Wider aspects of a career in entomology.
2. A winter project

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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 research at the Entomology Research Institute in Ottawa, starting in the late 1960s, focussed mainly on the cold hardiness of insects in small ponds, where severe winter conditions would be expected. Insect larvae should be easy to find in these shallow aquatic habitats, in contrast to my initial attempts to sample terrestrial insects overwintering above the snow under the bark of dead trees (see the previous article in this series [ESC *Bulletin* **50**: 25)]. As I began the study, local entomologists told me that the project would certainly be rewarding, because the small ponds in the region would be frozen and would contain abundant insects. The mean daily temperature in Ottawa for the 3 months of midwinter was about −10°C. Obviously, they said, all of these habitats will soon be converted to ice until the spring thaw.

It then took me nearly 3 months to find a suitable habitat that was solidly frozen, and not only because the difficulty had been increased that year by unusually early snow cover. This discovery brought a lesson about research: in the absence of first-hand information, even knowledgeable and competent people might be wrong about the adaptations of insects and the conditions they experience.

Actual examination and monitoring of sample habitats showed that three factors were chiefly responsible for these erroneous expectations. First, snow lying above the ice on a pond (as shown in Fig. 1a) provided even more effective insulation than expected, especially in sheltered habitats where snow accumulated. The large amount of air trapped between the snowflakes made for excellent insulation, even more so when the snow was light and fluffy. Second, the habitat did not cool steadily throughout the winter towards air temperatures that were always lower. Rather, there was equilibrium between the cold air above the insulating snow and the heat trapped in the earth below, so that habitat temperatures rose again whenever the air temperature was not extremely low. A third factor reducing the impact of winter temperatures on the fauna was the seasonal pattern of temperature and precipitation. Evaporation was reduced by cool temperatures in the fall at the same time as heavy rains refilled the ponds well beyond the edges of their smaller areas during the hot, dry summer (see Fig. 1b). Few organisms moved back before winter to the summer-dry edges. These three factors meant that most insect habitats were not completely

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Fig. 1a. Winter snow on one of the ponds studied in Ottawa.

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Fig. 1b. The same pond at its lowest level in late summer, showing the summer-dry edge.

frozen despite the cool-temperate climate. In reality, the insects overwintering there experienced patterns of winter temperature that were much less severe than anyone predicted, and relatively few habitats were exposed to temperatures below freezing. Greater exposure would only be likely in regions with less snow and colder winters, particularly in windswept ponds with more limited snow cover.

Sampling insects in winter posed several challenges, because even ponds that remained largely unfrozen were sealed beneath a covering of many centimetres of ice and a considerable depth of snow. Therefore, snow was first shovelled off, a job producing some perspiration. A steel ice chisel (Fig. 2) was then used to open a hole in the ice for sampling, a job producing more perspiration (a manual auger proved less effective, and a powered auger too heavy to carry regularly in the field). Finally, core samples were taken from the substrate, a cold job made even colder as the perspiration just generated cooled down. Moreover, samples from these shallow ponds were most accurate when the corer could be applied directly to the substrate by reaching down through the ice into the cold water below it. Arm-length rubber gloves helped to protect hands and arms, but gloves that were thick or lined, although warm, were unmanageable for sampling. Thin ones without insulation were required to deploy the sampler effectively, but were colder to use and froze up stiffly whenever they were withdrawn from the water.

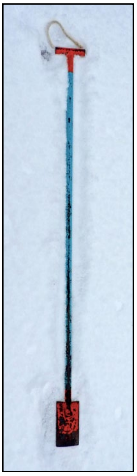

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Fig. 2. The ice chisel used for winter sampling in 1969 (total length 135 cm).

Some of the apparatus available in those days to assess the cold hardiness of chironomid larvae from these samples was more primitive than devices developed subsequently. Many techniques for scientific study have improved markedly over a relatively short period. Although walk-in freezers in the Institute could be used to determine rates of survival by exposing sets of larvae to subfreezing temperatures of different severity and duration, other experiments depended on more specialized equipment. For example, the Engineering Research Service of the Department of Agriculture worked with me to develop an apparatus to measure supercooling points, thereby allowing the temperatures at which individual larvae froze to be discovered, as well as whether they could survive the resulting formation of internal ice. The chamber that held the test insect was cooled by liquid nitrogen carried through insulated pipes from a giant tank, an extraordinarily inelegant device by modern standards (Fig. 3). Although the improvements in this arena have not been as dramatic as in some other fields, they bring a similar lesson: technology becomes obsolete faster than good scientific ideas do. Consequently, exclusive reliance on a given technique is unwise. Indeed, not many years ago a graduate student might invest most of the time

Fig. 3. An apparatus built in 1969 to measure insect supercooling points, and operated by liquid nitrogen.

during several years of research in documenting an appropriate number of DNA sequences, a task that can now be done with an automated machine in less than one afternoon.

Sophisticated equipment is not always best. On occasion in Ottawa, sampling could begin only after a very simple tool had been used to allow the driver of the field vehicle to see the road ahead—snow or ice had to be cleared from the windows with a snow-brush or ice-scraper! In later years, diverse types of snow brushes appeared on the market. A few of them were especially compact; one was even embellished with faux fur. Most were unbelievably large, rigid or extensible, made of exceptionally strong materials, with broad scraper blades, and with brushes that could be rotated. However, these large, complex, and expensive tools were cumbersome and generally less useful than the original format I had used: a hardwood stick with a simple brush at one end and a small plastic blade at the other. At first, I wondered why the smooth blade was relatively narrow, and why its back edge bore a number of teeth (Fig. 4). Even when snow had melted and refrozen on to a windshield (heated while the vehicle was being driven), the ice did not pose much of a challenge to the scraper; nor did a thin coating of freezing rain. However, the situation changed dramatically when a substantial amount of freezing rain fell—typically at an air temperature just below freezing—followed by a rapid decrease in temperature as a frigid air mass moved in. Such an event turned the frozen rain into a rock-hard coating that defied removal (Fig. 5). The toothed side of the blade was essential to give the user a chance of penetrating the coating of ice in order to break it up. The narrow blade and long handle allowed the necessary substantial pressure to be applied, but it was advisable to carry a spare unit in case the first one broke. In the most difficult circumstances, it would take a very long time to clear glass surfaces to provide an adequate view of the road for driving. Sometimes, for example, the temperature dropped well below

Fig. 4. A simple automobile snow-brush, showing the toothed side of the ice-scraper blade (total length 64 cm).

