BIOLOGICAL AND ECOLOGICAL NOTES ON *NEOHYADESIA SIGNYI* (ACARI; ASTIGMATA)

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ABSTRACT. An algophagid mite, *Neohyadesia signyi* (Acari; Astigmata), endemic to pools on Signy Island in the maritime Antarctic, was observed and collected during the austral summer 1982–83. The abundance and distribution of this species are associated with water depth, food resources and shelter. The mites survive in small coastal pools despite the fluctuating salinity caused by marine spray. Food is mainly algae, of which fragments were found together with large amounts of amorphous material, characteristic of microphytophages, in all the guts examined. Supercooling experiments demonstrated that adults of *N. signyi* freeze at *c.* −24°C, and that freezing is lethal. The results are discussed in terms of the taxonomy, ecophysiology and dispersal of *N. signyi*.

INTRODUCTION

Neohyadesia signyi was first described by Hughes and Goodman (1969) as a new genus and species. Specimens of this mite were found by B. J. A. Goodman during 1964–66 in small pools of fresh and brackish water on Signy Island in the maritime Antarctic (60°43′ S, 45°38′ W). Except for a subspecies, *Neohyadesia signyi punctulata*, from Iles Kerguelen (Fain, 1974), *Neohyadesia signyi* has been found exclusively on Signy Island. The Signy Island subspecies should properly be referred to as *Neohyadesia signyi* '*signyi*' until its taxonomic position is clarified, but throughout this paper it will be abbreviated to *N. signyi*.

Other mites of the family Algophagidae (Astigmata) are known from various parts of the world. They live in fresh and brackish water, and may be found in water-filled treeholes (Middleton and Fashing, 1983). Species from Iles Kerguelen were found in moss, phanerogams and plant litter on either wet or dry soil (Fain, 1974). Not all species feed on algae as was first suggested by the generic name (Halbert, 1915), some consuming fungi (Middleton and Fashing, 1983). The aim of this study was to provide additional information on the biology and ecology of this little-known mite, which [to] emphasize its special position in biogeographical, ecophysiological and distributional terms.

METHODS

During the austral summer 1982–83, further collections of *N. signyi* were made at Signy Island. On each of three promontories in Paal Harbour there are several pools varying from fresh to brackish water. One pool was monitored in detail on the second promontory. Samples of *c.*10 ml water containing organic detritus and algae were collected from several points in the pool (Fig. 1) and on different dates. Specimens of *N. signyi* in these samples were identified to instar and counted. A number of individuals were maintained alive at 5°C and transported at this temperature to the British Antarctic Survey laboratories at Cambridge. Their individual supercooling points (SCP) were measured using the method of Schenker (1983) and a cooling rate

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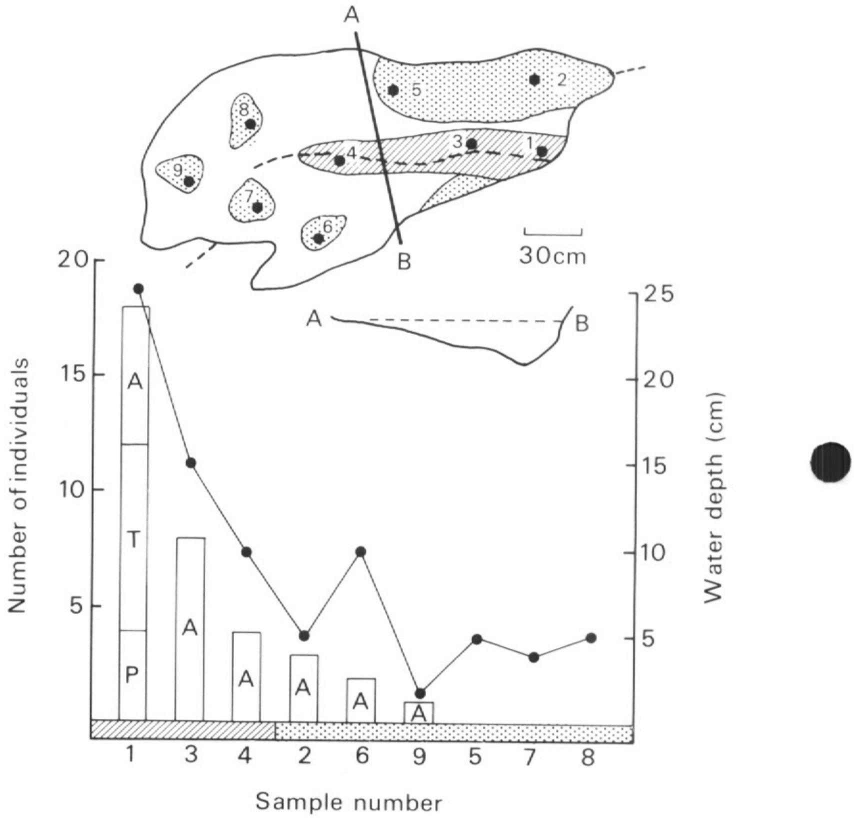

