the specific name.-The species is named *jasperensis* after the name of the type locality.

Geographical distribution.-This species is known only from the following locality:

CANADA. Alberta : Holotype ♂ Jasper, 17.vi.1966.

Phytomyza lactuca Frost

Phytomyza lactuca Frost : 1924 : 85.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; essentially dark pleura and femora; and two *Ors* equal. The adults differ from all other species in this group by having conspicuously long pubescence on the third antennal article and distinct male genitalia. The aedeagus of an Alberta specimen bred from *Crepis tectorum* L. is illustrated in figure 104. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae make long linear mines, usually on under surface of the leaves of *Taraxacum officinale* Weber, *Crepis tectorum* L. and *Sonchus uliginosus* Bieb., family Compositae. Larvae are also known to mine the leaves of *Lactuca scariola* var. *integrifolia* (Bogenh.) G. Beck in Pennsylvania, U.S.A. (Frost 1924).

Geographical distribution.-The members of this species are known from United States (Frick 1959) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Blairmore, 28.vi.1966; 1 ♂ Edmonton, River bed near University of Alberta campus, from leaf mines on *Crepis tectorum* L., coll. 15.vi.1969 em. 12.vi.1969; 1 ♀ same locality, from leaf mines on *Sonchus uliginosus* Bieb., coll. 15.vi.1969, em. 6.vii.1969; 3 ♀♀ Edmonton, University of Alberta campus, from leaf mines on *Taraxacum officinale* Weber, coll. 7.x.1966, em. 19.xii.1966 and 5-6.iii.1967; 2 ♂♂ and 2 ♀♀ Waterton National Park, same host, coll. 6.ix.1966, em. 10-22.ix.1966 and 25.ii.1967.

Phytomyza lanati Spencer

Phytomyza lanati Spencer 1969 : 250.

Comparison and diagnostic characters.-The members of this species differ from those of a similar species *spondylii* R.-D. in having second costal segment shorter, about three and a half times length of fourth. These specimens cannot be satisfactorily separated on the basis of external characteristics alone; however, the male genitalia are distinct. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae mine leaves of *Heracleum*, family Umbellifereae. Details of leaf mine not known (Spencer 1969).

Geographical distribution.-The members of this species are known from California in United States and Alberta in Canada. The Alberta locality is:

CANADA. Alberta : Jasper (Spencer 1969).

Phytomyza lupini Sehgal

Phytomyza lupini Sehgal 1968 : 73.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; mostly dark pleura and femora; two *Ors* equal; third antennal article black, with normal pubescence and broad epistoma. The adults resemble those of *P. aquilegiophaga* Spencer and differ in having slightly paler grey mesonotum and distinct male genitalia. They differ from another similar species, *P. blairmorensis* new species, in having the second antennal article yellowish brown and distinct male genitalia. Sehgal (1968) illustrated the head, wing and male genitalia characteristic of this species. Spencer (1969) also illustrated the aedeagus.

Biology.-Larvae bore inside the stems of *Lupinus sericeus* Pursh, family Leguminosae. The pale whitish puparia are found inside the stems. The puparia are characteristic in having a small horn in the posterior spiracles.

Geographical distribution.-The members of this species are known only from western Canada: Alberta and British Columbia (Sehgal 1968). The material examined remain the same as reported earlier (Sehgal 1968).

Phytomyza lupinivora Sehgal

Phytomyza lupinivora Sehgal 1968 : 74.

Comparison and diagnostic characters.-The main distinguishing characters of the member of this species are: dark frons; distinctly mat greyish mesonotum and scutellum; dark tarsi; normal third antennal article and acrostichals in two rows. The adult resembles that of *P. oxytropidis* new species from which it is separated by having slightly longer second costal segment, approximately one and a quarter times the length of the fourth, and darker orbits. Sehgal (1968) illustrated the head and wing characteristic of this species.

Biology.-Larvae make linear mines on the leaves of *Lupinus sericeus* Pursh, family Leguminosae. Pupation occurs outside the mine.

Geographical distribution.-A member of this species is known only from the type locality:

CANADA. Alberta : Blairmore (Sehgal 1968).

Phytomyza luteiceps new species

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum and yellow femora. The adults resemble those of *P. flavicornis* Fallén and can be separated reliably only by examination of characters of the male genitalia. Spencer (1965, 1969) illustrated the aedeagus of *P. flavicornis* Fallén. It is doubtful at present if the true *P. flavicornis* Fallén occurs in Alberta. This species is included in Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén, by amending and extending the couplet 10 as below:

10. All coxae yellow; jowls exceptionally deep at rear, at least two-third of eye height.......................... 10a

\- Mid- and hind-coxae black................. *rufipes* Meigen

10a. Mesonotum black, weakly shining; aedeagus as illustrated (Spencer 1969)........................ *flavicornis* Fallén

\- Mesonotum mat greyish black; aedeagus as in figure 106....... .... *luteiceps* n. sp.

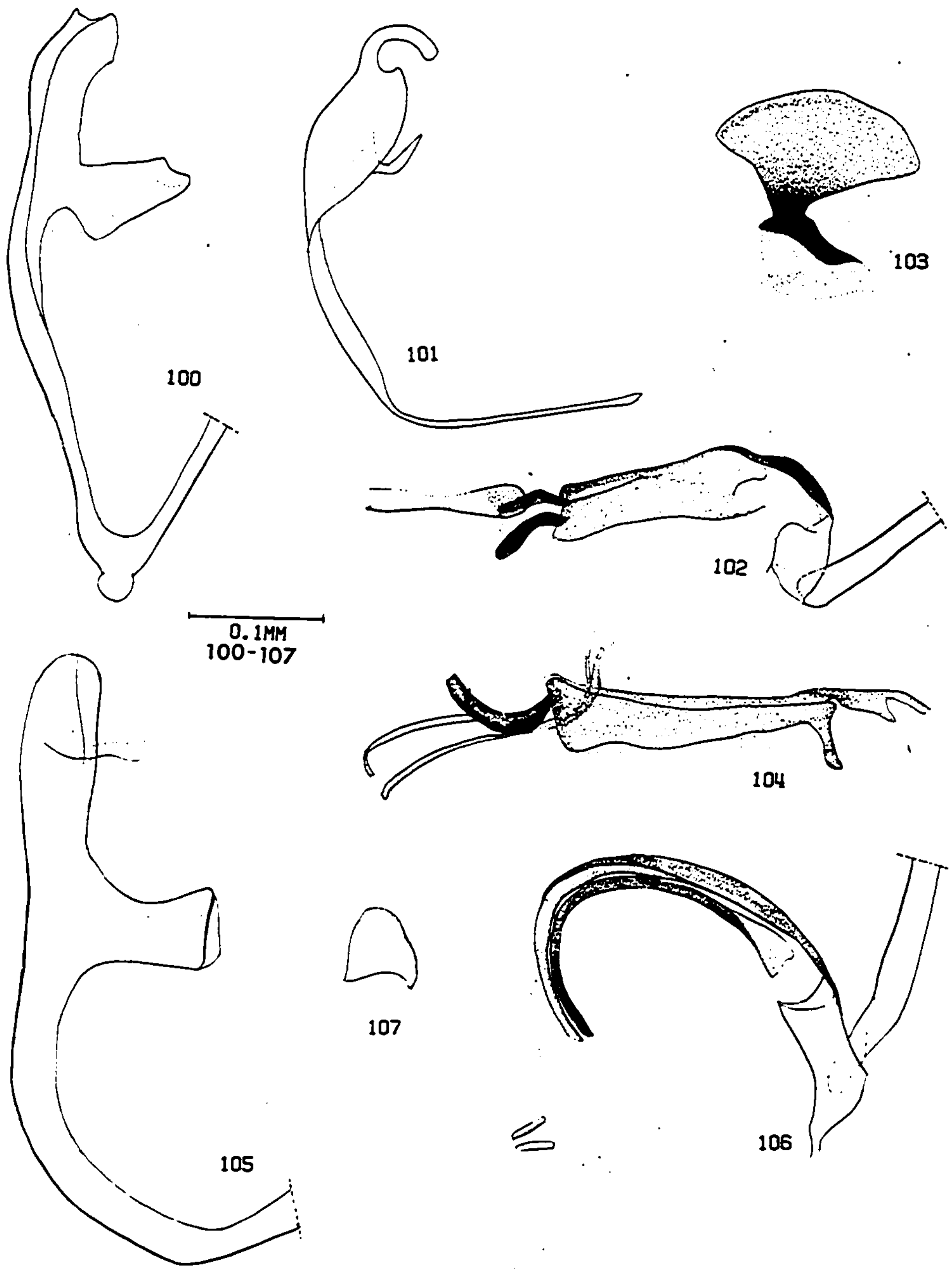
Description.-Head. Frons wide, little more than three times width of eye at level of front ocellus, conspicuously projected in front of eye margin in profile. Broad epistoma present; lunule low. One strong *Ors* and three strong *Ori*; orbital setulae 10-11, proclinate. Eyes oval and slanting; their vertical height being almost equal to their length, bare; ocellar triangle small. Gena deep, approximately 0.7 times vertical eye height. Third antennal article rounded at tip, with short upcurved pubescence; arista normal and pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* in approximately two rows.

Wing. Length 2.5 to 2.8 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.3 : 0.4; crossvein m-m absent.

Male genitalia (Figs. 105-107). Hypandrium (Fig. 105) almost circular below, with broad arms as illustrated; pregonites broad; postgonites long with small process anteriorly; aedeagus (Fig. 106) as illustrated; ejaculatory apodeme (Fig. 107) short, bulb small.

Colour. Frons bright yellow; orbits and gena yellow; *Vte* on



Figs. 100 - 103. *Phytomyza jasperensis*. 100. hypandrium. 101. postgonite. 102. aedeagus, lateral view. 103. aedeagus, ventral view. Fig. 104. *P. lactuca*, aedeagus, lateral view. Figs. 105 - 107. *P. luteiceps*. 105. hypandrium. 106. aedeagus, lateral view. 107. ejaculatory apodeme.

black and *Vti* on yellow ground; ocellar triangle shining black; lunule yellow; antennae completely yellow; arista brown; mesonotum and scutellum mat grey; humeral and notopleural areas yellow; sternopleura slightly brownish at base; meso- and pteropleura yellow; legs with coxae, femora and tibiae yellow, tarsi slightly brownish; squamae yellow, fringe brown; halteres yellow.

Derivation of the specific name.-This species is named *luteiceps* because of mostly yellow head.

Biology.-Not confirmed, but the larvae will probably prove to be feeder in stems of *Urtica*, family Urticaceae.

Geographical distribution.-The members of this species are known only from the localities of its type series as below:

CANADA. Alberta : Holotype ♂ St. Albert, near Edmonton, 14.vi. 1966; allotype ♀ same data; paratypes 3 ♂♂, 3 ♀♀ same data; 2 ♂♂ Jasper, 16.vi.1966.

Phytomyza major Malloch

Phytomyza major Malloch 1913b : 150.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons and yellow scutellum. The adults differ from those of other species in this group, *P. clematiphaga* Spencer and *P. ranunculi* (Schrank) in having a mostly yellow body, yellow third antennal article and distinct male genitalia. The adults are largely yellow flies, wing length approximately 4.0 mm. Spencer (1969) illustrated the distinctive aedeagus. The aedeagus of an Alberta specimen is as in the figure 108.

Geographical distribution.-The members of this species are known from Labrador (Frick 1959) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂, 1 ♀ Banff, 14.vii.1949, coll. E.H. Strickland; 1 ♀ George Lake, near Busby, University of Alberta, Entomology Dept. Field Station, Malaise Trap Collection, 17-21.vi.1966, coll. P. Graham.

Phytomyza matricariae Hendel

Phytomyza matricariae Hendel 1920 : 161; Spencer 1969 : 254.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; essentially dark femora; upper *Ors* shorter than lower; and with slight yellow on upper parts of mesopleura, humeral and notopleural areas. The adults resemble those of *P. spondylii* R.-D. but differ in having the second costal segment shorter, approximately three times the length of the fourth and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-In Alberta the larvae make linear mines in the leaves of *Achillea millefolium* L., *A. sibirica* Ledeb., *Chrysanthemum sp.* (cultivated), *Matricaria matricarioides* (Less.) Porter, and *Tanacetum vulgare* L., belonging to the family Compositae. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are known from Europe (Hendel 1935) and Canada (Spencer 1969). I examined numerous specimens bred from all hosts listed above from various localities around Edmonton.

Phytomyza mertensiae new species

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by dark frons; upper *Ors* shorter than lower; dark mesonotum and scutellum; essentially dark femora and pleura; and second costal segment less than three times length of fourth. The adults differ from those of the similar species *P. prava* Spencer and *P. sehgali* Spencer in having darker frons and distinct male genitalia. This species is included in Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén by amending and extending couplet 88 as below:

88. Third antennal article distinctly enlarged.. *nepetae* Hendel

\- Third antennal article small........................... 88a

88a. Frons paler, brownish above; *acr* strong...*sehgali* Spencer

\- Frons dark brown; *acr* normal; aedeagus as in figures 110, 111.................................. *mertensiae* n. sp.

Description.-Head. Frons approximately two and a half times width of eye level of front ocellus, slightly projected in front of eye margin in profile. Mouth margin normal; lunule high. Two *Ors*, directed upwards, upper smaller than lower; two *Ori*, directed inwards and upwards, lower one weaker than upper; orbital setulae few, approximately 6-7, proclinate. Eyes oval, approximately 1.17 times higher than their length, bare; ocellar triangle small. Gena approximately 0.22 times vertical eye height. Third antennal article normal, rounded at tip; arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* in four irregular rows.

Wing. Length approximately 2.0 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.32 : 0.35; crossvein m-m absent.

Male genitalia (Figs. 109-112). Hypandrium (Fig. 109) small, V-shaped, with broad side arms; pregonites broad; postgonites elongate; surstyli normal; aedeagus (Figs. 110,111) complex as illustrated; ejaculatory apodeme (Fig. 112) broad, bulb small and membranous.

Colour. Frons, orbits, gena and lunule dark brown; ocellar triangle weakly shining black; antennae black; mesonotum, scutellum and pleura mat greyish black; coxae black; femora black, with yellow on distal tips; tibiae and tarsi dark brown; squamae yellow, fringe brown; halteres pale.

Derivation of the specific name.-The members of this species are named after the generic name of their food plant.

Biology.-Larvae make linear mines in the leaves of *Mertensia paniculata* (Ait.) G. Don, family Boraginaceae. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Holotype ♂ Edmonton, White Mud Creek Park, from leaf mines on *Mertensia paniculata* (Ait.) G. Don, coll. 10.ix. 1966, em. 10.iii.1967; paratypes 1 ♀ same data; 1 ♂ same locality, 8.vi.1967.

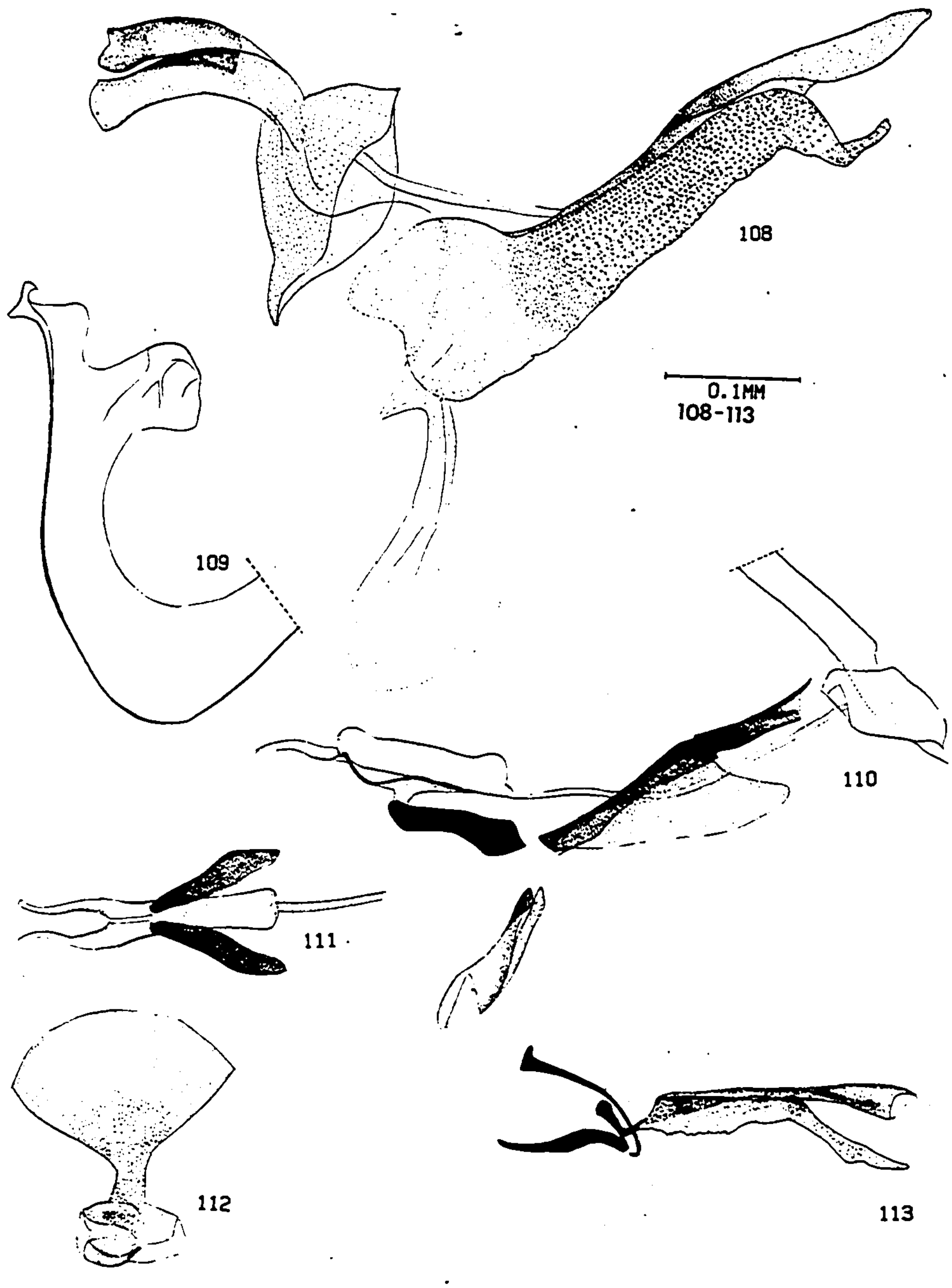


Fig. 108. *Phytomyza major*, aedeagus, lateral view. Figs. 109 - 112. *P. mertensiae*. 109. hypandrium. 110. aedeagus, lateral view. 111. distiphallus, ventral view. 112. ejaculatory apodeme. Fig. 113. *P. milii*, aedeagus, lateral view.

Phytomyza merula Spencer

Phytomyza merula Spencer 1969 : 254.

Comparison and diagnostic characters.-The members of this species differ from those of a very similar species *gregaria* Frick in having deeper gena, about one-half eye height and orbits in form of a broad ring below eyes. Spencer (1969) illustrated the distinctive aedeagus.

Geographical distribution.-Known only from Alberta, Canada from the following locality:

CANADA. Alberta : Jasper (Spencer 1969).

Phytomyza milii Kaltenbach

Phytomyza milii Kaltenbach 1864 : 248; Spencer 1969 : 255.
Phytomyza intermedia (Spencer); Griffiths 1964 : 405.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by dark frons; mat black mesonotum and scutellum; two equal *Ors* black tarsi and second costal segment at least three times the length of the fourth. The adults resemble those of *P. involucratae* Spencer and can be reliably separated only by examination of male genitalia. The sclerotization of distiphallus varies in this species (Griffiths 1964). The aedeagus of an Alberta specimen is as illustrated in figure 113. Griffiths (1964) illustrated the aedeagus of European and Faroese specimens. Spencer (1969) also illustrated the aedeagus.

Biology.-Larvae probably mine the leaves of grasses (Gramineae) in Alberta.

Geographical distribution.-The members of this species are known from Europe, Iceland, Faroes (Griffiths 1964) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Banff, 3.ix.1966; 2 ♂♂ Jasper, 1-2. ix.1966; 3 ♂♂ Jasper, Mt. Edith Cavell, 1.ix.1966.

Phytomyza miranda Spencer

Phytomyza miranda Spencer 1969 : 255.

Comparison and diagnostic characters.-The members of this species differ from those of a similar species *luteiceps* new species in having black third antennal article. The elongate surstyli and aedeagus as figured by Spencer (1969) are quite distinct.

Geographical distribution.-The members of this species are known only from Alberta, Canada from the following locality:

CANADA. Alberta : Blairmore (Spencer 1969).

Phytomyza misella Spencer

Phytomyza misella Spencer 1969 : 256.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; normal mouth margin and third antennal article; two equal *Ors*; essentially dark femora and pleura; acrostichals in two rows; and yellow fore-coxae. The adults differ from those of the similar species *P. subtenella* Frost by having frons less projected,narrower gena and distinct aedeagus. They also resemble those of *P. pedicularicaulis* Spencer and *P. jasperensis* new species but have entirely different male genitalia. The aedeagus of an Alberta specimen is illustrated (Fig. 114). Spencer (1969) also illustrated the aedeagus.

Geographical distribution.-The members of this species are known only from western Canada from the type locality (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 4 ♂♂ Jasper, 17.vi.1966.

Phytomyza multifidae new species

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by dark frons; two equal *Ors*; brilliantly shining black mesonotum, scutellum and pleura; and second costal segment less than three times length of fourth. The members of this species were included in Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén at couplet 61 as *Phytomyza sp.* (Sehgal). This couplet is amended as below:

61. Orbits normal in width; only fore knees yellowish.......... .... *canadensis* Spencer

\- Orbits broad; knees variable from yellow to almost dark; wing base yellow; aedeagus as in figure 116............. .... *multifidae* n. sp.

Description.-Head. Frons approximately 1.6 times width of eye at level of front ocellus, not projected in front of eye margin in profile. Mouth margin normal; lunule low. Two *Ors*, directed upwards, equal in size; two *Ori*, directed inwards, the lower one smaller than upper; orbital setulae few, approximately 7-8, proclinate. Eyes almost circular, approximately 1.1 times higher than their length, bare; ocellar triangle small. Gena approximately one-third vertical eye height. Third antennal article rounded at tip, with normal pubescence; arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* in 3-4 irregular rows.

Wing. Length 1.5-1.6 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.33 : 0.66; crossvein m-m absent; M_{3+4} at wing tip.

Male genitalia (Figs. 115-117). Hypandrium (Fig. 115) small, V-shaped; pregonites broad; postgonites elongate; surstyli normal; aedeagus (Fig. 116) complex, as illustrated; ejaculatory apodeme (Fig. 117) small, fan-shaped, bulb small, membranous.

Colour. Frons, orbits, gena and lunule dark; ocellar triangle shining black; antennae black; mesonotum, scutellum and pleura shining black; legs black; distal tips of femora in females bright yellow, but in male dark; wing base yellow; squamae and fringe pale; halteres bright yellow.

Derivation of the specific name.-This species is named after the specific epithet of its food plant *Anemone multifida* Poir.

Biology.-Larvae make linear mines in the leaves of *Anemone multifida* Poir., family Ranunculaceae. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Holotype ♂ Tolman bridge, Red Deer Valley (Badlands), from leaf mines on *Anemone multifida* Poir., coll.14.vi.1969, em. 8.vii.1969; paratypes 2 ♀♀ same locality and host, em. 5.vii. 1969; coll. G.C.D. Griffiths.

Phytomyza oxytropidis new species

Comparison and diagnostic characters.-The members of this species belong to the group characterized by dark frons; two equal *Ors*; normal third antennal article; mat greyish black mesonotum and scutellum; two rows of acrostichals; and dark tarsi. The adults resemble the member of *P. lupinivora* Sehgal from which they may be separated as shown below in extension to Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén.

65. Second costal section short; less than 1¼ times length of fourth 65a

\- Second costal section longer, at least 1½ times length of fourth 66

65a. Second costal section approximately 1¼ times length of fourth; orbits dark .... *lupinivora* Sehgal

\- Second costal section almost equal to fourth; orbits yellowish ....*oxytropidis* n. sp.

Description.-Head. Frons approximately twice the width of eye at level of front ocellus, slightly projected in front of eye margin in profile. Two *Ors* equal in size, directed upwards; two *Ori*, lower one smaller than upper, directed inwards; orbital setulae few, 6-7, proclinate. Eyes oval, approximately 1.2 times higher than their length; ocellar triangle small. Third antennal article rounded at tip, with normal pubescence; arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* few, 3-6 scattered hairs.

Wing. Length in male 1.6 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.5 : 0.93; crossvein m-m absent; M_{3+4} at wing tip.

Male genitalia (Figs. 118-120). Hypandrium (Fig. 118) with broad side arms and conspicuously long apodeme; pregonites broad; postgonites elongate and broad anteriorly; surstyli small, without any big spines; aedeagus (Fig. 119) with characteristic long spines between two long, darkly sclerotized arms of basiphallus; distiphallus separated by a small membranous section; ejaculatory apodeme (Fig. 120) broad, bulb small.

Colour. Frons, gena, lunule and antennae all black; orbits slightly yellowish in most specimens; ocellar triangle weakly shining black; legs black; mesonotum, scutellum and pleura mat greyish black.

Derivation of the specific name.-The members of this species are named *oxytropidis* after the generic name of their food plant.

Biology.-Larvae make linear mines on the leaflets of *Oxytropis splendens* Dougl. and *O. campestris gracilis* (A. Nels.), family Leguminosae. Pupation occurs inside the leaf mine.

Geographical distribution.-The members of this species are known only from the localities of its type specimens as below:

CANADA. Alberta : Holotype ♂ Jasper, 5 miles south of Athabasca Falls, from leaf mines on *Oxytropis splendens* Dougl., coll. 15.x.1967, em.iv.1968; paratypes 1 ♂, 2 ♀♀ same data. Yukon Territory : 1 ♂ Lake Laberge, from leaf mines on *Oxytropis campestris gracilis* (A. Nels.), coll. 9.viii.1968, em. 20.v.1969, coll. G.C.D. Griffiths.

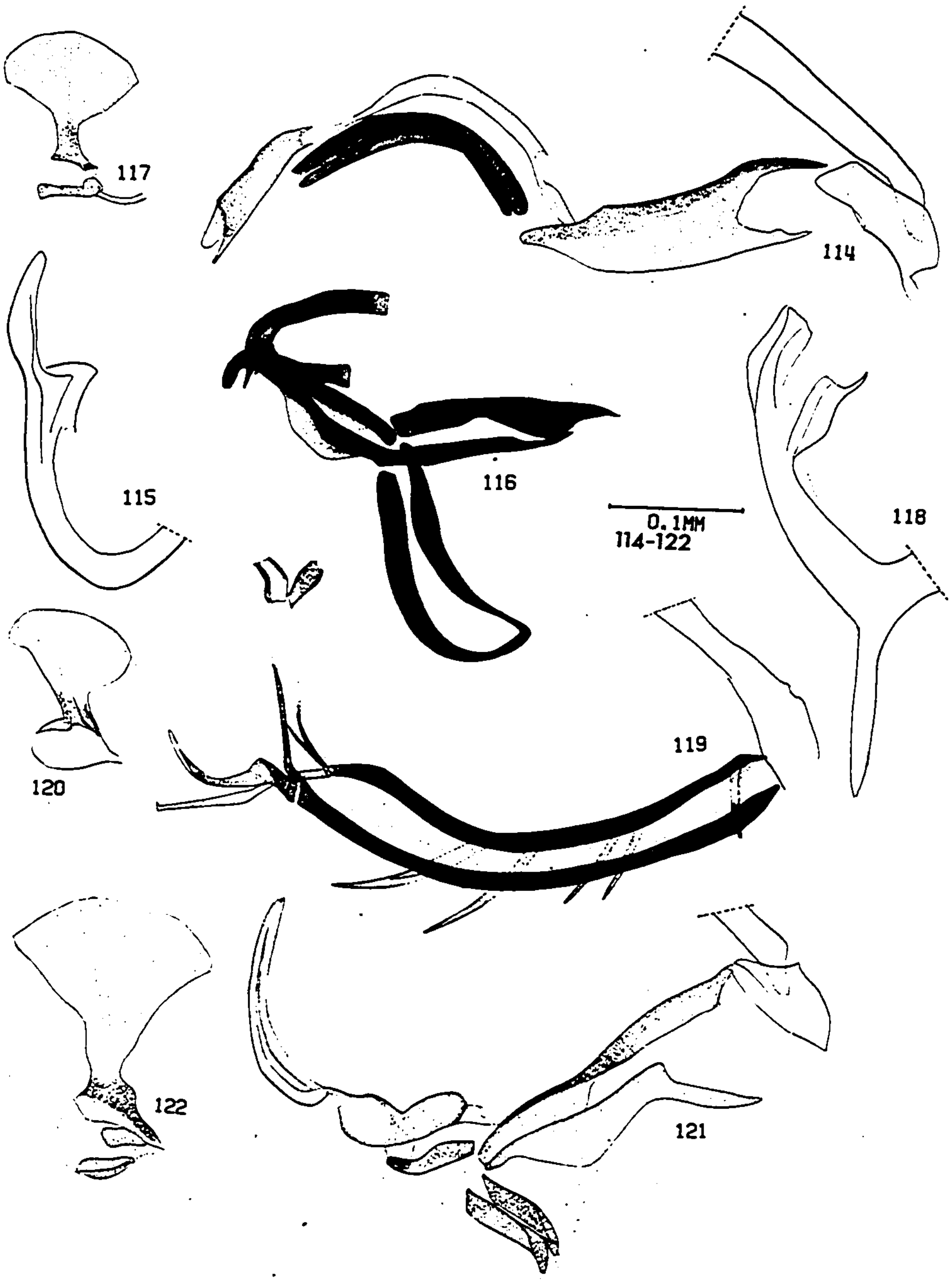


Fig. 114. *Phytomyza misella*, aedeagus, lateral view. Figs. 115 - 117. *P. multifidae*. 115. hypandrium. 116. aedeagus, lateral view. 117. ejaculatory apodeme. Figs. 118 - 120. *P. oxytropidis*. 118. hypandrium. 119. aedeagus, lateral view. 120. ejaculatory apodeme. Figs. 121 - 122. *P. riparia*. 121. aedeagus, lateral view. 122. ejaculatory apodeme.

Phytomyza penstemonis Spencer

Phytomyza penstemonis Spencer 1969 : 265.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; essentially dark femora and pleura; two equal *Ors*; acrostichals approximately 3-4 scattered hairs; and pale squamal fringe. The adults resemble those of *P. plantaginis* R.-D. and *P. colemanensis* new species but differ in having second antennal article black and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae make linear mines on the leaves of *Penstemon confertus* Dougl. and *P. procerus* Dougl., family Scrophulariaceae. Larvae pupate inside the leaf mine.

