OBSERVATIONS ON TESTATE AMOEBAE (PROTOZOA: RHIZOPODA) FROM SIGNY ISLAND, SOUTH ORKNEY ISLANDS

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ABSTRACT. Eighteen species of Testacea have been found in four soils from Signy Island. One species, *Corythion dubium*, constituted about 80 per cent of the population. In *Deschampsia* grassland the numbers of live Testacea were estimated at $890 \pm 150 \times 10^6$/m.^{2} with an approximate biomass (live weight of protoplasm) of 2·0 g./m.^{2}.

DURING February 1962, 170 soil samples were collected by Dr. M. W. Holdgate on Signy Island, South Orkney Islands (lat. 60°43′S., long. 45°38′W.). The samples were transported in a refrigerated condition to England and the present paper describes the Testacea (Protozoa) found in them.

Holdgate (1964) gives a preliminary account of the vegetation and climate of the island, and full descriptions of the soils and their chemical constituents are being prepared by M. W. Holdgate, S. E. Allen and J. B. Cragg, and by M. J. G. Chambers. The samples examined were briefly: Series L, *Deschampsia antarctica* turf over fibrous peat or loam, pH 4·8–5·6; Series K, granular marble soil with very little or no vegetation, pH 6·0–8·5; Series D, *Polytrichum* and *Dicranum* over fibrous peat, pH 4·3–4·7; Series N, *Polytrichum* over fibrous peat, pH 4·6–5·2.

METHODS

Cultures for qualitative examination were prepared by adding about 0·5 g. of soil or moss to soil extract in 10 cm. petri dishes. These were examined for Testacea after about one month at room temperature (12–18° C).

For direct quantitative examination of the soil a method based on Jones and Mollison (1948) was used. Agar films containing a dilute suspension of a known quantity of soil were made, stained and the number of Testacea/film counted. From these counts, numbers/g. and numbers/m.^{2} were estimated. The two methods are fully described by Heal (1964).

RESULTS

Composition of fauna

Eighteen species and varieties of Testacea were recorded by the two methods (for details see Table I). All the recorded species are known from temperate soils where most of them occur regularly and the composition of the fauna is not markedly different from that of soils in Great Britain. One group of Testacea, however, whose absence is noticeable is the *Nebela–Heleopera–Hyalosphenia* group. These are common in organic soils and horizons, and in moss, and might have been expected to occur in Series L, D and N, but only a single empty test of *Nebela* sp. was observed. The scarcity of *Nebela* species under similar conditions was recorded by Penard (1911, 1913), who also noted that cultures from Antarctic samples never developed large numbers of organisms, a feature observed in the present study.

The *Deschampsia* grassland samples were given the most thorough examination and all 18 species were recorded in this soil. The number of species recorded is compared with samples of three northern English soils in Table II, the number of Jones and Mollison films and cultures being the same for all soils. The results indicate a slightly lower number of species occurring in the Antarctic soil. The figures for soils of Series K, D and N (Table I) also suggest a fauna with a restricted number of species, although relatively few samples were taken from these soils.

From the data obtained from Jones and Mollison films, the proportion of various species in the population can be estimated (Table III). The commonest species in the *Deschampsia* soil was *Corythion dubium* which comprised 72 per cent of the live individuals observed. If the results from sites D, K and N are included, 82 per cent of the total of 91 live individuals

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TABLE I. TESTACEA RECORDED FROM SIGNY ISLAND SOILS
+ empty tests (dead); ++ full tests (live).

