Wider aspects of a career in entomology. 5. Spring to fall research in Canada

Hugh V. Danks

This series of articles outlines some ancillary aspects of my entomological career, for the potential amusement of readers. It reports the sometimes unexpected challenges of working in new places and in the real world, an approach that serves also to expose some conclusions about research activities and some information about insects and their environments.

My work at the Entomology Research Institute in Ottawa on the cold-hardiness of larvae of chironomid midges (introduced by the winter and arctic themes of previous articles in this series [ESC *Bulletin* **50**: 25, 50, 115, 173]) was extended into warmer seasons by exploring other parts of the life cycle. I studied shallow pond habitats, similar to the cattle ponds shown in Figure 1 and the natural ponds shown in Figure 2. Later, comparable habitats near St. Catharines, Ontario, were investigated.

Studied in most detail were species in a pond that had been sampled extensively during the Ottawa winter while the surface was frozen (illustrated in *ESC Bulletin* **50**: 51). Relatively little previous work had been done in such small pond habitats at any time of year. Indeed, the commonest species

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Figure 1. Shallow cattle ponds near Ottawa, representative of habitats sampled during the research noted here.

Hugh Danks (hughdanks@yahoo.ca) retired in 2007 after many years as head of the Biological Survey of Canada. In that role, he helped to coordinate work on the composition and characteristics of the arthropod fauna of the country, and to summarize the results. In addition, his research studied cold-hardiness, diapause, and other adaptations to seasonality in northern regions.


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Figure 2. Natural ponds near Ottawa, similar to those sampled during research.

there, which was my main focus, even required taxonomic description so that the ecological and other work could be referenced. This finding emphasizes the fact, visible more widely, that many components of the Canadian fauna are not well known.

The substrate of the pond was composed of very fine muck, making it difficult to sort. Therefore, an initial challenge was how to separate chironomid larvae from the millions of tiny substrate particles. This sorting was done by flotation with sugar solution: concentrated solutions of sugar are so dense that they cause insect larvae to float to the surface. I was anxious to learn what the habitat would yield, because it had been chosen in the hope that larvae were abundant. I stirred the first sample into the solution and waited briefly as the mixture swirled. Suddenly, dozens of larvae burst to the surface and lashed about, confirming the abundance of material in the pond.

During summer, some of the smallest particles were first removed by sieving each sample through a net of very fine mesh. It was not practicable to process an adequate number of samples without this step, although many first-instar and some second-instar larvae were also removed. Many research decisions require compromises of this sort: in this instance, a comprehensive assessment of spatial and temporal variation in larger larvae was more important than retaining every small larva.

Substantial amounts of sugar are needed for flotation (cf. Figure 3). Granulated sugar is a relatively harmless laboratory substance, but the strong solution used for sorting sometimes proved troublesome. For example, an unnoticed spill that had not been cleaned promptly off the floor turned into something resembling a huge sticky-trap, entangling the feet of unsuspecting pedestrians, including me, on more than one occasion. Once, I failed

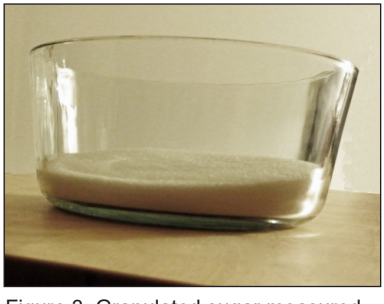
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Figure 3. Granulated sugar measured out into a dish to make a solution for sorting chironomid larvae from a substrate sample by flotation (about 2 cups [475 ml]). An effective solution is obtained by adding about twice this volume of water, for a specific gravity of 1.12.

to notice that some solution had spilled on to my pants. Those particular pants could not be washed because they were made of wool, and so in due course were dry cleaned. When I went to pick them up, the dry cleaner took great pride in regaling me with the story of how he had fought valiantly to get the garment spotlessly clean, trying multiple techniques to remove one especially stubborn stain. Finally, he had succeeded—using hot water. I thought it politic to congratulate him on his expert work without mentioning my use of sugar solution.

The pond bottom was sampled with a brass corer. A soft rubber cap was applied before the corer was withdrawn, sealing the top end to limit disturbance of the substrate. The lower end was sealed with a styrofoam plug before the corer was lifted from the water. This procedure not only prevented loss of any of the sample, but also allowed each core to be pushed out in sections, so that larvae in the surface layers could be distinguished from those located more deeply. In the winter, when the pond was covered by ice, the corer had been carefully applied to the substrate by hand to ensure that samples were undisturbed and accurately confined to layers that might be inhabited. In summer, extensive growth of the alga *Chara* in the pond made similar precise sampling very difficult and time-consuming, but this extra effort was necessary to capitalize on the winter work. It is always essential to concentrate during research to ensure that procedures are optimized and followed closely—avoiding any lapse into a robotic state induced by repetitive chores.