Fig. 5. Freezing rain on the window of a car.

−10°C overnight after several millimetres of freezing rain had fallen. In the morning, as everyone prepared to set off for work and fought to remove ice from the windshields of cars that had been parked out of doors, the air was filled all over the city with multiple loud, harsh scraping sounds, like the erratic stridulation of dozens of giant grasshoppers.

In the ponds under study, temperatures were recorded throughout the winter. Knowing these conditions helped to interpret the results of laboratory experiments on the cold-hardiness of chironomid larvae. The temperatures in several ponds could be measured manually during frequent visits, but continuous automatic records from one such pond were also required for comparison. However, no compact data loggers or computer units had yet been developed that could be left unattended for long periods or could transmit results to off-site monitors. Rather, a dozen long grey wires ran from temperature sensors (thermistors) in various relevant subhabitats to a waterproof box containing a machine with a drum that rotated to record the tracings of multiple pens, programmed to strike a chart of specially treated pressure-sensitive paper at frequent intervals. Considerable power was needed to run this machine for long periods; one or two car batteries were kept beside it and had to be replaced at intervals. Snowshoes were essential to drag the heavy sled carrying the batteries into the remote location chosen for study. Nevertheless, this machine supported many more sensors and was much more compact than its laboratory equivalent (which is shown on the right hand side of Fig. 3). The manufacturer described it somewhat optimistically as a “portable thermograph”.

On a midwinter day I was in a location outside Ottawa at one of my study ponds, checking the thermograph and changing its paper chart, when the silence was broken by what sounded like the loud inhalations and exhalations of a very distressed cow struggling towards me. An RCMP officer soon appeared, red-faced and sucking in air with great effort as he walked through the deep snow in ordinary boots, sinking in to well above his knees at each step. He seemed to be close to exhaustion, as he pulled each leg out again with considerable difficulty and a gasp for breath. I got the impression that he might soon pass out. Clearly, he had seen my car parked by the side of the road and had followed my snowshoe tracks into the woods for several hundred metres, pursuing someone presumed to be up to no good. Had he found such a person, it is unclear how the miscreant could have been apprehended. Gulping in breaths and barely coherent, he stopped and asked what I was doing. I explained my experiment briefly, and also noted that he was standing near the location of some of my sensors beneath the snow, which was not desirable. “I’m terribly sorry, sir”, he panted, turned around, and set off the way he had come, continuing to wheeze painfully as he floundered slowly back along his conspicuous trail to the road. He must have survived the double journey, however, because his vehicle had gone by the time I returned to my car.

When spring was foreshadowed and snow was starting to melt but still covered the ground, some cold-hardy adult insects appeared. Terrestrial species gain access to the snow surface especially around the bases of deciduous trees where snow melts around trunks warmed by the sun (Fig. 6). Insects difficult to collect at other times, such as snow scorpionflies (Boreidae), can be found on the snow in late winter. At the same time, adults of several species of chironomid midges emerge from the water. They can come up even through cracks in the ice, for example, and are active at very low temperatures. I went into the field in March to


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Fig. 6. The base of a tree in late winter, with the snow receding around it especially on the sunny south side.

look for these midges with Don Oliver, a chironomid taxonomist who worked at the Entomology Research Institute, and who had assisted in identification of the species I had sampled from ponds during the winter. Don knew of some likely habitats in nearby Gatineau Park, and so we set off along the park trails. These lengthy trails were used mainly by cross-country skiers, and would be ruined by anyone walking in boots. Because I could not yet ski, I wore snowshoes. Don used his skis. I would walk on for many paces, while similar progress by my companion required only that he slide forward after a single stride, assisted by a push with a ski pole. He spent most of his time at rest between slides waiting for me to catch up. Despite the amount of practice in snowshoeing that I had accrued by then, it was a challenge to trudge non-stop for many kilometres while we looked for the habitats and their midges. As Don claimed repeatedly that the habitats he remembered must be just around the next corner, I began to harbour the suspicion that he was not trying to find them but was giving me exercise instead! Some people might consider this punishment to be the result of karma generated by the exhausting trek of the RCMP officer earlier in the year.

A number of years later, I discovered that the same experimental site visited by the officer had been "tidied up" as part of a park and its trails, eliminating the pond. This trend continued, so that still later, when I needed photographs to illustrate a presentation on winter environments and insect cold hardiness, suitable places were hard to find. Moreover, many images were spoiled by highly visible and intrusive man-made features, ranging from water-containment structures to distant apartment buildings (as exemplified in Fig. 7a). Fortunately, by then—in the absence of any general trend to reduce the footprint of humans on the environment—the introduction of digital photography and the advance of software such as Photoshop had made it feasible to remove these distracting elements from the final images (compare Fig. 7b).

Fig. 7a. Ice along the edge of an island in the Ottawa River, with buildings in the background.

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Fig. 7b. The same photograph modified to remove the buildings.