SHORT NOTES

AGROTIS IPSILON (LEPIDOPTERA) AT SOUTH GEORGIA

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INTRODUCTION

It is likely that apart from a few small refugia, South Georgia was ice-covered as recently as 10000 years BP. In consequence, most of the terrestrial flora and fauna have been established since then, accounting for the relatively low level of endemicity. The processes of colonization, resulting from chance arrivals at a favourable habitat, are of general interest to biogeographers. This paper records three occurrences of the moth *Agrotis ipsilon* at South Georgia, and the circumstances of its arrival are discussed.

THE SPECIMENS

On 16 March 1985 a small brown moth was found by Callan Duck in a bucket near the research station at Bird Island, South Georgia, lat. 54° 00′ S, long. 38° 03′ W. This was subsequently identified by one of us (M.R.H.) as a male *Agrotis ipsilon* (Hufnagel, 1766), Lepidoptera, Noctuidae (Fig. 1). This was the third record of the

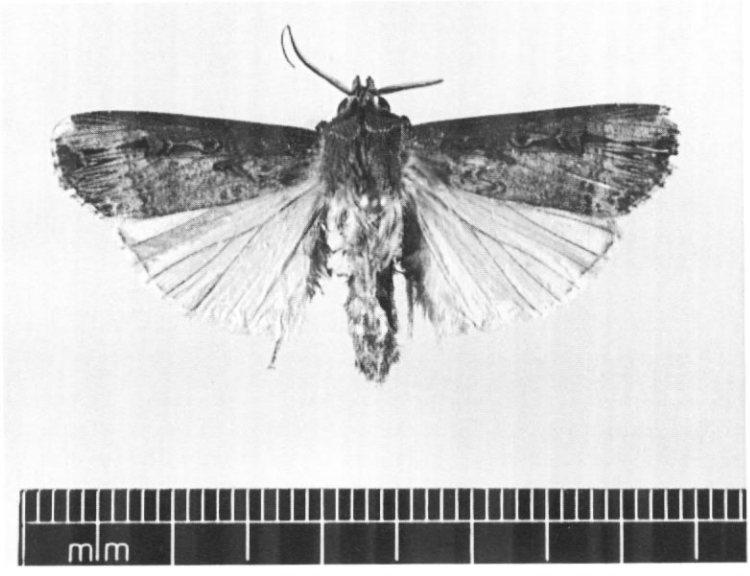

Fig. 1. Male *Agrotis ipsilon* collected at Bird Island, South Georgia, 16 March 1985. (Photograph, British Museum (Natural History).)

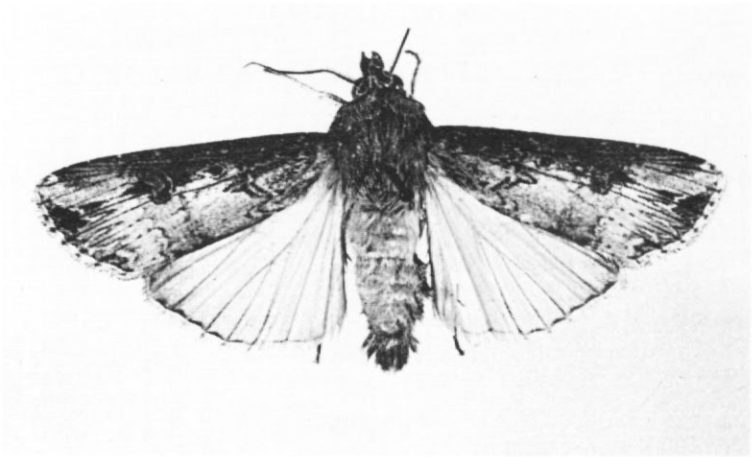

Fig. 2. Male *Agrotis ipsilon*, Ample Bay, South Georgia, 30 January 1954. (Photograph, British Museum (Natural History).)

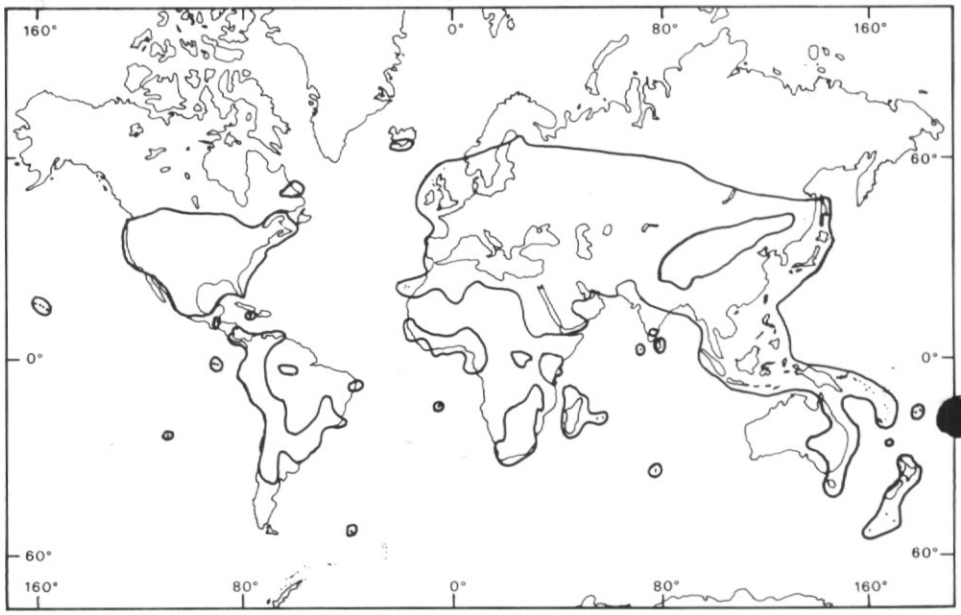

Fig. 3. Distribution of *Agrotis ipsilon*. (Based on the Commonwealth Institute of Entomology distribution maps of pests, with additional information.)

species from South Georgia. On 30 January 1954 W. N. B. found the first recorded specimen (Fig. 2), also a male, resting on a patch of moss in the tussock grass (*Poa* (*Parodiochloa*) *flabellata*) zone behind the beach at Ample Bay, Bay of Isles, South Georgia, lat. 54° 04′ S, long. 37° 23′ W. This was identified at the British Museum (Natural History) by Allan Watson, and the specimen was donated to the collection in 1958. Unfortunately, it has proved impossible to trace it subsequently. The only other record is of a specimen that flew into an open window of the house of one of

the authors (W.N.B.) at King Edward Point, South Georgia, lat. 54° 17′ S, long. 36° 30′ W, during one of the austral summers between 1958 and 1961. Unfortunately, this specimen and all its records have been lost.