Emergence traps were deployed to monitor adults (Figure 4). I also visited the pond at dusk during the period of adult activity to observe oviposition and to catch some females, which readily laid egg-batches in the laboratory. There is no substitute for observations of living insects in the field to understand the species under study. Field observations are therapeutic too, because the excitement of watching insects in nature helps to compensate for the heavy burden of chores required in research. In fact, because worthwhile data depend on these chores, researchers use their full knowledge and training only a small fraction of the time.

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Figure 4. Floating emergence traps on the main study pond in Ottawa, 1970.

A useful technique for associating the larvae and pupae of chironomids with their adult stages (favouring identification) is to place individual larvae that have finished feeding into vials with a little water. These larvae can be recognized because the thorax is slightly swollen prior to pupation. Daily checks reveal if any adults have emerged. Larvae in that stage were so easy to find in the spring that I was tempted into setting up too many vials, adding another seemingly endless commitment of daily checking to the burden of research-related chores.

The reward for these labours became apparent later, however. Studying several species in the same pond showed that each one had its own characteristic seasonality, preferred water depth, and other features. Studying many components of the life cycle of a single species revealed interesting patterns and linkages in seasonal timing, larval distribution, population size, and other elements, few of them fully documented for any species.

That particular species had only one generation per year, and adult emergence was strikingly synchronized in spring. Females could produce more than one egg mass. More larvae occupied central than peripheral areas, although there was some movement in response to seasonal changes in depth. Larvae penetrated into deeper substrate layers and curtailed development not only during the cold winter but also in late summer. Many winter larvae made special sealed winter cocoons that were very different from the summer cases. Apparently, these cocoons protected larvae from mechanical injury by surrounding ice, and were not made until the water temperature fell close to the freezing point.

From this pond, which occupied only 800 square metres at the spring maximum (and much less after the summer), at least 145,000 adults of this species emerged during a period of only one week, although more than 9 million larvae inhabited it in the third instar. However, there were substantial year-to-year differences in the population levels and in the instars reached before winter, although development continued into November after the late summer lull.

These findings reinforce the lesson that a great deal of detailed information is required to understand the natural history even of a single species. The need for proper detail is underappreciated, in entomology as in other fields. Emphasis has often been placed instead on deriving some kind of index to interpret the world with minimal effort, and without any need for comprehensive knowledge. Most of these shortcuts have misled scientists for years until proven to be of limited application, or even worthless. By the same token, the potential for differences from year to year, and from one habitat or subhabitat to another, is not always recognized.

As summer turned to fall, I continued to monitor the larvae in the study pond after the seasonal emergence of every species had ended. On one typical day, fieldwork was scheduled to begin in the morning, leaving enough time to sort the samples in the laboratory the same day. However, as I drew close to the pond the road was suddenly lined with a large number of burly gentlemen, standing near well-used pickup trucks, wearing camouflage vests, and carrying rifles. The deer-hunting season had begun[1]. Some hunters identify their quarry with insufficient care before shooting, making simultaneous occupation of hunting areas hazardous. I decided that sampling was not so urgent after all! Several hours later, the hunters had gone and it was possible to complete the sampling.

Typical study ponds had shallow basins, but one habitat in St. Catharines was larger and deeper than the rest. Therefore, an old canoe was left beside it to use during sampling. The pond was on private property and out of sight of the road, but even so someone took a ride in the canoe, and in addition amused themselves by sinking the emergence traps after removing the floats. Fortunately, because the water was only a few metres deep, an Ekman dredge could be used as a grab to recover the traps, though not the sampled adults. Many of my research projects over the

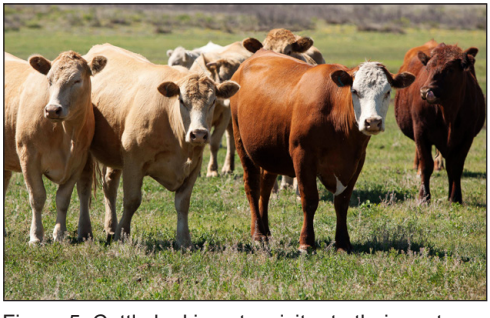
[1] Hunter orange was not required in Ontario until 1997.

years have suffered disruptions, usually much more significant than this one, delivering the message that it is unwise to promise results too early in a project.

That pond in St. Catharines was unusually exposed, and so the traps were difficult to empty when it was raining hard. The heaviest rain often seemed to start just as sampling was scheduled—one component of Murphy's Law of Fieldwork! The impact of the rain was doubled when the wind was strong, and windy conditions also made it difficult to control the canoe single-handed whilst emptying emergence traps or taking bottom samples.