Geographical distribution.-The members of this species were previously known only from the locality of its type series from western Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Blairmore, from leaf mines on *Penstemon confertus* Dougl., coll. 26.vi.1966, em. 2.vii.1966; 1 ♂ Coleman, 27.vi.1966; 2 ♂♂, 3 ♀♀ Nevis, from leaf mines on *Penstemon procerus* Dougl., coll. 14.vi.1969, em. 23-26.vi.1969, coll. G.C.D. Griffiths.

Phytomyza periclymeni de Meijere

Phytomyza periclymeni de Meijere 1924 : 145.

Comparison and diagnostic characters.-The main distinguishing characters of the members of this species are: dark frons; normal third antennal article; two equal *Ors*; mat grey mesonotum, scutellum and pleura; dark tarsi; second costal segment less than three times the length of the fourth; and acrostichals in approximately four rows. The adults resemble those of *P. caprifoliae* Spencer and reliably separated only by examination of male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-In Alberta the larvae mine the leaves of *Lonicera involucrata* (Richards) Banks, family Caprifoliaceae.

Geographical distribution.-The members of this species are known from Europe (Hendel 1935) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 4 ♂♂, 2 ♀♀, Edmonton, river bed, near University of Alberta campus, from leaf mines on *Lonicera involucrata* (Richards) Banks, coll. 26.vii.1966, em. 15-16.viii.1966; 1 ♂ Elk Island Park, 4.vi.1967; 2 ♂♂ St. Albert, near Edmonton, 14.vi.1966.

Phytomyza petasiti Spencer

Phytomyza petasiti Spencer 1969 : 266.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; essentially dark femora; and mostly yellow pleura. The adults resemble those of *P. spondylii* R.-D. and *P. matricariae* Hendel and differ in having both *Ors* equal and distinct male genitalia. The aedeagus of this species has been illustrated by Spencer.

Biology.-Larvae make linear mines on the leaves of *Petasites* *sagittatus* (Pursh) A. Gray, family Compositae. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are known only from Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Devon, Botanical Garden, University of Alberta, from linear mines on leaves of *Petasites sagittatus* (Pursh) A. Gray, coll. 28.vii.1966, em. 13.iii.1967; 1 ♂ Elk Island Park, same host, coll. 13.vii.1968, em. viii.1968.

Phytomyza plantaginis R.-D.

Phytomyza plantaginis Robineau-Desvoidy 1851 : 404.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; two equal *Ors*; third antennal article elongate and with normal pubescence; essentially dark femora and pleura; and acrostichals usually few isolated hairs. The adults differ from those of the similar species *P. syngenesiae* (Hardy) by having pale squamal fringe; shorter second costal segment, approximately one and a half times length of fourth, and conspicuously yellow fore-coxae. They differ from those of other similar species *P. penstemonis* Spencer and *P. colemanensis* new species by having yellow second antennal article and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-In Alberta the larvae make linear mines in the leaves of *Plantago major* L., family Plantaginaceae. Pupation occurs inside the leaf mine.

Geographical distribution.-The members of this species are Holarctic in distribution, known from Europe, Australia, Japan, North America and Canada (1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♀ Edmonton, river bed near University of Alberta campus, from leaf mines on *Plantago major* L., 26.vii-5.viii. 1966; 4 ♀♀ George Lake, near Busby, Entomology Dept. Field Station, University of Alberta, coll. 21.viii.1966, em. 25-31.viii.1966..

Phytomyza prava Spencer

Phytomyza prava Spencer 1969 : 269.

Comparison and diagnostic characters.-The members of this species are distinctive in having frons which is basically yellow, but is conspicuously darkened. This species has therefore been included in both parts of the key having yellow frons and dark frons. Other diagnostic characters of the members of this species are: dark scutellum; dark femora and pleura and only one *Ors*. The adults resemble those of *P. mertensiae* new species, but differ in having yellowish frons and gena, and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae make dark blotch mines on the leaves of *Anemone canadensis* L., family Ranunculaceae. The leaf mine of this species was illustrated among undetermined mines in figure 531 (Spencer 1969). Pupation occurs outside the mine.

Geographical distribution.-The members of this species were previously known from Canada only from the locality of its type series (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂, 1 ♀ Edmonton, White Mud Creek Park, from leaf mines on *Anemone canadensis* L. (Ranunculaceae), coll. 4.ix.1968, em. 20.ix.1968; 8 ♂♂, 9 ♀♀, same locality and host, coll. 3.ix.1968, em. 19-25.ix.1968, 26.v.1969 and 4.vi.1969, coll. G.C.D. Griffiths; 1 ♂ George Lake, near Busby, University of Alberta Entomology Dept. Field Station, 21.vi.1966.

Phytomyza queribunda Spencer

Phytomyza queribunda Spencer 1969 : 271.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by dark frons; mat greyish mesonotum and scutellum; two *Ors* equal; dark tarsi; second costal segment less than three times length of fourth; and acrostichals in four rows. The adults resemble those of *P. caprifoliae* Spencer and *P. periclymeni* de Meijere but differ in having frons slightly paler above and entirely different male genitalia. Spencer (1969) illustrated the characteristic aedeagus of this species.

Geographical distribution.-The members of this species are known only from the type locality in Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ George Lake, near Busby, University of Alberta, Entomology Dept. Field Station, 7.vi.1968, coll. G.C.D. Griffiths.

Phytomyza ranunculi (Schrank)

Musca ranunculi Schrank 1803 : 140.

Phytomyza flavoscutellata Fallén 1823b: 4.

Phytomyza albipes Meigen 1830 : 195.

Phytomyza ranunculi (Schrank); Hendel 1920 : 153, 1935 : 463; Frick 1952 : 428, 1959 : 434; Spencer 1969 : 271.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark third antennal article and yellow scutellum. They differ from another species *P. clematiphaga* Spencer in this group by hav ing the upper orbital bristle shorter than lower and distinct male genitalia.

The Alberta specimens from Elk Island Park, bred from leaf mines on *Ranunculus abortivus* L., correspond in colour to the form *albipes* Meigen having yellow on mesonotum. One specimen from George Lake corresponds in colour to the form *flavoscutellata* Fallén having darker mesonotum.

The number of coils in the distiphallus vary from one coil in a Faroes specimen (Griffiths 1964) to eight coils in Alberta specimens. There are five coils in the European specimen illustrated by Nowakowski (1962). Besides, there is variation in the direction of coils, which in some specimens are coiled upwards, while in others downwards. The number of coils and their direction does not seem to be related to their external colour variations in this species as was pointed out by Griffiths (1964). However it is possible that more than one species is involved in its entire range.

The male genitalia of this species is also very close to that of

P. vibeana Griffiths, but the latter differs in having eleven coils in the distiphallus and dark mesonotum and scutellum.

Biology.-In Alberta the larvae make linear mines in the leaves of *Ranunculus abortivus* L., family Ranunculaceae. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are Holarctic in distribution, known from Europe (Hendel 1935), United States (Frick 1959), Faroes, Iceland and Greenland (Griffiths 1966), Japan (Sasakawa 1961) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 10 ♂♂, 6 ♀♀ Elk Island Park, from linear mines in the leaves of *Ranunculus abortivus* L., coll. 22.v.1969, em. 5-8. vi.1969, coll. G.C.D. Griffiths; 1 ♂ George Lake, near Busby, University of Alberta Dept. Entomology Field Station, 21.vi.1966.

Phytomyza riparia new species

Comparisons and diagnostic characters.-A member of this species belongs to the group characterized by yellow frons; upper *Ors* shorter than lower; mouth margin normal; mat greyish mesonotum and scutellum; upper margins of mesopleura, humeral and notopleural areas yellow; essentially dark femora; and second costal segment approximately three and a half times length of fourth. The adult resembles that of *P. spondylii* R.-D., from whom it may be separated as shown below in extension to Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén:

13. Two *Ors* equal.. 14

- Upper *Ors* shorter than lower or lacking............... 13a

13a. Third antennal segment with normal pubescence; upper *Ors* sometimes lacking; aedeagus as illustrated (Spencer (1969)................................*spondylii* R.-D.

- Third antennal segment with conspicuously long pubescence; upper *Ors* present; aedeagus as in figures 121............. .... *riparia* n. sp.

Description.-Head. Frons almost twice width of eye at level of front ocellus, only slightly projected in front of eye margin in profile. Mouth margin normal. Two *Ors*, upper shorter than lower, one side of holotype has only one *Ors*, directed upwards; two strong *Ori*, directed inwards; orbital setulae few, 6-7, proclinate. Eyes oval, approximately 1.2 times higher than their length, bare; ocellar triangle small. Gena approximately one-fourth of vertical eye height. Third antennal article rounded at tip, with conspicuously long pubescence; arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* in almost five irregular rows.

Wing. Length in male 2.0 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.3 : 0.3; crossvein m-m absent.

Male genitalia (Figs. 121-122). Hypandrium with broad side arms and inconspicuous or small apodeme; pregonites broad; postgonites elongate; surstyli normal; aedeagus (Fig. 121) as illustrated with two long characteristic processes in the distiphallus; ejaculatory apodeme (Fig. 122) broad, bulb small.

Colour. Frons, orbits and gena yellow; both *Vt's* on dark ground; third antennal article dark brown; upper parts of mesopleura, humeral and notopleural areas yellow; mesonotum and scutellum mat greyish, slightly paler; coxae black; femora dark brown, with yellow on distal tips; tibiae and tarsi yellowish brown; squamae yellow, fringe brown; halteres yellow.

Derivation of the specific name.-The members of this species are named *riparia* as its holotype was collected along the Saskatchewan River bank.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Holotype ♂ Edmonton, Saskatchewan River bank near University of Alberta campus, 20.vii.1966.

Phytomyza sehgali Spencer

Phytomyza sehgali Spencer 1969 : 274.

Comparisons and diagnostic characters.-The members of this species differ from those of *mertensiae* new species in having paler frons and from *prava* Spencer in having strong acrostichals, small third antennal article and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-Known only from Alberta, Canada from the following locality:

CANADA. Alberta : Edmonton, White Mud Creek (Spencer 1969).

Phytomyza senecionella new species

Comparison and diagnostic characters.-The members of this species beong to the group characterized by yellow frons; two *Ors* equal; dark scutellum; essentially dark femora and pleura; normal mouth margin and third antennal article; acrostichals only two to three scattered hairs; dark squamal fringe and fore-coxae. The adults resemble those of the similar species *P. syngenesiae* (Hardy) and males of the two can be separated reliably only by examination of the genitalia. This species is included in Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén as below:

40. Second costal section short; 1½ times length of fourth; third antennal segment enlarged; squamal fringe pale.... 41

\- Second costal section longer, approximately twice length of fourth; third antennal segment normal; squamal fringe dark.. 40a

40a. Aedeagus as illustrated (Spencer 1969)...................... ....*syngenesiae* (Hardy)

\- Aedeagus as in Fig. 123.............. *senecionella* n. sp.

Description.-Head. Frons wider than width of eye at level of front ocellus (1 : 0.55), very slightly projected in front of eye margin in profile. Two *Ors* equal, directed upwards; one strong *Ori* and one small hair present below directed inwards; orbital setulae few, 6-7, proclinate. Eyes almost circular, their vertical height being almost equal to their length, bare; ocellar triangle small. Gena deep, approximately two-fifth of eye height. Antennal bases approximate; third antennal article rounded at tip, with normal pubescence; arista normal and pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* 2-3 scattered hairs.

Wing. Length in male 2.75 mm; costa extended to vein R_{4+5}; costal segments 2-4 in ratio of 1 : 0.3 : 0.56; crossvein m-m absent; vein M_{3+4} at wing tip.

Male genitalia. (Figs. 123-124). Hypandrium with side arms broad and no conspicuous apodeme; pregonites broad; postgonite with small hook anteriorly; surstyli small and normal; aedeagus (Fig. 123) as illustrated; ejaculatory apodeme (Fig. 124) slightly broad, bulb small and membranous.

Colour. Frons, orbits and gena yellow; both *Vt's* on dark grounds; all antennal articles black; ocellar triangle shining black; mesonotum, scutellum and pleura mat grey; legs black, only tips of femora with slight yellow, coxae black; squamae yellow, fringe dark; halteres yellow.

Derivation of the specific name.-This species is named after the generic name of its food plant.

Biology.-Larvae make broad linear mines on the leaves of *Senecio congestus* var. *palustris* (L.), family Compositae. The leaf mines were more or less communal with more than one larva feeding in them. Pupation occurs usually at the leaf bases or sometimes on the stem.

Geographical distribution.-The members of this species are known only from the type locality:

CANADA. Alberta : Holotype ♂ Elk Island Park, from leaf mines on *Senecio congestus palustris* (L.), coll. 2.vii.1969, em. 6.vii.1969; paratypes 2 ♂♂ same locality and host, em. 6-12.vii.1969, coll. G.C.D. Griffiths.

Phytomyza solidaginivora Spencer

Phytomyza solidaginivora Spencer 1969 : 274.

Comparison and diagnostic characters.-The members of this species differ from those of similar species *matricariae* Hendel in having dark second antennal article and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae make linear leaf mines on *Solidago*, family Compositae.

Geographical distribution.-Known only from Alberta, Canada from the following locality:

CANADA. Alberta : Edmonton, University of Alberta campus (Spencer 1969).

Phytomyza solidaginophaga new species

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; two equal *Ors*; normal third antennal article; dark scutellum; mostly dark femora and pleura; and 3-6 rows of acrostichals. The adults resemble those of *P. aquilegiana* Frost and *P. aquilegioides* new species but differ in having the frons slightly darkened below and distinct male genitalia. They also resemble those of another similar species *P. ilicis* Curtis and may be separated as shown below in extension to Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén:

32. Frons distinctly darkened, either above or below......... 32a

\- Frons entirely pale, yellow or orange, at most orbits dark.. 33

32a. Aedeagus as illustrated (Spencer 1969); larva leaf-miner in *Ilex* .... *ilicis* Curtis

\- Aedeagus as in figure 126; larva leaf-miner in *Solidago*.......................... *solidaginophaga* n. sp.

Description.-Head. Frons approximately twice eye width at level of front ocellus, slightly projected in front of eye margin in profile. Mouth margin normal; lunule low. Two equal *Ors*, directed upwards (one specimen has only one *Ors*, but has two bristles in the same socket as upper *Ori*; two *Ors* have therefore been considered as normal for the members of this species). Two *Ori*, directed inwards, lower one weaker than upper; orbital setulae few, approximately 7, proclinate. Eyes oval, approximately 1.2 times higher than their length, bare; ocellar triangle small. Gena approximately 0.28 times vertical height of eye. Third antennal article rounded at tip, with normal pubescence; arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* in approximately four irregular rows.

Wing. Length in male approximately 2.1 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.26 : 0.3; crossvein m-m absent.

Male genitalia (Figs. 125-127). Hypandrium (Fig. 125) V-shaped, with broad side arms; pregonites broad; postgonites elongate; surstyli normal; aedeagus (Fig. 126) with characteristic row of small spines between two long arms of basiphallus, as illustrated; ejaculatory apodeme (Fig. 127) small, bulb small and membranous.

Colour. Frons yellow, slightly darkened just above lunule; orbits slightly darkened along eye margins; lunule and gena darkened; ocellar triangle weakly shining black; both *Vt's* on dark ground; antennae black; mesonotum, scutellum and pleura mat greyish black; femora black, with yellow distal tips; tibiae and tarsi dark brown; squamae yellow, fringe brown; halteres yellow.

Derivation of the specific name.-This species has been named after the generic name of its food plant.

Biology.-Larvae make linear mines in the leaves of *Solidago lepida* DC, family Compositae. Pupation occurs outside the mine.

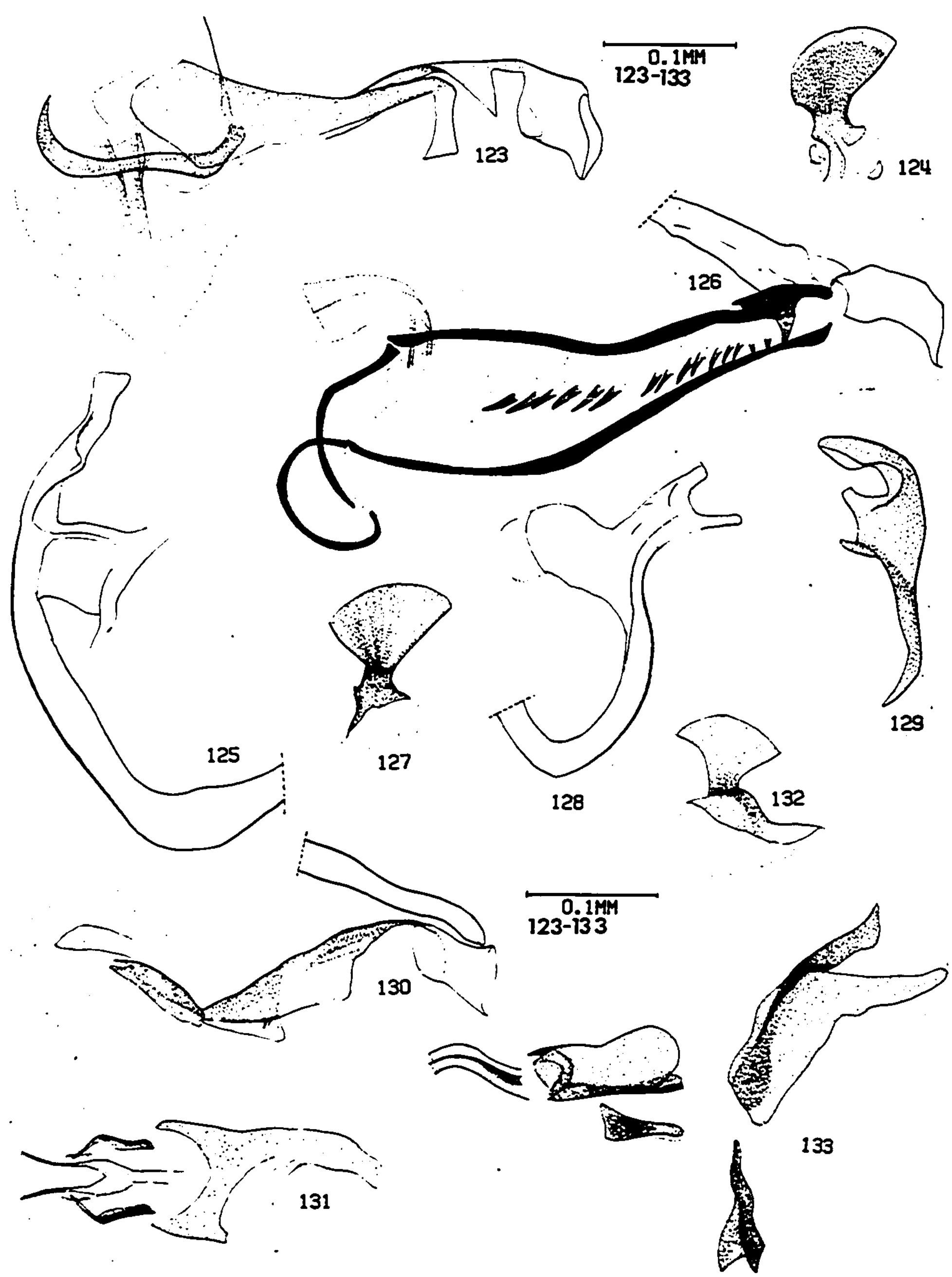
Geographical distribution.-The members of this species are only known from the type locality:

CANADA. Alberta : Holotype ♂ George Lake, near Busby, University of Alberta, Entomology Dept. Field Station, from mines on the leaves of *Solidago lepida* DC, coll. 7.vi.1968, em. 30.iv.1969, coll. G.C.D. Griffiths; paratype 1 ♂ same data.

Phytomyza spondylii R.-D.

Phytomyza spondylii Robineau-Desvoidy 1851 : 147.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; and essentially dark femora. The colour of the upper margins of the mesopleura, humeral and notopleural areas is variable from yellow to almost dark. A small upper *Ors* is usually present. The adults having yellow on the sides resemble those of *P. matricariae*



Figs. 123 - 124. *Phytomyza senecionella*. 123. aedeagus, lateral view. 124. ejaculatory apodeme. Figs. 125 - 127. *P. solidaginophaga*. 125. hypandrium. 126. aedeagus, lateral view. 127. ejaculatory apodeme. Figs. 128 - 132. *P. subalpina*. 128. hypandrium. 129. postgonite. 130. aedeagus, lateral view. 131. aedeagus, ventral view. 132. ejaculatory apodeme. Fig. 133. *P. timida*, aedeagus, lateral view.

Hendel and differ in having the second costal section longer, approximately three and a half times the fourth and dark second antennal article. The darker forms resemble those of *P. asterophaga* Spencer but differ in having entirely different male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae make linear mines in the leaves of *Heracleum lanatum* Michx., family Umbelliferae. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are known from Europe (Hendel 1935) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂, 2 ♀♀ Edmonton, White Mud Creek Park, from leaf mines on *Heracleum lanatum* Michx., em. 18-19.vii.1966.

Phytomyza subalpina new species

Comparisons and diagnostic characters.-A member of this species belongs to the group characterized by yellow frons; normal mouth margin and third antennal article; two *Ors* equal; dark scutellum; essentially dark femora and pleura; acrostichals in two rows; and dark fore-coxae. The adult resembles that of *P. fuscula* Zetterstedt but differs in having a pale squamal fringe and distinct male genitalia. It differs from another similar species *P. atripalpis* Aldrich as shown below in extension to Spencer's (1969) key to Canadian species of the genus *Phytomyza* Fallén:

53. Second costal section short, less than twice length of fourth..53a

- Second costal section longer, twice length of fourth.................................... *gelida* Spencer

53a. Gena two-fifths of eye height.......... *atripalpis* Aldrich

- Gena one-fifth of eye height............... *subalpina* n. sp.

Description.-Head. Frons approximately twice width of eye at level of front ocellus; mouth margin normal; lunule low. Two equal *Ors* directed upwards; two *Ori*, lower one weaker, both directed inwards; orbital setule 4-5, proclinate. Eyes oval, their vertical height being approximately 1.3 times their length, bare; ocellar triangle small. Gena approximately one-fifth vertical eye height. Third antennal article rounded at tip, with normal pubescence; arista normal, pubescent.

Mesonotum. Dorsocentrals 3+1 strong bristles; *acr* approximately 9 hairs, in two rows.

Wing. Length in male approximately 2.1 mm; costa extended to vein R_{4+5}; costal segments 2-4 in the ratio of 1 : 0.35 : 0.65; crossv ein m-m absent.

Male genitalia (Figs. 128 - 132). Hypandrium (Fig. 128) U-shaped with broad side arms; pregonites broad; postgonites (Fig. 129) elongate, with hook-like process anteriorly; surstyli normal; aedeagus (Figs. 130, 131) as illustrated; ejaculatory apodeme (Fig. 132) small, bulb membranous.

Colour. Frons, gena and lunule yellow; orbits yellow, slightly darkened near upper *Ors*; ocellar triangle weakly shining black; both *Vt's* on dark ground; antennae black; mesonotum, scutellum and pleura mat grey; femora, tibiae and tarsi black; squamal fringe dirty pale, squamae pale; halteres yellow.

Derivation of the specific name.-This species is named *subalpina* as its holotype was collected in the subalpine zone of foothills at Rocky Mountains.

Geographical distribution.-This species is known only from the type locality:

CANADA. Alberta : Holotype ♂ Coleman, 27.vi.1966.

Phytomyza subtenella Frost

Phytomyza subtenella Frost 1924 : 89.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; normal mouth margin and third antennal article; usually two equal *Ors*(but one specimen has three equal *Ors*); essentially dark femora and pleura; acrostichals in two well-defined rows and yellow fore-coxae.

The adults, wing length approximately 2.5 mm, differ from those of the similar species *P. jasperensis* in having the frons strongly projected in front of eye margin; gena deeper, approximately two-third of eye height and distinct male genitalia. The paraphalli in Alberta specimen were independent of the basiphallus and not joined as it appears from Spencer's (1969) illustration in which they are overlapping.

Geographical distribution.-The members of this species are known from the United States (Frick 1959) and Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Banff, 28.vi.1966; 5 ♂♂ Hinton, 23.vii. 1967; 1 ♂ Jasper, 17.vi.1966.

Phytomyza subtilis Spencer

Phytomyza subtilis Spencer 1969 : 276.

Comparison and diagnostic characters.-The members of this species differ from those of a very similar species *urbana* Spencer in having darker grey mesonotum and slightly brownish frons. The male genitalia as figured by Spencer (1969) are however very distinct.

Biology.-Larvae make blotch mines on the leaves of *Lathyrus ochroleucus* Hook., family Leguminosae.

Geographical distribution.-Known from Alaska and Alberta. The Alberta locality is as follows:

CANADA. Alberta : Wabamun Lake (Spencer 1969).

Phytomyza syngenesiae (Hardy)

Chromatomyia syngenesiae Hardy 1849 : 391.

Phytomyza chrysanthemi Kowarz 1891 : 243; Smulyan 1914 : 21.

Phytomyza atricornis Meigen *sensu* Hendel 1920 : 162 (in part); Frost 1924 : 68; Frick 1952 : 424; 1959 : 425 (nomen dubium).

Phytomyza syngenesiae (Hardy); Griffiths 1967 : 7; Spencer 1969 : 278.

Comparisons and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; mostly dark femora and pleura; two *Ors* equal; normal third antennal article; and acrostichals normally lacking or at most 3 to 4 isolated hairs present. The adults resemble closely those of an Old World species *P. horticola* Goureau and can be separated reliably only by examination of the male genitalia. Griffiths (1967) and Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae make linear mines in the leaves of numerous Compositae and rarely on non-Compositae hosts (Griffiths 1967). In Alberta the flies have been bred from only two host-plants of the family Compositae, *Senecio sp*. (Spencer 1969) and *Crepis gracilis* (D.C. Eat.) Rydb.

Geographical distribution.-The members of this species are wides-spread in Europe, Australia, New Zealand, U.S.A. and Canada (Griffiths 1967). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂, 2 ♀♀ Edmonton, University of Alberta campus, from leaf mines on *Crepis gracilis* (D.C. Eat.) Rydb., coll. 4.vi.1966.

Phytomyza thalictrivora Spencer

Phytomyza thalictrivora Spencer 1969 : 279.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by dark frons, mesonotum and scutellum; essentially dark femora and pleura; upper *Ors* lacking; and second costal segment less than three times length of fourth. The adults resemble those of *P. aquilegivora* Spencer but differ in having darker frons and few acrostichals. They also resemble those of *P. minuscula* Goureau, but possess distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Biology.-Larvae make linear mines on the leaves of *Thalictrum venulosum* Trel., family Ranunculaceae. Pupation occurs outside the mine.

Geographical distribution.-The members of this species are known only from Canada (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 1 ♂ Edmonton, White Mud Creek Park, from leaf mines on *Thalictrum venulosum* Trel., coll. 12.vi.1966, em. 17.vi.1966; 1 ♂ Edmonton, Rainbow Valley, 31.v.1969.

Phytomyza timida Spencer

Phytomyza timida Spencer 1969 : 279.

Comparison and diagnostic characters.-The members of this species belong to the group characterized by yellow frons; dark scutellum; and essentially dark femora and pleura. Spencer (1969) includes this species among those having upper orbital bristle shorter than lower. This character is probably variable as the Alberta specimens examined had both upper orbital bristles almost equal. The aedeagus of a specimen from Banff, Alberta is illustrated (Fig. 133) and agrees with that figured by Spencer (1969).

Geographical distribution.-The members of this species are known from Canada only from the locality of its type series (Spencer 1969). I examined the following material from Alberta:

CANADA. Alberta : 2 ♂♂ Banff, 18.vi.1966; 1 ♂ Jasper, 16.vi.1966.

Phytomyza urbana Spencer

Phytomyza urbana Spencer 1969 : 281.

Comparison and diagnostic characters.-The members of this species differ from those of a similar species *subtilis* Spencer in having paler greyish mesonotum and paler frons and distinct male genitalia. Spencer (1969) illustrated the aedeagus characteristic of this species.

Geographical distribution.-Known only from Alberta, Canada from the following locality:

CANADA. Alberta : Blairmore (Spencer 1969).

Phytomyza sp. (*Angelica arguta* Nutt.)

Comparison and diagnostic characters.-The distinguishing characters of the female of this species are: yellowish brown frons; wing length 2.5 mm; second costal segment three times length of fourth; dark squamal fringe; dark mesonotum, scutellum, pleura and femora and acrostichals in 2-3 rows. It resembles the adults of *P. aralivora* Spencer but have entirely different biology. This species cannot be definitely determined at present as no males are available for examination.

Biology.-Larvae make linear mines in the leaves of *Angelica arguta* Nutt., family Umbelliferae.

Geographical distribution.-The members of this species were examined only from southwestern Alberta as below:

CANADA. Alberta : 1 ♀ Blairmore, from leaf mines on *Angelica arguta* Nutt., coll. 5.ix.1966, em. 10.iii.1967; numerous leaf mines same locality.

INSECT HOST-PLANT RELATIONSHIP IN THE FAMILY AGROMYZIDAE

The members of the family Agromyzidae are exclusively internal plant feeders during their larval stage. Larval feeding results in a definite pattern called the mine, and the study of the mining habits is called minology or hyponomology (Hering 1951).

The agromyzid mines fall into two general categories. First, the epidermal leaf mines, in which the mining larva feeds only inside the epidermal layer of the leaf. These are restricted mainly to the tropics. The second, the parenchymal mine, in which the larva feeds on the parenchymatous tissue inside the leaf or other part of the plant. The majority of mines belong to this category. Leaf mines are usually seen externally and generally are more visible from one side than the other. Surface mines on other parts of a plant can also be detected as whitish or greenish channels with faecal granules distributed in definite tracks. Mines inside the stem or root are not easily detected, however, the injury caused by the mining larva can be seen by breaking the injured plant part. The shape of the larval mine is usually constant within the species, but varies between species. This helps greatly in the separation of closely related species which cannot otherwise be reliably identified by adult morphology. Hering (1951) dealt with shapes of mines in mining insects and later in 1957 illustrated the mines of European species in detail.

The relationship between the endophagous larvae of mining insects and their food plants is typically parasitic in nature. However, modern parasitology as a science does not concern itself with the study of such relationships. Nowakowski (1962) commenting on this situation proposed the term "zoophytoparasitology" for the study of animals as parasites and plants as hosts. The most important features of this relationship in the family Agromyzidae are the active choice of host-plant by the mining insect, the varying degree of host-plant specificity, and the adaptations of the maggot for an endoparasitic life in the semi-liquid environment of the leaf parenchyma. The understanding of this relationship is of great importance in dealing with systematics of this group as it permits the use of the host-parasite discrimination method. It provides valuable information for identification of similar species, which cannot be identified from adult characteristics alone.