Discussion

Agrotis ipsilon is an abundant moth that occurs virtually worldwide (Fig. 3). In places it is an important pest species, its larva being known as the black or greasy cutworm. *Agrotis ipsilon* has numerous other common names, the usual British one being the Dark Sword-grass. Cutworms get their name from their larval feeding habit. They live primarily on or under the surface of the soil, usually emerging at night to feed by eating through the stems and leaves of young plants at soil level. The adults of *A. ipsilon* are known to have migratory ability (Johnson, 1969; Odiyo, 1975).

South Georgia has been reasonably well covered by entomological expeditions; the only Lepidoptera previously recorded were a few unidentified first-instar larvae, possibly Pyralidae, collected in 1961 by N. V. Jones at Grytviken whaling station (Gressitt, 1970*a*). It was suggested by Gressitt that these newly hatched larvae resulted from an accidental introduction of an egg mass with packing material. The lack of records of Lepidoptera, other than those reported here, is good evidence that indigenous Lepidoptera do not occur at South Georgia.

Gressitt (1970*b*) has drawn attention to the paucity of the insect fauna of the sub-Antarctic islands, including South Georgia, and to the fact that there are many unoccupied niches. The existing indigenous insect fauna is believed to be derived from a few relicts from a less heavily glaciated period (Pleistocene), together with those 'waifs' that have arrived subsequently by means of natural dispersion. Lepidoptera are particularly poorly represented and the majority of the indigenous fauna is flightless, as in the case of *Pringleophaga kerguelensis* (Tineidae) on Marion Island, Kerguelen and the Crozets, and *Embryonopsis halticella* (Yponomeutidae) on Marion, Kerguelen, the Crozets and Heard Island. Crafford and others (1986) give an almost complete list and distribution of the species native to the Prince Edward Islands (Marion Island and Prince Edward Island), and record *Plutella xylostella* (Yponomeutidae) as a naturalized alien. The colony was first recorded in April 1986, but it is already expanding and may present a serious threat to the only indigenous 'brassica', *Pringlea antiscorbutica* (the Kerguelen cabbage). In addition, four species of Lepidoptera, including *A. ipsilon*, are recorded as transient aliens, presumed to have been introduced with vegetable supplies.

Agrotis ipsilon is known to be an early colonizer. Lindroth and others (1966) list this species as having been collected on the island of Surtsey on 15 October 1964, less than one year after the eruption and formation of Surtsey. Its wide distribution (Fig. 3), abundance and migratory potential, combined with favourable weather conditions, may make it a regular arrival at South Georgia. The three records in the past 33 years probably represent only a small proportion of its occurrence.

The origins of the three specimens recorded are open to conjecture. They may have been accidental introductions, carried to the vicinity of the island by ships, but a more likely explanation is that they are accidental landfalls of specimens resulting from active migration or transported by prevailing weather conditions.

The species is widespread in continental South America, and examination of the material from Argentina in the British Museum shows that this species is on the wing virtually all year. There are no dated specimens from June, October or December, but this may be due to chance. The nearest locality recorded in the British Museum

(Natural History) collections is San Martin de los Andes, Argentina, 3000 km distant from South Georgia, but it is known to occur further south from specimens, collected in Patagonia, that are now in the collection of the Zoological Museum, Copenhagen. There is a record from 'Cabo Virenes' which has proved impossible to locate, but this may refer to Cabo Virgenes, the northern cape of the eastern entrance to the Straits of Magellan. The nearest part of South America to South Georgia is Tierra del Fuego, some 1750 km distant.

It is debatable whether *Agrotis ipsilon* could establish itself at South Georgia. The climate is cool oceanic, with sub-zero temperatures recorded in every month of the year. At Bird Island, at the western end of South Georgia, which is probably representative of most of the sea-level areas of South Georgia, air temperatures rarely rise above 10°C (Headland, 1984). Winter temperatures at South Georgia, which are moderated by the surrounding sea, probably never fall much below −15°C and are certainly well above those recorded in other parts of the moth's range. *A. ipsilon* overwinters as a pupa and Roberts and others (1972) have reported that pupae can supercool to −23°C, which would provide more than adequate protection. It is possible that the cool summers, with frequent snowfalls and frosts, would be more of a limitation, though the fact that the larva feeds in the litter layer would give it some protection.

A very wide range of food plants is recorded for *Agrotis ipsilon* (Rings and others, 1974) but we could trace no record of the species feeding on any of the 18 native South Georgia phanerogams. The most likely potential food plants are tussock grass and two species of burnet, *Acaena magellanica* and *A. tenera* (together with their hybrid), which occur in large stands and provide nutritious shoots near the ground surface. Tussock grass is the dominant plant of the coastal zone of South Georgia (Greene, 1964), forming extensive closed stands on the lower slopes. It also occurs in large (*c.* 1.5 m diameter) clumps in favoured positions behind beaches. Tussock stores soluble carbohydrate at the bases of its shoots and provides rich forage. It would appear to be a suitable food plant for *Agrotis*. Kelsey (1957) has recorded *A. ipsilon* (as *ypsilon* Rott., a synonym) from three species of tussock grass that are native to New Zealand (*Festuca novae-zelandiae* Cockayne, *Poa caeposita* Forst. and *P. colensoi* Hook.).

Agrotis ipsilon has demonstrated its ability to reach South Georgia. It seems likely that potential food plants are available and that the lower temperature limits are within the range tolerated by this species. *A. ipsilon* should therefore be regarded as a potential insect colonizer at South Georgia.

Acknowledgements

We are grateful to Callan Duck for the Bird Island specimen. The photographs for Figs 1 and 2 were taken by British Museum (Natural History) staff. Tony Sylvester (British Antarctic Survey) prepared Fig. 3.

References

Crafford, J. E., Scholtz, C. H. *and* Chown, S. L. 1986. The insects of sub-Antarctic Marion and Prince Edward Islands; with a bibliography of entomology of the Kerguelen Biogeographical Province. *South African Journal of Antarctic Research*, **16** (2), 41–84.

Greene, S. W. 1964. The vascular flora of South Georgia. *British Antarctic Survey Scientific Reports*, No. 45, 58 pp.

Gressitt, J. L. 1970*a*. Coleoptera: Dytiscidae and Lathriidae of South Georgia. *Pacific Insects Monographs*, **23**, 235–9.

