EMEND





ECOSYSTEM-BASED MANAGEMENT EMULATING NATURAL DISTURBANCE

EMEND Insights #2

Ecological Messages:

- Ichneumonids are parasitoid wasps that play key roles within forests and can help to regulate pest populations.
- Our understanding of ichneumonid diversity is limited because few studies have looked at them in the boreal forest.
- 64 species of ichneumonid were identified in this study, all of which are new additions to the EMEND species list; we estimate that over 500 species of ichneumonids are present at EMEND.

Management Implications:

- As retention levels increase, so too do the number of ichneumonids present.
- No species showed a preference for clear-cut habitats.
- Variable retention harvesting contributes to maintaining the number of ichneumonids in the forest.
- Landscape management strategies that do not take into account the requisites for this large and diverse community may present risks for the normal regulation of endemic or exotic pest populations within mature forests.

Gatekeepers of the forest: the ichneumonids of EMEND

By Marla Schwarzfeld and Felix Sperling

A lot of things go unnoticed in a forest, and insects are one of the more common things we might overlook. But have you ever wondered what role that hovering wasp might play in keeping the forest healthy? One family of wasp-like critters, the Ichneumonids, are part of a specialized group of insects called 'parasitoids'. Parasitoids perform many critical roles within the forest, including keeping forest pest species (like forest tent caterpillars) in check. They do this by injecting their eggs inside 'hosts'- insects and spiders that are in their early stages of development (e.g. caterpillars). As the parasitoids grow they eat away at the host, ultimately killing it. It sounds gruesome but it is actually a critical part of the 'circle of life' within forests.

Despite the importance of ichneumonids, we actually know very little about their diversity. For example, we identified 64 species at EMEND, all of which are new additions to the growing EMEND species list. At least 13 of these species have never been recorded in Alberta before, so we were able to provide new information about their habitats and distribution. In total, we estimate that we collected over 500 species of ichneumonids at EMEND.

In addition to this, we investigated how ichneumonids respond to forest harvesting. Although the patterns were highly variable, we did find that as the number of green-trees retained after harvesting increased, so too did the number of ichneumonid individuals. We also found that there were fewer individuals present in clear-cuts. This tells us that in order to maintain the free benefits that ichneumonids provide (e.g. keeping forest pests in check), it is beneficial to maintain green-trees following forest harvesting. ***Read on to find out more. . .***

Figure 1: *Apechthis picticornis. An example of Ichneumonidae from the subfamily Pimplinae. Photo by J. Dombroskie.*

What are ichneumonids and why are they important?

Ichneumonids are part of a specialized group of insects called parasitoids, and look more like flies than wasps (hornets, yellow-jackets) to the untrained eye. Adult parasitoids (Figures 1, 2) lay their eggs in or on other insects and spiders, often after paralyzing them with venom injected using a 'stinger' at the tip of the abdomen. When the parasitoid larva hatches, it feeds on its host until reaching maturity, ultimately killing the host.

So why are parasitoids, such as ichneumonids, so important in forest ecosystems? **Parasitoids play a large role in regulating populations of insect and spider species,** usually preventing these species from becoming pests, or helping to reduce population levels after outbreaks occur. For example, most species of insects and spiders are attacked by one or more species of parasitoids. Larvae of moths and sawflies tend to have the highest diversity of parasitoids attacking them as they are soft-bodied, slow-moving, and are generally easily accessible to parasitoid adults. These groups include many pest species such as the forest tent caterpillar, spruce budworm and large aspen tortrix.

Did you know?

The family Ichneumonidae is considered the largest group of wasps; some researchers estimate that the Ichneumonidae are in fact the most species-rich family of insects on Earth! Despite their abundance, diversity and ecological importance, however, the Ichneumonidae remain very little-studied, with large gaps in our knowledge of their basic biology and taxonomy.