Fig. 1. Abundance and distribution of *Neohyadesia signyi* in a pool at Paal Harbour, Signy Island in relation to water depth and food resources. Samples are grouped according to abundance. Cross hatching indicates a thick organic detritus layer with semi-decayed plant material and algae, and stipple shows the thin organic detritus layer with algal growth. ●: sampling points (upper part), water depth (lower part); P: Protonymphs, D: Deutonymphs; Tritonymphs; A: Adults; A–B: depth transect.

of 1 deg min^{-1}. Before the mites were attached to the thermocouple, excess moisture was removed by replacing them briefly on filter paper.

Scanning electron microscope photographs of the mites were taken at the Laboratorium für Raster-Elektronenmikroskopie, Geologisch-Paläontologisches Institut der Universität Basel, with a Cambridge Stereoscan S 2 A instrument. The specimens were prepared by dehydrating in alcohol and dried by the critical point procedure before being coated with gold in a vacuum evaporator.

For gut content analysis, animals were squashed between a microscope slide and a cover slip using gentle pressure. The composition of food pellets in the gut was then identified by using a high power light microscope at magnifications up to ×400.

Results and Discussion

Abundance, distribution and food

The pools were visited regularly and checked for *N. signyi* starting on 21 December 1982. It was found there for the first time on 16 January 1983. On 19 February the