GRESSITT, J. L. 1970*b*. Subantarctic entomology and biogeography. *Pacific Insects Monographs*, **23**, 295–374.

HEADLAND, R. K. 1984. *The island of South Georgia*. Cambridge, Cambridge University Press, xvi + 293 pp.

HUFNAGEL, [initials unknown]. 1766. Zwote Fortsetzung der Vierten Tabelle von des Insectes. *Berlinisches Magazin*, **3** (4), 416.

JOHNSON, C. G. 1969. *Migration and dispersal of insects by flight*. Methuen, London, xxii + 763 pp.

KELSEY, J. M. 1957. Insects attacking tussock. *New Zealand Journal of Science and Technology*, **38** (6), 638–43.

LINDROTH, C. H., ANDERSON, H. *and* BODVARSSON, H. 1966. Report on the Surtsey Investigation in 1956. Terrestrial invertebrates. *Surtsey Research Progress Report*, **2**, 16.

ODIYO, P. O. 1975. Seasonal distribution and migration of *Agrotis ipsilon* (Hufnagel) (Lepidoptera, Noctuidae). *Tropical Pest Bulletin*, **4**, 1–26.

RINGS, R. W., ARNOLD, F. J., KEASTER, A. J. *and* MUSICK, G. J. 1974. A world annotated bibliography of the black cutworm *Agrotis ipsilon* (Hufnagel). *Ohio Agricultural Research and Development Center, Research Circular* No. 198, 1–106.

OBERTS, S. J., ARMBRUST, E. J. *and* SELL, D. K. 1972. Supercooling points of several species of Lepidoptera found on soybeans. *Environmental Entomology*, **1**, 671–2.

TARDIGRADA FROM THE MARITIME ANTARCTIC

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Between February 1981 and March 1982 vegetation and soil samples were collected from many localities in the maritime Antarctic; these samples were extracted for their soil arthropods (e.g. Usher and Booth, 1984). The extracts contained a total of 219 individual tardigrades of 14 taxa.

Jennings (1976*a*) summarized the knowledge of the tardigrades of Signy Island. He collected extensively on the island, obtaining 52013 specimens from 42 localities. These were identified as belonging to 14 taxa, two of which are now recognized as varieties of *Diphascon pingue* (see Dastych, 1984). Jennings (1976*b*) also documented 4830 tardigrades collected from 59 localities in the South Orkney Islands, the South Shetland Islands and the Antarctic Peninsula and its offshore islands. This collection contained 11 taxa. Dastych (1984) reviewed the occurrence of tardigrades in Antarctica; he both revised some species and described several new species. Dastych's list contained 19 taxa from the maritime Antarctic, one of which is represented by two varieties. Jennings' (1976*a*) list contained two species not in Dastych's list. Together with a species in a genus not previously recorded in Antarctica (see below), and one taxon previously only recorded from East Antarctica, a total of 23 species are now known to occur in the maritime Antarctic.

The arrangement in the list below follows Dastych (1984). After the species name, the number of specimens in the present collection is given. All specimens are being deposited in the British Museum (Natural History).

SPECIES LIST

Echiniscus pseudowendti Dastych (1 specimen)

A single specimen, collected from a *Prasiola* mat on Emperor Island (67° 52′ S, 68° 43′ W), Dion Islands Specially Protected Area, is probably referable to this taxon, which has previously only been collected in East Antarctica.

Echiniscus jenningsi Dastych (11 specimens)

This species has been recorded from the South Orkney Islands (as *E. capillatus* by Jennings, 1976*a*), from King George Island and, as *Echiniscus* sp., from Torgersen Island and from four islands around Marguerite Bay (Jennings, 1976*b*). The specimens in this collection are the first Peninsula records, coming from Cape Roquemaurel (63° 33′ S, 58° 57′ W) in *Drepanocladus uncinatus* and in a mixed community of *D. uncinatus* with *Cladonia balfouri*, and from Mount Alexander, Joinville Island (63° 19′ S, 55° 45′ W) in a mixed community of *Andreaea depressinervis* and *Usnea sulphurea*.

Echiniscus meridionalis Murray (4 specimens)

This species has been recorded from the South Orkney Islands (the type locality) and King George Island. The four specimens in this collection came from three different samples collected on Ardley Island, South Shetland Islands (62° 12′ S, 58° 54′ W); the habitats were a stand of *Andreaea regularis*, a mixed stand of *D. uncinatus* with *Stereocaulon glabrum*, and a mixture of *D. uncinatus*, *Tortula excelsa* and *Bryum algens*. It is interesting to note that although this species has been recorded from the two archipelagos (South Orkney and South Shetland) it has not yet been recorded from the Peninsula or its offshore islands.

Macrobiotus furciger Murray (17 specimens)

This was shown by Jennings (1976*a*, *b*) to be an abundant species in the South Orkney Islands, South Shetland Islands and south along the Peninsula to Alexander Island. The specimens recorded here came from Brabant Island (Metchnikoff Point, 64° 02′ S, 62° 35′ W; Astrolabe Needle, 64° 07′ S, 62° 38′ W), collected by the Joint Services Expedition in February and March 1984; Green Island Specially Protected Area (65° 19′ S, 64° 10′ W); Courtier Islands (Dion Islands S.P.A.) (67° 52′ S, 68° 43′ W); Fauré Islands (68° 06′ S, 68° 51′ W); and Refuge Islands (68° 21′ S, 67° 08′ W).

Isohypsibius sp. (1 specimen)

Signy Island, back slopes, Factory Cove. (The specimen is in the 'simplex-stage' and hence cannot be identified to species. It is not *I. asper* because the cuticle is smooth.)

Hypsibius arcticus (Murray) (27 specimens)

Although Dastych (1984) recorded this species from a number of habitats on King George Island, Jennings (1976*a*, *b*) recorded it neither from Signy Island nor from the Peninsula. In the present collection it was found at seven localities, including Ardley Island, Byers Peninsula S.S.S.I. on Livingston Island (62° 42′ S, 61° 09′ W) and Pendulum Cove, Deception Island (62° 56′ S, 60° 36′ W), in the South Shetland Islands.