Fortunately, I had gained a good deal of paddling practice during a previous summer as part of a project to sample a number of large lakes near Ottawa. On those occasions, my small car transported a heavy fibreglass freight canoe, which was large enough to carry the two summer students who accompanied me. One evening, as I drove back towards Ottawa, three deer leapt out of the woods just in front of us. At that time, it was not unusual to see a mattress, a sheet of plywood, or a piece of siding hand-held on to the roof of a car, from which a gust of wind or a sudden manoeuvre might launch the item from its platform to sail away into adjacent traffic like a giant Frisbee. However, the canoe was properly secured and did not move during our abrupt emergency stop, serving as a reminder that safe procedures are important throughout research work, not just during the sampling itself (including the life-jackets that were mandatory in this project).

Cattle ponds, such as those shown in Figure 1, provided water to the stock. In turn, nutrient-rich deposits contributed by the animals made the ponds highly eutrophic, supporting substantial populations of chironomids. Cattle were sometimes present during sampling (cf. Figure 5). I was not always convinced that they were only curious, or that they were friendly; now and again, young bulls would make mock charges. Subsequently, I heard about an Australian stockman who, when told that this behaviour merely showed that the animals wanted to play, replied that he would play with them all right—with a crowbar!



H. Ryan (USFWS)

Figure 5. Cattle looking at a visitor to their pasture.

At one site, a calf had died after being trapped in mud exposed at the edge of the pond as the water receded during summer. I avoided further sampling from that especially muddy shore lest I meet the same fate! The dead calf was already starting to bloat, and I alerted the owners (who initially had given permission to access the property, of course). Apparently, they were not the most engaged herdsmen. "Oh yes," one of them said, "I remember we heard the cow bellowing the other day." The body was not removed until several days later.

Samples in addition to substrate cores were sometimes taken to obtain larvae for rearing and experiments. Usually I worked alone, but a technician from the Entomology Research Institute once helped me to collect qualitative samples from a pond that was well used by the local cattle. The technician seemed to wear an unusual grin as he handed me one of the many samples for labelling; and on the journey back to the laboratory he made particular reference to "Sample 4". I concluded during sorting that the sample had been drawn entirely from a submerged, recently deposited, cow pat—a subhabitat unlikely to contain insect larvae...

The abundance of larval chironomids in typical samples from ponds of this sort permitted experiments with large numbers of larvae and appropriate numbers of replicates. At St. Catharines, laboratory experiments on larval development and life-cycle control were conducted in four environmental cabinets. Inside the cabinets, sets of larvae were relatively easy to rear using a shallow depth of water in petri dishes and a diet based on dry dog treats. Each cabinet was labelled with the respective conditions of temperature and photoperiod to which the larvae were exposed, such as 25°C/16L:8D.

I shared that laboratory with another faculty member. In his area at the other end of the room he had several constant-temperature cabinets too, but he had labelled the doors with human forenames, including "Percy" (for the manufacturer Percival) and others far too clever for me to remember now. Almost every time we met, he asked me when I was going to label my own units. Eventually, I mentioned to him while we were in another part of the building that individual designations had indeed been applied to my cabinets. He rushed away to see them: the labels read A, B, C, and D.

Recently, I revisited some of my sites near Ottawa that were examined about 50 years ago. All of the ponds that had received more than preliminary study were now modified beyond recognition or destroyed by housing and other developments, as the population of the city and its surroundings grew from about 580,000 people to nearly 1.4 million.

Many other changes took place in Ottawa over the same period. Several of them have links to entomology. For example, nearly all of the city's large elm trees succumbed to bark-beetle-transmitted Dutch elm disease in the 1970s and 1980s, including more than 100,000 on public property. In particular, a striking tree tunnel of magnificent elms along the National Capital Commission driveway through the Central Experimental Farm was gradually destroyed, and the replacement trees are still much smaller than the original graceful giants.

The aspect of many suburban roads lined by mature trees has also been markedly impoverished over the past few years because numerous tall ash trees killed by the emerald ash borer had to be removed, a task lasting several years because about 140,000 publicly owned trees were affected in these and other locations. This tally included ash trees that had been planted to replace some of the missing elms.

Finally, my more recent appearance differs somewhat from the way I looked during my early projects in the city (Figure 6)!

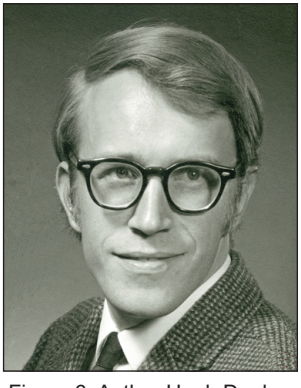


Figure 6. Author Hugh Danks in Ottawa during 1971.