Hering (1951) discussed the distribution of leaf mining species on plants of various families and examined the established phylogenetic relationships between the plant families in a system based on serum diagnosis alone as proposed by Mez (1926). Mez's system of classification has now been criticized by modern botanists because of similar serum reactions obtained for certain plant families which clearly are not closely related.

Table 2 lists the known local host-plants for the Albertan species. It is realized that the information on host-plants of all species is inadequate, but some useful observations can still be made. The arrangement of plant families is after the supposedly phylogenetic system of Takhtajan (1969). The phylogenetic relationships between plant families and or orders is still a matter of controversy. Most plant classifications fall into two groups depending on the supposed nature of the primitive angiosperm flower (Davis and Heywood 1965). One system is based on the assumption that the earliest angiosperms were wind pollinated and that the monocotyledons and dicotyledons have arisen independently from unknown gymnosperms. According to the second system, dicotyledons and monocotyledons were both derived from primitive angiosperms which were insect-pollinated. Such a view is also supported by many recent workers (Eames 1961, Hutchinson 1964, Takhtajan 1969). Hutchinson (1964) in his revised edition of classification of angiosperms maintained a basic division of dicotyledons into woody "Lignosae" and herbaceous "Herbaceae," a system which allegedly leads to wide separation of certain plant families which are markedly similar in the structure of their flowers. In the absence of established phylogenies of both angiosperms and agromyzid parasites, it is difficult to study the trends in their coevolution.

It is generally accepted that the larvae of Cyclorrhapha were primitively saprophagous from which various specialized feeding habits like phytophagy, carnivory and parasitism have been derived (Hennig 1952).

The dominance of agromyzids on angiosperm hosts suggests that angiosperms were well established as flowering plants before the agromyzids made their appearance. Although opinions differ as to precisely when angiosperms first appeared on the evolutionary scene, there is a general agreement that they came into prominence suddenly during the late Cretaceous (Eames 1961). Hennig (1965) reviewed all supposed records of agromyzid fossils and concluded that Agromyzidae is not yet known to be represented in the Tertiary baltic amber. In fact there are so far no fossils which can be definitely referred to the family. The occurrence of a large number of closely related and poorly differentiated species and their abundance on hosts belonging to highly evolved plant families suggests that much of the diversification of the family Agromyzidae is relatively recent. However, the possibility that the group goes back to late Cretaceous as suggested by Nowakowski (1962) must be admitted.

The recent use of male genitalia in agromyzid taxonomy has split many groups originally supposed to be polyphagous or oligophagous species, into species with much narrower host-plant specificity. It is becoming increasingly apparent that the majority of agromyzid species are restricted feeders, being monophagous or oligophagous. Strict monophagy also appears to be rare unless it results from a plant genus being monotypic. Nowakowski (1962) discussed the subject of host-plant specificity among the European species and revealed many examples where the original wide host range was found to be the result of misidentifications or assemblage of many species under the same name. The most polyphagous species *Phytomyza syngenesiae* (Hardy) appears to be a restricted feeder in Alberta, has been bred from only two plant genera *Crepis* and *Senecio* of the family Compositae. This species is known from many Compositae and rarely from other host-plants (see Frick 1959 as *Phytomyza atricornis* Meigen; Griffiths 1967).

Most agromyzid genera occurring on species of monocot families are also represented on various dicotyledons. The few exceptions are the species of the genus *Cerodontha* Rondani occurring only on monocot families Gramineae, Cyperaceae, and Juncaceae; and the members of the *ambigua/nigripes* groups of the genus *Agromyza* Fallén which feed only on grasses. The species in these groups are uniform in external morphology of adults and in the general shape of the male genitalia, and probably represent early specialization of their feeding habit. Various species of the agromyzid genera *Liriomyza* Mik and *Phytomyza* Fallén feeding on grasses will probably prove to be oligophagous. The oligophagy of various grass-mining species has not been investigated because of the problems of identification of grasses at the time the mining larvae are collected.

The family Ranunculaceae is selected by members of the agromyzid genera *Melanagromyza* Hendel, *Ophiomyia* Braschnikov and *Phytomyza* Fallén. *Melanagromyza actaeae* n. sp. feeding inside the stems of *Actaea rubra* (Ait.) Wild and an *Ophiomyia sp.* making surface mines below the stem epidermis of *Thalictrum venulosum* Trel. appear to be specialized monophagous species. There are many closely related and poorly differentiated *Phytomyza* species feeding on the plant genera *Aquilegia* and *Thalictrum*, some of which are oligophagous species feeding on both. The species of the genus *Phytomyza* Fallén feeding on the plant genera *Clematis*, *Delphinium* and *Ranunculus* are specialized monophagous species. Three local species of the plant genus *Anemone* support three different leaf miners of the genus *Phytomyza* Fallén. The members of the agromyzid genera *Agromyza* Fallén, *Melanagromyza* Hendel and *Hexomyza* Enderlein feeding on Ulmaceae, Urticaceae and Salicaceae are all specific feeders. Two species known to have rosaceous host-plants in Europe and the United States have not yet been discovered on Alberta hosts. One is a specific cambium miner *Phytobia amelanchieris* (Greene) feeding on *Amelanchier canadensis* (L.) (Frick 1959), and the other *Agromyza spiraceae* Kaltenbach, an oligophagous species feeding on various genera of the subfamily Rosoidea in Europe. Members of the family Leguminosae are fed on by the representatives of the agromyzid genera *Liriomyza* Mik and *Phytomyza* Fallén. Most of these species are monophagous in Alberta, with the exception of *Liriomyza fricki* Spencer which is oligophagous. The plant families Cornaceae, Araliaceae, Umbellifereae and Elaeagnaceae are fed on by specific feeders of the agromyzid genera *Phytomyza* Fallén and *Amauromyza* Hendel. Members of the plant family Caprifoliaceae support oligophagous species belonging to the agromyzid genera *Paraphytomyza* Enderlein and *Phytomyza* Fallén. The oligophagous species feed on the plant genera *Lonicera* and *Symphoricarpos*. The plant families Boraginaceae, Scrophulariaceae; Plantaginaceae and Labiatae have specialized specific feeders. The family Compositae support a highly specialized agromyzid fauna belonging to the genera *Melanagromyza* Hendel, *Ophiomyia* Braschnikov, *Liriomyza* Mik, *Calycomyza* Hendel, *Nemorimyza* Frey and *Phytomyza* Fallén. Most of these species are specific monophagous feeders. However, some oligophagous species feed on the plant genera *Crepis*, *Taraxacum*, and *Sonchus*, others feed upon members of tribe Anthemidae of the family Compositae, as shown by the host range of *Phytomyza matricariae* Hendel and *Liriomyza millefolii* Hering.

Table 2. Albertan host-plants of agromyzid species.

DICOTYLEDONES	
Family Ranunculaceae	
Actaea rubra (Ait.) Willd	*Melanagromyza actaeae* n. sp.
Anemone canadensis L.	*Phytomyza prava* Spencer
Anemone multifida Poir	*Phytomyza multifidae* n. sp.
Anemone riparia Fern	*Phytomyza canadensis* Spencer
Aquilegia sp. (cultivated var.)	*Phytomyza aquilegiana* Frost
	Phytomyza aquilegiophaga Spencer
	Phytomyza aquilegivora Spencer
	Phytomyza columbinae n. sp.
Clematis verticellaris DC	*Phytomyza clematiphaga* Spencer
Delphinium sp. (cultivated)	*Phytomyza delphinivora* Spencer
Ranunculus abortivus L.	*Phytomyza ranunculi* (Schrank)
Thalictrum venulosum Trel.	*Phytomyza aquilegioides* n. sp.
	Phytomyza columbinae n. sp.
	Phytomyza thalictrivora Spencer
	Ophiomyia sp. (on stems)
Thalictrum sp.	*Phytomyza aquilegiana* Frost
Family Ulmaceae	
Ulmus americana L.	*Agromyza aristata* Malloch
Family Urticaceae	
Urtica gracilis Ait.	*Melanagromyza martini* Spencer
	Phytomyza sp. ? *luteiceps* n. sp.

Family Salicaceae	
Populus tremuloides Michx.	*Agromyza populoides* Spencer
	Hexomyza schineri (Giraud)
	Paraphytomyza sp.
Family Rosaceae	
Potentilla sp.	*Agromyza* sp.
Family Leguminosae	
Lathyrus ochroleucus Hook.	*Liriomyza fricki* Spencer
	Liriomyza lathyri n. sp.
	Phytomyza subtilis Spencer
Lupinus sericeus Pursh	*Phytomyza lupini* Sehgal
	Phytomyza lupinivora Sehgal
Oxytropis splendens Dougl.	*Phytomyza oxytropidis* n. sp.
Trifolium repens L.	*Liriomyza fricki* Spencer
Vicia americana Muhl.	*Liriomyza fricki* Spencer
	Liriomyza viciae Spencer
Family Cornaceae	
Cornus canadensis L.	*Phytomyza agromyzina* Meigen
Cornus stolonifera Michx.	*Phytomyza agromyzina* Meigen
Family Araliaceae	
Aralia nudicaulis L.	*Phytomyza aralivora* Spencer
Family Umbellifereae	
Angelica arguta Nutt.	*Phytomyza* sp.
Heracleum lanatum Michx.	*Phytomyza spondylii* R.-D.
Family Elaeagnaceae	
Shepherdia canadensis (L.)	*Amauromyza shepherdiae* n. sp.

Family Caprifoliaceae	
Lonicera dioica L.	*Paraphytomyza lonicerae* (R.-D.)
	Paraphytomyza orbitalis (Melander)
	Paraphytomyza spenceri n. sp.
Lonicera involucrata (Richards)	*Paraphytomyza plagiata* (Melander)
	Phytomyza gregaria Frick
	Phytomyza periclymeni de Meijere
Lonicera tartarica L.	*Paraphytomyza lonicerae* (R.-D.)
Symphoricarpos albus (L.)	*Paraphytomyza lonicerae* (R.-D.)
	Paraphytomyza orbitalis (Melander)
Symphoricarpos occidentalis Hook.	*Paraphytomyza spenceri* n. sp.
Symphoricarpos sp.	*Phytomyza caprifoliae* Spencer
Family Rubiaceae	
Galium boreale L.	*Praspedomyza galiivora* Spencer
Family Boraginaceae	
Mertensia paniculata (Ait.)	*Agromyza canadensis* Malloch
	Phytomyza mertensiae n. sp.
Family Scrophulariaceae	
Penstemon confertus Dougl.	*Phytomyza penstemonis* Spencer
Penstemon procerus Dougl.	*Phytomyza penstemonis* Spencer
Veronica sp. (cultivated)	*Phytomyza crassiseta* Zetterstedt
Family Plantaginaceae	
Plantago major L.	*Phytomyza plantaginis* R.-D.
Family Labiatae	
Mentha arvensis L.	*Calycomyza menthae* Spencer

Family Compositae

Achillea millefolium L.	*Phytomyza matricariae* Hendel
Achillea sibirica Ledeb.	*Melanagromyza achilleana* n. sp.
	Liriomyza millefolii Hering
	Phytomyza matricariae Hendel
Arnica cordifolia Hook	*Phytomyza arnicivora* n. sp.
Aster ciliolatus Lindl.	*Phytomyza ciliolati* Spencer
Aster conspicuus Lindl.	*Phytomyza asterophaga* Spencer
Bidens cernua L.	*Melanagromyza bidenticola* n. sp.
Chrysanthemum sp. (cultivated)	*Phytomyza matricariae* Hendel
Crepis gracilis (D.C. Eat) Rydb.	*Phytomyza syngenesiae* (Hardy)
Crepis tectorum L.	*Phytomyza lactuca* Frost
Matricaria matricarioides (Less) Porter	*Phytomyza matricariae* Hendel
Petasites sagittatus (Pursh)	*Phytomyza petasiti* Spencer
Senecio congestus palustris (L.)	*Phytomyza senecionella* n. sp.
Senecio pauciflorus Pursh	*Liriomyza senecionivora* n. sp.
Senecio sp.	*Phytomyza syngenesiae* (Hardy)
Solidago lepida DC	*Phytomyza solidaginophaga* n. sp.
Solidago sp.	*Ophiomyia maura* (Meigen
	Calycomyza ? solidaginis (Kaltenbach)
	Nemorimyza posticata (Meigen)
Sonchus uliginosus Bieb.	*Phytomyza lactuca* Frost
Sonchus sp.	*Calycomyza sonchi* Spencer

Tanacetum vulgare L.	*Liriomyza millefolii* Hering
	Phytomyza matricariae Hendel
Taraxacum officinale Weber	*Liriomyza taraxaci* Hering
	Phytomyza lactuca Frost
Taraxacum sp.	*Calycomyza sonchi* Spencer

MONOCOTYLEDONES

Family Liliaceae

Smilacina stellata (L.)	*Liriomyza smilacinae* Spencer
Maianthemum canadense Desf.	*Liriomyza* sp.

Family Cyperaceae

Scirpus sp.	*Cerodontha (Dizygomyza) ? scirpi* (Karl)

Family Gramineae

Agropyron repens (L.) Beauv.	*Cerodontha (Poemyza) incisa* (Meigen)
Agropyron smithii Rydb.	*Cerodontha (Poemyza) incisa* (Meigen)
Deschampsia caespitosa (L.)	*Liriomyza cordillerana* Sehgal
Phalaris arundinacea L.	*Cerodontha (Poemyza) incisa* (Meigen)
Triticum aestivum	*Cerodontha (Poemyza) lateralis* (Macquart)

PART 2. A STUDY OF HOST-PLANT RELATIONSHIPS OF AN OLIGOPHAGOUS SPECIES *PHYTOMYZA MATRICARIAE* HENDEL

INTRODUCTION

Literature on various aspects of host selection, feeding, and host preference in phytophagous insects has been reviewed by many authors (Lipke and Fraenkel 1956, Friend 1958, Thorsteinson 1960, Kennedy 1965, Dethier 1966, Schoonhoven 1968).

Verschaffelt (1910) for the first time demonstrated that host selection in *Pieris brassicae* and *P. rapae* is determined by mustard oil glucosides in cruciferous and related plant families. Since then the food ranges of many oligophagous insects have been explained by the botanical distribution of secondary plant chemicals (Fraenkel 1959). Feeding or token stimuli which evoke special feeding responses in phytophagous insects have been investigated (Thorsteinson 1953, Sugiyama and Matsumoto 1959, Nayar and Fraenkel 1962, 1963, Nayar and Thorsteinson 1963, Harris and Mohyuddin 1965, Keller and Davich 1965, Stride 1965). Recent studies on phytophagous insects have demonstrated that feeding stimulants, which may be token stimuli as well as nutritive substances, and deterrents may play an important role in determining the range of host-plants (Thorsteinson 1960, Jermy 1961, 1965). Many recent studies on the host range of oligophagous species have shown that plants not closely related to natural host-plants may be acceptable for normal growth and development (Jermy 1961, 1966, Hsiao and Fraenkel 1968). Physical plant characteristics like hardness pubescence etc., of leaves may be of significant importance in determining host selection by phytophagous insects, but this has only been demonstrated experimentally in few species (Tanton 1962, Schillinger and Gallun 1968, Sincir 1968). Recently Brown, Eisner and Whittaker (1970) introduced two new terms, allomone and kairomone, to facilitate discussion of various behavioral responses between individuals of different species. Allomone is a chemical substance, produced or acquired by an organism, which, when it contacts an individual of another species in the natural context, evokes in the receiver a behavioral or physiological reaction adaptively favorable to the emitter. Such substances may be mutualistic or antagonistic. Nectar, floral scents as well as toxic substances with which organisms defend themselves fall in this category. A kairomone, on the contrary is the substance, the adaptive benefit of which falls on the recipient rather than an emitter. This includes substances which attract insects and other organisms to their food plant.

Most research in the field of insect host-plant relationships has been restricted to external plant feeders and relatively less attention has been given to insect host-plant relationships in internal plant feeders. Agromyzids having evolved as exclusively internal plant feeders are more closely bound to plants than any group of external plant feeders. This group therefore is ideal for the study of insect-food plant relationships. The female agromyzid deposits an egg individually inside the tissues of a selected plant. The emerging larva, unlike that of external plant feeders, is unable to select a more suitable food plant which might be available in its ecological range. The larva either feeds on the plant tissue selected for it or dies if the plant is toxic or unpalatable, due to its mother's error of judgement. Although an agromyzid larva is not concerned with the selection of a suitable food plant, it is directly involved with its acceptance. These larvae are therefore most suitable for the study of their potential to use various food plants for their development. The toxic and deterrent effects, if any, of a plant can also be investigated.

Among Agromyzidae, monophagy and oligophagy are both of common occurrence. Strict monophagy, where an agromyzid species is restricted to a single plant species, is rare unless it results from a plant genus being represented by a single species. Extreme polyphagy is also very rare, all known polyphagous species are restricted in their range of food plants. Most species therefore feed on botanically related plants in nature. My main objective was to understand aspects of insect host-plant relationships in oligophagous agromyzid species. The agromyzid species selected for this purpose was *Phytomyza matricariae* Hendel.

Most of our knowledge of the biology of agromyzid flies is due to the late Professor E. M. Hering who in 1951 in his book 'Biology of the leaf miners' reviewed all existing information and compiled an extensive bibliography on this subject. Numerous other workers in the past have also studied the biology of many leaf mining species in detail (Webster and Parks 1913, Smulyan 1914, Cohen 1936, Ahmad and Gupta 1941, Allen 1956, Oatman and Michelbacher 1958, 1959, Tauber and Tauber 1968).

MATERIALS AND METHODS

Biology of Phytomyza matricariae Hendel.

Observations on mating, oviposition, feeding habits, and life cycle, were made on one of the natural food plants, *Tanacetum vulgare* L., under laboratory conditions of 70 $\pm$ 1 F and 12 hours of daily illumination. The flies used in these observations were bred from *Tanacetum vulgare* L.

In order to determine the incubation period, individual leaves of *Tanacetum vulgare* L., were caged with a large population of flies. After six hours the leaves were removed, examined for eggs, and the positions of individual eggs marked. The leaves were then observed at twelve hour intervals.

The progress of larval mines was marked with different water soluble colors every twelve hours and the mine examined for moulted mouth hooks, which can be seen inside the mine by transmitted light under a binocular microscope. Duration of larval stadia was calculated from the position of moulted mouth hooks. The exact time of moulting during any twelve hour period was estimated by measuring the relative length of leaf mine before and after the position of moulted mouth hooks. This method of recording larval activity has been used by Allen (1956) and Tauber and Tauber (1968). It was thus possible to estimate the duration of larval stadia, length of leaf mine excavated by different instars, and observe the mining habits of the larva. Leaf mines were fixed in 'Formal Acetic Alcohol' (F.A.A.) for microtomy.

Host-plant relationship in adult females.

Range of food plants.-Plants used in this study were grown under greenhouse conditions, but some were also collected from the field.

Small twigs of various plant species bearing few young leaves were exposed individually to a batch of five gravid females inside a muslin cage, for a period of 24 hours. Plant cuttings were kept in Sach's solution for culturing plants. The experiment was carried out inside a growth chamber maintained at 70 $\pm$ 1 F, 12 hours of daily illumination. At the end of the experiment, flies were removed from the cages and the leaves examined for feeding punctures and punctures with eggs.

Feeding and oviposition preference by gravid females.-A circular plastic petri dish 5 1/2 inch in diameter was used as a choice chamber to test the feeding and oviposition preference of adult females. The young leaves of six different plants, grown under greenhouse conditions, were placed around the periphery of the dish equidistant from one another. The petioles of leaves were pulled out through small holes in the periphery of the dish and wrapped with cotton kept moist with distilled water. The plants used in this experiment were *Tanacetum vulgare* L., *Achillea sibirica* Ledeb, *Matricaria matricarioides* (Less) Porter, *Artemisia* sp., *Chrysanthemum* sp., (cultivated var.) and *Helianthus annuus* L.

Five gravid females from a laboratory culture maintained on *Tanacetum vulgare* L. were used in each test. The flies were isolated from their food plant for one hour before being used in the test. They were anesthesized with CO_2 and then introduced at the centre of the petri dish.

Host-plant relationships of the larva

Transfers of larvae from natural host-plants to test plants.-First instar larvae normally less than 24 hours old were used in these experiments. The supply of healthy first instar larvae was from plants in which eggs were laid in the laboratory. Field collected larvae were not used in order to avoid any early parasitization by braconids or chalcidoids.

Test plants were mainly grown in the greenhouse; a few were obtained from the field. Small cuttings from the test plants were kept in Sach's culture solution during the experimental period. By changing the solution it was possible to keep the cuttings healthy during the test period. Only young and tender leaves which are easier to handle than the mature leaves were used in these experiments.

A small slit was made in the leaf of a test plant, using fine insect pins under a binocular microscope. It is normally easier to make the slit near the base of the leaf or near the mid rib, more so on one side of the leaf than the other, depending on the test plant. A first instar larva is then removed by opening its mine on the natural host-plant and transferred with a fine tip of a soft brush into the slit made on the leaf of the test plant. The larva is pushed inside the slit so that it is completely surrounded by the tissue of the test plant. The leaf of the test plant along with a small portion of petiole or twig was then enclosed inside a square plastic petri dish containing moist filter paper in order to prevent any sudden drying of the tissue around the slit. Two small holes were cut in upper corners of plastic petri dish and covered with thin muslin cloth to permit transpiration and to prevent excessive condensation inside the petri dish.

The larva inside the test plant can be observed by transmitted light, moving its mouth hooks in an attempt to eat the new tissue. Leaves of the test plants were checked within couple of hours of making the transfers of larvae. If the larva was still moving its mouth hooks, the transfer was considered right; if the larva did not show any movement it was assumed to have been injured and the transfer was rejected. With patience and experience with particular test plant, it was possible to make good transfers of larvae, except to *Artemisia* because of the very woolly surface of the leaf. The transferred larva usually ended up inside the fibres on the leaf, rather than inside the leaf tissue.

Observations were made every twelve hours on larval feeding and pupation if any during the previous twelve hour period. The pupae obtained were kept individually in small vials containing moist sand, for emergence of adults. The emergence of adults was also checked every twelve hours.

BIOLOGY OF *PHYTOMYZA MATRICARIAE* HENDEL

Introduction

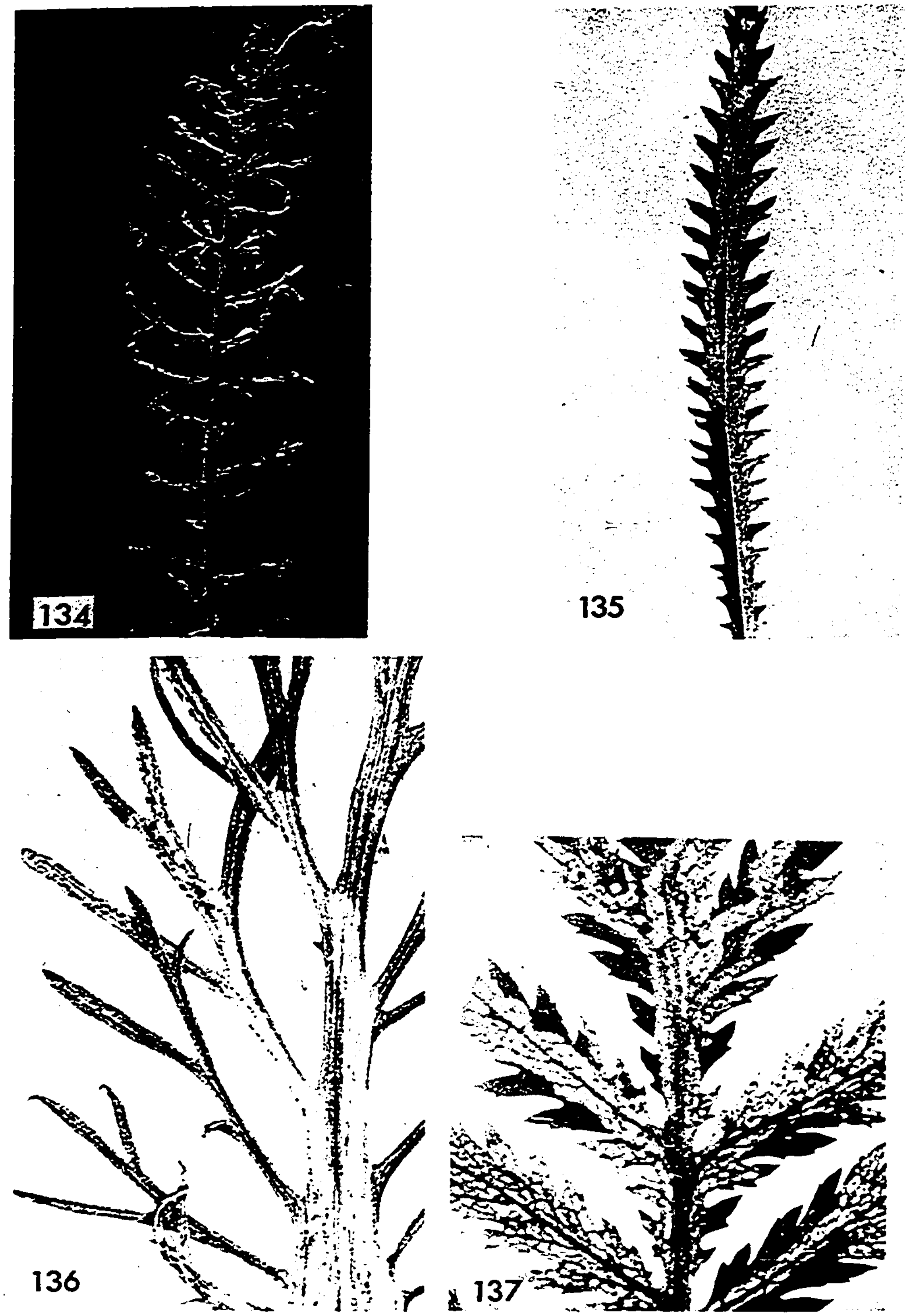
Phytomyza matricariae Hendel is an oligophagous species whose members feed in nature around Edmonton, Alberta, Canada, only on the representatives of the tribe Anthemideae, family Compositae. The plant species attacked are *Achillea millefolium* Michx. (Fig. 134), *Achillea sibirica* Ledeb (Fig. 135), *Achillea* sp. (cultivated variety), *Chrysanthemum* sp. (cultivated soft leaf variety), *Matricaria matricarioides* (Less.) Porter (Fig. 136), and *Tanacetum vulgare* L. (Fig. 137). Hering (1957) lists *Achillea, Anacyclus, Anthemis, Cotula* and *Matricaria* as European hosts for the members of this species. However, the flies bred from some of these hosts probably need confirmation by examination of the characters of the male genitalia. Spencer (1969) lists *Tanacetum* also as European host.

Natural incidence

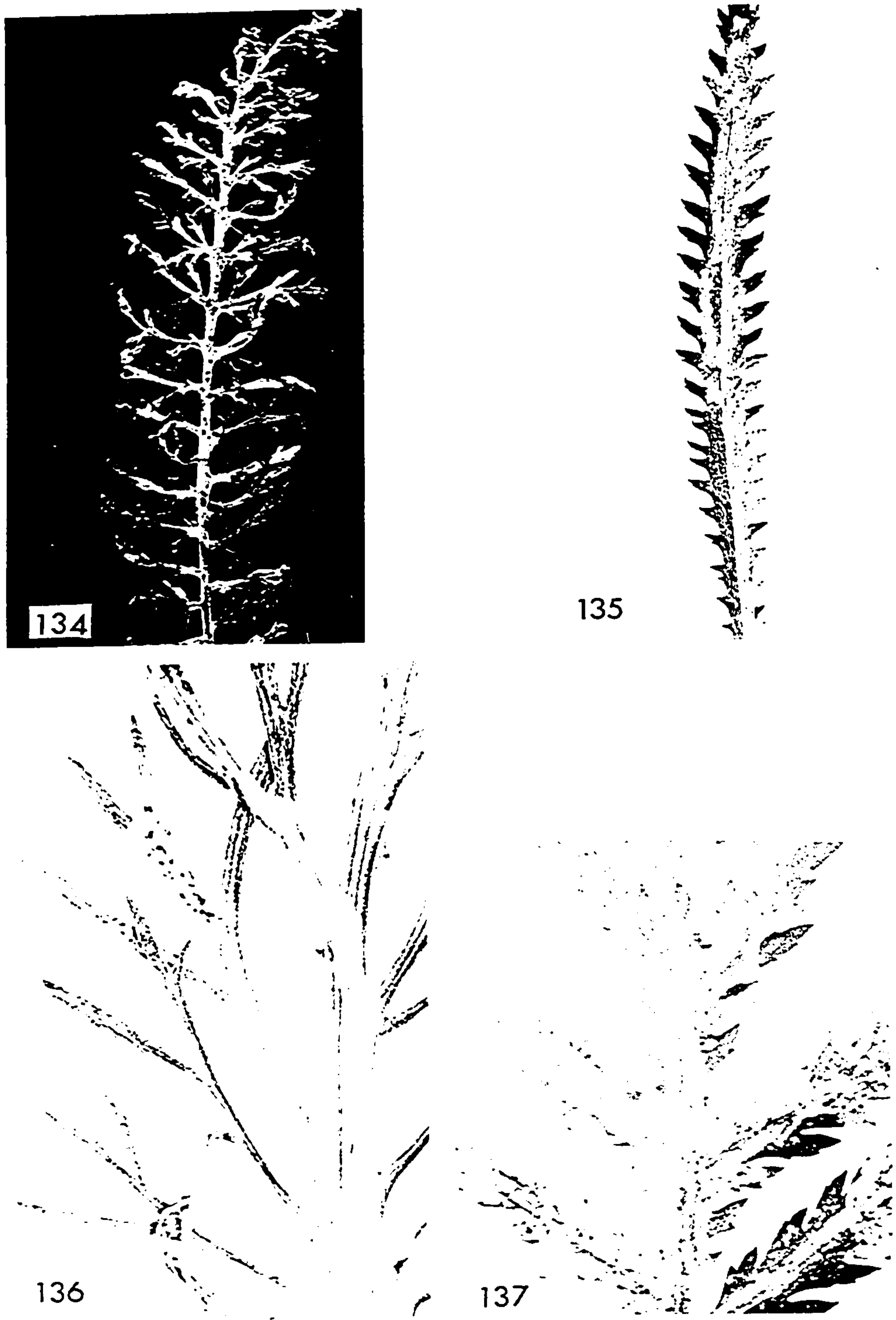
The adults of this species appear around Edmonton, Alberta during the first week of June. The leaf mines and larvae start appearing simultaneously on various host-plants by the second week of June. The members of this species have numerous overlapping generations during July, August, and up to mid-September, when their numbers start declining. At this time the host-plants also decline in their vigor due to shorter days and lower temperatures. Towards the end of September, puparia go into winter diapause.