On and near the Peninsula it was collected from Welchness, Dundee Island (63° 29′ S, 56° 13′ W), Metchnikoff Point on Brabant Island by the Joint Services Expedition, Thumb Rock (65° 15′ S, 64° 16′ W), Emperor Island (Dion Islands S.P.A.), and Red Rock Ridge (68° 17′ S, 67° 11′ W). Unlike the majority of species which showed no habitat preference, *H. arcticus* is more commonly associated in the present collection with areas without vegetation; for example, it was found in gravelly material at Welchness, under stones at Brabant Island, amongst scattered *Prasiola* in the emperor penguin colony area of Emperor Island, and in unvegetated soil at Red Rock Ridge.

Hypsibius renaudi Ramazzotti (141 specimens)

This species was recorded from 13 localities in the South Orkney Islands, South Shetland Islands and along the Peninsula as far south as Alexander Island by Jennings (1976*b*), but was only recorded from Hope Bay by Dastych (1984). In the present collection it was found in moss on the beach at Pendulum Cove, Deception

Island, on Astrolabe Island (63° 17′ S, 58° 42′ W), at both Astrolabe Needle and Metchnikoff Point on Brabant Island, Brewster Island (64° 43′ S, 62° 34′ W) and Thumb Rock. In Marguerite Bay the species is particularly abundant on the Dion Islands S.P.A. (103 of the specimens were collected on Emperor and Courtier Islands).

Diphascon schusteri Dastych (1 specimen)

This is predominantly a species of East Antarctica, since of the 377 specimens seen by Dastych (1984) when he described the species, only one came from King George Island. The present collection contains one specimen that is probably referable to this species; it was collected in a mixed community of *A. depressinervis* and *U. sulphurea* on Mount Alexander, Joinville Island.

Diphascon puniceum (Jennings) (3 specimens)

Although the type locality is Signy Island, South Orkney Islands, the species appears to be of restricted distribution since it was not recorded from the Peninsula (Jennings, 1976*b*) and from only one habitat on King George Island (Dastych, 1984). The three specimens in this collection come from fellfield on Signy Island; from a mixed community (*Chorisodontium aciphyllum*, *Polytrichum alpinum*, *A. regularis*, *Sphaerophorus globosus*, *Usnea antarctica* and *Cladonia furcata*) on Steepholm, South Orkney Islands (60° 46′ S, 45° 09′ W); and from a mixed community of *Deschampsia antarctica*, *D. uncinatus* and *P. alpinum* on Takaki Promontory (65° 31′ S, 64° 12′ W). The latter represents the current southern limit of the species distribution.

Diphascon pingue (Marcus) (5 specimens)

In Jennings' (1976*b*) study of the distribution of tardigrades, this was the most abundant species, being recorded in 34 localities from the South Orkney Islands to Alexander Island (recorded as a mixed taxon of *D. pingue* and *D. alpinum*). Dastych (1984) showed that there were two varieties, named 'A' and 'B', in Antarctica, of which variety 'B' (corresponding to Jennings' *D. pingue*) appeared to be the most abundant. The five specimens in this collection, probably all referable to variety 'A', came from Signy Island, Ardley Island, Charlotte Bay (64° 35′ S, 61° 42′ W) and Green Island S.P.A.

Diphascon greveni Dastych (2 specimens)

This species has been recorded only from King George Island, although as *D. scoticus*, Jennings (1976*b*) probably recorded it in the South Orkney Islands, the South Shetland Islands, Avian Island and Alexander Island. This collection contains one specimen from Byers Peninsula S.S.S.I., Livingston Island (also in the South Shetland Islands) together with one specimen from fellfield on Signy Island.

Diphascon mirabile Dastych (2 specimens)

Again this species has only been recorded previously from King George Island. The two specimens in this collection both come from the central live portion of a clump of *P. alpinum*, previously buried by volcanic ash, at Collins Point, Deception Island (63° 00′ S, 60° 35′ W).

Milnesium tardigradum Doyère (1 specimen)

This large species tends to be uncommon, having only been recorded from Signy Island (Jennings, 1976*a*), King George Island (Dastych, 1984) and Alexander Island (Jennings, 1976*b*). The single individual in this collection was extracted from a mixed community of *A. depressinervis* and *U. sulphurea* on Mount Alexander, Joinville Island.

Hexapodibius sp. (3 specimens)

These three individuals were extracted from gravelly material at Welchness, Dundee Island. The genus has not previously been recorded for Antarctica, and these specimens probably represent a new species from a currently controversial genus. The quality of the specimens is insufficient to form the basis of a complete description of a new species at the present time.

Discussion

The extraction method used to collect these tardigrades was designed for mites and springtails, and hence the efficiency was very low. The specimens, being collected into and stored in ethanol, were generally of poor quality. However, compared with the previous studies of Jennings (1976*a*, *b*) and Dastych (1984), this collection again demonstrates the comparative richness of the tardigrade fauna of Antarctica.

The previous studies have tended to concentrate on the tardigrades of well-vegetated environments in Antarctica, especially Angiosperm- (*Deschampsia antarctica*) and moss-dominated communities. Several of the collections in this study were in more open communities, either fellfield or totally unvegetated gravel or shingle. The fellfield community has proved to be rich in species, with *E. jenningsi*, *D. puniceum*, *D. pingue* and *D. greveni* being found in fellfield at 'Paal Col' on Signy Island. The greater abundance of *H. arcticus* in the present collection also probably reflects the difference in collection habitats, since it was almost completely confined to unvegetated or poorly vegetated environments. The collection from unvegetated material at Welchness, Dundee Island, is particularly interesting since it contained only two species, *H. arcticus* and a species in the genus *Hexapodibius*, previously unrecorded from the Antarctic.

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References

Dastych, H. 1984. The *Tardigrada* from Antarctic with descriptions of several new species. *Acta Zoological Cracoviensia*, **27**, 377–436.

Jennings, P. G. 1976*a*. The Tardigrada of Signy Island, South Orkney Islands, with a note on the Rotifera. *British Antarctic Survey Bulletin*, No. 44, 1–25.

Jennings, P. G. 1976*b*. Tardigrada from the Antarctic Peninsula and Scotia Ridge region. *British Antarctic Survey Bulletin*, No. 44, 77–95.

Usher, M. B. *and* Booth, R. G. 1984. A portable extractor for separating microarthropods from soil. *Pedobiologia*, **26**, 17–23.

A CHECKLIST OF MARINE DIATOMS FOUND ON WOOD BLOCKS EXPOSED IN THE LITTORAL ENVIRONMENT OF SIGNY ISLAND, SOUTH ORKNEY ISLANDS

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INTRODUCTION

As part of a study of marine fungi in Antarctic inshore waters, a number of wood blocks were exposed in Borge Bay, Signy Island (lat. 60.40° S, long. 45° W). It was found that in addition to fungal colonization, diatoms also occurred on many of the blocks. This note describes the species found in these assemblages.