About EMEND:

The Ecosystem-based Management Emulating Natural Disturbance (EMEND) Project is a multi-partner, collaborative forest research program. The EMEND project documents the response of ecological processes to experimentally-delivered variable retention and fire treatments. The research site is located in the western boreal forest near Peace River, Alberta, Canada, with monitoring and research scheduled for an entire forest rotation (i.e. 80 years).

Parasitoids have sometimes been used by humans as biocontrol agents to target pest species, especially non-native species, and bring them under control. In fact, the classic biocontrol examples involve the introduction of a plant-eating insect (herbivore) into an area where its parasitoids are not present. The species is then able to proliferate uncontrollably, becoming a serious pest in its new range, even when it was rare and non-destructive in its native range. Introducing its parasitoid(s) from its native range is often effective at stemming this uncontrolled population growth and reducing the herbivore's destructiveness. This exact scenario is happening constantly in natural ecosystems – **parasitoids are quietly keeping herbivore populations in check, often unnoticed and unappreciated.**

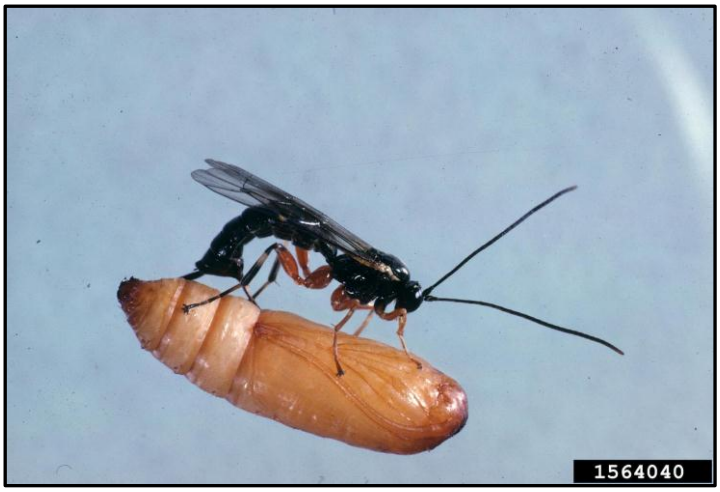

Figure 2: *An example of a parasitoid laying its eggs into a host (Photo: Roger Ryan, USFS PNW Station, Bugwood.org).*

Dozens of new species records for EMEND, and at least 13 new records for Alberta

Ichneumonidae are extremely abundant in the boreal forest. Through our trapping efforts, we collected one of the highest abundances of Ichneumonidae ever reported (an average of 66 specimens/trap/day).

We estimate that well over 500 ichneumonid species were present in the samples taken at EMEND. In addition, there are undoubtedly many species that have not yet been collected from that landbase as we targeted only a limited number of habitats. We identified 47, 721 specimens to subfamily (a total of 23 subfamilies); however the vast number of individuals, and the lack of good identification resources for many groups, made it unfeasible to identify all individuals to species. We therefore focused our efforts on three target subfamilies: Pimplinae, Poemeniinae and Rhyssinae.

We identified 3,878 individuals and 64 species in these three subfamilies. **At least 13 species were new for Alberta, and all 64 were new records for the EMEND landbase.** This illustrates that even though the EMEND landbase is one of the best studied in Alberta, and in all of Canada, the vast majority of species have not yet been inventoried.

As a result of our sampling in selected habitats, we have contributed significantly to our knowledge of species diversity, relative abundance and habitat associations of parasitoids at EMEND and in the western boreal forest. **This baseline knowledge is critical** for us to be able to better understand the dynamics between parasitoids and their host species within forest environments, and to assess the impacts of forest management on a broad range of biodiversity.

How does harvesting affect ichneumonids?

Many researchers believe that parasitoids, such as ichneumonids, may be particularly vulnerable to ecological disturbances. This is because parasitoids often have low population sizes, and many are specialized to lay their eggs in only a few host species. As well, some parasitoids are more sensitive to habitat fragmentation than their hosts, which could lead to an increase in outbreaks of herbivorous insects in managed ecosystems**. It is therefore very important to determine how this group responds to forest harvesting, in order to improve our understanding of forest biodiversity, and forest health.**

We were interested in determining if there was any impact of harvesting on Ichneumonidae, and secondly, if these impacts were mediated by retention harvesting.