Mating

Mating was observed in the laboratory at all times. It occurs many times in the life of both sexes, usually on the leaves of the



Figs. 134 - 137. Natural host-plants of *Phytomyza matricariae*. 134. leaf mine on *Achillea millefolium* Michx. 135. leaf mine on *Achillea sibirica* Ledeb. 136. leaf mine on *Matricaria matricarioides* (Less.) Porter. 137. leaf mine on *Tanacetum vulgare* L.



Figs. 134 - 137. Natural host-plants of *Phytomyza matricariae*. 134. leaf mine on *Achillea millefolium* Michx. 135. leaf mine on *Achillea sibirica* Ledeb. 136. leaf mine on *Matricaria matricarioides* (Less.) Porter. 137. leaf mine on *Tanacetum vulgare* L.

food plant. The mating pósture in a superimposed position is typical of other agromyzid flies. Its duration as in other agromyzid flies varies greatly, from half an hour to approximately two hours.

Adult feeding

The flies feed upon plant exudates soon after emergence. The female selects a suitable spot on the leaf tissue, bends the tip of her abdomen vertically downwards, pierces the epidermis and then rotates the tip of her ovipositor within the leaf tissue. She then withdraws her ovipositor, turns around and imbibes the sap exuding from the wound. The puncture thus made is almost conical in shape. This method of feeding among agromyzid flies is of wide occurrence and has been described for many species.

The female spends most of her lifetime making punctures in leaf tissue. These punctures are made both on upper and lower surfaces of the leaf, but are usually more numerous on the upper surface. The males, which are incapable of making such punctures, feed on the sap from punctures made by females or on natural plant exudates and probably also on nectar of flowers. Pollen grains could not be found in the guts of about ten field collected males examined for this purpose.

Plants normally survive the injury made by feeding punctures on the leaf, but under severe laboratory infestations they become greatly etiolated and sometimes collapse.

Oviposition

The eggs are laid singly inside the leaf parenchyma in punctures made in a similar way to feeding punctures. The egg punctures, like feeding punctures, were found both on upper and lower surfaces of the leaf, but unlike feeding punctures were usually more common on the lower surface. The feeding punctures always greatly outnumber oviposition punctures. This method of oviposition is of general occurrence among the leaf mining agromyzid flies and has been described in many species.

Incubation period

The incubation period (Table 3) ranged from 90-102 hours, with an average of approximately 91 hours or 3.8 days. The egg, originally transclucent, becomes opaque white within the first 24 hours. The cephalopharyngeal skeleton appears as a darkly sclerotized structure at the end of 72 hours. At this time the embryo is almost fully developed and the mouth hooks can sometimes be seen to move horizontally.

Larval activity

The average duration of first, second and third instar larvae (Table 3) was 64.2, 45.0 and 56.4 hours respectively. The total larval period was 165.6 hours or 6.9 days on an average.

From the time of hatching to shortly before pupation, the larva is completely endophagous, feeding between the two epidermal layers of the leaf. This results in the excavation of a linear leaf mine. The leaf mine starts from the upper or lower surface of leaf depending upon the site of oviposition and terminates also on the upper or lower surface, when the larva leaves by cutting a small crescent shaped slit at the end of the mine. The larva then falls to the ground and pupates. The larva like most other agromyzid larvae (Hering 1951) seems unable to re-enter the leaf once it is removed

Table 3. Duration of life history of *Phytomyza matricariae* Hendel on its natural host-plant *Tanacetum vulgare* L.

Stage in life cycle	Number of observations	Duration of the stage in life cycle: Range (hrs.)	Duration of the stage in life cycle: Average (hrs.)	Total Average duration (Days)
Egg stage	44	90.0-102.0	91.0*	3.8
First larval instar	20	55.0- 73.0	64.2	
Second larval instar	20	40.0- 51.5	45.0	
Third larval instar	20	44.0- 65.0	56.4	
Total larval stage	20	144.0-180.0	165.6	6.9
Pupal stage	15	13.0- 14.5 (Days)	13.7 (Days)	13.7
Total life cycle				24.4

* Out of 44 observations the values of 40 were 90.0 hours and of four 102.0 hours

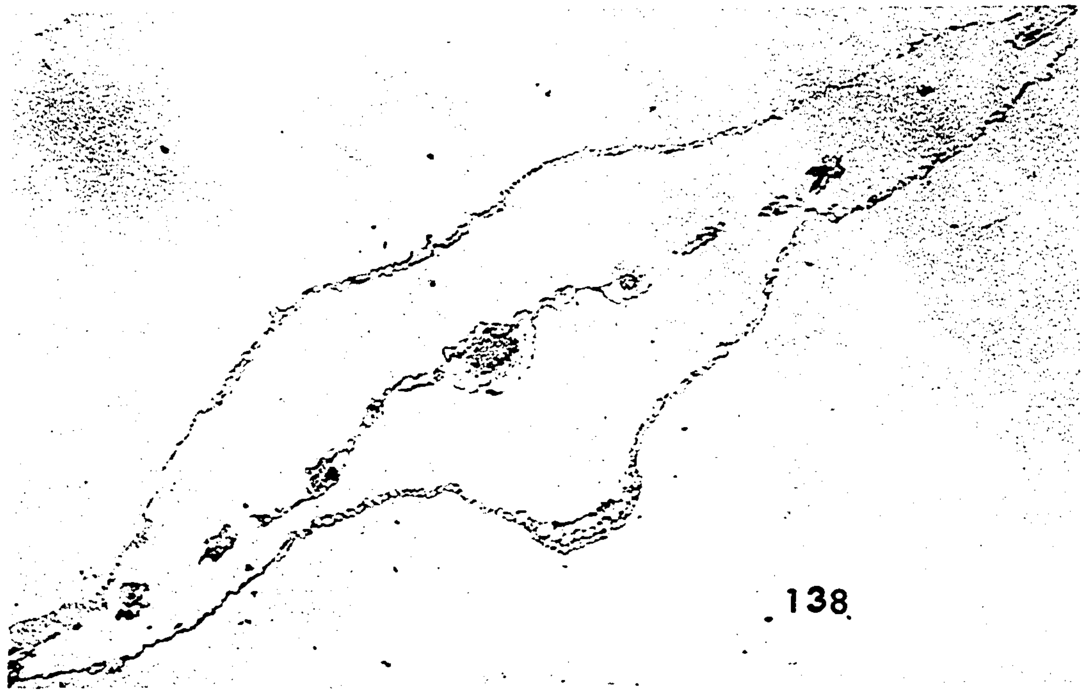
from it. The ability of the larvae of '*Liriomyza pusilla* Meigen' (Tilden 1950) and at least some members of *Agromyza rufipes* group (Nowakowski 1964; Griffiths, verbal communication) to re-enter the leaf during larval period seems very unusual.

The mouth hooks can be seen cutting through the leaf tissue in a lateral and semicircular motion. The larvae, like those of other agromyzids (Hering 1951), mine the leaf while lying on their sides and they alternate from one side to another. The frass is deposited in discrete granules along the sides of the mine alternately as the larva turns from one side to another.

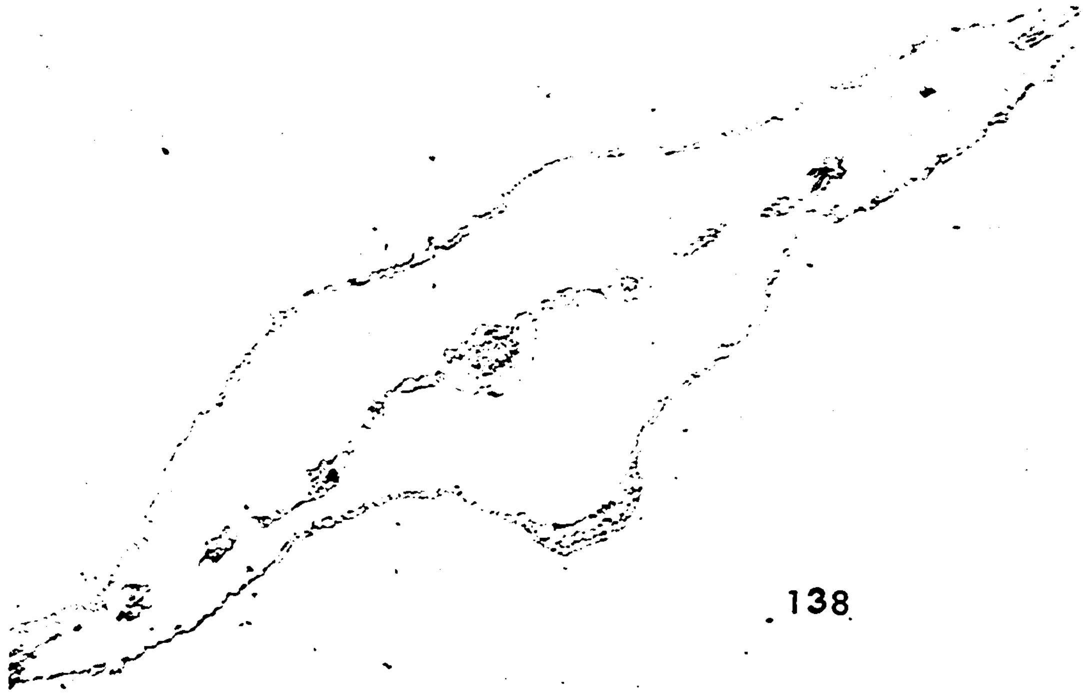
Many larvae may start mining the same leaf simultaneously resulting in numerous mines crossing each other, however, every mine remains distinct and contains only one miner. The larvae normally feed only on the leaf tissue, but under heavy infestations also migrate to the leaf petiole or mine under the epidermis of the stem.

Transverse sections of the mined leaves (Figs. 138, 139) show that larvae feed indiscriminately on the palisade and spongy mesenchymatous tissue between the two epidermal layers of the leaf. The larvae do not consume the entire tissue between upper and lower epidermis except when this is very heavily infested. Thus the leaf mine is normally more visible from one side of the leaf. The larvae are capable of crossing the leaf veins but the vascular bundles are not attacked as they are by some other agromyzid leaf mining species (Trehan and Sehgal 1963, Tauber and Tauber 1968).

The average length of mine (Table 4) excavated by first, second and third instar was 13.5, 29.1 and 99.4 mm respectively. The total



Figs. 138 - 139. Vertical sections of leaf mines of *Phytomyza matricariae*. 138. leaf mine on *Achillea sibirica* Ledeb. 139. leaf mine on *Matricaria matricarioides* (Less.) Porter.



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Figs. 138 - 139. Vertical sections of leaf mines of *Phytomyza matricariae*. 138. leaf mine on *Achillea sibirica* Ledeb. 139. leaf mine on *Matricaria matricarioides* (Less.) Porter.

Table 4. Measurements of leaf mines excavated by different larval instars of *Phytomyza matricariae* Hendel on its natural food plant *Tanacetum vulgare* L.

Stage of larva	Number of observations	Length of leaf mine (mm)	
		Range	Average
First instar larva	19	8.0-18.4	13.5
Second instar larva	19	13.4-42.5	29.1
Third instar larva	19	71.2-127.0	99.4
Total larval life	19	110.0-177.0	142.0

length of leaf mine was 142.0 mm on an average. This was much shorter than that for "*Phytomyza lanati* Spencer" which was reported by Tauber and Tauber (1968) to average 273.0 mm. Although the duration of the third larval instar is approximately the same as that for first instar, the major portion of the mining activity was confined to the third instar.

Pupation

The mature larva when ready to pupate leaves the leaf mine and falls to the ground, where it seeks a suitable site for pupation. Often the larva remains sticking to the exit slit in the mine and there forms the puparium. Duration of the puparium stage varies considerably. This normally lasts 13.7 days on an average. The pupae from the fall generation undergo winter diapause.

DESCRIPTION OF THE IMMATURE STAGES

Egg

The egg (Fig. 140) when freshly laid is translucent white, smooth, elongate, ovo-cylindrical, slightly broader at posterior end, and with a small, almost indistinguishable micropyle at the anterior end. The eggs of the members of the *Phytomyza syngenesiae* group have a similar micropyle (see Smulyan 1914 as '*Phytomyza chrysanthemi* Kowarz' and Cohen 1936 as '*Phytomyza atricornis* Meigen'). The egg measures (Table 5) on an average 0.293 x 0.129 mm.

Larva

There are three larval instars which can be easily recognised by the size of their cephalopharyngeal skeleton. The larval measurements of length, width and length of cephalopharyngeal skeleton of various instars are given in Table 5.

The first instar larva when freshly hatched is translucent white, but soon becomes greenish due to the ingested leaf tissue. The second and third instar larvae are yellowish green in colour.

The first instar larva is metapneustic i.e., only the posterior pair of spiracles is functional; while the second and third instar larvae are amphipneustic i.e., have a small anterior pair of spiracles located dorsally on the first thoracic segment and a relatively larger posterior pair located dorsally on the last or eighth abdominal segment. The anterior spiracles (Fig. 141) of the mature third instar larva has approximately 7-9 small oval bulbs, while the posterior pair (Fig. 142) has approximately 19-21 small oval bulbs. De Meijere (1926) illustrated the anterior and posterior spiracles in the European

Table 5

The dimensions of egg, larva, cephalopharyngeal skeleton and puparium of *Phytomyza matricariae* Hendel

Stage	Range (mm)	Average (mm)
Egg		
Length	0.283–0.316	0.293
Width	0.100–0.141	0.129
First instar larva		
Length	0.300–0.550	0.412
Width	0.116–0.208	0.152
Second instar larva		
Length	0.592–0.825	0.732
Width	0.208–0.300	0.243
Third instar larva		
Length	2.125–2.625	2.395
Width	0.625–0.750	0.667
Cephalopharyngeal skeleton length		
First instar larva	0.116–0.125	0.121
Second instar larva	0.216–0.233	0.220
Third instar larva	0.308–0.316	0.316
Puparium		
Length	1.675–1.950	1.810
Width	0.800–0.925	0.852

All measurements based on ten observations.

members of this species bred from *Matricaria chamomilla* L. He reported about 12 bulbs on the anterior and 18 bulbs on the posterior spiracles.

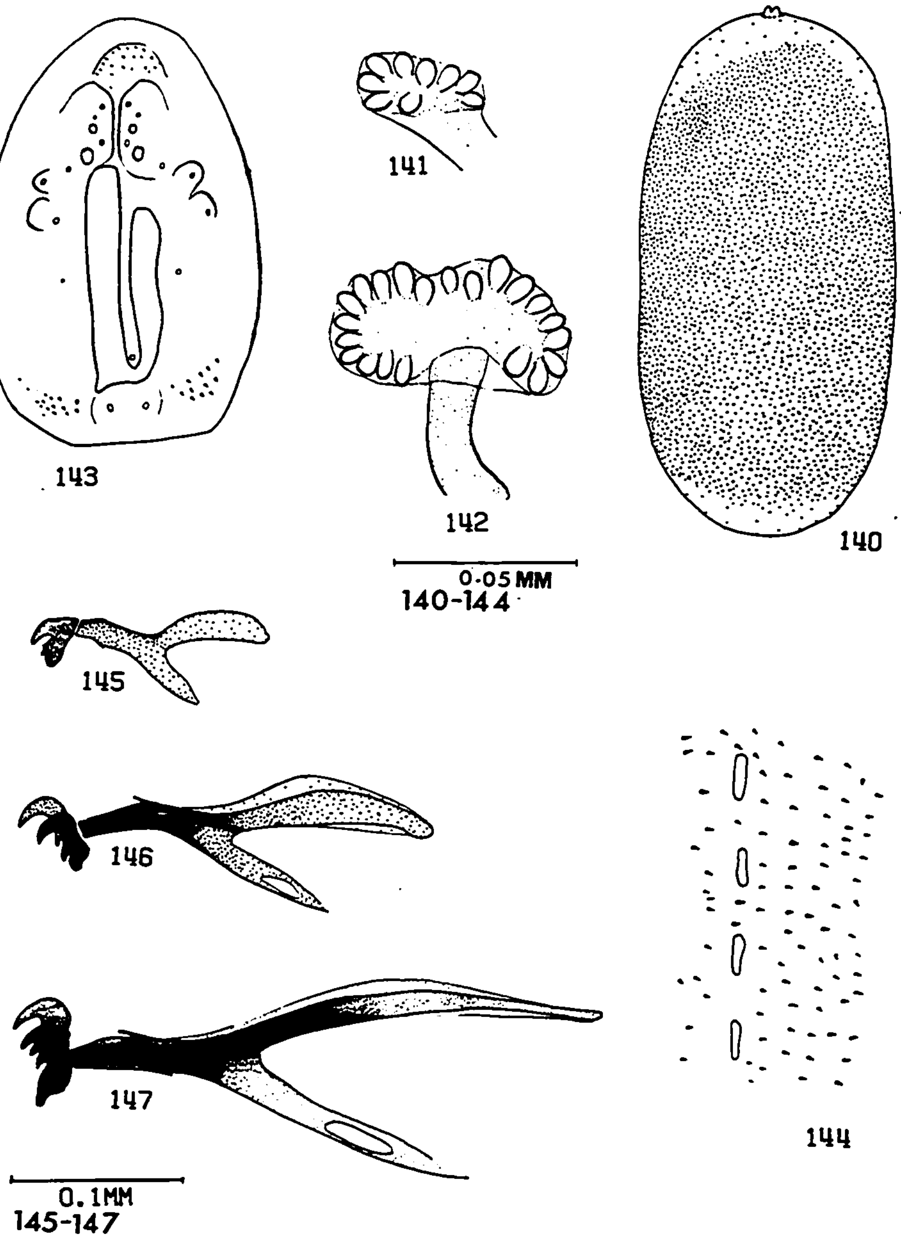
The head (Fig. 143) bears two small longitudinal sclerites just above the mouth hooks, small but conspicuous maxillary palps and a pair of small antennae and numerous sense papillae.

The muscle scars on the intersegmental membrane (Fig. 144) are small, oval and transversely elongated. The tubercle bands (Fig. 144) consist of small conical processes irregularly scattered along the intersegmental membrane. The tubercle bands as in other agromyzid larvae (Allen 1957) are best developed along lateral portions of intersegmental membrane.

The cephalopharyngeal skeleton of the first, second and third instar is illustrated in Figs. 145-147. It consists of paired mouth hooks or mandibles, labial sclerite and paired paraclypeal phragma. The mouth hooks in the first instar larva are small, simple and sickle shaped; while in second and third instars are well developed with two teeth each, alternating with one another. Right mouth hook is higher than left and both mouth hooks are joined at base (Fig. 143). Labial sclerite and paraclypeal phragma are smaller in first and second instars, but are well differentiated in the third instar. The dorsal process of the paraclypeal phragma consists of a long, single, slender and darkly sclerotized arm; the ventral arm is short, lightly sclerotized, and has a conspicuous foramen towards its posterior end.

Puparium

The puparium is small, conspicuously segmented, shining black in colour and measures 1.81 x 0.85 mm (Table 5) on an average.



Figs. 140 - 147. *Phytomyza matricariae*. 140. egg. 141. anterior spiracle. 142. posterior spiracles. 143. facial mask of third instar larva. 144. muscle scars and tubercle band from a lateral portion of first abdominal segment of larva. 145. cephalopharyngeal skeleton of first instar larva. 146. cephalopharyngeal skeleton of second instar larva. 147. cephalopharyngeal skelton of third instar larva.

The puparium is the hardened skin of the third instar larva. This hardening is due to the deposition of the calcospherites (Frick 1952, Allen 1957). The puparial skin can be softened by treatment with dilute hydrochloric acid and can be cut open for detailed examination. Although the puparium preserves the complete record of the larval morphology, this is best studied in the larva itself.

HOST-PLANT RELATIONSHIPS OF ADULT FEMALES

Introduction

The agromyzid larva being completely internal feeder, depends entirely on its mother for the choice of a suitable food plant. The ovipositing female comes across numerous other plants besides those normally attacked in nature. In order to test the specificity of feeding and oviposition a selection of wide range of plants was exposed to a batch of five gravid females, for a period of 24 hours. Plants used in this study included some common plants, which the female would encounter in the field, as well as some plants which are known for certain secondary substances like alkaloids, glycosides etc. A total of 38 plants belonging to 17 plant families were tested for feeding and oviposition. Feeding and oviposition preference of females when offered a choice of acceptable plants was also studied. Degree of phylogenetic relationship of the test plant to the natural host-plant was determined for comparison with the index of test plant for feeding and oviposition.

Index of plant relationship

Botanical relationship of the test plant species, used in experiments on feeding and oviposition by adult females and transfers of larvae, to one of the natural food plants of *Phytomyza matricariae* Hendel was examined.

The phylogenetic relationships between plant families and orders is still a matter of controversy. Most plant classifications fall into two groups depending on the supposed nature of primitive angiosperm flowers (Davis and Heywood 1965). One system is based on the assumption that the earliest angiosperms were wind-pollinated and that the monocotyledones and dicotyledones have arisen independently from hypothetical gymnosperms. According to the second system dicotyledones and monocotyledones were both derived from primitive angiosperms which were insect-pollinated. The second system has the support of most recent botanists (Eames 1961, Hutchinson 1964, and Takhtajan 1969). Hutchinson (1964) has maintained a basic division of dicotyledons into woody "Lignosae" and herbaceous "Herbaceae", a system which allegedly leads to the wide separation of certain plant families which otherwise seem closely related in the structure of their flowers. The arrangement of plant families used in this study is after Takhtajan (1969), which is considered to reflect more closely the phylogenetic relationships between plant families.

An index of plant relationship between 1 and 10 was calculated based on the degree of known phylogenetic relationship as follows:

Relationship of the test plant species to natural host-plant	Index of plant relationship
1. Same species	10
2. Same genus	9
3. Same tribe (Anthemideae)	8
4. Same family (Compositae)	7
5. Same order (Asterales)	6
6. Same superorder (Asteranae)	6
7. Same subclass (Asteridae)	4
8. Same class (Dicotyledoneae)	3
9. Same division (Angiospermae)	2
10. Same phylum (Tracheophyta)	1

Index of acceptability for feeding and oviposition

An index of acceptability of a test plant for feeding and oviposition relative to that of the natural food plant from which flies were obtained was calculated for comparison with the index of plant relationship.

In experiments with feeding and oviposition studies, females used were obtained from the natural host-plant *Tanacetum vulgare* L. Data given in Tables 6 and 7 were used to calculate the index of acceptability in feeding and oviposition as follows:

$$\text{Index of acceptability for feeding and oviposition} = \frac{\dfrac{\text{Number of feeding punctures on test plant}}{\text{Number of feeding punctures on } \textit{Tanacetum vulgare} \text{ L.}} + \dfrac{\text{Number of punctures with an egg on test plant}}{\text{Number of punctures with an egg on } \textit{Tanacetum vulgare} \text{ L.}}}{2}$$

Range of food plants

Data on the acceptability of plants for feeding and oviposition by gravid females is summarized in Table 6. Indices of plant relationship and of acceptability of a test plant for feeding and oviposition are given for each test species. Of the 38 plant species tested only seven belonging to the family Compositae were acceptable for feeding and oviposition both. The acceptable plants were *Achillea sibirica* Ledeb, *Artemisia* sp., *Chrysanthemum* sp. (cultivated var.), *Matricaria matricaricides* (Less.) Porter and *Tanacetum vulgare* L. of the tribe Anthemideae, and *Helianthus annuus* L. and *Zinnia* sp. of

Table 6.

Feeding and oviposition by females of

Phytomyza matricariae Hendel on various plant species

Test Plant	Number of feeding punctures	Number of punctures with an egg	Index of acceptability	Index of plant relationship
Pteridophyta				
Polypodiaceae				
Nephrolepis	2	-	0.002	1
ANGIOSPERMAE-DICOTYLEDONES				
Ranunculaceae				
Aquilegia sp. (cultivated)	16	-	0.018	3
Clematis verticellaris DC	12	-	0.013	3
Delphinium sp. (cultivated)	-	-	0.000	3
Papaveraceae				
Papaver sp. (cultivated)	11	-	0.012	3
Chenopodiaceae				
Chenopodium sp.	5	-	0.005	3
Cucurbitaceae				
Cucumis sp.	11	-	0.012	3
Cruciferae				
Brassica khaber (DC.) Wheeler	3	-	0.003	3
Thlaspi arvense L.	22	-	0.024	3

Test Plant	Number of feeding punctures	Number of punctures with an egg	Index of acceptability	Index of plant relationship
Rosaceae				
Potentilla sp.	-	-	0.000	3
Leguminosae				
Caragana arborescens Lam.	3	-	0.003	3
Lathyrus odoratus L.	-	-	0.000	3
Lupinus sp. (cultivated)	-	-	0.000	3
Pisum sativum L.	32	-	0.036	3
Vicia americana Muhl.	-	-	0.000	3
Tropaeolaceae				
Tropaeolum sp. (cultivated)	3	-	0.003	3
Solanaceae				
Lycopersicon esculentum L.	3	-	0.003	4
Nicotiana tabacum L.	4	-	0.004	4
Solanum tuberosum L.	3	-	0.003	4
Scrophulariaceae				
Antirrhinum sp. (cultivated)	-	-	0.000	4
Labiatae				
Galeopsis tetrahit L.	5	-	0.005	4
Campanulaceae				
Campanula sp. (cultivated)	-	-	0.000	5

Test Plant	Number of feeding punctures	Number of punctures with an egg	Index of acceptability	Index of plant relationship
Compositae				
Achillea sibirica Ledeb	567	28	1.039	8
Artemisia sp.	227	10	0.398	8
Aster ciliolatus Lindl.	10	-	0.011	7
Chrysanthemum sp. (cultivated)	467	34	1.012	8
Helianthus anuus L.	292	19	0.600	7
Matricaria matricarioides (Less.) Porter	441	30	0.926	8
Senecio vulgaris L.	54	-	0.060	7
Solidago sp.	12	-	0.013	7
Sonchus uliginosus Bieb.	4	-	0.004	7
Tanacetum vulgare L.	443	35	1.000	10
Taraxacum officinale Weber	124	-	0.139	7
Zinnia sp. (cultivated)	44	3	0.092	7
ANGIOSPERMAE-MONOCOTYLEDONES				
Liliaceae				
Allium cepa L.	1	-	0.001	2
Smilacina stellata (L.) Desf.	-	-	0.000	2
Gramineae				
Hordeum vulgare L.	7	-	0.007	2
Typhaceae				
Typha latifolia L.	-	-	0.000	2

the tribe Heliantheae. Among these *Artemisia, Helianthus* and *Zinnia* were not found attacked in nature.

Fern, various monocots, non-composit dicots as well as other composits tested did not provide sufficient stimulus for oviposition; however varying numbers of feeding punctures were made on many of these plant species.

Index of acceptability for feeding and oviposition based on the data in Tables 6 and 7 was plotted against the index of plant relationship for comparison (Fig. 148). Index of acceptability was very low for most species of test plants, but became high when the index of plant relationship reaches upper limits of 8 or over. This indicates that only plants having very close phylogenetic relationship with the natural food plant were acceptable for feeding and oviposition to adult females.

Feeding and oviposition preference by gravid females

The preference of gravid females for feeding and oviposition when offered a choice of six acceptable plants was examined. The plants used in this study were *Achillea sibirica* Ledeb, *Artemisia* sp., *Chrysanthemum* sp., *Helianthus annuus* L., *Matricaria matricarioides* (Less.) Porter and *Tanacetum vulgare* L. belonging to the family Compositae. Results of this experiment are summarized in Table 7.

The number of feeding punctures on *Tanacetum* was significantly higher than on other plants tested. The numbers of feeding punctures on *Chrysanthemum, Achillea, Matricaria* and *Helianthus* were not significantly different from each other, but were significantly lower than on *Tanacetum*. The numbers of feeding punctures on *Achillea,*

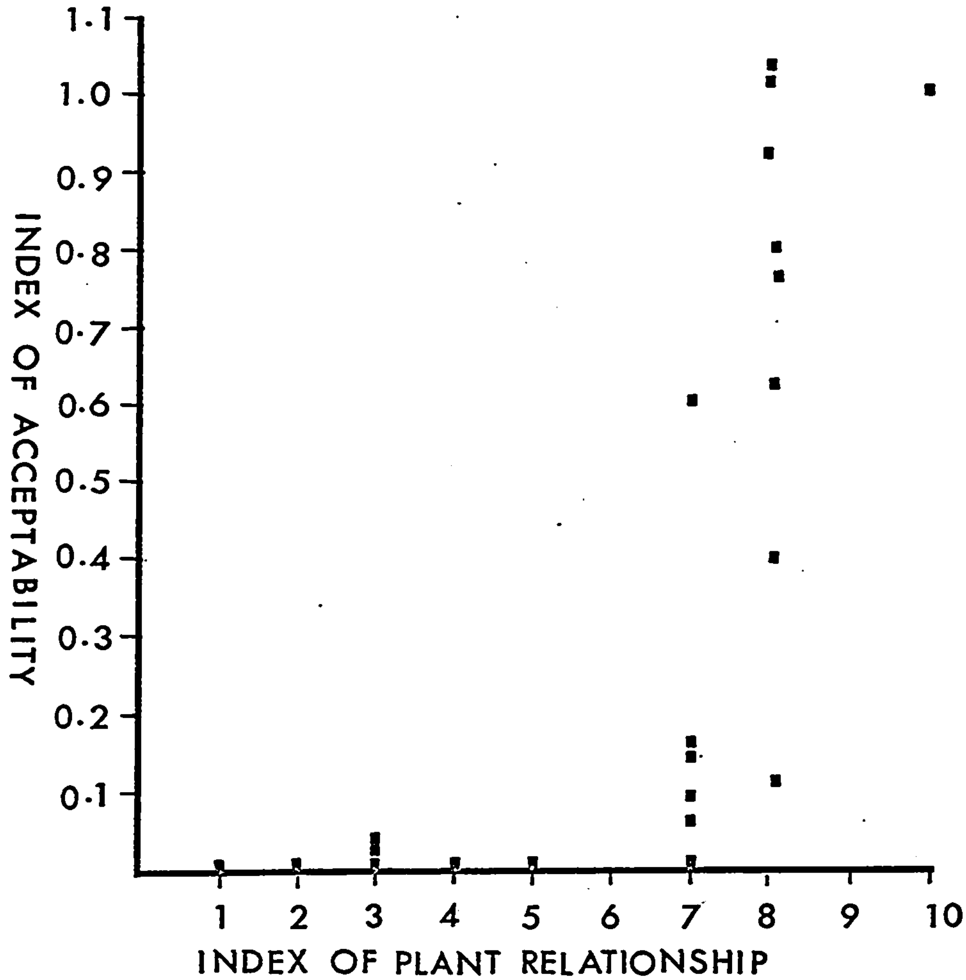


Fig. 148 Graph showing the index of acceptability of test plant for feeding and oviposition, and the index of plant relationship.