MATERIALS AND METHODS

Wood blocks, approximately 40 × 40 × 8 mm, were cut from planks of deal (*Pinus sylvestris*). A hole was drilled in the centre of each block and the blocks were threaded on to lengths of polypropylene line. The strings were weighted and then placed in Borge Bay, just above the sediments, at approximately 20 m depth, during the summer period, January–March 1980. They were recovered and returned to the UK in cool storage (4°C) and subsequently stored at 5°C. A fuller description of Borge Bay is given in Whitaker (1977).

The blocks were scraped to remove the surface film, which was then placed in acid and cleaned of organic material as described by Hendey (1964). The siliceous components were mounted in Naphrax (R.I. 1.74) for light-microscope examination at 1000 × magnification using phase-contrast and bright-field illumination on a Wild M20 microscope.

Taxonomy

All identification was based on light-microscopy measurements. In addition to the principal references cited, the following general references were used: Schmidt, 1878; Van Heurck, 1880–85; Hudstedt, 1930; Hudstedt, 1927–37; Hendey, 1937; Hudstedt, 1939; Cleve–Euler, 1951–55; Hendey, 1964; Fukushima, 1965; Priddle and Fryxell, 1985.

RESULTS

The following species list is not a complete record of all taxa observed. Other species not yet identified require further examination by electron microscopy.

Achnanthes brevipes Ag. var. *arctica* (Cleve) Kobayashi[1]
Achnanthes delicatula ssp. *haukiana* (Grun. in Cleve *et* Grun.) Lange-Bertalot *et* Ruppel
Actinocyclus actinochilus (Ehrenb.) Simonsen
Amphora proteus Greg.
Cocconeis balatonis Pant.
Cocconeis disculoides Hust.

Cocconeis fasciolata (Ehrenb.) Brown
Cocconeis schuetti var. *minor* Van Heurck[2]
Fragilaria charcotti M. Perag.
Fragilaria pseudoatomus Manguin
Gomphonema charcotii M. Perag.
Gomphonema littorale Hendey
Gomphonema kamtschaticum Grun. var.?[3]
Grammatophora angulosa Ehrenb.
Licmophora sp.[4]
Melosira sol (Ehrenb.) Kütz.
Navicula directa (Wm. Smith) Ralfs in Pritchard[5]
Navicula marnieri Manguin
Nitzschia angulata Hasle[6]
Nitzschia curta (Van Heurck) Hasle
Nitzschia cylindrus (Grun. ex Cleve) Hasle
Nitzschia dissipata (Kütz.) Grun.
Nitzschia obliquecostata (Van Heurck) Hasle
Odontella litigiosa (Van Heurck) Hoban
Rhoicosphenia sp.[7]
Thalassionema nitzschioides (Grun.) Hust.
Thalassiosira antarctica Comber
Thalassiosira oliverana (O'Meara) Makarova & Nikolaev
Trachyneis aspera (Ehrenb.) Cleve

Taxonomic notes

(1) *Achnanthes brevipes Ag.* var. *arctica* Kobayashi, 1965

All measurements and morphological features reported by Kobayashi (1965) match those of the Signy material. The full range of variability in valve outline illustrated from Kasumi Rock (Prince Olav Coast) was not found at Borge Bay, Signy Island. The Signy material tended to have more eliptical valves with broadly rounded apices, corresponding with the smaller forms observed by Kobayashi.

It is possible that this variety is a synonym of *Achnanthes groenlandica* (Cleve) Grun. 1880, as both descriptions are very similar. However, there is some confusion in the interpretation of the figures drawn for *Ach. groenlandica* from various sources in the literature, particularly with respect to features of striation of the valve. The original description (Cleve and Grunow, 1880) gives no figure with the text, but the earliest reference (Cleve, 1873, described as *Achnanthidium groenlandica*) describes both the convex and concave valves as coarsely striate and punctate, as described by Kobayashi. Cleve's (1873) figure does not illustrate this particular feature very clearly. A critical examination of the type material of both taxa is required before they can be declared as synonymous. The Signy material corresponds more clearly to Kobayashi's description, so his identification is applied.

(2) *Cocconeis schuetti* var. *minor* Van Heurck, 1909

Two descriptions match the material collected from Signy Island, that given above and *Cocconeis schuetti* var. *litigiosa* Manguin. Only the raphid valve is illustrated for the latter variety. As both valves have been described for the former and match the measurements recorded from Signy, this is the classification applied here.

(3) *Gomphonema kamtschaticum* Grun. var. 1878

Both the dimensions and morphological features of the Signy material closely resemble those given in Giffen (1970). This species has also been previously reported from the Adélie Coast (Manguin, 1960) and other Antarctic regions (Heiden and Kolbe, 1928). However there are consistent features in the Signy material which differ from the type species: (1) the axial and central areas are generally much wider than published illustrations; (2) there is a pseudoseptum at the footpole of the valve (which is described by Grunow, 1878); (3) it has a slightly coarser striation (11–12 in 10 μm). These features are consistent with other varieties *californicum* and *islandicum* (Medlin and Round, 1986) but further investigation is required before a new variety or species status can be declared.

(4) *Licmophora* sp.

This species has not been classified at a specific level because insufficient material was available to obtain all measurements to ensure correct identification. The valve is clavate, with a prominent apical pore field. There is a distinct hyaline median line along the apical axis of the valve. Striae are extremely coarse and punctate. Valve length 98 μm, width 14 μm, 5–6 striae were measured in 10 μm, and 10–11 punctate in 10 μm. These dimensions can most closely be related to *Licmophora kamtschatica* (Grun.) De Toni.

(5) *Navicula directa* (Wm. Smith) Ralfs in Pritchard, 1861 (*sensu* Hendey, 1964)

N. directa is easily confused with *N. criophila* (Castr.) De Toni and other closely allied forms. Hustedt (1939) has discussed the confusion encountered in the literature in some detail. The distinguishing feature separating these two species is the density of striation. *N. directa* is more coarsely striate (5–6 striae in 10 μm) than *N. criophila*, which has 10 striae in 10 μm. The Signy material has morphological features which are associated with both species. As in Hendey's (1964) description of *N. directa*, the striae are strongly lineate throughout the length of the valve. However, the central area is asymmetrical, as described for *N. criophila* by Hustedt (1939). Since the latter feature is variable and the other distinguishing features discussed for *N. directa* are considered to be reliable taxonomic features, the Signy material is classified as *N. directa*.

