

Why We Kill Bugs – The Case for Collecting Insects

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Introduction

As I go about my work doing biodiversity research, I kill thousands of insects every year. I am not proud of that particular fact, but I am proud of the work that it contributes to. Despite terminating so many insect lives, I have a deep connection to these fascinating beings of tergites and tarsi, and I know that the knowledge our research team reveals is helping to protect their habitats. It must seem incongruous to some folks that I will go to great lengths to release a wayward spider unharmed out of my house, yet kill hundreds of moths in a black-light trap in the same evening. Most entomologists have no trouble understanding this apparent contradiction, because they understand the nature of insect populations and the techniques required to study them. This is not so obvious to members of the general public.

It pains me when, in my entomological pursuits, I receive a comment along the lines of; “great, kill them all!” These are typically from people who only notice insects when they are a nuisance, and who will stomp on them whenever possible. Theirs are very simple reactions, and the solution is basically education. Depending on the situation, I often try to open their eyes just a little to the wonders of the miniature world around them. More complex is the occasional expression of horror at the carnage of my nets and traps. These responses usually come from people who are concerned about the environment, but do not have much ecological knowledge. Generally they are familiar with vertebrates, and assume that other organisms operate in similar ways. The solution in these situations is also education, but the approach we take is critical. We can either engage in a mutually destructive fight that distracts us all

from the real threat of habitat loss, or recognise that we share the same concerns, and try to work together to protect wild places and wild species. As someone who also cares deeply about these creatures, I would much rather have these people as allies than enemies in the struggle for environmental preservation.

I have recently dealt with a concerted campaign against “bug collecting” by a well-meaning but misguided naturalist group. I approached it as an opportunity to educate them, and took considerable time and energy to explain how insects are not the same as vertebrates, and why entomologists do what we do. In this article I present the arguments I used in that case; I hope this will serve as a resource for entomologists who may find themselves in a similar situation where they are obliged to defend what they do.

Opposition to insect collecting generally comes from people familiar with birds and mammals. However, insects are vastly different creatures. As I will detail below they are incredibly numerous and prolific, so the effects of collecting on their populations are minimal. Because we know little or nothing about most insect species, and they are very difficult to identify, it is necessary to kill and collect them to study them. I will detail how collecting insects is a vital part of most entomology research, including taxonomic, diagnostic, biodiversity, and pest management work. Much of this work is carried out by amateurs, who have become world-class experts through collecting insects. Finally, I will argue that the conservation of insects and other organisms will benefit from MORE, rather than less, collecting of insects.

Why are insect populations resilient to collecting?

Insects are very different from birds and other vertebrates in that they have short generation spans, they have a phenomenal capacity for reproduction, and their populations regularly number in the billions. Insects are so abundant that their numbers simply cannot be considered in the same terms as those of vertebrates. Think of the thousands of insects that a single songbird eats during its lifetime; while each species is important in the ecosystem, a given individual of each species do not have equal ecological importance.

Because of their population size and their ability to reproduce, it is very difficult to affect insect populations by collecting. While it is true that over-collecting may pose a threat to species that are already endangered, those species did not become endangered as a result of collecting (New *et al.* 1995). Pyle (2002) states “while it is extremely difficult to make a dent in most insect populations with a net, the bulldozer, the cow, and the plow eradicate whole butterfly colonies in no time.” Habitat loss is by far the most significant threat to insects in Canada and elsewhere.

The special challenges of entomology

Insects are incredibly diverse: Before delving into why entomologists must collect specimens, we must first discuss the enormous diversity of insects, and the special challenge this presents to entomologists. Insects comprise over 2/3 of the approximately 2 million known species of living things on the planet, and scientists estimate there are millions more species of insects remaining to be discovered. Danks (1979) estimated that approximately 66 000 species of insects and related terrestrial arthropods live in Canada, slightly more than half of which had been discovered and described at that time. Compared to birds and other vertebrates, the number of insect species is staggering. There are over ten times as many known kinds of beetles in the world (approximately 357 000 known species; Bouchard *et al.* 2009)



Biologist Derrick Kanashiro sweeps for insects, as part of an inventory of insect species in native prairie near Purple Springs, Alberta.
(photograph by G.R. Pohl)

as all terrestrial vertebrates – birds, mammals, reptiles, and amphibians – combined (20 000 species; Tree of Life 2009). There are more species of butterflies and moths in one small area of Boreal forest in Alberta (500+; Pohl *et al.* 2006), than there are resident bird species in all of Canada (470; Avibase 2009). This is the special challenge that entomologists deal with every day – identifying, recognizing, describing, and cataloguing the millions of species of insects is almost overwhelming.