Table 7

Feeding and oviposition preference

of *Phytomyza matricariae* Hendel

Test Plant	Average number of feeding punctures	Average number of punctures with an egg	Index of success	Index of plant relationship
Tanacetum vulgare	519.5 a	11.8 a'	1.000	10
Chrysanthemum sp.	200.5 b	13.3 a'	0.756	8
Achillea sibirica	181.6 b c	10.5 a'	0.614	8
Matricaria matricarioides	161.0 b c	15.0 a'	0.790	8
Helianthus annuus	58.5 b c	2.3 b'	0.153	7
Artemisia sp.	36.8 c	1.6 b'	0.102	8

1. Females used in this experiment were from a laboratory culture maintained on *Tanacetum vulgare* L.
2. Averages are based on six replicates.
3. Treatments which are not significantly different from each other have the same letter opposite; as calculated by Duncan's multiple range significance level test.

Matricaria, Helianthus and *Artemisia* were not significantly different from each other, but were significantly lower than on *Tanacetum*.

The numbers of punctures with an egg on *Tanacetum, Chrysanthemum, Achillea* and *Matricaria* were not significantly different from each other, but were significantly higher than on *Helianthus* and *Artemisia*.

The number of eggs were not dependent on the number of feeding punctures.

Feeding preference by freshly emerged females

Feeding preference by freshly emerged females, which had not been exposed to any food plant, was examined in a similar experiment as described above for feeding and oviposition studies. Results of this experiment are summarized in Table 8.

The number of feeding punctures on *Tanacetum* was significantly higher than on other plants tested. The numbers of feeding punctures on *Achillea, Matricaria* and *Chrysanthemum* were not significantly different from each other, but were significantly lower than on *Tanacetum* and higher than on *Helianthus* and *Artemisia*. The numbers of feeding punctures on *Helianthus* and *Artemisia* were not significantly different from each other, but were significantly lower than on other plants tested.

Table 8

Feeding preference of freshly
emerged females of *Phytomyza matricariae* Hendel

Test plant	Average number of feeding punctures	
Tanacetum vulgare	250.8	a
Achillea sibirica	174.6	b
Matricaria matricarioides	139.5	b
Chrysanthemum sp.	128.6	b
Helianthus annuus	28.3	c
Artemisia sp.	14.3	c

1. Females used in this experiment emerged within last 24 hours from puparia obtained from the host *Tanacetum vulgare*.
2. Averages are based on six replicates.
3. Treatments which are not significantly different from each other have the same letter opposite; as calculated by Duncan's multiple range significance level test.

HOST-PLANT RELATIONSHIPS OF LARVAE

Introduction

In nature the larvae feed only on the plants accepted for oviposition by the female. The larva, from the time of its emergence from an egg to a little before pupation, is completely surrounded by the tissue of the food plant. Thus being a completely internal plant feeder, it is unable to select a more suitable food plant which might be avilable in its geographical range. In order to test the ability of larva to use different plants as food which may be available in its geographical range, the first instar larvae obtained from the natural food plant were transferred inside the tissue of the test plant. Index of suitability of test plant for larval development based on larval feeding, pupation and emergence of imago was calculated for comparison with the index of plant relationship.

Index of suitability of test plant for larval development

An index of suitability of test plant for larval development was calculated from results obtained in the transfers of larvae from natural host-plant to test plants, for comparison with the index of plant relationship. This calculation was based on three components as follows:

1. *Duration of larval feeding on test plant.*-This is assumed to be equal to the duration of time spent by a larva, after its transfer, inside the tissue of the test plant. Studies on the life history as summaraized in Table 3 show that the average duration of a larval stage in *Phytomyza matricariae* Hendel on

Tanacetum vulgare L. is 6.9 days. The first instar larvae used in transfer experiments were about one day old. Therefore under normal conditions the remainder of larval feeding time should be 5.9 days on an average. Success in larval feeding was expressed as the ratio of the duration of feeding of larva on test plant to 5.9 days.

2. *Pupation.*-This is considered as successful termination of larval development. Success was expressed as the proportion of the transferred larvae pupating successfully on the test plant.

3. *Emergence.*-In most plants the larvae which pupated also emerged as adult flies. The emergence was given one-fourth as much weighting as pupation in calculation of index of success, that is it was expressed as one quarter of the proportion of transferred larvae which yielded adult flies.

The overall index of suitability of test plant for larval development, based on duration of larval feeding, pupation, and emergence of adult on test plant was calculated by

$$\begin{array}{l}\text{Index of}\\ \text{suitability}\\ \text{of test plant}\\ \text{for larval}\\ \text{development}\end{array} = \frac{\dfrac{\begin{array}{l}\text{Duration of}\\ \text{larval feeding}\\ \text{on test plant}\\ \text{(Days)}\end{array}}{\begin{array}{l}\text{5.9 days, aver-}\\ \text{age duration of}\\ \text{larval feeding}\\ \text{on natural host-}\\ \text{plant}\end{array}} + \dfrac{\begin{array}{l}\text{Number of}\\ \text{larvae pupated}\\ \text{on test plant}\end{array}}{\begin{array}{l}\text{Number of}\\ \text{larvae}\\ \text{transferred}\end{array}} + \dfrac{\begin{array}{l}\text{Number of}\\ \text{flies}\\ \text{emerged}\end{array}}{\begin{array}{l}\text{Number}\\ \text{of larvae}\\ \text{transferred}\end{array}} \times 1/4}{2.25}$$

Transfers of larvae from natural host-plant to test plant

Larvae were transferred from the natural host-plants *Tanacetum vulgare* L. and *Achillea sibirica* Ledeb to test plants. Test plants used in this study were those related as well as unrelated to the natural host-plant, and were selected from a wide range of plant families.

Due to practical difficulties of making large numbers of transfers of larvae at one time; availability of the first instar larvae and the test plants in suitable condition; and the brief period of activity of this species in nature, the transfers of larvae were made over a period of two summers. In order to test wide range of plants, the controls, i.e., transfers on the same plant from which larvae are obtained, were made only once, as were the transfers on other test plants.

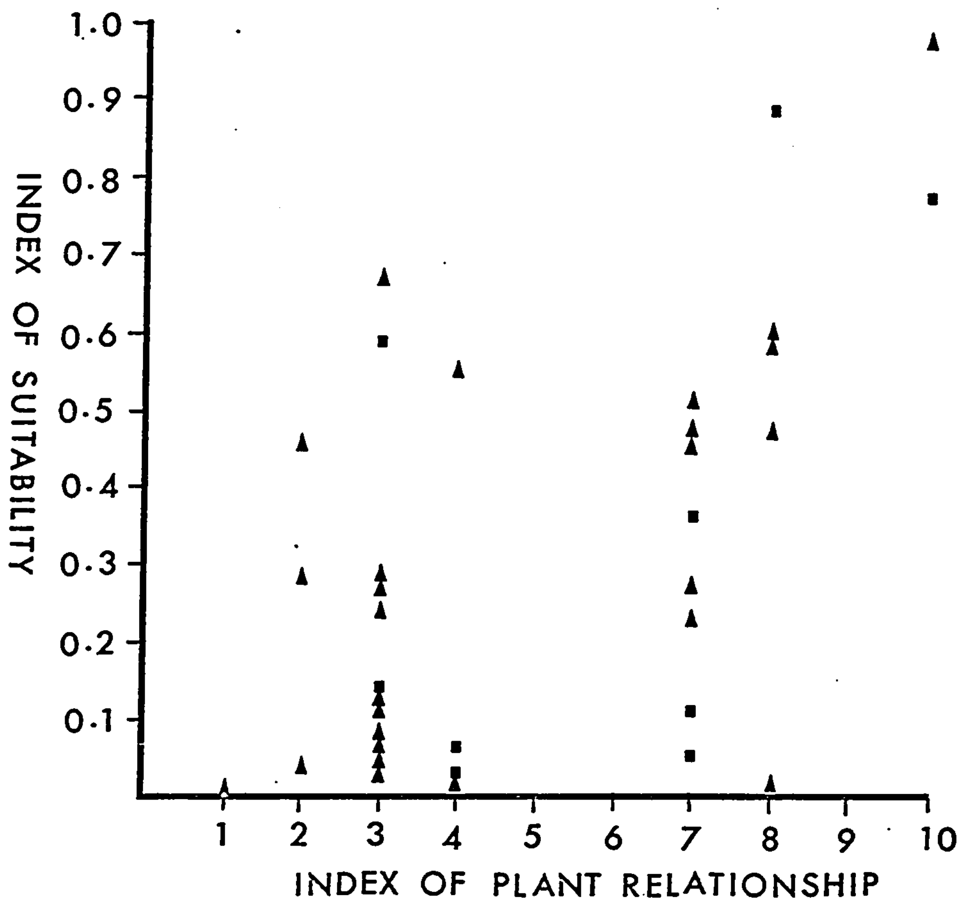
The number of larvae transferred individually from the natural host-plant to inside the tissue of test plant was 20, except in few plants when it was 10. Because of the small number of transfers made and the absence of separate control for each transfer, it is not possible to make elaborate statistical comparisons about the overall superiority of one plant over the other, but nevertheless, some trends regarding the suitability of a wide range of plants tested for larval development can be observed.

Data on the progress of mortality, pupation and emergence of adult, after transfers of larvae are represented in the histograms (Figs. 154-190). Results of the transfers of larvae are summarized in Tables 9 and 10. Values for the index of suitability and the index of plant relationship are also given in Tables 9 and 10, and these have been plotted graphically (Fig. 149).

Among Pteridophyta, the only greenhouse fern *Nephrolepis* sp. tested for transfers of larvae from *Tanacetum*, could not be used by larvae as food for completing their development. All 20 larvae transferred died in less than half day, indicating the plant to be toxic or otherwise unacceptable.

Among dicotyledons, 28 plants belonging to 10 plant families were tested for transfers of larvae from *Tanacetum* (Table 9) and *Achillea* (Table 10). At least one larva could complete its development on the following 16 plants belonging to 5 families:

Ranunculaceae	:	*Aquilegia* sp. (cultivated)
Cruciferae	:	*Brassica khaber* (DC.), *Brassica oleracea* L. (Fig. 150)
Leguminosae	:	*Melilotus officinalis* (L.), *Pisum sativum* L. (Fig. 151)
Labiatae	:	*Galeopsis tetrahit* L.
Compositae	:	*Achillea sibirica* Ledeb, *Chrysanthemum* sp. (cultivated), *Dahlia* sp. (cultivated), *Helianthus annuus* L., *Matricaria matricarioides* (Less.) Porter, *Senecio vulgaris* L., *Sonchus uliginosus* Bieb., (Fig. 152), *Tanacetum vulgare* L., *Taraxcum officinale* Weber, *Zinnia* sp. (cultivated)



▲ Transfers of larvae from *Tanacetum vulgare* L. to test plant spp.

▪ Transfers of larvae from *Achillea sibirica* Ledeb to test plant spp.

Fig. 149 Graph showing the index of suitability of test plant for larval development, and index of plant relationship.

Table 9

Summary of the results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to test plant

Test plant	Number of larval transfers	Duration of larval feeding in test plant (Days) Range	Average	Standard deviation	Number of larvae pupated	Number of flies emerged	Index of success	Index of plant relationship
PTERIDOPHYTA								
Polypodiaceae								
Nephrolepis sp. (cultivated)	20	0.5-0.5	0.25	$\pm$ 0.0	-	-	0.018	1
ANGIOSPERMAE-DICOTYLEDONS								
Ranunculaceae								
Aquilegia sp. (cultivated)	20	0.5-9.0	2.57	$\pm$ 3.0	3	3	0.276	3
Caryophyllaceae								
Silene noctiflora L.	20	1.0-2.0	1.07	$\pm$ 0.3	-	-	0.080	3
Chenopodiaceae								
Chenopodium album L.	20	0.5-2.0	0.97	$\pm$ 0.5	-	-	0.072	3
Crucifereae								
Brassica khaber (DC.)	20	1.0-7.5	2.47	$\pm$ 2.0	2	2	0.241	3
Thlaspi arvense L.	20	1.0-4.0	1.80	$\pm$ 0.8	-	-	0.135	3
Rosaceae								
Potentilla sp.	20	0.5-2.0	0.67	$\pm$ 0.4	-	-	0.050	3
Leguminosae								
Lathyrus odoratus L.	20	0.5-4.0	1.55	$\pm$ 1.0	-	-	0.116	3

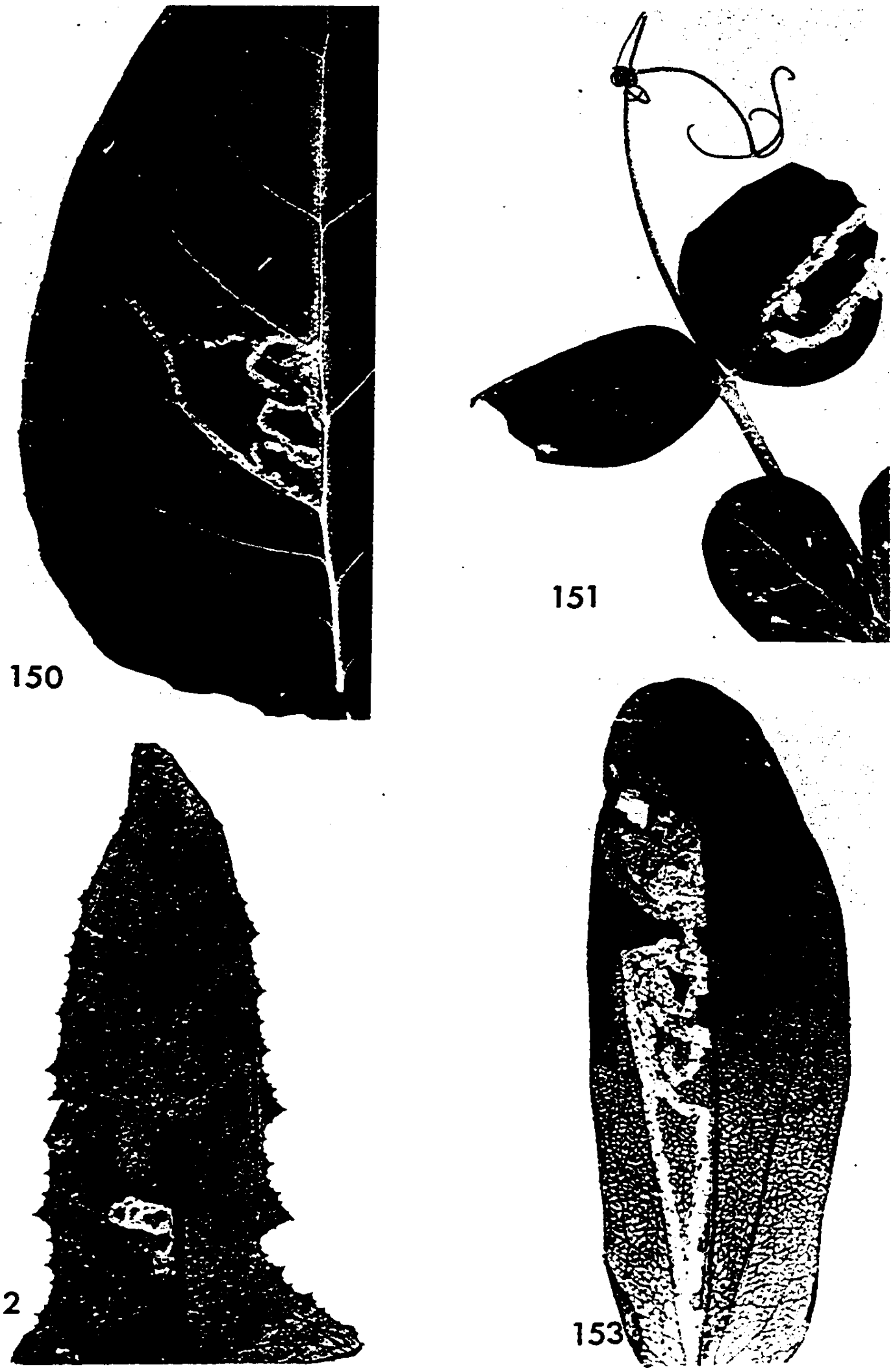
Test plant	Number of larval transfers	Duration of larval feeding in test plant (Days) Range	Average	Standard deviation	Number of larvae pupated	Number of flies emerged	Index of success	Index of plant relationship
Lupinus sp.	20	1.0-4.5	1.72	± 0.9	-	-	0.129	3
Melilotus officinalis (L.) Lam.	20	1.0-9.0	3.07	± 2.6	2	1	0.280	3
Pisum sativum L.	20	2.0-6.5	4.47	± 1.3	12	12	0.669	3
Umbellifereae								
Apium sp.	20	0.5-1.5	0.35	± 0.2	-	-	0.026	3
Solanaceae								
Nicotiana tabacum L.	20	0.2-1.0	0.25	± 0.1	-	-	0.018	4
Labiatae								
*Galeopsis tetrahit*L.	20	1.0-7.0	3.65	± 1.9	10	10	0.552	4
Compositae								
Achillea sibirica Ledeb.	10	1.0-6.0	4.65	± 1.4	9	8	0.594	8
Artemisia sp.	10	0.5-0.5	0.25	± 0.0	-	-	0.018	8
Chrysanthemum sp. (cultivated)	20	1.5-8.5	4.07	± 2.8	6	6	0.472	8
Dahlia sp. (cultivated)	20	1.0-8.0	2.37	± 1.8	2	1	0.228	7
Helianthus annuus L.	20	0.5-6.0	2.97	± 2.3	10	10	0.501	7
Matricaria matricarioides (Less.) Porter	10	0.5-5.5	4.40	± 1.4	9	9	0.580	8
Senecio vulgaris L.	20	0.5-7.5	3.85	± 2.2	6	5	0.450	7
Sonchus uliginosus Bieb.	20	0.5-7.0	3.02	± 2.6	9	9	0.476	7
Tanacetum vulgare L.	20	2.0-7.0	5.57	± 1.0	19	19	0.966	10

Test plant	Number of larval transfers	Duration of larval feeding in test plant (Days)			Number of larvae pupated	Number of flies emerged	Index of success	Index of plant relationship
		Range	Average	Standard deviation				
Taraxacum officinale Weber	20	0.5-6.0	2.25	$\pm$ 2.3	4	3	0.274	7
ANGIOSPERMAE-MONOCOTYLEDONES								
Liliaceae								
Allium cepa L.	20	1.0-9.0	3.95	$\pm$ 2.4	6	5	0.458	2
Gramineae								
Hordeum vulgare L.	20	1.0-7.0	2.67	$\pm$ 1.7	3	3	0.284	2
Typhaceae								
Typha latifolia L.	20	0.5-1.0	0.55	$\pm$ 0.2	-	-	0.041	2

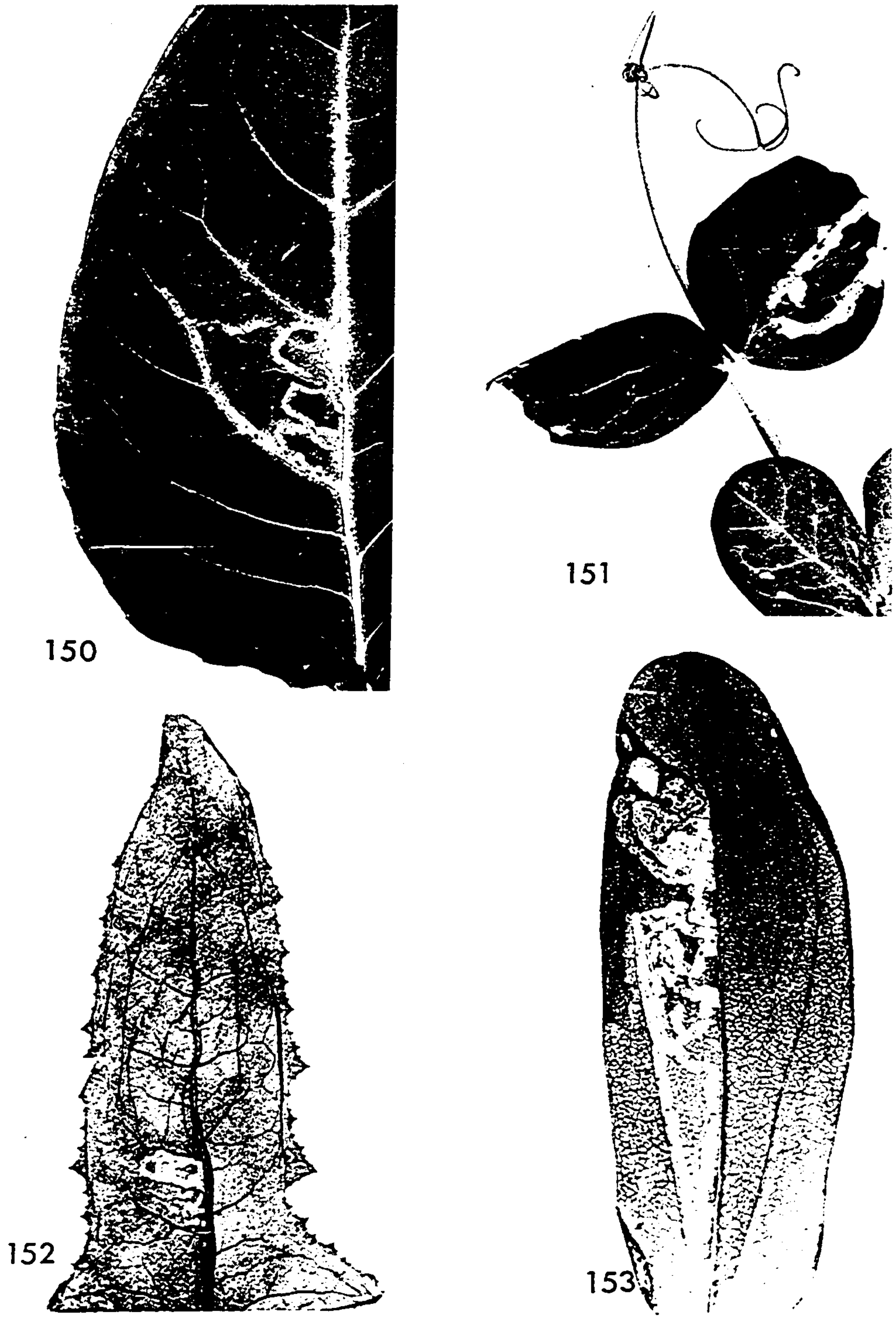
Table 10

Summary of the results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb to test plants

Test plant	Number of larval transfers	Duration of larval feeding in test plant (Days) Range	Average	Standard deviation	Number of larvae pupated	Number of flies emerged	Index of success	Index of plant relationship
ANGIOSPERMAE-DICOTYLEDONS								
Cruciferae								
Brassica oleracea L.	20	0.5-5.5	1.50	± 0.9	1	1	0.140	3
Leguminosae								
Lupinus sp. (cultivated)	20	0.5-7.0	1.45	± 1.3	-	-	0.108	3
Pisum sativum L.	20	2.0-6.0	4.17	± 1.2	10	10	0.591	3
Solanaceae								
Nicotiana tabacum L.	20	0.5-2.0	0.80	± 0.4	-	-	0.060	4
Solanum tuberosum L.	10	0.5-1.5	0.50	± 0.4	-	-	0.037	4
Compositae								
Achillea sibirica Ledeb	20	1.0-7.5	4.72	± 1.6	15	15	0.772	10
Solidago sp.	20	0.5-2.0	0.67	± 0.4	-	-	0.050	7
Sonchus arvensis L.	20	1.0-6.0	1.50	± 1.3	-	-	0.112	7
Tanacetum vulgare L.	10	2.5-6.5	5.05	± 1.1	9	9	0.880	8
Zinnia sp. (cultivated)	20	1.0-5.5	2.72	± 1.5	6	5	0.365	7



Figs. 150 - 153. Leaf mines formed after transfers of larvae of *Phytomyza matricariae* from natural host-plants to various test plants. 150. leaf mine on *Brassica oleracea* L. 151. leaf mine on *Pisum sativum* L. 152. leaf mine on *Sonchus uliginosus* Bieb. 153. leaf mine on *Zinnia sp.* (cultivated).



Figs. 150 - 153. Leaf mines formed after transfers of larvae of *Phytomyza matricariae* from natural host-plants to various test plants. 150. leaf mine on *Brassica oleracea* L. 151. leaf mine on *Pisum sativum* L. 152. leaf mine on *Sonchus uliginosus* Bieb. 153. leaf mine on *Zinnia sp.* (cultivated).

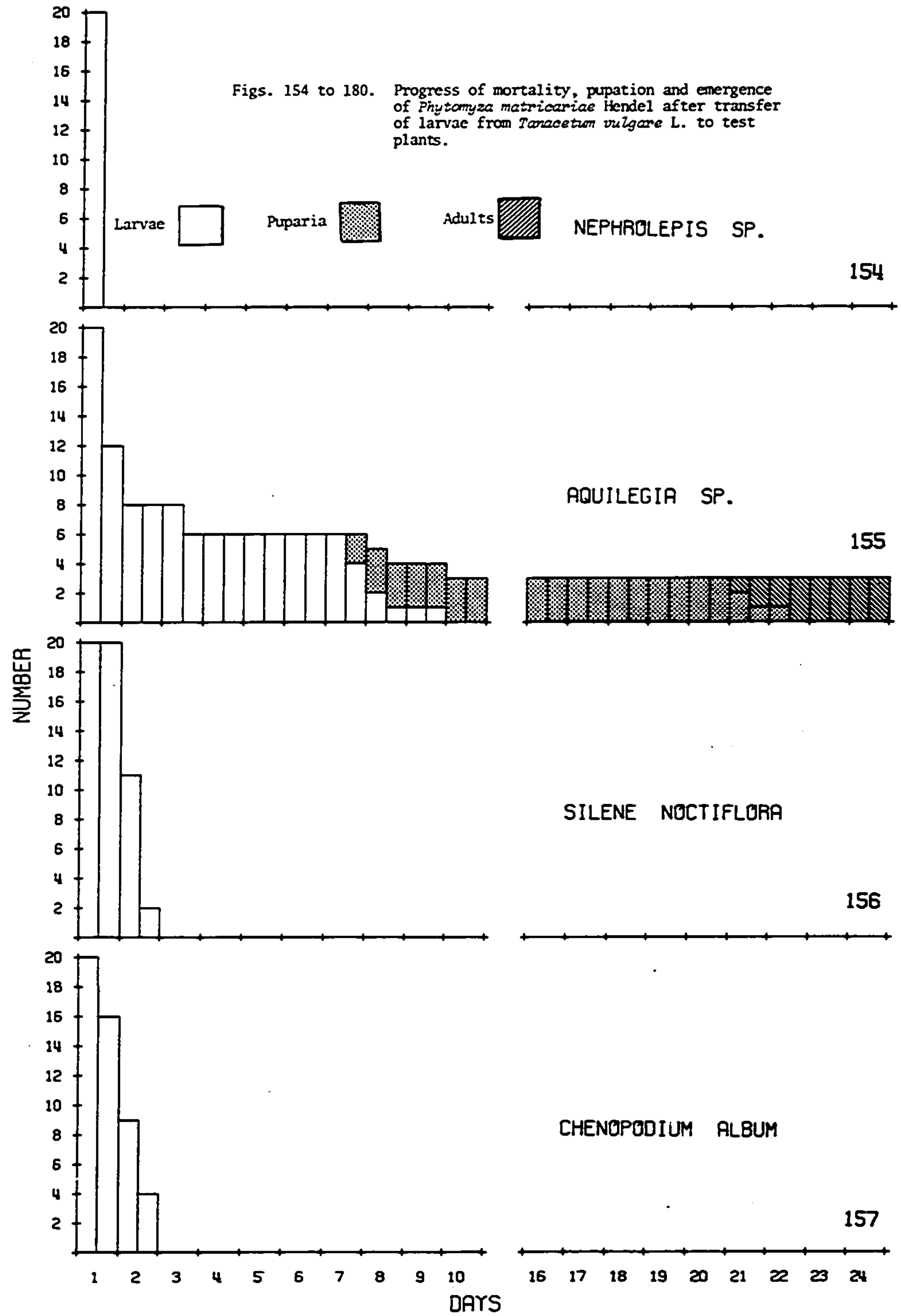
On the basis of available data, although it may not be possible to make statistical comparisons of the relative success of larval development on these plants, but the experience tells that some of these plants were certainly more suitable for larval development than others. Two of the noncomposits, *Pisum sativum* L. and *Galeopsis tetrahit* L., were if not better at least as good as *Tanacetum*, their natural food plant, in their suitability for larval development. *Brassica* spp. tested were quite resistant to larval development: besides others, one reason was the reaction of the young leaf to form callus in the injured area. Among other plants tested, the formation of callus in the punctures made for feeding and oviposition, and in other small injuries on the young leaf of *Helianthus* was very frequent.

The following 12 dicotyledones were not used by larvae in these experiments as food for completing larval development, though they did survive for certain length of time on most of these plants (see data in histograms):

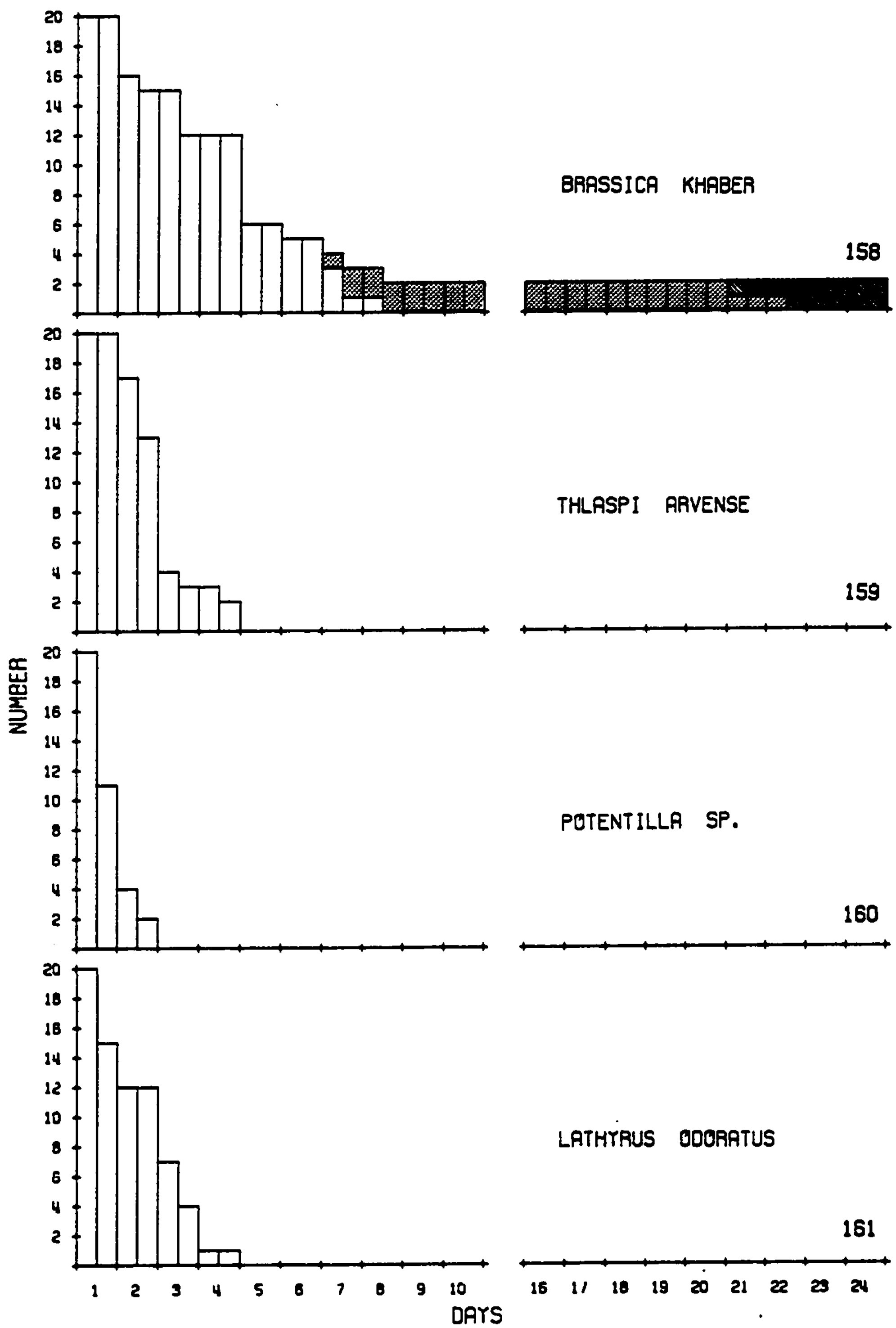
Caryophyllaceae	:	*Silene noctiflora* L.
Chenopodiaceae		*Chenopodium album* L.
Cruciferae		*Thlaspi arvense* L.
Rosaceae		*Potentilla* sp.
Leguminosae		*Lathyrus odoratus* L., *Lupinus* sp. (cultivated)
Umbellifereae		*Apium* sp. (cultivated)
Solanaceae		*Nicotiana tabacum* L., *Salanum tuberosum* L.
Compositae		*Artemisia* sp., *Solidago* sp., *Sonchus arvensis* L.

