REPORTS ON ANTARCTIC FIELDWORK

ADAPTATIONS OF ARTHROPODS TO THE SUB-ANTARCTIC ENVIRONMENT

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INTRODUCTION

During the 1987–1988 austral summer, an international party of terrestrial biologists worked at Husvik (54° 10′ S, 36° 43′ W) on the north-east coast of South Georgia, supported by the British Antarctic Survey. The five members of the party undertook an integrated programme of field research on the ecological and physiological adaptations of terrestrial arthropods. The location provided an opportunity to study a wider range of species, including some 'higher' insects such as Coleoptera and Diptera, than encountered further south in the maritime and continental Antarctic. Fieldwork covered aspects of both the ecology and physiology of selected species from a range of terrestrial communities. The results will contribute in particular to further the understanding of the mechanisms of the adaptations of arthropods to extreme environments and to island biology in general, and the research formed part of the British Antarctic Survey's Fellfield Ecology Research Programme. The party was in the field from 17 January through to 14 March 1988, and used the Manager's house (also known as 'the Villa') at the old whaling station of Husvik as a base. This provided living accommodation and simple laboratory facilities.

Previous entomological work at South Georgia has concentrated on systematic studies (Gressitt, 1970) with some ecological studies (Vogel and others, 1984; Vogel, 1985), and a single physiological study (Block and Sømme, 1983).

There are two main components to the adaptations of arthropods to polar conditions: firstly, their activity, metabolism, growth and development under summer conditions; and secondly, their tolerance and survival of cold, and possibly desiccation, under winter conditions. Both components were investigated as far as possible. The work divided into three main areas: ecology, physiology and microclimatology.

ECOLOGY

The insect fauna of South Georgia is remarkable with the complete absence of lepidopterans and curculionid beetles found on many other sub-Antarctic islands. Within the Coleoptera there are nine species, the main families being the ground beetles (Carabidae) and the little-known Perimylopidae, which are related to the tenebrionids. Both families are represented by two species in the South Georgian fauna. Other coleopterans include a dytiscid (an aquatic diving beetle), two staphylinids, a lathridiid and a ptinid. In the Diptera, 14 species have been recorded, ranging from a trichocerid, various sciarids, three chironomid midges to a helcomyzid

and two sphaerocerids. A single parasitic hymenopteran, a mymarid, and a thrip species complete the present faunal list.

The abundance, distribution and surface activity of all the terrestrial arthropods were investigated by the use of pitfall or Barber traps situated in a wide spectrum of terrestrial communities ranging from lowland grasslands (*Festuca contracta*) through mires (*Rostkovia–Tortula*) to alpine fellfields with little or no vegetation. A total of 44 trapping sites was used over an altitudinal range from sea level to *c.* 200 m, each with 6 pitfall traps, which were emptied three times, each after 13 days of trapping. These field samples provided a large quantity of both macro- and micro-arthropods including beetles, flies, spiders, and numerous mites and springtails. The collected material is being analysed with respect to plant cover and microclimate.

The diurnal activity patterns of six species of Coleoptera, which were abundant in the lowlands around Husvik, were examined using experimental arenas containing small pitfall traps. Continuous observations were made over 9-day periods with temperature and atmospheric humidity being recorded. All the species appeared to be nocturnal in their activity.

A comparative study was made of the ecology of the two carabid species, *Oopterus soledadinus* and *Trechisibus antarcticus*, in the Husvik area. The former species inhabits areas around the whaling station, whilst the latter is more widespread, occurring up to 200 m asl. Various features of their biology, ecology and physiology were examined in an attempt to explain their different field distributions.

Physiology

Although the ice-free mountains surrounding the Husvik area rise steeply to around 800 m asl, insects are rarely found above 300 m altitude. Such a short altitudinal gradient allowed a comparative approach to the physiology of a few selected species, e.g. the adults and larvae of the perimylopid beetles *Hydromedion sparsutum* and *Perimylops antarcticus*. An upper site was established at just under 300 m asl in an alpine fellfield with very sparse vegetation (scattered mosses and a few lichens). This was in contrast to a lowland site in a *Festuca* grassland at *c.* 20 m asl. A microclimate monitoring station was established at both sites (see below).

Two species of spiders, a larval midge (*Eretmoptera murphyi* – Diptera, Chironomidae) together with the adult and larval perimylopid beetles from both upper and lower sites, were tested for their tolerance to cold and dryness using summer and autumn acclimatized samples. Individuals were screened for the following parameters: (i) their supercooling potential, (ii) the presence of antifreezes in haemolymph samples, (iii) their survival at sub-zero temperatures, (iv) their chill and heat coma temperatures, (v) polyhydric alcohol and sugar levels in their body fluids, and (vi) their body water contents and resistance to desiccation. No significant changes were detected in any of these parameters between summer and autumn samples, but differences between species and between sites were recorded, which are being analysed in detail.

Experiments were undertaken to determine the metabolic rates of adults and larvae of both species of perimylopids at temperatures between 5 and 20° C collected from the alpine fellfield and lowland grassland sites. Engelmann capillary respirometers were used to record rates of oxygen uptake of individual insects ranging from 4 to 36 mg live weight. In addition, feeding studies were made on these species to determine food preferences and to assess the quantities of plant material consumed. Results for *P. antarcticus* and *H. sparsutum* show that the former feeds mainly on

epiphytic lichens and algae growing on rocks, whilst the latter preferred mosses, grasses and other plants from lower altitudes.

Adults of the two carabid species were also screened for selected physiological parameters, together with comparative assessments of their feeding, gut contents and resistance to cold and dryness.

Microclimatology

Microclimate monitoring stations were operated at both the upper, alpine site and the lowland, grassland site throughout the period of fieldwork at Husvik. Data were logged on Grant Squirrels (a 1200 series instrument at the lower site and a 400 series instrument at the upper site). They were downloaded in the field onto an Epson HX20 portable microcomputer and analysed at base. Environmental parameters which were recorded included air, soil and vegetation temperatures, atmospheric relative humidity and temperature in microsites under rocks inhabited by beetles, together with radiation (incoming and reflected) and wind speed. Information on the environmental conditions prevailing in the habitats of arthropods will aid the interpretation of both the ecological and physiological data from the other components of the research programme.

Attempts were made to measure the heating and cooling rates of individual adult beetles of three species exposed to ambient conditions near the base, and to develop simple thermal budgets. Fine copper-constantan thermocouples inserted into the thoracic muscles of the beetles allowed continuous records to be made of their body temperature, which were directly compared with that of the surrounding air.

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