Insects are tiny: Another challenge in entomology is that insects are so small. With the exception of a few large and distinctive species like some butterflies and moths, the majority of insects need to be examined under a microscope to make an accurate species identification. Often specimens need to be dissected and their internal reproductive organs examined in order to accurately identify them. Needless to say, this precludes identification of living specimens in all but a slim minority of insect groups. Thus, killing and collecting insects is a necessary part of almost all entomological research that requires species identifications.

Insects are poorly known: Because of the enormity of the task, and the lack of resources and people to carry it out, entomologists are still in the exploratory stage of discovering and naming species. At last count, approximately 1.2 million insect species have been described, out of a total estimated at between five and ten mil-

lion (Marshall 2006). Except for a few species that have economic or health impacts on people, just about nothing is known about them. Many species are known only from a very brief description, often unaccompanied by illustrations, in an obscure journal article over 100 years old. Some species cannot be identified at all with our present state of knowledge. We simply do not possess the knowledge required to put together comprehensive identification guides to most insect groups. General insect guides cover only a few representative species, and omit the myriad of lesser-known but very similar-looking ones. A few relatively well-known groups such as butterflies and odonates have been the subjects of some excellent field guides published in recent years (Layberry *et al.* 1998; Acorn 2001, 2004, 2007; Cannings 2002; Jones *et al.* 2008). Even among these groups, many species-level taxonomic problems remain (for example in the butterfly genera *Boloria* and *Polygonia* and the ladybeetle genus *Scymnus*).

The comfortable position ornithologists and birders are in today, where comprehensive field guides exist and accurate field identifications can be made without killing specimens, is built on a strong taxonomic foundation. That exists now because, at one time, people collected birds and studied their skins and skeletons to arrive at a stable nomenclature and classification. For entomologists, that level of knowledge is a dream that is still decades or even centuries away. In entomology we are still building that foundation, and are highly dependent on insect collecting to do so.

Why is it necessary to collect insects?

Taxonomy: Insect collections are a critical building block to almost all other aspects of entomology (Danks 1991, Wiggins *et al.* 1991). A basic field of entomological research that is heavily dependent on collections is taxonomy – the discovery and description of new species. To describe and name a new species, a “type specimen,” and ideally a “type series,” must be designated and safeguarded so that future work-

ers can re-examine the organism in detail. These types are the basis of our nomenclature and are required for a stable system of names. Insect collections are the repository for existing type material, as well as the source for future types. It is not an exaggeration to say that taxonomists make just as many exciting discoveries among historical specimens in collections as they make in the field. The accumulation of unidentified specimens, as long as they are properly labeled, is exactly the substrate from which crucial new discoveries are made. The existence of a whole new insect order, the Mantophasmatoidea, was discovered recently among old museum specimens obtained years earlier in the course of general collecting (Klass *et al.* 2002). It may not seem valuable to an observer or even a collector at the time, but well labeled and curated specimens of all but the most common species are a useful addition to any collection.

Diagnostics: Getting a correct identification on a sample is important in scientific research and in pest management. An incorrect species determination can result in spurious research results, in costly and needless application of pesticides being applied in error to a non-pest species, or in failing to detect a new outbreak in the early stages.

Because of the aforementioned challenges of diversity, small size, and lack of published identification guides, insects are difficult to identify. Thus synoptic insect collections are an essential tool for making identifications. Where comprehensive guidebooks do not exist, entomologists examine specimens that have been authoritatively identified in the past, and exchange information and specimens with researchers in other collections. As entomologists encounter new species, they add these to the collection, which becomes an ever-expanding “identification guide” to the insects of a given region.

Vouchers: Because nomenclature changes over time as we discover new species and refine our understanding of existing species, it is very important, in all entomological research, to collect and save vouchers of the species being studied (Huber 1998, Wheeler 2003). Over time, if

our understanding and definition of a particular species changes, we can go back and re-examine the vouchers from past research and determine the current identity of the organisms being studied, and thus ensure the ongoing scientific value of the work. For example, the symbiotic relationship between yuccas and yucca moths has been the subject of many studies over the past century. Before Pellmyr (1999), all these pollinator moths were thought to be a single widespread species, *Tegeticula yuccasella*. It is now recognised that yucca moths are in fact a complex of 13 very similar species with different natural history, identifiable only via microscopical examination. Any previous research on yucca moths is of questionable value, unless voucher specimens were kept so it can now be determined which species was really the subject of the research.