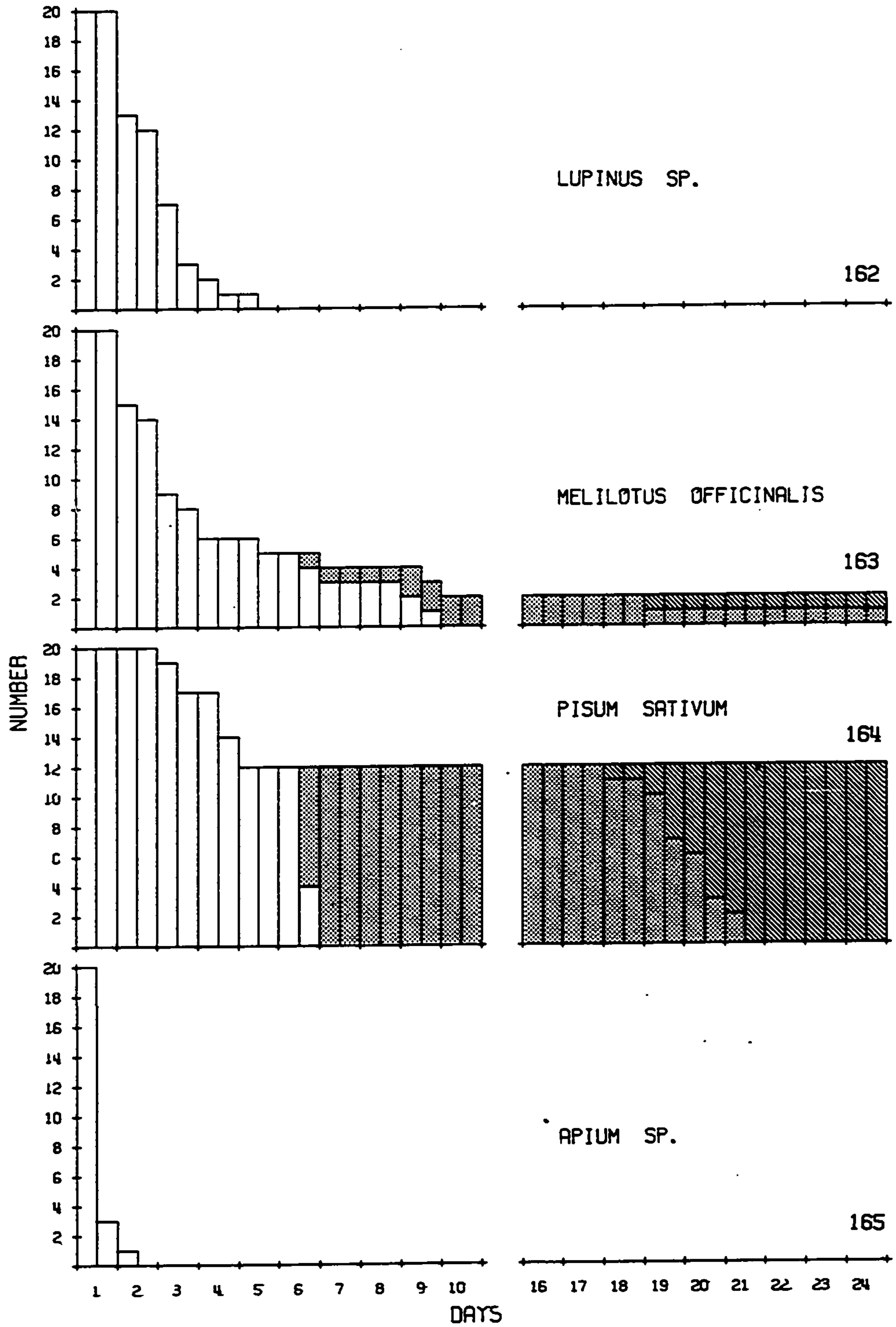
Among the above listed plants the failure of larva to use *Artemisia* sp. as food was probably due to the fact that larva would bite its way out into the woolly fibres of the leaf. This is the only plant where the failure could probably be attributed to inadequate transfer. On all other plants the experimental larva died inside the tissue of test plant, often after certain amount of feeding.

Among 3 monocotyledons only two species, *Allium cepa* L. and *Hordeum vulgare* L. were used by larvae to complete their development to adult fly. The third species *Typha latifolia* L. was not used in these experiments, probably because of the presence of large air spaces in its leaf tissue.

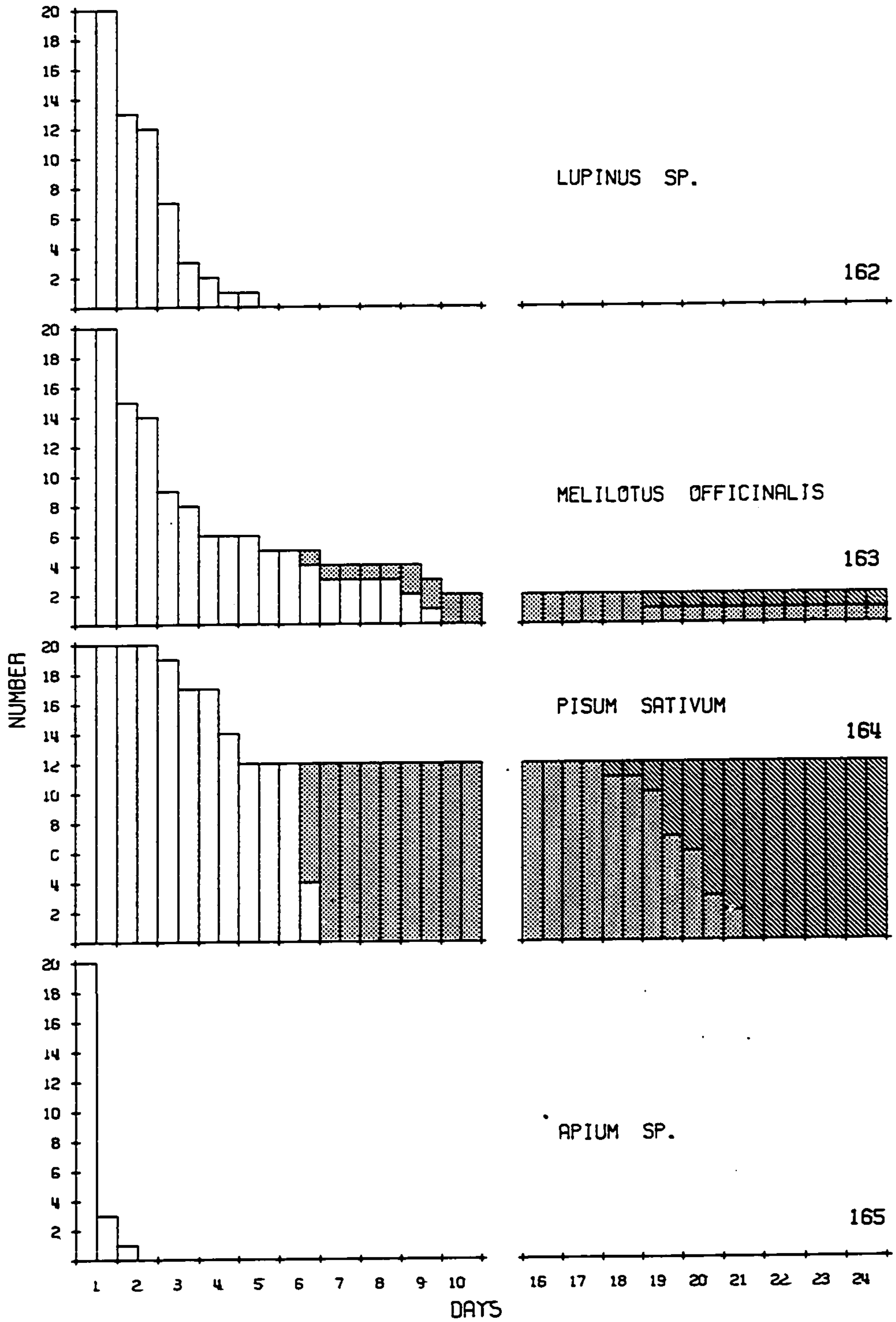


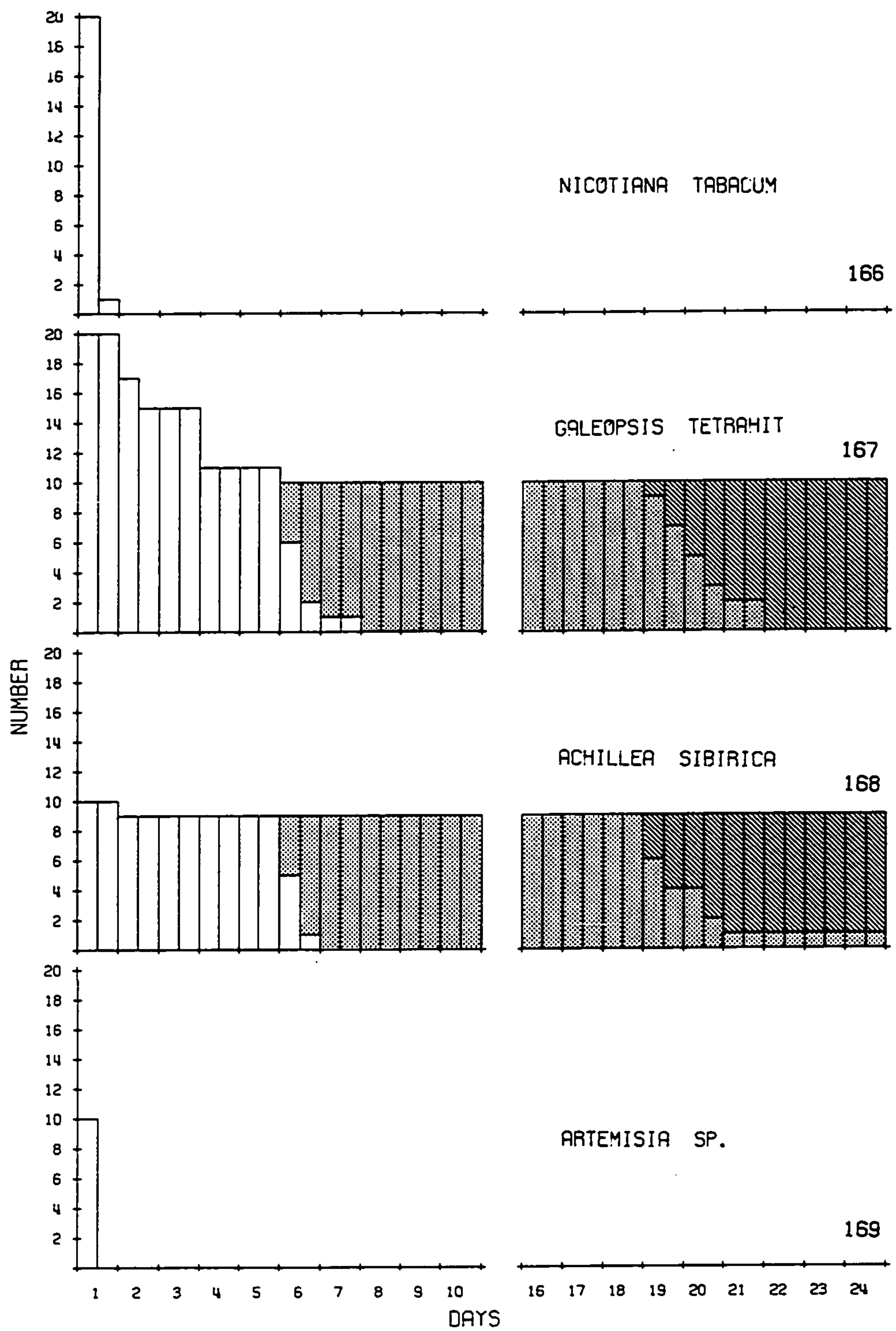
Figs. 154 to 180. Progress of mortality, pupation and emergence of *Phytomyza matricariae* Hendel after transfer of larvae from *Tanacetum vulgare* L. to test plants.

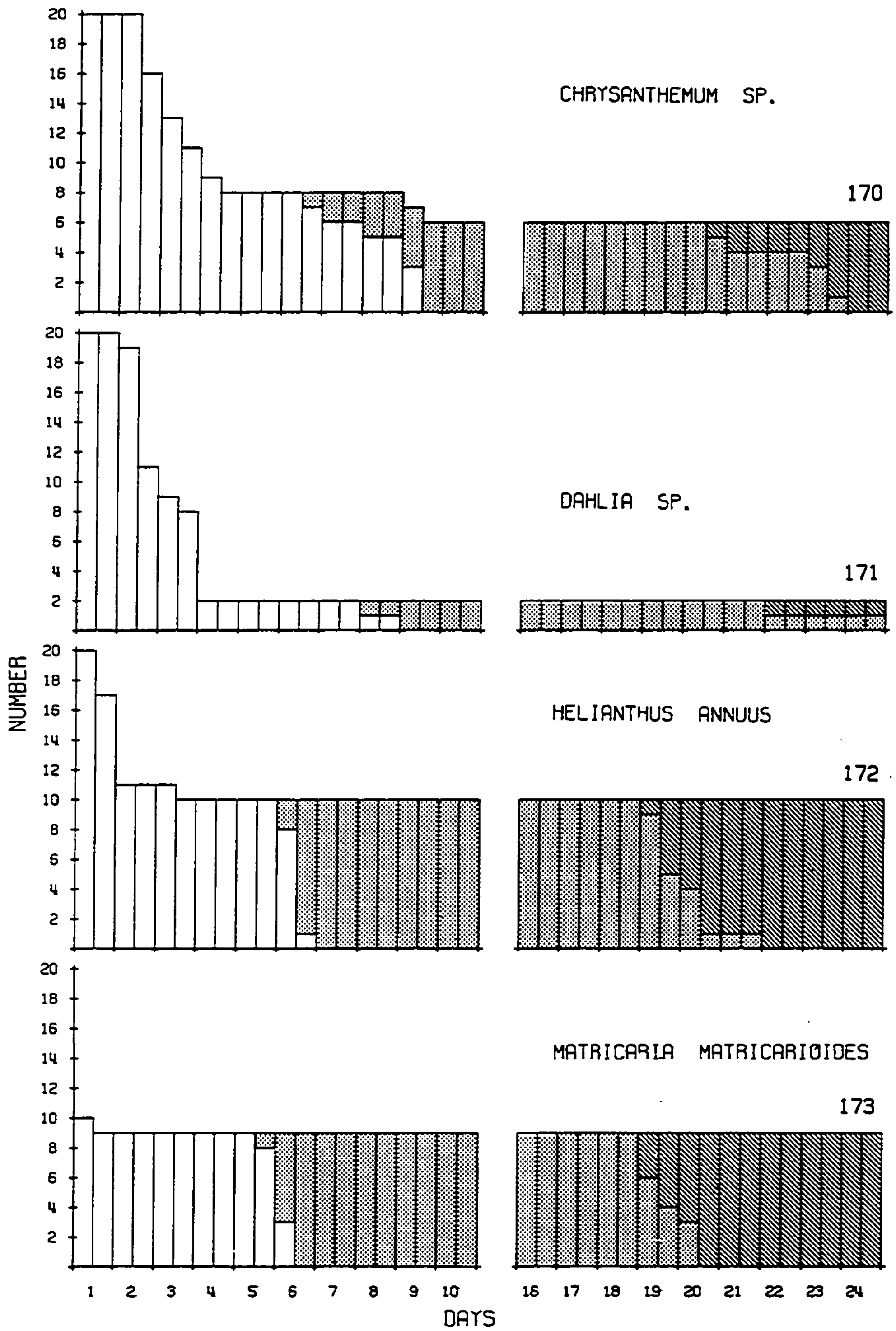

BRASSICA KHABER
158
THLASPI ARVENSE
159
POTENTILLA SP.
160
LATHYRUS ODORATUS
161
NUMBER
DAYS
20
18
16
14
12
10
8
6
4
2
1 2 3 4 5 6 7 8 9 10
16 17 18 19 20 21 22 23 24



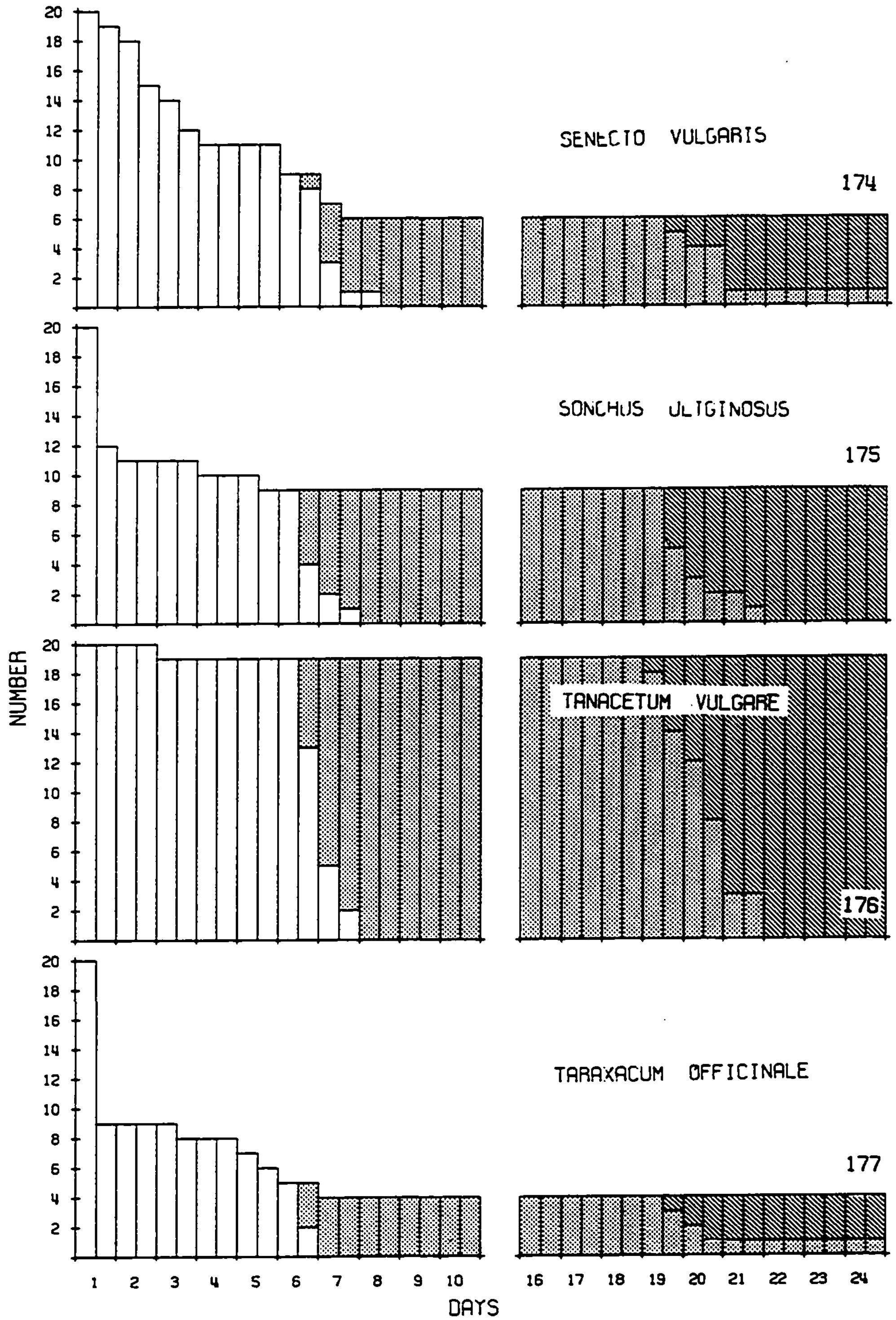
LUPINUS SP.
162
MELILOTUS OFFICINALIS
163
PISUM SATIVUM
164
APIUM SP.
165
NUMBER
DAYS

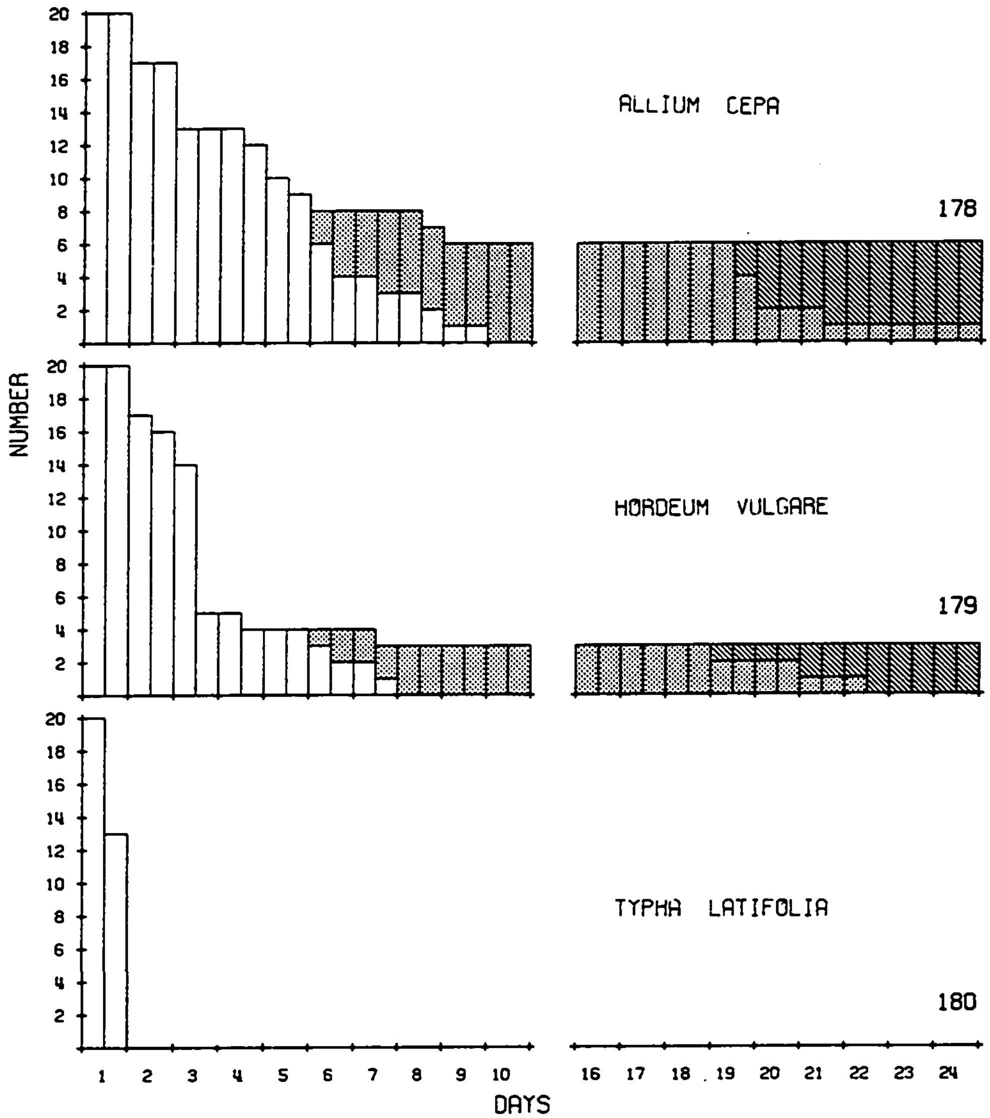

LUPINUS SP.
162
MELILOTUS OFFICINALIS
163
PISUM SATIVUM
164
APIUM SP.
165
NUMBER
DAYS
20
18
16
14
12
10
8
6
4
2
1 2 3 4 5 6 7 8 9 10
16 17 18 19 20 21 22 23 24

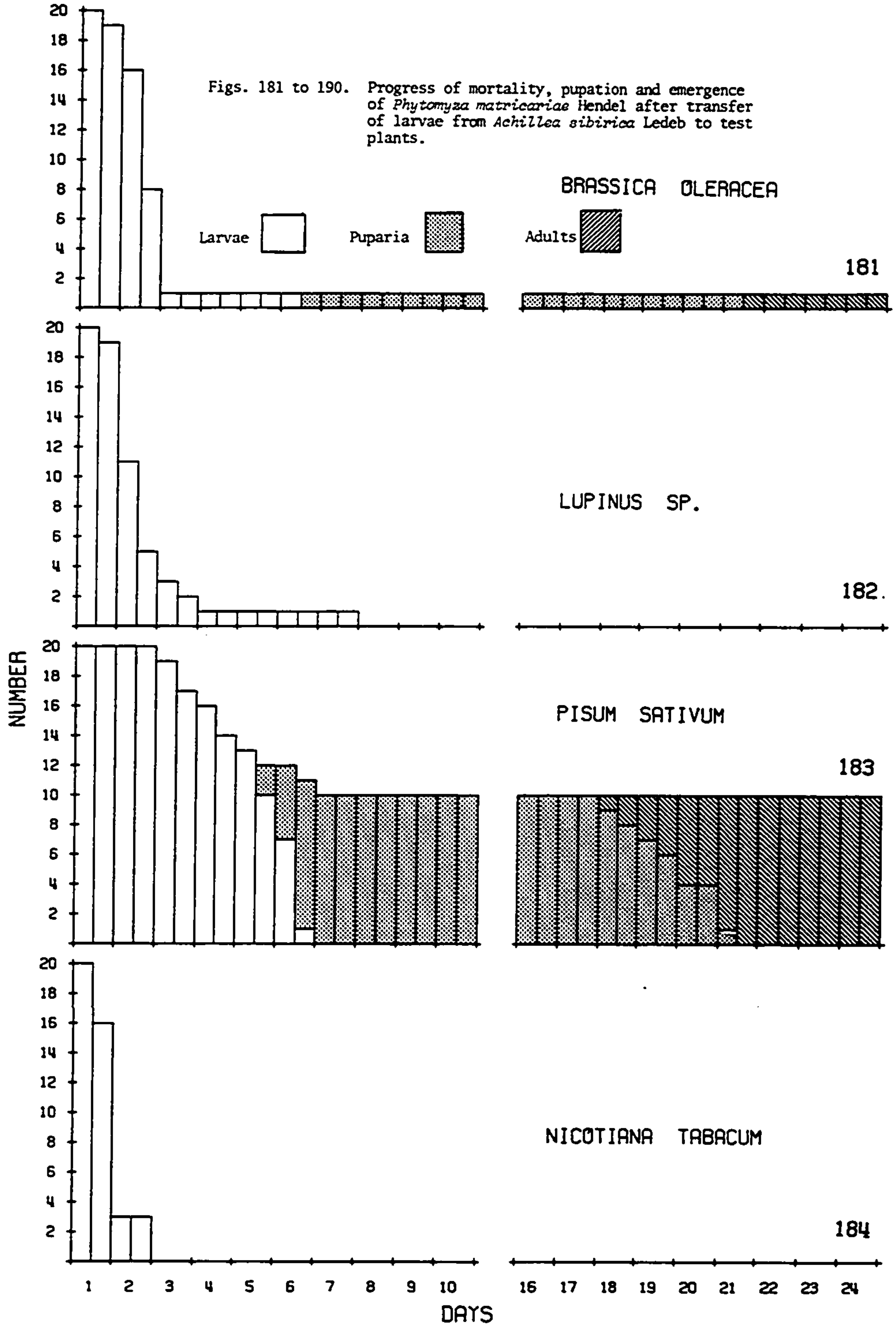

NICOTIANA TABACUM
166
GALEOPSIS TETRAHIT
167
ACHILLEA SIBIRICA
168
ARTEMISIA SP.
169
NUMBER
DAYS
1 2 3 4 5 6 7 8 9 10 16 17 18 19 20 21 22 23 24