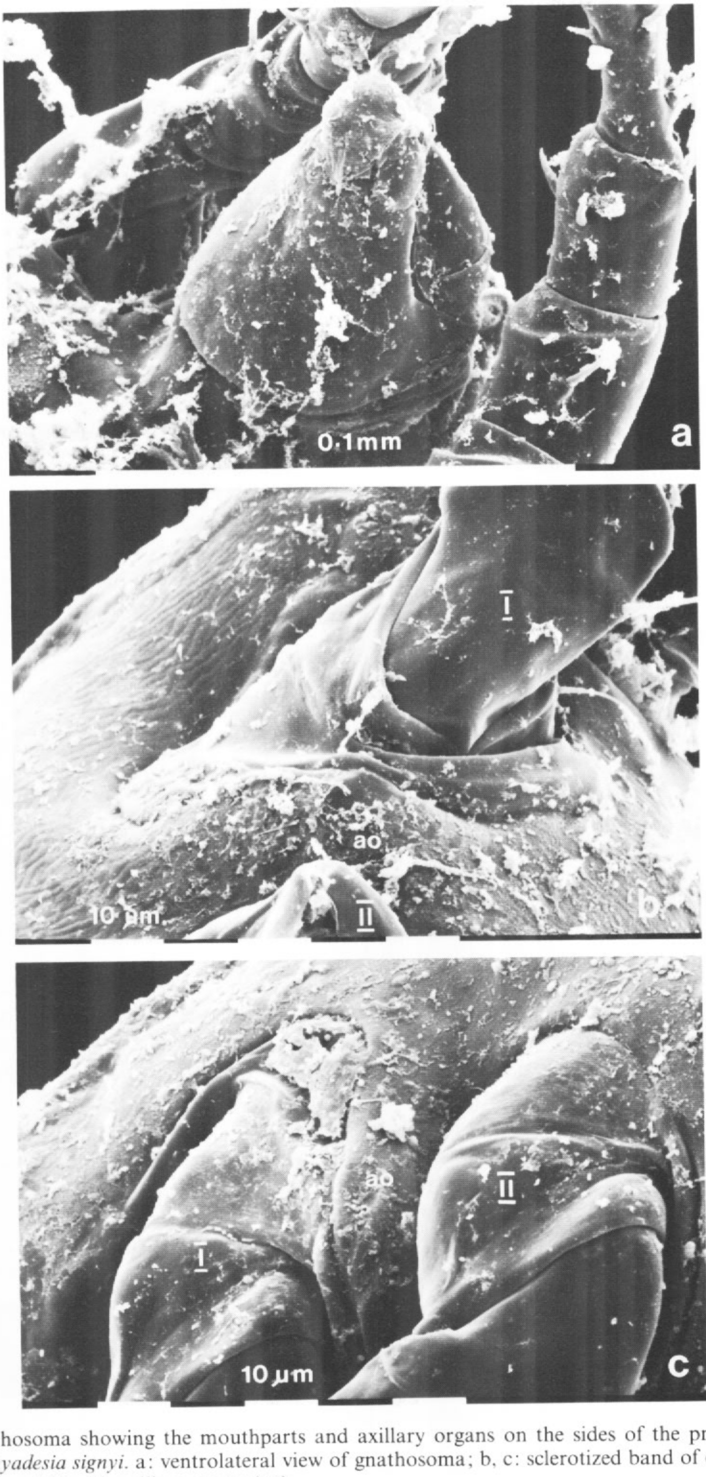

Fig. 2. Gnathosoma showing the mouthparts and axillary organs on the sides of the propodosoma of *Neohyadesia signyi*. a: ventrolateral view of gnathosoma; b, c: sclerotized band of cuticle between legs I and II with axillary organ (ao).

pool was covered by a thin layer of ice, but was otherwise washed out by the heavy storms of the previous week. No visible algae or other organic material remained in the pool and no specimens of *N. signyi* were found.

The samples of 28 January contained a total of 36 individuals. The species' distribution was strongly dependent on water depth, food resources and the presence of a sheltered microhabitat consisting of a thick layer of living and dead organic material (Fig. 1). The regression between the number of individuals in the samples (y) and water depth (x) in centimetres is expressed by the equation $y = -2.99 + 0.78x$ ($r^2 = 0.92$, $P < 0.01$). However, a strong linear relationship was found only for water that exceeded 10 cm in depth but, due to the small sample size, this trend requires confirmation. In the samples, *N. signyi* showed a tendency to cling to pieces of organic material (moss, algae). Fifty percent of the mites collected on this occasion were from the deepest point in the pool (25 cm, sample 1) where a 10-cm-thick layer of moss, alga and other semi-decayed vegetation occurred. This was also the only sample in which different life stages of the mite were present. Besides six adult individuals (two females and four males), eight tritonymphs and four protonymphs were found. No hypopae were collected. Following the small channel through the pool (samples 3 and 4) the number of animals decreased, although similar organic material was present in sample 1. In all other samples, located between the centre and edge of the pool and at depths between 2 and 10 cm, few or no animals were found. Here, only a thin moss layer with a little algal growth was present (samples 2, 6, 9, 5, 7 and 8).

Their distribution in the pool and gut content analysis of ten specimens suggest that *N. signyi* feeds on the most abundant algae in the pools, the blue-green filamentous *Lyngbya* spp. Most of the gut contents, however, consisted of amorphous material, which is found in many microphytophagous mites. The mouth parts (Fig. 2a) are typical of microphytophagous mites with the chelicerae being fine and forcep-like.

Morphology

One morphological feature of *N. signyi* deserves special attention (Fig. 2b, c). It was described by Hughes and Goodman (1969) as a supracoxal fossa encircled by a sclerite that is situated above the base of leg I. This structure is a feature of several species of the Algophagidae and its function has been variously described. It is distinct from the 'oil' gland on the side of the hysterosoma in *Algophagus antarcticus* (Hughes, 1955). Fashing (1984) described the former structure as a sclerotized band of cuticle located on each side of the propodosoma between legs I and II and proposed the name 'axillary organ' for it.

As the supracoxal fossa in *N. signyi* corresponds to the axillary organ in morphology (Fig. 2b, c), it is considered analogous to it. Assuming a function similar to that described by Fashing (1984), i.e. active ion absorption for hyperosmotic regulation, it may help to explain the capacity of this mite to survive in Antarctic pools, which experience large fluctuations in salinity and chemical composition. The normal water source of these pools is limited to precipitation and sea spray in summer (Goodman, 1969). Therefore, the concentrations of most ions and the salinity of the water fluctuate greatly during this period. The fine structure of the axillary organ in *N. signyi*, however, must be examined to establish the presence of chloride cells as are found in the genus *Algophagus*, in the Hydrachnellae (aquatic mites) and in aquatic insects where they are thought to be responsible for osmoregulation.