A voucher collection is also very important in the legal realm, to stand as proof that a particular species existed at a particular time and place. This can be very important information when a corporation fights against environmental restriction on resource development. Vouchers are also important when legal action or trade sanctions are pursued over exotic pest issues; they can prove what was intercepted in a shipment, and whether or not a species occurred in an area at a given time.

Inventory and biodiversity work: Insects are also collected to do inventory work – to fully understand which species live in a given area, and what the range and habitat associations of a given species are. Such information on many species forms the basis of biodiversity information. By sampling and identifying the insects that live at a given location, researchers measure the composition and diversity of the insect community there. They can then use the insect community as a tool to assess the relative “ecological health” of the area, and compare it to other areas – this allows us to identify biodiversity hotspots, to determine which areas should be set aside for protection, and to assess whether existing areas adequately protect biodiversity. Researchers also use this biodiversity information to measure the environmental effects of

human activities such as agriculture, mining, forestry, and urbanization on the environment.

To carry out biodiversity work, researchers choose an appropriate target group (for example moths, ground beetles, or aquatic larvae) and then deploy traps that catch these particular insects in a standardised, repeatable manner. By its very nature, this work requires broad sampling of many individuals of an insect community, to generate the data that will lead us to more sustainable land use decisions and, ultimately, to more protection for all wildlife.

Existing insect collections can also be a useful source of baseline environmental data in biodiversity research. Each specimen represents proof of the historical occurrence of a species at a particular place and time. This information allows us to retroactively track the arrival and extinction of various species, and forms a baseline for the study of the effects of human disturbance and climate change.

Pest management: Pest control in agriculture, forestry, and human health obviously accounts for the deaths of billions of harmful insects, but many beneficial insects are killed in pest control operations as well. Some pest monitoring work, which is vital to the protection of our agricultural and forest products and our health, involves the unavoidable collection of beneficial insects. Monitoring programs for exotic forest pests depend on traps that broadly sample insects, and collect beneficial as well as harmful species. Likewise, mosquito traps for monitoring West Nile Virus carriers inevitably collect non-pest species as well. However, this supposed “bycatch” does not have to be wasted; when examined it often yields new species records, including unexpected introduced pests. For example, the first detection in Alberta of the exotic shot-hole borer (*Scolytus rugulosus*; a pest of fruit trees) came from the “bycatch” in traps deployed to monitor elm bark beetles (Pohl *et al.* 2007).

Education and training: An insect collection is a wonderful tool to open people’s eyes to the beauty and wonder of the natural world before them. Entomologists who regularly bring col-



The author, Greg Pohl, gives a presentation about insects to high school students in Fort McMurray, AB. (photograph by R. Walters, Timberlea Public School)

lections to schools will attest to the sense of excitement and wonder they bring to the students. The building of an insect collection is a valuable training tool as well – there is no better way to get to know the species in an area than to make an insect collection. Every expert identifier of insects that I know in western Canada developed and continues to develop his/her expertise by building and maintaining an insect collection.

DNA: Another use of old specimens that may not have been imagined by the original collectors is the extraction and analysis of DNA from them. With modern techniques, it is now possible to take a single leg from a specimen up to several decades old, and extract and sequence DNA from it (Meusnier *et al.* 2008). This is an incredibly powerful tool that allows researchers to check identifications, discern species relationships, and study changes in the genetic make-up of populations over time. Old specimens can also yield parasites and phoretic mites, and plant and fungus spores, helping us

make ecological associations. Thus, specimens from inventory and biodiversity work, voucher collections and “bycatch” from pest monitoring programs, all continue to provide valuable information. Who knows what uses we will find for insect collections in the future?

Amateurs versus professionals

The argument for allowing professional researchers to collect insects is clear, but collecting by amateurs is at least as important (Miller 1986). The distinction between “amateur” and “professional” is largely artificial. Just about everyone involved in entomology was drawn to the field by a love of the subject. We are all passionate about what we do, but some of us are lucky enough to get paid for it, while others do it on their own time at their own expense. The quality of the resulting information often has nothing to do with whether or not the researcher got paid to do the work. Some of the most knowledgeable people in entomology are folks who are self-taught, and carry out their avocation in their spare time. This is especially true in taxonomy, where all one needs to do excellent work is a microscope, access to specimens, and an aptitude for the subject. In this era of “fiscal restraint,” governments provide little support for basic taxonomic research. Thus the discovery and inventory of non-pest species is largely left to those who do it for the love of it. The majority of the data points on our species distribution maps have likely been obtained by amateurs.