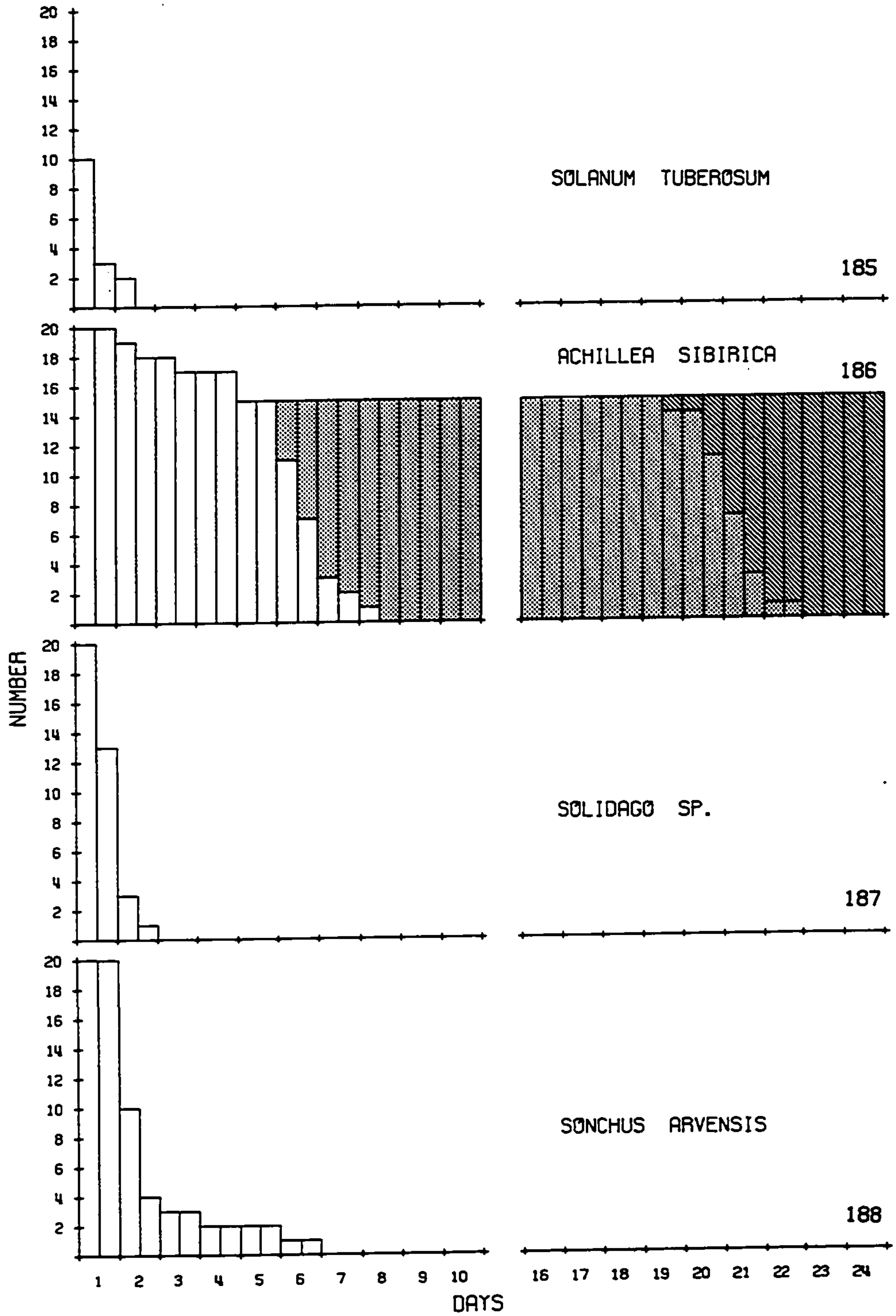
CHRYSANTHEMUM SP.
170
DAHLIA SP.
171
HELIANTHUS ANNUUS
172
MATRICARIA MATRICARIOIDES
173
NUMBER
DAYS

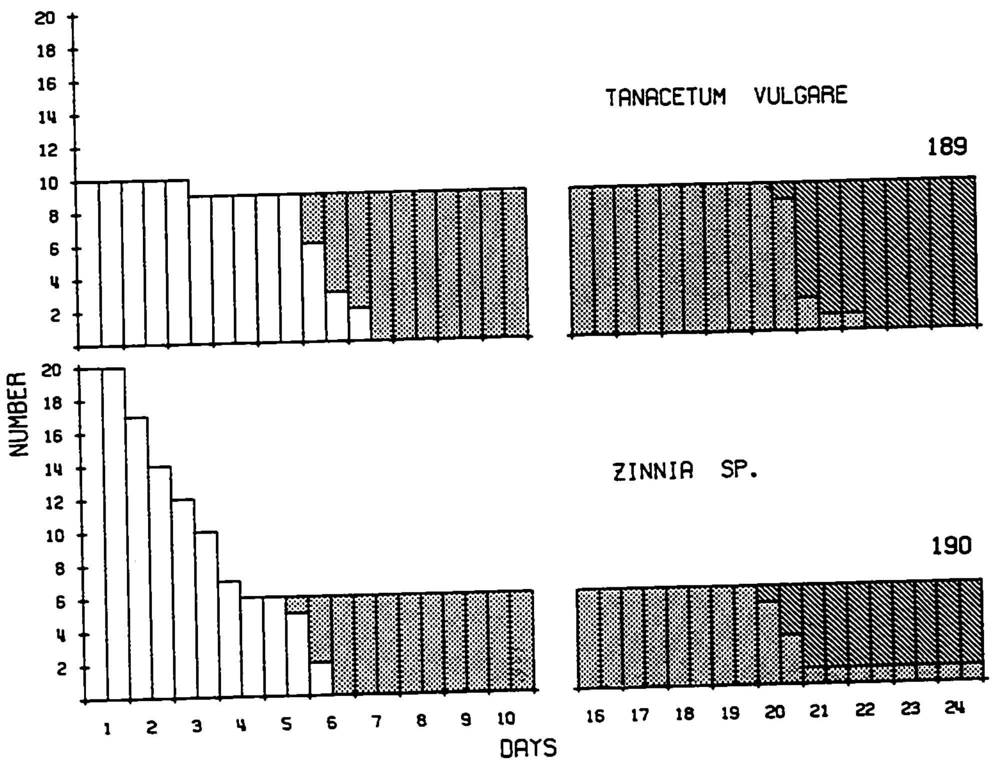

SENECIO VULGARIS
174
SONCHUS ULIGINOSUS
175
TANACETUM VULGARE
176
TARAXACUM OFFICINALE
177
NUMBER
DAYS
20
18
16
14
12
10
8
6
4
2
1 2 3 4 5 6 7 8 9 10
16 17 18 19 20 21 22 23 24


ALLIUM CEPA
178
HORDEUM VULGARE
179
TYPHA LATIFOLIA
180
NUMBER
20
18
16
14
12
10
8
6
4
2
1 2 3 4 5 6 7 8 9 10
16 17 18 19 20 21 22 23 24
DAYS



Figs. 181 to 190. Progress of mortality, pupation and emergence of *Phytomyza matricariae* Hendel after transfer of larvae from *Achillea sibirica* Ledeb to test plants.


SOLANUM TUBEROSUM
185
ACHILLEA SIBIRICA
186
SOLIDAGO SP.
187
SONCHUS ARVENSIS
188
NUMBER
20
18
16
14
12
10
8
6
4
2
1 2 3 4 5 6 7 8 9 10
16 17 18 19 20 21 22 23 24
DAYS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DISCUSSION

Host-plant relationships of adult female

Range of food plants.-The experiments on the acceptability of plants tested for feeding and oviposition show that even though females made varying numbers of feeding punctures on many plants, the eggs were only deposited on the members of the family Compositae belonging to the tribes Anthemideae and Heliantheae. The plants which are not accepted for feeding and oviposition both are considered as non-hosts. The physical characteristics of the plant do not seem to be important in the selection of larval host-plant, although they may play some role in their preference. The acceptability of closely related plants for feeding and oviposition both clearly indicate chemical factors involved and very high degree of host-plant specialization. Fraenkel (1959) and many other workers in the past emphasized the role of botanically distributed specific feeding stimulants in the host-plant selection of oligophagous species. The presence of many plants not acceptable as hosts by *Phytomyza matricariae* Hendel is also indicative of deterrent effects in the plants. Numerous authors have also stressed the importance of deterrents in determining the host range of phytophagous insects (Fraenkel 1959, Thorsteinson 1960, Jermy 1961, 1964, 1966, Hsiao and Fraenkel 1968). The plants acceptable for feeding must therefore have necessary substances which provide stimulus for feeding and at the same time lack substances which have deterrent effect. Since the females oviposited only on closely related members of the family Compositae, the plants accepted for oviposition must also have substances which provide aedequate stimuli for egg laying and these are not necessarily the same substances which provide stimuli for feeding. Hsiao and Fraenkel (1968) working with Colorado potato beetle, *Leptinotarsa decemlineata* (Say), suggested that host specific stimuli from some solanaceous plants were required in the oviposition behavior of this species.

When the index of success in feeding and oviposition was compared with the index of plant relationship (Fig. 148), only plants most closely related to natural food plants were acceptable for feeding and oviposition, thus confirming the observed oligophagy of this species in nature.

Hering (1951) pointed out numerous species of mining insects in which the ovipositing females committed errors in their choice of host-plants and concluded that such instances of erroneous oviposition were quite common and yet escaped our attention. Later Nowakowski (1962) examined such known instances in the family Agromyzidae and found that these were mainly due to misidentifications. The results of the experiments on the host range of *Phytomyza matricariae* Hendel indicate that the females are unlikely to make such mistake of ovipositing on the wrong host under normal circumstances.

Feeding and oviposition preference of females.-When females were offered a choice of six acceptable plants for feeding and oviposition, *Tanacetum* from which the flies used were obtained, was most preferred for feeding (Table 7); however, the number of eggs were not significantly higher than on some other plants in the test. In another experiment in which freshly emerged females obtained from pupae bred on *Tanacetum* were used, *Tanacetum* was still most preferred (Table 8) in number of feeding punctures. The preference for feeding on *Tanacetum* may either be explained by the preconditioning of the females in their own life, or by preconditioning in their larval life as defined by the Hopkin's (1917) host selection principle, or by greater quantity of substances which stimulate feeding, or just by the taste preference of the females. This however, cannot be clarified at present and would need further detailed studies. However, such a behaviour is in agreement with the observations of Jermy, Hanson and Dethier (1968) who working with the larvae of *Manduca sexta* (Johanssen) and *Heliothis zea* (Boddie) found that these when fed on different host-plants, show preference for the plant previously eaten. It may be pointed out that *Tanacetum* appeared to be more heavily attacked in nature than other host-plants. This however may also be due to various other factors like greater abundance of this plant in the habitat.

Among other plants used in the study *Achillea*, *Chrysanthemum*, and *Matricaria* were almost equally preferred, while *Helianthus* and *Artemisia* were least preferred for feeding and oviposition (Tables 7 8). The first three plants belong to the same tribe Anthemideae as *Tanacetum* and also serve as host-plants in nature. In *Chrysanthemum* only the soft leaf variety was found to be attacked in nature. This suggests the importance of physical characteristics of the plant in their selection. *Artemisia*, although closely related to *Tanacetum*, was not preferred, probably because the leaves used had a thick covering of woolly fibres on their lower surface, which may act as physical barrier for females of this species to feed and to oviposit.

Helianthus which was also not preferred, belongs to a different tribe, Heliantheae, and is not as closely related to *Tanacetum*. It was also not found to be attacked in nature.

Hussey and Gurney (1962) suggested the use of feeding punctures and egg ratio as method of assessing host preference in agromyzid species. They worked with a polyphagous species '*Phytomyza atricornis* Meigen' which was later shown by Griffiths (1967) to consist of two distinct species, *Phytomyza syngenesiae* (Hardy) feeding predominantly on composits and *Phytomyza horticola* Goureau feeding on composits and noncomposits. Therefore the results of their experiments cannot be properly evaluated. In the populations used they found that feeding puncture and egg ratio was lower on preferred plants and concluded that preferred plants are nutritionally superior. It appears that the differential feeding and oviposition in their experiments with different varieties of *Chrysanthemum* were due to the presence or absence of substances which act as stimulants or deterrents for feeding and oviposition, rather than strict nutritional superiority of some plants over the others. However, some chemicals of nutritional value may also act as feeding or ovipositional stimulants (Thorsteinson 1960).

Host-plant relationships of larvae

The ability of the larva to use 16 plants belonging to five different families for its development clearly show that it is far less sensitive to deterrents than the adults which would only feed and oviposit on certain members of the family Compositae. The larva having evolved a completely internal parasitic mode of life have reduced or poorly developed sense organs, which in turn also probably reduce its ability to discriminate between various plants. This is further supported by the observation that the larva starts feeding almost as soon as it is transferred to the test plant. The act of feeding was inferred from the movement of larval mouth hooks inside the test plant. However, the larva is capable of distinguishing between various kinds of tissue within the leaf, as only the mesenchymatous tissue is eaten. It is apparent that plants widely removed phylogenetically were nutritionally adequate for the completion of larval development, if they lack substances which are toxic or otherwise inhibitory.

Buhr (1937) was the first to carry out transplantation experiments using agromyzid larvae. He found that among the plants tested, the transferred larvae developed only on plants phylogenetically related to their natural food plant and died on plants not related to the normal host-plant. *Liriomyza eupatorii* (Kaltenbach) was exceptional, but it was already known to feed on *Eupatorium*, family Compositae and *Galeopsis*, family Labiatae. He also succeeded in transferring larvae of *Liriomyza cannabis* Hendel from *Cannabis*, family Urticaceae, to *Eupatorium* and *Galeopsis*. However it is not known whether these two "species", *Liriomyza eupatorii* (Kaltenbach) and *L. cannabis* Hendel, represent host races or sibiling species, as was considered by Nowakowski (1962), due to absence of any clear morphological distinction between them.

Admittedly, the possibility that the agromyzid female would oviposit in nature on plants not closely related to natural host-plant is very small. But, if the female did oviposit on plants outside the normal range, there is a good possibility that the emerging larva would complete development, if the plant is not toxic or otherwise inhibitory. This is contrary to Nowakowski's (1962) suggestion that the probability of larval survival is very small. Experiments on the transfers of larvae to plants outside the host range of the members of *Phytomyza matricariae* Hendel have shown that the larvae can use such plants for completing their development to adult flies. It would indeed be very interesting to investigate whether such flies show any change in fertility, and how this preconditioning in the larval stage would affect their food preference behaviour.

This ability of the larvae to use successfully certain plants outside the range of normal host-plants of the ovipositing female in *Phytomyza matricariae* Hendel, can also explain such observed patterns in agromyzids and also in external feeders. *Liriomyza eupatorii* (Kaltenbach) normally feeds in nature on *Eupatorium,* family Compositae and *Galeopsis,* family Labiatae. *Liriomyza brassicae* (Riley) an oligophagous species feeding on Cruciferae and related families has also been reported to feed on *Pisum,* family Leguminosae (Spencer 1964, Sehgal 1965). Gupta and Thorsteinson (1960) showed that the leaves of non-cruciferous plants were normally accepted by the caterpillars of *Plutella maculipennis,* which normally feed on cruciferous plants. Jermy (1961) showed that Colorado potato beetle, normally a solanaceous feeder, accepted the leaves of *Asclepias syriaca* L., family Asclepiadaceae and *Allium cepa,* family Liliaceae. He later (1966) suggested that in these plants some other substances replace the specific phagostimulants. Hsiao and Fraenkel (1968) working on Colorado potato beetle found the leaves of *Asclepias,* family Asclapiadaceae and *Lactuca,* family Compositae to be most suitable non-solanaceous plants and these plants could support reproduction and continous culturing. They further reported that these plants were not fed upon in the presence of normal solanaceous hosts. They therefore concluded that the host selection in this species was determined not only by the presence of adequate feeding stimuli and nutrients, but also by the presence of host specific substances which induce the initial feeding behaviour. In *Phytomyza matricariae* Hendel such host specific substances could be important in the specificity of oviposition only on certain members of the family Compositae, but were not necessary in the larval feeding on various test plants. These larvae, being internal plant feeders, have no choice but to feed on the available food.

Jermy (1966) working with various chewing phytophagous insects suggested that in certain plant families like Papavaraceae and Compositae feeding inhibition occurs more frequently than in others e.g., Leguminosae. Experience with transfer of larvae of *Phytomyza matricariae* Hendel suggests that this need not always be true. The distribution of inhibitory effects in the plant kingdom would probably differ with different species and this could probably be dependent on the normal host range of the species. *Phytomyza matricariae* Hendel, although normally a very specialized feeder on certain members of the family Compositae, had more composits outside its normal host range suitable for larval development than noncomposits (Fig. 149). Jermy (1966) further suggested that certain plants like *Pisum sativum* L. and *Malva sylvestris* L. seem to be free of strong feeding inhibitors in general, while others like *Solidago* are strongly deterrent. Results of transfers of larvae of *Phytomyza matricariae* Hendel support this view, as *Pisum sativum* L. was quite suitable for larval development while *Solidago* was not. *Galeopsis tetrahit* L. probably also belongs to a similar category of non-inhibitory plants.

Conclusions

The majority of species in the family Agromyzidae are restricted feeders, being monophagous or oligophagous. This study of insect host-plant relationships of adults and of larvae of *Phytomyza matricariae* Hendel, as well as recent studies involving other oligophagous species have shown that botanically unrelated plants can also serve as adequate food plants for normal development. However, in nature an oligophagous species normally selects botanically related plants for feeding and oviposition. This restricted feeding by an oligophagous species does not imply that other plants are nutritionally inadequate. Oligophagy in nature probably is the result of evolutionary adaptations of the phytophagous insect to the kairomones of the host-plant(s) to which the species is normally restricted.

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APPENDIX A. Data on host-plant relationships of adult females

Table 11. Feeding and oviposition preferences of *Phytomyza matricariae* Hendel.

Test plant	Number of punctures made by 5 gravid females during a period of 24 hours in the following replicates (feeding punctures/egg punctures):						
	R1	R2	R3	R4	R5	R6	Average
Tanacetum vulgare L.	256/12	353/ 8	571/15	1050/10	632/18	255/ 8	519.5/11.8
Achillea sibirica Ledeb.	168/ 4	242/15	121/13	265/15	200/ 9	94/ 7	181.6/10.5
Matricaria matricarioides (Less.) Porter	74/ 9	236/29	295/31	127/ 4	139/10	95/ 7	161.0/15.0
Helianthus annuus L.	21/ 1	135/ 6	50/ 1	18/ 1	95/ 4	32/ 1	58.5/ 2.3
Artemisia sp.	43/ 1	44/ 2	13/ 2	94/ 4	25/1	2/ -	36.8/ 1.6
Chrysanthemum sp. (Cultivated var.)	108/ 6	229/12	175/11	342/24	118/14	231/12	200.5/13.3

Table 12. Feeding preference of *Phytomyza matricariae* Hendel.

Test plant	Number of feeding punctures made by 5 females* during a period of 24 hours on the following replicates:						
	R1	R2	R3	R4	R5	R6	Average
Tanacetum vulgare L.	285	251	235	137	455	142	250.8
Achillea sibirica Ledeb.	204	136	213	104	290	101	174.6
Matricaria matricarioides (Less.) Porter	132	188	225	176	75	41	139.5
Helianthus annuus L.	26	70	5	10	35	24	28.3
Artemisia sp.	8	-	11	6	38	23	14.3
Chrysanthemum sp. (Cultivated var.)	112	202	111	68	152	127	128.6

*The females used in this experiment emerged within last 24 hours from the puparia and thus were not gravid.

APPENDIX B. Data on host-plant relationships of larvae

Table 13. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Nephrolepis* sp., family Polypodiaceae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1868	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead
4.xi.1968	4.xi.1968	0.5	Dead

Average 0.5, Correction -0.25, Corrected Average 0.25

Table 14. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Aquilegia* sp. (cultivated), family Ranunculaceae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
25.ix.1968	26.ix.1968	0.5	Dead		
25.ix.1968	2. x.1968	6.5	Pupated	emerged	13.5
25.ix.1968	2. x.1968	6.5	Pupated	emerged	14.0
25.ix.1968	2. x.1968	7.0	Pupated	emerged	14.5
25.ix.1968	26.ix.1968	0.5	Dead		
25.ix.1968	26.ix.1968	0.5	Dead		
25.ix.1968	26.ix.1968	0.5	Dead		
25.ix.1968	26.ix.1968	0.5	Dead		
25.ix.1968	26.ix.1968	0.5	Dead		
25.ix.1968	26.ix.1968	0.5	Dead		
25.ix.1968	26.ix.1968	1.0	Dead		
25.ix.1968	2. x.1968	7.0	Dead		
26.ix.1968	27.ix.1968	0.5	Dead		
26.ix.1968	4. x.1968	7.5	Dead		
26.ix.1968	5. x.1968	9.0	Dead		
26.ix.1968	27.ix.1968	1.0	Dead		
26.ix.1968	29.ix.1968	2.5	Dead		
26.ix.1968	27.ix.1968	1.0	Dead		
26.ix.1968	27.ix.1968	1.0	Dead		
26.ix.1968	29.ix.1968	2.5	Dead		

Average 2.82, Correction -0.25, Corrected Average 2.57

Table 15. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Silene noctiflora* L., family Caryophyllaceae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
11.x.1968	12.x.1968	1.5	Dead
11.x.1968	12.x.1968	1.0	Dead
11.x.1968	13.x.1968	2.0	Dead
11.x.1968	13.x.1968	2.0	Dead
11.x.1968	12.x.1968	1.5	Dead
11.x.1968	12.x.1968	1.5	Dead
11.x.1968	12.x.1968	1.5	Dead
11.x.1968	12.x.1968	1.5	Dead
11.x.1968	12.x.1968	1.0	Dead
11.x.1968	12.x.1968	1.0	Dead
11.x.1968	12.x.1968	1.5	Dead
11.x.1968	12.x.1968	1.0	Dead
11.x.1968	12.x.1968	1.0	Dead
11.x.1968	12.x.1968	1.5	Dead
11.x.1968	12.x.1968	1.0	Dead
11.x.1968	12.x.1968	1.0	Dead
11.x.1968	12.x.1968	1.0	Dead
11.x.1968	12.x.1968	1.0	Dead
11.x.1968	12.x.1968	1.5	Dead
11.x.1968	12.x.1968	1.5	Dead

Average 1.32, Correction -0.25, Corrected Average 1.07

Table 16. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Chenopodium album* L., family Chenopodiaceae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
29.x.1968	31.x.1968	2.0	Dead
29.x.1968	31.x.1968	2.0	Dead
29.x.1968	30.x.1968	1.0	Dead
29.x.1968	30.x.1968	1.5	Dead
29.x.1968	31.x.1968	2.0	Dead
29.x.1968	30.x.1968	1.0	Dead
29.x.1968	31.x.1968	1.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	31.x.1968	1.5	Dead
29.x.1968	30.x.1968	1.0	Dead
29.x.1968	31.x.1968	1.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	31.x.1968	1.5	Dead
29.x.1968	30.x.1968	1.0	Dead
29.x.1968	31.x.1968	2.0	Dead
29.x.1968	30.x.1968	1.0	Dead
29.x.1968	30.x.1968	1.0	Dead
29.x.1968	30.x.1968	1.0	Dead
29.x.1968	30.x.1968	0.5	Dead

Average 1.22, Correction -0.25, Corrected Average 0.97

Table 17. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Brassica khaber* (DC.) Wheeler, family Crucifereae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
8.x.1968	10.x.1968	1.5	Dead		
8.x.1968	15.x.1968	6.5	Pupated	emerged	15.0
8.x.1968	12.x.1968	4.0	Dead		
8.x.1968	14.x.1968	6.0	Dead		
8.x.1968	14.x.1968	6.0	Pupated	emerged	14.0
8.x.1968	9.x.1968	1.0	Dead		
8.x.1968	9.x.1968	1.0	Dead		
8.x.1968	15.x.1968	6.5	Dead		
8.x.1968	12.x.1968	4.0	Dead		
8.x.1968	9.x.1968	1.0	Dead		
8.x.1968	12.x.1968	4.0	Dead		
8.x.1968	12.x.1968	4.0	Dead		
8.x.1968	11.x.1968	2.5	Dead		
8.x.1968	11.x.1968	2.5	Dead		
8.x.1968	9.x.1968	1.0	Dead		
8.x.1968	12.x.1968	4.0	Dead		
8.x.1968	13.x.1968	5.0	Dead		
8.x.1968	16.x.1968	7.5	Dead		
8.x.1968	11.x.1968	1.5	Dead		
8.x.1968	12.x.1968	4.0	Dead		

Average 3.72, Correction -0.25, Corrected Average 2.47

Table 18. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Thlaspi arvense* L., family Cruciferae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
19.viii.1968	21.viii.1968	2.0	Dead
19.viii.1968	22.viii.1968	3.5	Dead
19.viii.1968	21.viii.1968	2.5	Dead
19.viii.1968	21.viii.1968	2.0	Dead
8.x.1968	9.x.1968	1.5	Dead
8.x.1968	12.x.1968	4.0	Dead
8.x.1968	10.x.1968	2.0	Dead
8.x.1968	10.x.1968	2.0	Dead
8.x.1968	9.x.1968	1.5	Dead
8.x.1968	9.x.1968	1.5	Dead
8.x.1968	10.x.1968	2.0	Dead
8.x.1968	10.x.1968	2.0	Dead
8.x.1968	9.x.1968	1.0	Dead
8.x.1968	10.x.1968	2.0	Dead
8.x.1968	12.x.1968	4.0	Dead
8.x.1968	9.x.1968	1.5	Dead
8.x.1968	10.x.1968	2.0	Dead
8.x.1968	9.x.1968	1.0	Dead
8.x.1968	9.x.1968	1.0	Dead
8.x.1968	10.x.1968	2.0	Dead

Average 2.05, Correction -0.25, Corrected Average 1.80

Table 19. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Potentilla* sp., family Rosaceae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
5.xi.1968	6.xi.1968	0.5	Dead
5.xi.1968	6.xi.1968	1.0	Dead
5.xi.1968	6.xi.1968	1.0	Dead
5.xi.1968	6.xi.1968	0.5	Dead
5.xi.1968	7.xi.1968	1.5	Dead
5.xi.1968	6.xi.1968	0.5	Dead
5.xi.1968	6.xi.1968	0.5	Dead
5.xi.1968	7.xi.1968	1.5	Dead
5.xi.1968	6.xi.1968	0.5	Dead
5.xi.1968	6.xi.1968	1.0	Dead
5.xi.1968	6.xi.1968	1.0	Dead
5.xi.1968	6.xi.1968	0.5	Dead
5.xi.1968	6.xi.1968	0.5	Dead
5.xi.1968	6.xi.1968	1.0	Dead
5.xi.1968	6.xi.1968	1.0	Dead
5.xi.1968	6.xi.1968	0.5	Dead
5.xi.1968	7.xi.1968	2.0	Dead
5.xi.1968	7.xi.1968	2.0	Dead
5.xi.1968	6.xi.1968	0.5	Dead
5.xi.1968	6.xi.1968	1.0	Dead

Average 0.92, Correction -0.25, Corrected Average 0.67

Table 20. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Lathyrus odoratus* L., family Leguminosae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
25.ix.1968	26.ix.1968	0.5	Dead
25.ix.1968	26.ix.1968	1.0	Dead
25.ix.1968	27.ix.1968	2.0	Dead
25.ix.1968	28.ix.1968	3.0	Dead
25.ix.1968	26.ix.1968	0.5	Dead
25.ix.1968	27.ix.1968	2.0	Dead
25.ix.1968	27.ix.1968	2.0	Dead
25.ix.1968	27.ix.1968	2.0	Dead
25.ix.1968	28.ix.1968	3.0	Dead
25.ix.1968	26.ix.1968	0.5	Dead
25.ix.1968	28.ix.1968	3.0	Dead
25.ix.1968	29.ix.1968	4.0	Dead
25.ix.1968	26.ix.1968	1.0	Dead
25.ix.1968	26.ix.1968	0.5	Dead
25.ix.1968	27.ix.1968	2.0	Dead
25.ix.1968	26.ix.1968	1.0	Dead
25.ix.1968	28.ix.1968	2.5	Dead
25.ix.1968	26.ix.1968	0.5	Dead
25.ix.1968	28.ix.1968	2.5	Dead
25.ix.1968	28.ix.1968	2.5	Dead

Average 1.80, Correction -0.25, Corrected Average 1.55

Table 21. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Lupinus* sp. (cultivated), family Leguminosae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
28.ix.1968	29.ix.1968	1.0	Dead
28.ix.1968	2. x.1968	4.5	Dead
28.ix.1968	29.ix.1968	1.0	Dead
28.ix.1968	30.ix.1968	2.0	Dead
28.ix.1968	30.ix.1968	2.5	Dead
28.ix.1968	1. x.1968	3.5	Dead
28.ix.1968	29.ix.1968	1.0	Dead
28.ix.1968	30.ix.1968	2.0	Dead
28.ix.1968	30.ix.1968	2.5	Dead
28.ix.1968	30.ix.1968	2.5	Dead
28.ix.1968	29.ix.1968	1.0	Dead
28.ix.1968	29.ix.1968	1.0	Dead
28.ix.1968	30.ix.1968	2.5	Dead
28.ix.1968	29.ix.1968	1.0	Dead
28.ix.1968	30.ix.1968	2.0	Dead
28.ix.1968	30.ix.1968	2.0	Dead
28.ix.1968	29.ix.1968	1.0	Dead
28.ix.1968	1. x.1968	3.0	Dead
28.ix.1968	29.ix.1968	1.5	Dead
28.ix.1968	30.ix.1968	2.0	Dead

Average 1.97, Correction −0.25, Corrected Average 1.72

Table 22. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Melilotus officinalis* (L.) Lam., family Leguminosae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
6.xi.1968	15.xi.1968	8.5	Dead		
6.xi.1968	8.xi.1968	2.0	Dead		
6.xi.1968	7.xi.1968	1.0	Dead		
6.xi.1968	11.xi.1968	4.5	Dead		
6.xi.1968	8.xi.1968	2.0	Dead		
6.xi.1968	7.xi.1968	1.0	Dead		
6.xi.1968	8.xi.1968	2.0	Dead		
6.xi.1968	15.xi.1968	9.0	Dead		
6.xi.1968	7.xi.1968	1.0	Dead		
6.xi.1968	8.xi.1968	2.0	Dead		
6.xi.1968	9.xi.1968	3.0	Dead		
6.xi.1968	14.xi.1968	8.0	Pupated	Dead	
6.xi.1968	8.xi.1968	2.0	Dead		
6.xi.1968	9.xi.1968	3.0	Dead		
6.xi.1968	9.xi.1968	2.5	Dead		
6.xi.1968	12.xi.1968	6.0	Dead		
6.xi.1968	7.xi.1968	1.0	Dead		
6.xi.1968	8.xi.1968	1.5	Dead		
6.xi.1968	7.xi.1968	1.0	Dead		
6.xi.1968	12.xi.1968	5.5	Pupated	emerged	12.5

Average 3.32, Correction -0.25, Corrected Average 3.07

Table 23. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Pisum sativum* L., family Leguminosae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
14.viii.1968	20.viii.1968	6.0	Pupated	emerged	12.0
14.viii.1968	20.viii.1968	5.5	Pupated	emerged	11.5
14.viii.1968	20.viii.1968	5.5	Pupated	emerged	13.0
14.viii.1968	18.viii.1968	3.5	Dead		
14.viii.1968	18.viii.1968	3.5	Dead		
14.viii.1968	20.viii.1968	5.5	Pupated	emerged	13.0
14.viii.1968	21.viii.1968	6.5	Pupated	emerged	13.5
14.viii.1968	18.viii.1968	3.5	Dead		
14.viii.1968	20.viii.1968	5.5	Pupated	emerged	14.0
14.viii.1968	20.viii.1968	5.5	Pupated	emerged	14.0
14.viii.1968	17.viii.1968	2.5	Dead		
14.viii.1968	20.viii.1968	5.5	Pupated	emerged	13.5
14.viii.1968	17.viii.1968	2.5	Dead		
26.ix.1968	2. x.1968	5.5	Pupated	emerged	13.0
26.ix.1968	3. x.1968	6.5	Pupated	emerged	14.0
26.ix.1968	2. x.1968	6.0	Pupated	emerged	14.5
26.ix.1968	30.ix.1968	4.0	Dead		
26.ix.1968	28.ix.1968	2.0	Dead		
26.ix.1968	30.ix.1968	4.0	Dead		
26.ix.1968	2. x.1968	5.5	Pupated	emerged	14.0

Average 4.72, Correction -0.25, Corrected Average 4.47

Table 24. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Apium* sp., family Umbelliferae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
24.x.1968	25.x.1968	1.0	Dead
24.x.1968	26.x.1968	1.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	1.0	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead
24.x.1968	25.x.1968	0.5	Dead

Average 0.60, Correction -0.25, Corrected Average 0.35

Table 25. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Nicotiana tabacum* L., family Solanaceae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
23.x.1968	24.x.1968	1.0	Dead
23.x.1968	24.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	29.x.1968	0.25	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	29.x.1968	0.25	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead
29.x.1968	30.x.1968	0.5	Dead

Average 0.50, Correction -0.25, Corrected Average 0.25

Table 26. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Galeopsis tetrahit* L., family Labiatae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
22.x.1968	27.x.1968	5.0	Pupated	emerged	13.0
22.x.1968	27.x.1968	5.0	Pupated	emerged	14.0
22.x.1968	27.x.1968	5.0	Pupated	emerged	15.0
23.x.1968	30.x.1968	7.0	Pupated	emerged	14.0
23.x.1968	24.x.1968	1.0	Dead		
23.x.1969	26.x.1968	3.0	Dead		
23.x.1968	29.x.1968	5.5	Pupated	emerged	14.0
23.x.1968	28.x.1968	5.0	Pupated	emerged	14.0
23.x.1968	25.x.1968	1.5	Dead		
23.x.1968	29.x.1968	5.5	Pupated	emerged	13.0
23.x.1968	29.x.1968	5.5	Pupated	emerged	13.0
23.x.1968	29.x.1968	6.0	Pupated	emerged	15.0
23.x.1968	26.x.1968	3.0	Dead		
23.x.1968	26.x.1968	3.0	Dead		
23.x.1968	25.x.1968	1.5	Dead		
23.x.1968	28.x.1968	5.0	Dead		
23.x.1968	29.x.1968	5.5	Pupated	emerged	14.0
23.x.1968	26.x.1968	3.0	Dead		
23.x.1968	24.x.1968	1.0	Dead		
23.x.1968	24.x.1968	1.0	Dead		

Average 3.90, Correction −0.25, Corrected Average 3.65

Table 27. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Achillea sibirica* Ledeb., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
6.ix.1969	11.ix.1969	5.0	Pupated	emerged	13.0
6.ix.1969	11.ix.1969	5.5	Pupated	emerged	13.0
6.ix.1969	11.ix.1969	5.5	Pupated	emerged	14.0
6.ix.1969	12.ix.1969	6.0	Pupated	emerged	14.0
6.ix.1969	7.ix.1969	1.0	Dead		
6.ix.1969	11.ix.1969	5.0	Pupated	emerged	13.0
6.ix.1969	11.ix.1969	5.0	Pupated	Dead	0.0
6.ix.1969	11.ix.1969	5.5	Pupated	emerged	14.0
6.ix.1969	11.ix.1969	5.0	Pupated	emerged	13.0
6.ix.1969	11.ix.1969	5.5	Pupated	emerged	13.0

Average 4.90, Correction -0.25, Corrected Average 4.65

Table 28. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Artemisia* sp., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
6.ix.1969	7.ix.1969	0.5	Dead
6.ix.1969	7.ix.1969	0.5	Dead
6.ix.1969	7.ix.1969	0.5	Dead
6.ix.1969	7.ix.1969	0.5	Dead
6.ix.1969	7.ix.1969	0.5	Dead
6.ix.1969	7.ix.1969	0.5	Dead
6.ix.1969	7.ix.1969	0.5	Dead
6.ix.1969	7.ix.1969	0.5	Dead
6.ix.1969	7.ix.1969	0.5	Dead
6.ix.1969	7.ix.1969	0.5	Dead

Average 0.5, Correction -0.25, Corrected Average 0.25

Remarks.-Successful transfer of larvae was probably not possible in this case as the plant surface was extremely woolly, and the transferred larvae usually ended up in the fibres of the woolly surface.