We conducted this study in deciduous-dominated stands at EMEND in 2008, eight years post-harvest. We collected ichneumonids using Malaise traps (Figure 3) within three different harvesting treatments (clear-cut, 20% retention, 50% retention) and uncut controls, with two replicates of each treatment and control.

Figure 3: *A Malaise trap in a partially harvested stand at EMEND.*

Number of species is influenced by local factors

Ichneumonid species richness, or the number of species present, is one way to compare different harvesting treatments to each other. For example, many studies of other taxa at EMEND have shown differences in species richness between harvested and unharvested areas. In this study, however, species richness was not affected by harvesting treatments at EMEND. We did find that traps from one set of replicates (across all treatments) tended towards having higher richness than the second, geographically separated, set of replicates. **This result indicates that species richness of Ichneumonidae is more strongly influenced by local factors than by harvesting.**

Increasing retention positively influences abundance

There was a general trend towards increased abundance (total number of individuals) of Ichneumonidae as green-tree retention increased. This pattern was strongest in three subfamilies, Cylloceriinae, Ichneumoninae and Pimplinae, and particularly for one species, *Dreisbachia slossonae* (Figure 4, *see next page*). Other species and subfamilies followed this same pattern, though less distinctly so, while some showed no distinct trends. We also found that no species or subfamilies were more abundant in the clear-cut treatments than in other harvested treatments and controls.

Retention is an important management tool

Little is known about the host associations and microhabitat requirements of the vast majority of these parasitoids so it is difficult to identify the underlying biological processes for the patterns observed. Patterns in ichneumonid abundance could be related to patterns in host availability or to habitat traits such as food (nectar) availability or roosting spots for adults. It may also be that environmental variables such as wind or degree of shade may affect preference of adults. The highly variable life-histories and hosts of Ichneumonidae also mean that different taxa may show similar patterns, but for different ecological reasons.

Nonetheless, **the clear message that has emerged is that increasing green-tree retention is associated with increasing numbers of ichneumonids.** The lack of any taxa showing preference for clear-cut stands implies that these are probably suboptimal forests for many or all species. **The preservation of Ichneumonidae and their function in the forest is closely linked to green-tree retention.**

Where do we go from here?

This is one of the first studies to examine the impact of forest harvesting on an entire assemblage of Ichneumonidae. **Although our work provided evidence for the benefit of green-tree retention for maintenance of parasitoids in forested stands, much more work is needed to understand the biological processes underlying this pattern.**

For example, since this study was conducted 8 years post-harvest, there were well-developed shrub communities in all treatments; future studies would be useful to determine which factors (e.g. tree cover, understory community, microclimate) have the strongest influence on the ichneumonid community. Other studies are needed to assess the value of various retention forms (e.g. dispersed vs. aggregated) on ichneumonid mobility and prey availability.

As this study was limited to deciduous-dominated stands, expansion of work to other stand types will ascertain whether the patterns we observed are universal regardless of stand type.

Finally, assessment of parasitoid assemblage patterns should be investigated in the surrounding operational landbase to ascertain whether predictions based on the EMEND experiment hold up.