(6) *Nitzschia angulata* Hasle, 1965

This is a homonym of *Fragilaria rhombica* (O'Meara) Hust. as discussed by Hasle (1972).

(7) *Rhoicosphenia* sp.

The R theca (raphid valve as defined by Mann, 1982) is characteristically heteropolar, with a central raphe. Costae are parallel except in the centre, where they are more widely spaced and are radial. The axial area is narrow. The valve margin is also characteristically thickened, most notably at the poles. Pseudoseptae are clearly observed at the valve apices. The raphe system is simple, but the large degree of curvature of the valve apices made it difficult to determine the external structure of the terminal fissure under the light microscope. No D theca was observed (araphid valve, Mann, 1982). Length 41 μm, width 6 μm; 6–7 striae in 10 μm.

The features described correspond to all the distinctive features of *Rhoicosphenia* (Mann, 1982), but cannot be matched at a specific level to any published description. As only one complete valve was observed, a new species description cannot be made. This specimen could simply be a deformity of *Rhoicosphenia curvata* var. *minor* M. Schmidt which is the most closely related morphological form.

Additional ecological notes

Only two species of those listed have been described as attached littoral forms: *Gomphonema kamtschaticum* (Manguin, 1960) and *Cocconeis fasciolata* (syn. *Cocconeis imperatrix* Hendey, 1937). These two forms were the most abundant in the acid-cleaned material examined. The table below lists the taxa found in the present study which have been assigned to a variety of habitats.

Species	Habitat	Source
Actinocyclus actinochilus	Planktonic	Priddle and Fryxell, 1985
Melosira sol	Tychopelagic	Hendey, 1937
Navicula directa	Planktonic	Hendey, 1964
Nitzschia angulata	Planktonic	Hasle, 1972
Nitzschia curta	Plankton/ice	Hasle, 1972 Whitaker, 1977
Nitzschia cylindrus	Plankton/ice	Hasle, 1972
Nitzschia obliquecostata	Plankton/ice	Hasle, 1972
Odontella litigiosa	Plankton	Priddle and Fryxell, 1985
Thalassionema nitzschioides	Plankton	Hustedt, 1939
Thalassiosira antarctica	Plankton	Hendey, 1937
Thalassiosira oliverana	Neritic/bottom dwelling	Hendey, 1937 Priddle and Fryxell, 1985

The species of *Achnanthes*, *Cocconeis*, *Gomphonema*, *Licmophora* and *Rhoicosphenia* are probably sub-dominant members of the periphytic assemblage on the wood blocks. However, most of the forms observed will have settled passively on the wood blocks rather than been active components of the attached assemblage. Little ecological information is available for species such as *Fragilaria pseudoatomus* and *Gomphonema charcotii*, so no comment is possible regarding their distribution. The list of taxa identified from the wood blocks clearly represents an assemblage of forms derived from a variety of marine habitats.

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REFERENCES

BROWN, N. E. 1920. Some new and old Antarctic diatoms. *English Mechanic*, **3**, part 1, 210–11, part 2, 219–20, part 3, 232–3.

CLEVE, P. T. 1873. On diatoms from the Arctic sea. *Bihang Kongliga Svenska Vetenskaps Akademiens Handlingar*, **1**, No. 13, 1–28.

CLEVE, P. T. *and* GRUNOW, A. 1880. Beitrage zur kenntniss der artishen diatomeen. *Kongliga Svenska Vetenskaps-Akademiens Handlingar*, **17**, 121 pp and 7 plates.

CLEVE-EULER, A. 1951–1955. Die diatomeen von Schweden und Finnland. *Kongliga Svenska Vetenskaps-Akademiens Handlinger*, Serien **1–5**, 959 pp. Stockholm.

FUKUSHIMA, H. 1965. Preliminary report on diatoms from South Georgia. J.A.R.E. 1956–1962. *Scientific Report*, Ser. E, **24**, 12 pp.

GIFFEN, M. H. 1970. New and interesting marine and littoral diatoms from Sea Point near Cape Town, South Africa. *Botanica Marina*, **13**, 87–99.

GRUNOW, A. 1878. Algen und diatomaceen aus dem Kaspischen Meere. Dr O. Schneider's naturwissen. Beitrage zur kenntniss der kaukasusländer. *Sitzunger der naturw. Gesellschaft. "Isis" zu Dresden, S.*, 100–33, Taf. 3–4 (Separat-Abdruck), 36 pp.

HASLE, G. R. 1965. *Nitzschia* and *Fragilariopsis* species studied in the light and electron microscope. III. The Genus *Fragilariopsis*. *Skrifter norske Videnskaps-akademi I Matematisk-naturvidenskabelig Klasse*, N.S. 16, **21**, 1–49.

HASLE, G. R. 1972. *Fragilariopsis* Hustedt as a section of the genus *Nitzschia* Hassall. (*In* SIMONSEN, R., *ed. Beihefte Zur Nova Hedwigia*, **39**, 111–17. Germany, Cramer.)

HEIDEN, H. *and* KOLBE, R. W. 1928. Die marinen Diatomeen der deutschen südpolar expedition 1901–1903, **8**, 5.

HENDEY, N. I. 1937. The plankton diatoms of the southern seas. '*Discovery*' *Reports*, **14**, 151–364 and 7 plates.

HENDEY, N. I. 1964. An introductory account of the smaller algae of British coastal waters. V. Bacillariophyceae diatoms. *Ministry of Agriculture, Fisheries and Food. Fishery Investigations Series*, **4**, 317 pp. H.M.S.O., London.

HENDEY, N. I. 1977. The species diversity index of some inshore diatom communities and its use in assessing the degree of pollution insult on parts of the north coast of Cornwall. *Nova Hedwigia*, **54**, 355–78.

HUSTEDT, F. 1930. *Die Süsswasser-flora mitteleuropas*, Heft 10, *Bacillariophyta* (*Diatomeae*), ed. A. Pascher, 466 pp. Jena.

HUSTEDT, F. 1959. Die kieselalgen Deutschlands, Oesterreich und der Schweiz, *Rabenhorst Kryptogamenflora*, **7**, part 1 920 pp., part 2 576 pp.

HUSTEDT, F. 1939. Diatomeen aus der Antarktis, und dem Südatlantik. *Deutsche Antarktisch Expedition 1938–1939 Ergebnisse*, 91 pp.