Table 29. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Chrysanthemum* sp. (cultivated), family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	10.x.1968	3.0	Dead		
7.x.1968	10.x.1968	3.0	Dead		
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	9.x.1968	2.0	Dead		
7.x.1968	12.x.1968	5.5	Pupated	emerged	14.0
7.x.1968	10.x.1968	3.5	Dead		
7.x.1968	13.x.1968	6.0	Pupated	emerged	14.0
7.x.1968	9.x.1968	2.5	Dead		
7.x.1968	9.x.1968	2.5	Dead		
7.x.1968	14.x.1968	7.0	Pupated	emerged	15.0
7.x.1968	15.x.1968	8.5	Dead		
7.x.1968	9.x.1968	2.0	Dead		
7.x.1968	15.x.1968	8.0	Dead		
7.x.1968	15.x.1968	8.5	Pupated	emerged	14.0
7.x.1968	15.x.1968	8.5	Pupated	emerged	14.0
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	9.x.1968	2.0	Dead		
7.x.1968	15.x.1968	8.0	Pupated	emerged	15.0

Average 4.32, Correction -0.25, Corrected Average 4.07

Table 30. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Dahlia* sp., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	10.x.1968	3.0	Dead		
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	9.x.1968	2.0	Dead		
7.x.1968	14.x.1968	7.0	Pupated	emerged	14.0
7.x.1968	10.x.1968	3.0	Dead		
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	9.x.1968	2.0	Dead		
7.x.1968	15.x.1968	8.0	Pupated	Dead	
7.x.1968	10.x.1968	3.0	Dead		
7.x.1968	10.x.1968	3.0	Dead		
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	10.x.1968	3.0	Dead		
7.x.1968	9.x.1968	2.5	Dead		
7.x.1968	10.x.1968	3.0	Dead		
7.x.1968	8.x.1968	1.5	Dead		
7.x.1968	8.x.1968	1.0	Dead		

Average 2.62, Correction −0.25, Corrected Average 2.37

Table 31. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Helianthus annuus* L., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
28.viii.1968	2.ix.1968	5.5	Pupated	emerged	13.0
28.viii.1968	2.ix.1968	5.5	Pupated	emerged	13.5
28.viii.1968	29.viii.1968	1.0	Dead		
28.viii.1968	29.viii.1968	1.0	Dead		
28.viii.1968	2.ix.1968	5.5	Pupated	emerged	14.0
28.viii.1968	29.viii.1968	1.0	Dead		
28.viii.1968	2.ix.1968	5.5	Pupated	emerged	13.0
27.ix.1968	2. x.1968	5.0	Pupated	emerged	13.0
28.ix.1968	30.ix.1968	2.5	Dead		
28.ix.1968	3. x.1968	5.5	Pupated	emerged	14.0
28.ix.1968	3. x.1968	5.5	Pupated	emerged	14.0
28.ix.1968	3. x.1968	5.0	Pupated	emerged	13.5
28.ix.1968	29.ix.1968	1.0	Dead		
28.ix.1968	29.ix.1968	1.0	Dead		
28.ix.1968	3. x.1968	5.5	Pupated	emerged	13.0
28.ix.1968	29.ix.1968	1.0	Dead		
28.ix.1968	28.ix.1968	0.5	Dead		
28.ix.1968	4. x.1968	6.0	Pupated	emerged	15.0
28.ix.1968	28.ix.1968	0.5	Dead		
28.ix.1968	28.ix.1968	0.5	Dead		

Average 3.22, Correction −0.25, Corrected Average 2.97

Table 32. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Matricaria matricarioides* (Less.) Porter, family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
6.ix.1969	11.ix.1969	5.5	Pupated	emerged	14.0
6.ix.1969	11.ix.1969	5.5	Pupated	emerged	14.0
6.ix.1969	11.ix.1969	5.0	Pupated	emerged	13.0
6.ix.1969	11.ix.1969	5.0	Pupated	emerged	13.0
6.ix.1969	11.ix.1969	5.0	Pupated	emerged	13.5
6.ix.1969	10.ix.1969	4.5	Pupated	emerged	14.0
6.ix.1969	11.ix.1969	5.5	Pupated	emerged	13.5
6.ix.1969	11.ix.1969	5.0	Pupated	emerged	14.5
6.ix.1969	6.ix.1969	0.5	Dead		
6.ix.1969	11.ix.1969	5.0	Pupated	emerged	13.0

Average 4.65, Correction -0.25, Corrected Average 4.40

Table 33. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Senecio vulgaris* L., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
29.viii.1968	3.ix.1968	5.5	Pupated	emerged	13.0
29.viii.1968	4.ix.1968	6.0	Pupated	emerged	14.0
29.viii.1968	30.viii.1968	1.5	Dead		
29.viii.1968	30.viii.1968	1.0	Dead		
26.ix.1968	2. x.1968	6.5	Dead		
26.ix.1968	2. x.1968	5.0	Dead		
26.ix.1968	2. x.1968	6.0	Dead		
26.ix.1968	2. x.1968	6.0	Dead		
26.ix.1968	2. x.1968	6.5	Pupated	emerged	13.5
26.ix.1968	3. x.1968	7.5	Pupated	Dead	
26.ix.1968	29.ix.1968	3.0	Dead		
26.ix.1968	28.ix.1968	2.0	Dead		
26.ix.1968	27.ix.1968	1.5	Dead		
26.ix.1968	28.ix.1968	2.5	Dead		
26.ix.1968	28.ix.1968	2.5	Dead		
26.ix.1968	1. x.1968	5.0	Dead		
26.ix.1968	2. x.1968	6.0	Pupated	emerged	14.0
26.ix.1968	2. x.1968	6.0	Pupated	emerged	13.0
26.ix.1968	27.ix.1968	1.5	Dead		
26.ix.1968	26.ix.1968	0.5	Dead		

Average 4.10, Correction -0.25, Corrected Average 3.85

Table 34. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Sonchus uliginosus* Bieb., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
24.x.1968	31.x.1968	7.0	Pupated	emerged	14.0
24.x.1968	25.x.1968	0.5	Dead		
24.x.1968	25.x.1968	0.5	Dead		
24.x.1968	17.x.1968	3.0	Dead		
24.x.1968	30.x.1968	5.5	Pupated	emerged	13.0
24.x.1968	30.x.1968	6.0	Pupated	emerged	13.0
25.x.1968	26.x.1968	0.5	Dead		
25.x.1968	31.x.1968	5.5	Pupated	emerged	13.5
25.x.1968	31.x.1968	5.5	Pupated	emerged	14.0
25.x.1968	26.x.1968	0.5	Dead		
25.x.1968	26.x.1968	0.5	Dead		
25.x.1968	26.x.1968	0.5	Dead		
25.x.1968	26.x.1968	1.0	Dead		
25.x.1968	2.xi.1968	6.5	Pupated	emerged	14.0
25.x.1968	26.x.1968	0.5	Dead		
25.x.1968	31.x.1968	5.5	Pupated	emerged	13.0
25.x.1968	31.x.1968	6.0	Pupated	emerged	12.5
25.x.1968	31.x.1968	5.5	Pupated	emerged	13.0
25.x.1968	30.x.1968	4.5	Dead		
25.x.1968	26.x.1968	0.5	Dead		

Average 3.27, Correction -0.25, Corrected Average 3.02

Table 35. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Tanacetum vulgare* L., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
30.ix.1968	7.x.1968	7.0	Pupated	emerged	13.0
30.ix.1968	7.x.1968	7.0	Pupated	emerged	14.0
30.ix.1968	6.x.1968	6.0	Pupated	emerged	14.0
30.ix.1968	5.x.1968	5.5	Pupated	emerged	13.0
30.ix.1968	5.x.1968	5.5	Pupated	emerged	12.5
30.ix.1968	6.x.1968	6.0	Pupated	emerged	13.0
30.ix.1968	6.x.1968	6.5	Pupated	emerged	13.0
30.ix.1968	2.x.1968	2.0	Dead		
6.x.1968	12.x.1968	5.5	Pupated	emerged	13.0
6.x.1968	12.x.1968	6.0	Pupated	emerged	14.0
6.x.1968	12.x.1968	5.5	Pupated	emerged	14.0
6.x.1968	12.x.1968	5.5	Pupated	emerged	13.0
6.x.1968	12.x.1968	6.0	Pupated	emerged	15.0
6.x.1968	12.x.1968	6.0	Pupated	emerged	14.0
6.x.1968	13.x.1968	6.5	Pupated	emerged	13.0
6.x.1968	13.x.1968	6.5	Pupated	emerged	13.0
6.x.1968	12.x.1968	6.0	Pupated	emerged	15.0
6.x.1968	12.x.1968	6.0	Pupated	emerged	14.0
6.x.1968	12.x.1968	6.0	Pupated	emerged	13.0
6.x.1968	12.x.1968	5.5	Pupated	emerged	13.0

Average 5.82, Correction -0.25, Corrected Average 5.57

Table 36. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Taraxacum officinale* Weber, family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
23.x.1968	28.x.1968	4.5	Dead		
23.x.1968	29.x.1968	5.5	Pupated	emerged	13.0
23.x.2968	24.x.1968	0.5	Dead		
23.x.1968	24.x.1968	0.5	Dead		
23.x.1968	26.x.1968	2.5	Dead		
23.x.1968	29.x.1968	6.0	Dead		
23.x.1968	28.x.1968	5.0	Dead		
23.x.1968	29.x.1968	5.5	Pupated	Dead	
23.x.1968	24.x.1968	0.5	Dead		
23.x.1968	27.x.1968	4.0	Dead		
23.x.1968	24.x.1968	0.5	Dead		
23.x.1968	29.x.1968	6.0	Pupated	emerged	13.0
23.x.1968	24.x.1968	0.5	Dead		
23.x.1968	24.x.1968	0.5	Dead		
23.x.1968	24.x.1968	0.5	Dead		
23.x.1968	24.x.1968	0.5	Dead		
23.x.1968	24.x.1968	0.5	Dead		
23.x.1968	29.x.1968	5.5	Pupated	emerged	14.0
23.x.1968	24.x.1968	0.5	Dead		
23.x.1968	24.x.1968	0.5	Dead		

Average 2.50, Correction −0.25, Corrected Average 2.25

Table 37. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Allium cepa* L., family Liliaceae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
23.ix.1968	25.ix.1968	2.0	Dead		
23.ix.1968	28.ix.1968	5.0	Pupated	emerged	13.5
23.ix.1968	1. x.1968	8.0	Dead		
23.ix.1968	28.ix.1968	4.5	Dead		
23.ix.1968	24.ix.1968	1.0	Dead		
23.ix.1968	24.ix.1968	1.0	Dead		
23.ix.1968	27.ix.1968	3.5	Dead		
23.ix.1968	2. x.1968	9.0	Pupated	Dead	
23.ix.1968	30.ix.1968	6.5	Pupated	emerged	14.0
23.ix.1968	29.ix.1968	5.5	Pupated	emerged	13.5
24.ix.1968	26.ix.1968	2.0	Dead		
24.ix.1968	26.ix.1968	2.0	Dead		
24.ix.1968	29.ix.1968	5.0	Dead		
24.ix.1968	28.ix.1968	4.0	Dead		
24.ix.1968	29.ix.1968	5.5	Pupated	emerged	13.0
24.ix.1968	1. x.1968	7.5	Dead		
24.ix.1968	26.ix.1968	2.0	Dead		
24.ix.1968	28.ix.1968	4.0	Dead		
24.ix.1968	29.ix.1968	5.0	Pupated	emerged	14.0

Average 4.20, Correction -0.25, Corrected Average 3.95

Table 38. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Hordeum vulgare* L., family Graminae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
13.ix.1968	18.ix.1968	5.0	Pupated	emerged	13.0
13.ix.1968	14.ix.1968	1.0	Dead		
22.ix.1968	24.ix.1968	2.5	Dead		
22.ix.1968	24.ix.1968	2.5	Dead		
22.ix.1968	24.ix.1968	2.5	Dead		
22.ix.1968	24.ix.1968	2.5	Dead		
22.ix.1968	25.ix.1968	3.5	Dead		
22.ix.1968	24.ix.1968	2.5	Dead		
22.ix.1968	24.ix.1968	2.5	Dead		
22.ix.1968	24.ix.1968	2.5	Dead		
22.ix.1968	24.ix.1968	2.0	Dead		
22.ix.1968	29.ix.1968	7.0	Pupated	emerged	14.5
22.ix.1968	23.ix.1968	1.0	Dead		
22.ix.1968	27.ix.1968	5.5	Pupated	emerged	14.5
22.ix.1968	24.ix.1968	2.0	Dead		
22.ix.1968	23.ix.1968	1.5	Dead		
24.ix.1968	25.ix.1968	1.0	Dead		
25.ix.1968	2. x.1968	6.5	Dead		
25.ix.1968	28.ix.1968	2.5	Dead		
25.ix.1968	28.ix.1968	2.5	Dead		

Average 2.92, Correction −0.25, Corrected Average 2.67

Table 39. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Tanacetum vulgare* L. to *Typha latifolia* L., family Typhaceae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	0.5	Dead
15.ix.1968	16.ix.1968	0.5	Dead
15.ix.1968	16.ix.1968	0.5	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	0.5	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	0.5	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	0.5	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	0.5	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	1.0	Dead
15.ix.1968	16.ix.1968	0.5	Dead

Average 0.80, Correction −0.25, Corrected Average 0.55

Table 40. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb. to *Brassica oleracea* L., family Cruciferae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
28.vi.1967	30.vi.1967	2.0	Dead		
2.vii.1967	7.vii.1967	5.5	Pupated	emerged	15.0
2.vii.1967	3.vii.1967	1.5	Dead		
10.vii.1967	12.vii.1967	1.5	Dead		
10.vii.1967	11.vii.1967	0.5	Dead		
10.vii.1967	12.vii.1967	2.0	Dead		
10.vii.1967	12.vii.1967	2.0	Dead		
10.vii.1967	12.vii.1967	2.0	Dead		
10.vii.1967	12.vii.1967	2.0	Dead		
10.vii.1967	11.vii.1967	1.0	Dead		
10.vii.1967	12.vii.1967	1.5	Dead		
10.vii.1967	12.vii.1967	1.5	Dead		
10.vii.1967	12.vii.1967	1.5	Dead		
15.vii.1967	16.vii.1967	1.0	Dead		
15.vii.1967	16.vii.1967	1.5	Dead		
15.vii.1967	16.vii.1967	1.5	Dead		
15.vii.1967	17.vii.1967	2.0	Dead		
15.vii.1967	17.vii.1967	2.0	Dead		
15.vii.1967	16.vii.1967	1.0	Dead		
15.vii.1967	16.vii.1967	1.5	Dead		

Average 1.75, Correction −0.25, Corrected Average 1.50

Table 41. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb. to *Lupinus* sp., family Leguminosae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
14.viii.1967	15.viii.1967	0.5	Dead
14.viii.1967	15.viii.1967	1.0	Dead
14.viii.1967	15.viii.1967	1.0	Dead
14.viii.1967	15.viii.1967	1.0	Dead
14.viii.1967	15.viii.1967	1.0	Dead
14.viii.1967	21.viii.1967	7.0	Dead
14.viii.1967	16.viii.1967	1.5	Dead
14.viii.1967	17.viii.1967	2.5	Dead
14.viii.1967	16.viii.1967	1.5	Dead
14.viii.1967	15.viii.1967	1.0	Dead
14.viii.1967	17.viii.1967	3.0	Dead
14.viii.1967	16.viii.1967	1.5	Dead
14.viii.1967	16.viii.1967	1.5	Dead
14.viii.1967	16.viii.1967	1.5	Dead
14.viii.1967	15.viii.1967	1.0	Dead
14.viii.1967	16.viii.1967	1.5	Dead
14.viii.1967	15.viii.1967	1.0	Dead
14.viii.1967	16.viii.1967	2.0	Dead
14.viii.1967	16.viii.1967	2.0	Dead
14.viii.1967	15.viii.1967	1.0	Dead

Average 1.70, Correction -0.25, Corrected Average 1.45

Table 42. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb. to *Pisum sativum* L., family Leguminosae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
3.vii.1967	7.vii.1967	4.0	Dead		
3.vii.1967	8.vii.1967	5.5	Pupated	emerged	15.0
7.vii.1967	13.vii.1967	5.5	Pupated	emerged	14.5
7.vii.1967	11.vii.1967	3.5	Dead		
7.vii.1967	13.vii.1967	6.0	Dead		
7.vii.1967	13.vii.1967	5.5	Pupated	emerged	13.5
8.vii.1967	10.vii.1967	2.5	Dead		
8.vii.1967	13.vii.1967	5.5	Pupated	emerged	14.5
8.vii.1967	11.vii.1967	3.0	Dead		
8.vii.1967	13.vii.1967	5.0	Pupated	emerged	15.0
8.vii.1967	13.vii.1967	5.0	Pupated	emerged	14.0
8.vii.1967	13.vii.1967	5.5	Pupated	emerged	13.0
8.vii.1967	10.vii.1967	2.5	Dead		
8.vii.1967	11.vii.1967	3.5	Dead		
8.vii.1967	13.vii.1967	5.5	Dead		
8.vii.1967	13.vii.1967	5.0	Pupated	emerged	13.0
9.vii.1967	14.vii.1967	4.5	Pupated	emerged	13.0
9.vii.1967	11.vii.1967	2.0	Dead		
9.vii.1967	14.vii.1967	4.5	Pupated	emerged	12.5
9.vii.1967	14.vii.1967	4.5	Dead		

Average 4.42, Correction −0.25, Corrected Average 4.17

Table 43. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb. to *Nicotiana tabacum* L., family Solanaceae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
5.vii.1967	6.vii.1967	1.0	Dead
5.vii.1967	6.vii.1967	1.0	Dead
5.vii.1967	5.vii.1967	0.5	Dead
5.vii.1967	6.vii.1967	1.0	Dead
5.vii.1967	5.vii.1967	0.5	Dead
5.vii.1967	6.vii.1967	1.0	Dead
12.vii.1967	13.vii.1967	1.0	Dead
12.vii.1967	13.vii.1967	1.0	Dead
12.vii.1967	14.vii.1967	2.0	Dead
12.vii.1967	13.vii.1967	1.0	Dead
12.vii.1967	13.vii.1967	1.0	Dead
12.vii.1967	12.vii.1967	0.5	Dead
12.vii.1967	13.vii.1967	1.0	Dead
12.vii.1967	14.vii.1967	2.0	Dead
12.vii.1967	14.vii.1967	2.0	Dead
12.vii.1967	13.vii.1967	1.0	Dead
12.vii.1967	13.vii.1967	1.0	Dead
12.vii.1967	13.vii.1967	1.0	Dead
12.vii.1967	13.vii.1967	0.5	Dead
12.vii.1967	13.vii.1967	1.0	Dead

Average 1.05, Correction −0.25, Corrected Average 0.80

Table 44. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb. to *Solanum tuberosum* L., family Solanaceae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
12.vii.1967	12.vii.1967	0.5	Dead
12.vii.1967	12.vii.1967	0.5	Dead
12.vii.1967	13.vii.1967	1.5	Dead
12.vii.1967	13.vii.1967	1.0	Dead
12.vii.1967	13.vii.1967	0.5	Dead
12.vii.1967	12.vii.1967	0.5	Dead
12.vii.1967	12.vii.1967	0.5	Dead
12.vii.1967	12.vii.1967	0.5	Dead
12.vii.1967	13.vii.1967	0.5	Dead
12.vii.1967	13.vii.1967	1.5	Dead

Average 0.75, Correction -0.25, Corrected Average 0.50

Table 45. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb. to *Achillea sibirica* Ledeb., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
10.vii.1967	16.vii.1967	6.0	Pupated	emerged	15.0
10.vii.1967	14.vii.1967	4.0	Dead		
10.vii.1967	16.vii.1967	6.0	Pupated	emerged	15.0
10.vii.1967	15.vii.1967	5.0	Pupated	emerged	14.5
10.vii.1967	11.vii.1967	1.0	Dead		
10.vii.1967	15.vii.1967	5.5	Pupated	emerged	14.5
10.vii.1967	16.vii.1967	6.0	Pupated	emerged	14.5
10.vii.1967	15.vii.1967	5.5	Pupated	emerged	13.0
10.vii.1967	14.vii.1967	4.0	Dead		
10.vii.1967	12.vii.1967	1.5	Dead		
10.vii.1967	15.vii.1967	5.0	Pupated	emerged	14.5
10.vii.1967	13.vii.1967	2.5	Dead		
10.vii.1967	15.vii.1967	5.0	Pupated	emerged	15.0
10.vii.1967	15.vii.1967	5.0	Pupated	emerged	15.0
30.vii.1967	4.viii.1967	5.5	Pupated	emerged	14.0
1.viii.1967	6.viii.1967	5.0	Pupated	emerged	14.5
1.viii.1967	8.viii.1967	6.5	Pupated	emerged	14.0
1.viii.1967	8.viii.1967	7.0	Pupated	emerged	15.0
1.viii.1967	7.viii.1967	6.0	Pupated	emerged	14.5
1.viii.1967	9.viii.1967	7.5	Pupated	emerged	13.0

Average 4.97, Correction −0.25, Corrected Average 4.72

Table 46. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb. to *Solidago* sp., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
1.vii.1967	2.vii.1967	1.0	Dead
1.vii.1967	2.vii.1967	1.0	Dead
1.vii.1967	1.vii.1967	0.5	Dead
3.vii.1967	4.vii.1967	1.0	Dead
3.vii.1967	4.vii.1967	1.0	Dead
3.vii.1967	3.vii.1967	0.5	Dead
5.vii.1967	5.vii.1967	0.5	Dead
5.vii.1967	6.vii.1967	1.0	Dead
5.vii.1967	5.vii.1967	0.5	Dead
5.vii.1967	6.vii.1967	1.5	Dead
10.vii.1967	11.vii.1967	1.0	Dead
10.vii.1967	12.vii.1967	1.5	Dead
10.vii.1967	12.vii.1967	2.0	Dead
10.vii.1967	11.vii.1967	1.0	Dead
10.vii.1967	11.vii.1967	0.5	Dead
10.vii.1967	11.vii.1967	0.5	Dead
10.vii.1967	11.vii.1967	1.0	Dead
10.vii.1967	11.vii.1967	1.0	Dead
10.vii.1967	11.vii.1967	0.5	Dead
10.vii.1967	11.vii.1967	1.0	Dead

Average 0.92, Correction −0.25, Corrected Average 0.67

Table 47. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb. to *Sonchus arvensis* L., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding
21.vii.1967	22.vii.1967	1.0	Dead
21.vii.1967	22.vii.1967	1.0	Dead
21.vii.1967	22.vii.1967	1.0	Dead
21.vii.1967	22.vii.1967	1.5	Dead
21.vii.1967	22.vii.1967	1.5	Dead
21.vii.1967	27.vii.1967	6.0	Dead
21.vii.1967	22.vii.1967	1.5	Dead
21.vii.1967	22.vii.1967	1.5	Dead
21.vii.1967	22.vii.1967	1.5	Dead
21.vii.1967	22.vii.1967	1.0	Dead
21.vii.1967	26.vii.1967	5.0	Dead
21.vii.1967	22.vii.1967	1.0	Dead
21.vii.1967	22.vii.1967	1.5	Dead
21.vii.1967	22.vii.1967	1.0	Dead
21.vii.1967	22.vii.1967	1.0	Dead
21.vii.1967	22.vii.1967	1.0	Dead
24.vii.1967	27.vii.1967	3.0	Dead
24.vii.1967	26.vii.1967	2.0	Dead
24.vii.1967	25.vii.1967	1.0	Dead
24.vii.1967	25.vii.1967	1.0	Dead

Average 1.75, Correction -0.25, Corrected Average 1.50

Table 48. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb. to *Tanacetum vulgare* L., family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
1.viii.1967	7.viii.1967	6.0	Pupated	emerged	14.0
2.viii.1967	9.viii.1967	6.5	Pupated	emerged	14.0
2.viii.1967	9.viii.1967	6.5	Pupated	emerged	15.0
2.viii.1967	8.viii.1967	5.5	Pupated	emerged	14.5
2.viii.1967	8.viii.1967	5.5	Pupated	emerged	14.5
2.viii.1967	7.viii.1967	5.0	Pupated	emerged	15.0
2.viii.1967	7.viii.1967	5.0	Pupated	emerged	15.0
3.viii.1967	5.viii.1967	2.5	Dead		
3.viii.1967	8.viii.1967	5.0	Pupated	emerged	15.0
3.viii.1967	8.viii.1967	5.5	Pupated	emerged	14.0

Average 5.30, Correction -0.25, Corrected Average 5.05

Table 49. Results of transfers of larvae of *Phytomyza matricariae* Hendel from *Achillea sibirica* Ledeb. to *Zinnia* sp. (cultivated), family Compositae.

Date of larval transfer	Date of end of larval feeding	Duration of larval feeding (Days)	Fate of larva at end of feeding	Fate of puparium	Duration of stage in puparium
30.vi.1967	5.vii.1967	5.0	Pupated	emerged	14.0
30.vi.1967	1.vii.1967	1.0	Dead		
30.vi.1967	2.vii.1967	2.0	Dead		
30.vi.1967	5.vii.1967	5.0	Pupated	emerged	15.0
30.vi.1967	3.vii.1967	3.0	Dead		
10.vii.1967	15.vii.1967	4.5	Pupated	Dead	0.0
10.vii.1967	12.vii.1967	2.0	Dead		
10.vii.1967	12.vii.1967	1.5	Dead		
10.vii.1967	13.vii.1967	2.5	Dead		
10.vii.1967	16.vii.1967	5.5	Pupated	emerged	14.0
10.vii.1967	12.vii.1967	1.5	Dead		
10.vii.1967	13.vii.1967	2.5	Dead		
10.vii.1967	11.vii.1967	1.0	Dead		
10.vii.1967	16.vii.1967	5.5	Pupated	emerged	14.5
10.vii.1967	15.vii.1967	5.0	Pupated	emerged	14.5
10.vii.1967	13.vii.1967	3.0	Dead		
10.vii.1967	11.vii.1967	1.0	Dead		
10.vii.1967	13.vii.1967	3.0	Dead		
10.vii.1967	12.vii.1967	1.5	Dead		
10.vii.1967	14.vii.1967	3.5	Dead		

Average 2.97, Correction −0.25, Corrected Average 1.72