Cold hardiness

The water temperatures of the pools at Signy Island recorded by Goodman (1969) during the summer ranged from 0 to 17°C with a mean of 4.5°C. During winter, the pools are frozen over and covered with snow. A snow layer of > 20 cm thickness provides insulation under which the temperature generally does not fall below −7°C (Tilbrook, 1967). Goodman (1969) reported a minimum of 50 cm of snow cover for all the pools during the coldest weather.

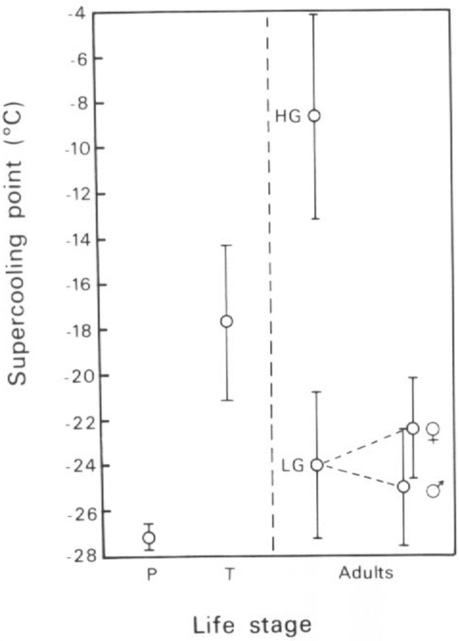

Fig. 3. Mean (±S.D.) supercooling points of *Neohyadesia signyi* in summer samples. HG: high group; LG: low group; P: Protonymphs; T: Tritonymphs.

The individual supercooling points (SCP) measured for *N. signyi* varied greatly, depending on their life stage (Fig. 3). As the number of nymphs tested was small, the picture is only an approximation. However, there is a distinct loss of supercooling capacity from the protonymph to the tritonymph stage. Thereafter the adults divide into a low and a high group (LG, HG) although only a few animals belong to the LG (17%). In the LG, females show a slightly higher mean SCP (−22.4°C) than the males (−25.0°C), but these are not significantly different (*F*-test; *t*-test). The mean SCP of the LG for all adults was −24.0°C.

All individuals tested died at their SCP. *N. signyi*, therefore, will probably not survive temperatures lower than *c.* −24°C in the field. However, as water temperatures do not decline below *c.* −10°C in the pools in winter this species is able to survive at Signy Island. Moreover, as *N. signyi* was observed first in the pools on 16 January 1983, it may be that it overwinters in the egg stage, which may be more cold resistant due to its physical properties (size, composition).

Conclusions

N. signyi is well adapted to survive in the pools at Paal Harbour with their large fluctuations in water temperature, salinity and other ions. It is sufficiently cold-hardy to survive cold periods in summer and during winter, possibly as eggs. Osmoregulatory organs enable this species to cope with its ever-changing chemical environment. However, it is not certain how *N. signyi* survives 'catastrophic' events, such as the pools being cleared of their visible biota by storms. Eggs may be deposited in small crevices in the rock substrate and provide a constant source for recolonization all year round. Adults appear actively to seek suitable microhabitats by moving into deeper water, where they are comparatively protected in the thick layers of organic material and where food is available.

Inter-tidal mites of various taxonomic groups have been recorded in the sub-Antarctic. In ecophysiological terms, they must be adapted to the extreme environment (Sømme and Block, 1983). *Hyadesia maxima*, an intertidal-mite from South Georgia (Fain and others, 1983), survives exposure to both fresh and salt water as well as dehydration.

Neohyadesia signyi 'signyi' has been found only in pools at Paal Harbour on Signy Island. If it is endemic to this site, it is also relatively abundant there. Its closest relative has been found on Iles Kerguelen, i.e. *Neohyadesia signyi punctulata*, where populations of the genus *Hyadesia* and subgenus *Hyadesiella* in the family Hyadesiidae, and of the genus *Algophagus* in the family Algophagidae are also found. Otherwise, these genera are unevenly distributed in a band covering the sub-Antarctic and maritime Antarctic islands from Tierra del Fuego eastwards to Iles Kerguelen and St Paul and New Amsterdam islands. Therefore, *Neohyadesia signyi 'signyi'* may be a relict subspecies rather than having been dispersed by drift or phoresy to Signy Island.

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