KOBAYASHI, T. 1965. VI. Variations in *Achnanthes brevipes* Agardh. var. *Arctica* P. T. Cleve Kobayashi. J.A.R.E. 1956–1962. *Scientific Report*, Ser. E, **24**, 9 pp.

LANGE-BERTALOT, H. *and* RUPPEL, M. 1980. A revision of some taxonomically most problematic groups in *Achnanthes*, important from the ecological point of view. *Archiv für Hydrobiologie* (supplement), **60**, 1–31.

MANGUIN, E. 1960. Les diatomées de la Terre Adélie campagne de 'Commandant Charcot'. *Annales des Sciences Naturelles* (*Botanique*), **12**, 223–363.

MANN, D. G. 1982. Structure, life history and systematics of *Rhoicosphenia* (Bacillariophyta). I. The vegetative cell of *Rh. curvata*. *Journal of Phycology*, **18**, 162–76.

MEDLIN, L. K. *and* ROUND, F. E. 1986. Taxonomic studies on marine gomphonemoid diatoms. *Diatom Research* **1**, No. 2, 205–25.

PERAGALLO, M. 1921. *Diatomées d'eau douce et diatomées d'eau salée*. Deuxième expédition Antarctique Française, 1908–1910. Science Naturelles: Documents Scientifique Botanique.

PRIDDLE, J. *and* FRYXELL, G. R. 1985. *Handbook of the common plankton diatoms of the Southern Ocean: Centrales except the genus Thalassiosira*. Cambridge, British Antarctic Survey. 159 pp.

SCHMIDT, A. 1874–1959. *Atlas der diatomeenkunde*, Heft 1–105. Leipzig: R. Reisland.

VAN HEURCK, H. 1880–5. *Synopsis des diatomées de Belgique*. Anvers. 235 pp and atlas.

VAN HEURCK, H. 1896. *A Treatise on the Diatomaceae*. London, Wm. Wesley and Son. 558 pp and 35 plates.

WHITAKER, T. M. 1977. *Plant production in inshore waters of Signy Island, Antarctica*. Ph.D. thesis, University of London. 196 pp.

A SPECIES-POOR TESTATE RHIZOPOD FAUNA ON BRABANT ISLAND

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INTRODUCTION

During 1984 and 1985 a Combined Services Expedition took place on Brabant Island, 40 km west of the Antarctic Peninsula (64° 17′ S, 62° 20′ W). In February and March 1984, thirty 1.0–1.5 g samples of vegetated terrestrial materials were collected from peninsulas in the north-western part of the island (Fig. 1) (Morris and others, 1986). These were sealed in Jorgensen bottles with Bouin's fixative for transport to the UK.

The samples were analysed for testate rhizopod by the direct observation method (Couteaux, 1967; Smith, 1978). Quantitative counts were done where possible to estimate the live population density at the time of sampling. Observations on empty tests or recognizable fragments were also used to assemble a species list.

RESULTS AND DISCUSSION

The vegetation of the samples was found to be grass (*Deschampsia antarctica*) or moss (*Drepanocladus uncinatus*) either alone or mixed with *Bryum* sp. or *Pohlia* sp. Microscopical inspection revealed the presence of seven species of testate rhizopod and also of diatom frustules, nematodes, egg cases of tardigrades and arthropod

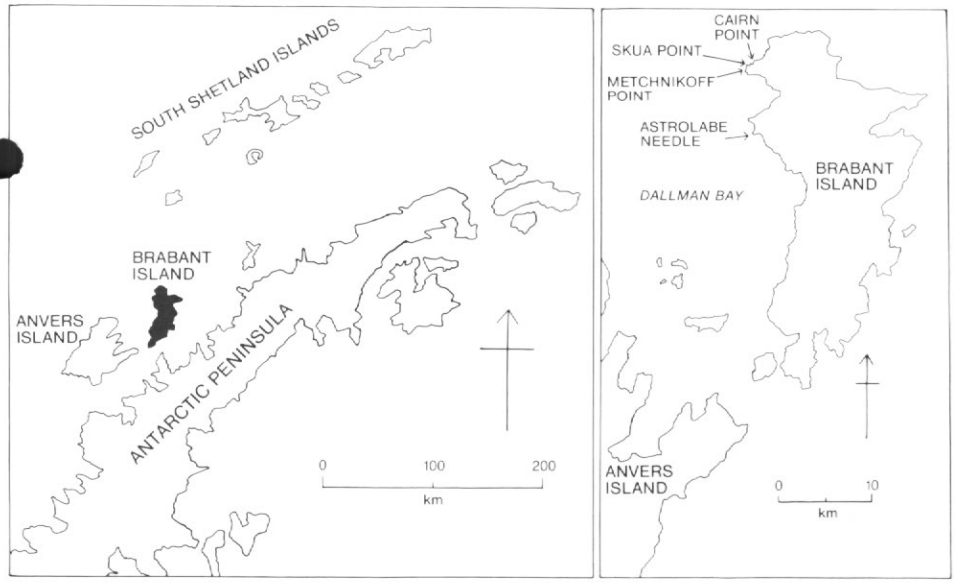

Fig. 1. Sketch maps showing the location of Brabant Island and the sampling sites.

skeleton fragments. The vegetation of the samples and the species of testate rhizopod identified are shown in Table I. In only three samples were testate rhizopods observed in sufficient numbers to make population estimates (numbers g^{-1} fresh weight $\pm$ standard errors from ten replicate counts):

Cairn Point (*Drepanocladus*, *Pohlia*): *Difflugia lucida* 200 ± 80;

Metchnikoff Point (*Drepanocladus*, *Bryum*): *Assulina muscorum* 250 ± 90;

Metchnikoff Point (*Deschampsia*): *Centropyxis aerophila* 360 ± 130.

The species composition of the fauna and the populations recorded are comparable to those in similar habitats at other maritime Antarctic locations (Smith, 1972, 1974, 1986). *Corythion dubium* was recorded infrequently and in only insignificant numbers – a result similar to that obtained from observations on *Drepanocladus* from Rothera Point, Adelaide Island (Smith, 1986). It appears therefore that the position of *C. dubium*, as the dominant or co-dominant species in the testate rhizopod communities of the sub-Antarctic (Grospietsch, 1971; Smith and Headland, 1983) does not extend to the southern parts of the maritime Antarctic.

