CANADIAN PERSPECTIVES: THE ARCTIC LIFE-ZONE[1]

Two and a half million square kilometres of northern Canada, or more than a quarter of the total area of the country, are treeless, making arctic regions one of the most characteristic life-zones in Canada.

The major features of the arctic as an environment for insects stem from climatic constraints, notably the long cold winters and short cool summers. Moreover, year-to-year variations in summer weather while temperatures are close to the limits of development and activity make the suitability of each season relatively unpredictable. The low and often discontinuous vegetation (comprised in the high arctic especially of perennial, dwarfed and often clump-forming herbs) allows winds to blow unhindered over the terrain, which in many areas is relatively flat and rounded from glacial action. Conditions above the ground are therefore unsuitable for insect activity on many days even during summer in the far north.

Most of the arctic, especially in the northeast, is also arid; precipitation is so low at higher latitudes that the region is a polar desert, further constraining the vegetation and limiting relatively rich habitats to certain lowlands well supplied with water, which comprise only a few percent of the total land area.

Not surprisingly, the arthropod fauna of arctic North America is impoverished. Only about two thousand species have been reported, three-quarters of them insects; most of the rest are mites. This probably represents no more than half of the actual total. The fauna of the high arctic (the Queen Elizabeth Islands) is smaller still, and no more than three hundred and fifty species have been reported there, less than one percent of the corresponding total for Canada as a whole, and less than two percent of the faunas of temperate regions of comparable area.

Reductions in the fauna of the arctic are highly selective, however. For example, beetles comprise only a few percent of the high arctic insect fauna, compared with two-fifths of world species; on the other hand, flies, one-tenth of the world's total insect species, constitute at least half of arctic insects. These selective reductions continue at lower taxonomic levels. Among the flies, chironomid midges predominate. Among the muscid flies, one genus (*Spilogona*) contributes nearly half of reported arctic species.

Such patterns suggest that the arctic fauna has been rigorously selected for survival in difficult climatic conditions, and indeed many characteristics of arctic insects appear to be adaptive to short cool summers and long cold winters. For example, most species live in warm microhabitats, taking advantage of solar warming at the ground surface. Various species show also melanism, basking behaviour, activity at low temperatures, and opportunistic activity at any time of day provided only that it is warm enough. Aerial mating behaviour may be curtailed, diminishing contact with cool above-ground conditions.

The shortness of the summer is reflected by prolonged life cycles in many species, which overwinter more than once in the larval stage. Most species continue to grow and develop at lower temperatures than in temperate relatives. Adults typically emerge as early as possible in the short season, permitting reproduction to take place before winter returns. Winter conditions

[1]This life zone can be discussed in detail because the Biological Survey has recently completed a review of knowledge on arctic arthropods, as cited on p. 52.

are met by cold-hardiness, including tolerance of freezing, and selection of particular sites for overwintering. Dormancy seems to be closely controlled in some species, though by no means in all.

Some species appear to be adapted to shortage of resources of food by using a wider range of foods than in temperate relatives. At least a few species can resist temporary starvation. In some arctic biting flies the blood-feeding habit has been lost.

Genetic systems of some arctic species may be adapted to retain variability and fix genotypes, especially by parthenogenesis which is relatively more common among insects in the arctic regions.

None of these types of adaptations is unique to arthropods of the arctic, though they are more frequent and more strongly developed there than in temperate regions. However, several features such as precipitate emergence, prolonged life cycles, resistance to shortage of resources, and buffered genotypes reflect various forms of insurance against unpredictable risks, and are best developed in the high arctic.

Faunal composition and ecological adaptation are therefore closely related to the constraints of habitats and resources. Certain general food sources are prevalent, notably detritus and associated microflora, other arthropods, and vertebrates and their products. This favours particular kinds of arthropods, and most northern forms in fact are saprophages, predators, and ectoparasites of vertebrates, whereas the fraction of species that eat vascular plants is much lower than in temperate regions. These trophic features are allied with habitat characteristics: most species are confined to the relatively warm habitats of superficial soil and water - in which insolation raises temperatures - and to the skin of warm-blooded hosts.

Despite the "simplification" of arctic habitat structure and food supply, there are many cross links within the system, not only among habitats, but also between arthropods and vertebrates (through dung and carrion, ectoparasitism, and vertebrate predation), insects and flowers, insects and parasitoids, and various arthropods and their invertebrate predators. The arctic ecosystem is therefore not the simple system sometimes believed, despite the reduced numbers of species.

Many of the arctic species are widely distributed across the continent. About half of the reported species are holarctic (though the proportion differs widely from group to group), a much higher fraction than in more southern faunas. Such broad ranges correspond with the fact that there are large areas of comparable terrain in the north, separated (at least at times in the past) by less formidable barriers than lands to the south. However, a number of arctic species have more restricted ranges. Northern (and often southern) range boundaries of individual species belonging to various taxonomic and ecological groups tend to be at tree line and at the level of the northern mainland and southernmost arctic islands. There they coincide with changes in vegetation, temperature, or growing season. The northwestern high arctic is especially impoverished, lacking the butterflies, bumble bees, and mosquitoes found elsewhere, and this region has a cooler, cloudier climate than other high arctic sites. Such findings suggest that ecological influences on distribution are most important. However, east-west range limits of arctic species on the mainland most often coincide at the Mackenzie River and at Hudson Bay. These are dispersal barriers for tundra forms, suggesting historical influences on distribution.

In summary, the nature of the arctic insect fauna is known in broad outline, but many questions remain about this characteristic life-zone in Canada. Most striking about what we know is (1) the apparent correspondence of the ecological valency and taxonomic composition of the fauna with known ecological pressures; (2) the complexity of interactions among arthropods, other organisms of all sorts, and climate, in the supposedly "simple" arctic system.

Most striking about what we do not know, is (1) the lack of basic knowledge of taxonomy, distribution and variation; (2) the lack of understanding of the functioning of arctic systems except through crude measures of energy flow or diversity. This understanding would be favoured by studies that are more detailed and of longer-term than most temporary expeditions to the arctic have hitherto allowed.