Another role of amateurs is that they are often our future experts, as noted above. The young people who might be casual hobby collectors today are the world-class experts of tomorrow. Not every “hobby collector” becomes a world-class taxonomist, but there is no doubt that virtually every world-class taxonomist started out as a “hobby collector.” If we discourage the casual collectors, we will have no experts in the future. I am especially concerned that undue restrictions placed on insect collecting would effectively relegate it to the “paid professionals” only. I cannot overstate the importance of amateurs to entomological

science and conservation – if we limit collecting to ill-defined “serious researchers” only, we will lose a huge resource of valuable specimens, information, and expertise.

Insect Conservation

Resource managers are beginning to recognise the importance of insect conservation (New *et al.* 1995; New 2004), but we cannot protect species that we do not know well. Many entomologists (including myself) sit on conservation boards such as the Arthropod Specialists Subcommittee of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and Alberta’s Endangered Species Conservation Committee. These are the bodies that assess species and make recommendations for protective legislation for them. The kind of information required to get protection for a species is derived from data from specimens in insect collections, most of which were collected by amateurs. Other than perhaps for the Monarch butterfly, there would be no formal protection of any insect species in Canada, if it were not for the work of amateur insect collectors.

Insects are also making a major contribution to the conservation of vertebrates and their habitats. An example of this is the yucca habitat in southeastern Alberta. The plant is already listed as Threatened federally and endangered provincially. However, three moths and one skipper butterfly, all obligate yucca associates, have also been or are in the process of being evaluated (Committee on the Status of Endangered Wildlife in Canada 2009). The addition of these four insects to the endangered species list will lend much greater voice to the protection of this unique community in southeastern Alberta. The same is true for dune habitats – several moths that are restricted to dunes (*Copablepharon grandis*, *Melaporphyria immortua*, *Schinia avemensis*, and *S. verna*) are in the process of being assessed nationally and provincially, based on work carried out by several amateurs (Committee on the Status of Endangered Wildlife in Canada 2009, Alberta’s Endangered Species Conservation Committee 2009). Listing of these species as threatened or

endangered will help provide protection for all the animals and plants living in dune habitats. These insects can only be assessed if they are well known taxonomically, and their range and population levels are well enough known. All that information can only be gathered accurately by killing and collecting insect specimens, so it remains necessary to kill some insects, in order to protect the rest.

Collecting and Endangered Species: As detailed by Pyle (1992), insect collectors are a very minor mortality factor for insects, and their efforts generally do far more good than harm. The Lepidopterists’ Society has developed a well-considered position on insect collecting (The Lepidopterists’ Society 1996). Of all the insects listed as threatened or endangered in Canada by COSEWIC, not one of the species assessments lists insect collecting as a significant threat (Committee on the Status of Endangered Wildlife in Canada 2009). In fact, without the work of collectors, we would not have had the background information required to measure their populations accurately enough to make such assessments in the first place. Once these species are recognized as threatened or endangered and protected by legislation, it becomes illegal to collect them on crown lands, and it is illegal to collect them or any other spe-



A boy hunts for bugs in the badlands of Alberta.
(photograph by G.R. Pohl)

cies in provincial or national parks and protected areas without a research permit. This is adequate protection for these threatened species from overzealous collectors. For the vast majority of insects that are not yet well enough known to make accurate assessments of their rarity, we need MORE collecting, not less, in order to gather that information.

Conclusion

In the recent campaign against “bug collecting” that I mentioned earlier, a society of local entomologists (The Alberta Lepidopterists’ Guild) decided to engage with naturalist groups in a constructive way, by joining the Federation of Alberta Naturalists (FAN), an umbrella group of local naturalists’ groups, including the group that had launched the anti-collecting campaign. I think that we have effectively communicated what entomologists do, and we are working with FAN to draw up a specimen collecting policy. The Alberta Lepidopterists’ Guild has also been drawn into a local fight over proposed gas well drilling in the Suffield National Wildlife Area in southern Alberta and we have been providing well-documented scientific information on rare and little-known insects there, which appears to have been instrumental in putting a halt to the proposed drilling. Time will tell, but so far this has been a mutually beneficial collaboration, resulting in a much greater understanding of “bug collecting” and entomology among the local naturalist community, and a greater contribution by scientists to specific habitat protection initiatives.

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The COSEWIC Arthropod Specialist Subcommittee visits Norman Criddle's historic entomology laboratory at Aweme, MB.

(L-R): Gloria Goulet, Gary Anweiler, Ron Hooper, Donna Hurlburt, Laurence Packer, Rob Roughley, Jean-Francois Landry (with net), Ross Layberry, Herni Goulet, Greg Pohl, Donna Giberson, Rob Cannings, Colin Jones, Paul Catling (kneeling), Robb Bennett, and Dan Johnson. (Photograph by Brenda Kostiuk)