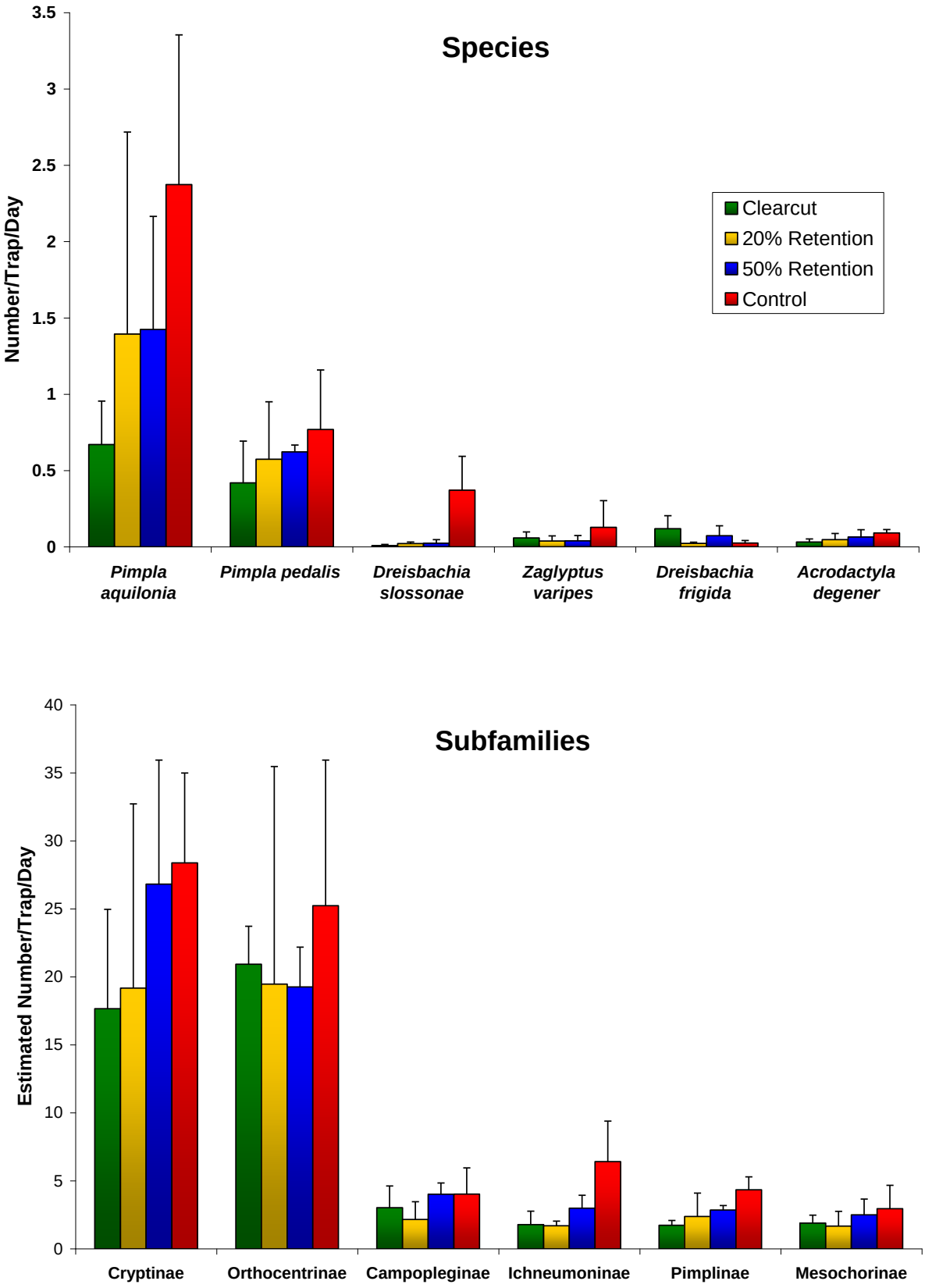

Figure 4: *Abundance patterns of species (from three target subfamilies), and Ichneumonidae subfamilies from four treatments in deciduous-dominated stands. Only the six most common species and subfamilies are shown.*

Management Implications

- Ichneumonid numbers were clearly impacted by the clear-cut treatment.
- Increasing green-tree retention is correlated with increasing Ichneumonidae numbers, particularly in some taxa. No taxa exhibit the reverse trend.
- Although most species are present in all harvesting treatments, the reduced numbers of parasitoids in heavily harvested stands could potentially lead to increased pest outbreaks in these stands.
- Landscape management strategies that do not take into account the requisites for this large and diverse community may present risks for the normal regulation of endemic or exotic pest populations within mature forests.

Further Reading

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