The observed species-richness is anomalous. In particular the absence of any species of the genera *Nebela*, *Euglypha* or *Trinema* is surprising. Previous records have shown that there is a significant trend of decreasing species-richness in Antarctic testate rhizopod communities with increasing latitude ($r = 0.881$***) (Smith, 1982). That this progressive faunal pauperization is associated with increasing climatic severity is shown by the significant correlation of species-richness with mean January temperature ($r = 0.879$**). This relationship is shown in Fig. 2, in which the regression of species-richness upon temperature indicates a loss of 3.3 species for every 1°C drop in temperature. This trend for the testate rhizopod community as a whole reflects closely that elucidated for the genus *Nebela* (Smith and Wilkinson, in press).

Meteorological records from the Brabant Island Expedition (Oakley and others, 1986) give mean temperatures for the summer months between -0.4 and $+2.9$°C; these are closely comparable to those elsewhere in the maritime Antarctic. Accordingly, a testate rhizopod species-richness of about 20 would be predicted for

Table I. Species of testate rhizopod recorded from Brabant Island.

Location of samples	*Vegetation*	*Number of samples*	*Testate rhizopod fauna*
Astrolabe Needle	*Drepanocladus*	2	*Centropyxis aerophila* *Trigonopyxis arcula* *Phryganella acropodia* *Corythion dubium*
	Deschampsia	2	None detected
Cairn Point	*Drepanocladus*	2	None detected
	Drepanocladus, *Pohlia*	2	*Difflugia lucida* *Phryganella acropodia*
	Deschampsia	2	*Difflugia lanceolata*
Skua Point	*Bryum*	2	*Centropyxis aerophila* *Assulina muscorum*
Metchinkoff Point	*Drepanocladus*	6	*Centropyxis aerophila* *Assulina muscorum*
	Drepanocladus, *Bryum*		
	Drepanocladus, *Pohlia*	2	None detected
	Deschampsia	8	*Centropyxis aerophila* *Difflugia lucida*

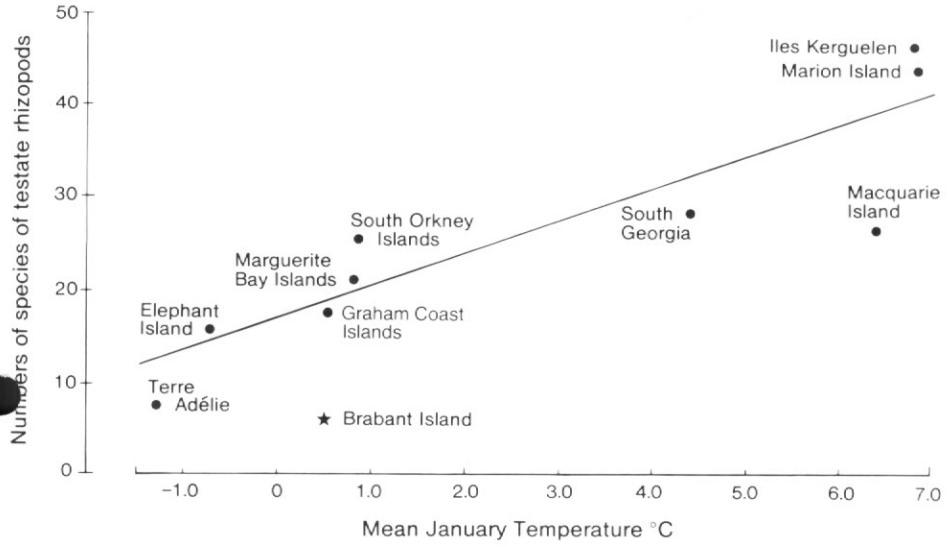

Fig. 2. The relationship of species-richness of Antarctic testate rhizopod communities to mean January temperature. Regression line $y = 17.1 + 3.3x$. ★ indicates the deviant co-ordinate for Brabant Island.

Brabant Island. However, only seven species were recorded. Being based on analyses of 30 samples, it is unlikely that this species-poverty is an artifact of insufficient observations, since it has been shown (Smith and Wilkinson, in press) that at other locations 15 samples are enough to reveal 90% of the species present. Therefore the pauperized nature of the Brabant Island testate rhizopod fauna remains unexplained.

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References

Couteaux, M. M. 1967. Une technique d'observation des Thecamoebiens du sol pour l'estimation de leur densite absolue. *Revue d'Ecologie et biologie du Sol*, **4**, 593–6.

Grospietch, Th. von 1971. Beitrag zur Okologie der Testacees Rhizopoden von Marion Island. (*In* van Zinderen-Bakker, E. M., Winterbottom, J. M. *and* Dyer, R. A. *eds. Marion and Prince Edward Islands, Report on the South African Biological and Geological Expedition, 1965–1966*. Cape Town, A. A. Balkema, 411–19.)

Morris, J., Beattie, J. *and* Martin, S. 1986. Terrestrial Invertebrates. (*In* Furse, J. R. C. *ed. Joint Services Expedition to Brabant Island, Antarctica, 1983–1985*. London, Ministry of Defence, Appendix 1K, 69.)

Oakley, H., Hankinson, W. *and* Taylor, S. 1986. Meteorology. (*In* Furse, J. R. C. *ed. Joint Services Expedition to Brabant Island, Antarctica, 1983–85*. London, Ministry of Defence. Appendix 1E, 63–4.)

Smith, H. G. 1972. The terrestrial Protozoa of Elephant Island, South Shetland Islands. *British Antarctic Survey Bulletin*, No. 31, 55–62.

SMITH, H. G. 1974. A comparative study of the Protozoa inhabiting *Drepanocladus* moss carpet in the South Orkney Islands. *British Antarctic Survey Bulletin*, No. 38, 1–16.

SMITH, H. G. 1978. The distribution and ecology of terrestrial Protozoa of sub-Antarctic and maritime Antarctic islands. *British Antarctic Survey Scientific Reports*, No. 95, 104 pp.

SMITH, H. G. 1982. The terrestrial protozoan fauna of South Georgia. *Polar Biology*, **1**, 173–9.

SMITH, H. G. 1986. The testate rhizopod fauna of *Drepanocladus* moss carpet near Rothera Station, Adelaide Island. *British Antarctic Survey Bulletin*, No. 72, 77–9.

SMITH, H. G. *and* HEADLAND, R. K. 1983. The population ecology of soil testate rhizopods on the sub-Antarctic island of South Georgia. *Revue d'Ecologie et de Biologie du Sol*, **20**, 269–86.

SMITH, H. G. *and* WILKINSON, D. M. In press. Biogeography of testate rhizopods in the southern temperate and Antarctic zones. *Revue d'Ecologie* (*Terre et Vie*), Paris.