Series	*L*		*K*		*D*		*N*	
Cultures: number	20		6		10		8	
Jones and Mollison Method — Number of samples	7		4		3		4	
Jones and Mollison Method — Number of films	30		16		20		16	
	J. & M.	*Culture*	*J. & M.*	*Culture*	*J. & M.*	*Culture*	*J. & M.*	*Culture*
Assulina muscorum Greeff	+					+	+	+
Corythion dubium Taraneck	++	++	++		++	++	++	++
Centropyxis aerophila Deflandre	++	++						
C. aerophila sphagnicola Deflandre	++	+						+
C. minuta Deflandre		+						
Cryptodifflugia eboracensis Wailes		+						
Cyclopyxis sp.	+							
Difflugia lucida Penard		++						
Euglypha laevis (Ehrenberg) Perty*	++	++			++	+	+	+
E. rotunda Wailes *sensu stricto*		++						
E. ciliata (Ehrenberg) Leidy		++						
E. ciliata v. *glabra* Wailes	++						+	+
E. strigosa v. *glabra* Wailes	++						+	
Nebela sp.†		+						
Parmulina cyathus Penard	+	+						
Phrynganella hemispherica Penard	++	++	++	++				
Trinema lineare Penard		+		++				+
T. enchelys (Ehrenberg) Leidy	+			++				
	11 13		2 3		2 3		5 6	
	18		4		3		7	
	18							

* Probably includes some *E. rotunda*.
† Nr *N. collaris*, length 102 μ, breadth 58 μ.

TABLE II. THE NUMBER OF SPECIES RECORDED IN *Deschampsia* GRASSLAND, SIGNY ISLAND, COMPARED WITH THREE TEMPERATE SOILS FROM ENGLAND

	Jones and Mollison (30 films)	*Cultures* (20)	*Total Number of Species Recorded by the Two Methods*
Deschampsia grassland (Series L)	11	13	18
Limestone grassland*	14	20	28
Juncus squarrosus moor*	18	17	23
Woodland acid moder on slate†	14	16	20

* At Moor House National Nature Reserve, Westmorland; for site details see Cragg (1961).
† At Roudsea Wood National Nature Reserve, Lancashire; for site details see Bocock and others (1960).

TABLE III. THE PROPORTION OF INDIVIDUAL SPECIES RECORDED BY THE JONES AND MOLLISON METHOD

	Deschampsia		*Series D, K and N*	
	Number of Full Tests	*Per cent*	*Number of Full Tests*	*Per cent*
Corythion dubium	33	72	42	93
Euglypha laevis	7	15	2	4
Phrynganella hemispherica	2	4	1	2
Centropyxis aerophila	1	2		
C. aerophila sphagnicola	1	2		
Euglypha ciliata v. *glabra*	1	2		
E. strigosa v. *glabra*	1	2		
TOTAL	46		45	

For the *Deschampsia* grassland (Series L) 30 films were examined; for Series D, K and N a total of 52 films were examined.

were of this species. This species is one of the most widely distributed of all Testacea but it is unusual for this, or any other species, to form such a large proportion of the population. In the Moor House limestone grassland and *Juncus squarrosus* moor, and Roudsea Wood slate soils (see Table II), *C. dubium* constituted 9, 39 and 32 per cent of the population, respectively.

Numbers and biomass

From the *Deschampsia* grassland, the numbers of Testacea/g. were estimated using the Jones and Mollison method. These figures have been converted to numbers/cm.^{3} and numbers/m.^{2} using a volume : dry weight ratio of 1 : 0·20 based on measurement of five samples. These results are compared with estimates from temperate soils in Table IV. The

TABLE IV. THE NUMBERS OF TESTACEA RECORDED FROM *Deschampsia* GRASSLAND COMPARED WITH TEMPERATE SOILS FROM ENGLAND

		Number/g. Dry Soil ± Standard Error × 10^3	*Number/cm.^{3} ± Standard Error × 10^3*	*Number/m.^{2} ± Standard Error × 10^6*
Deschampsia grassland	0–8 cm.	40±7	9±2	890±150
Limestone grassland*	0–3 cm.	69±5	7±1	448±76
	3–6 cm.	9±2	7±2	
Juncus squarrosus moor*	0–3 cm.	32±6	4±1	195±58
	3–6 cm.	25±11	3±1	
Woodland acid moder on slate*	0–3 cm.	31±4	6±1	188±42† to 465±71
	3–6 cm.	4±1	2±1	
Woodland acid moder on slate‡	—	—	—	888 and 1,050
Woodland mull on limestone‡	—	—	—	505

* See footnote to Table II.
† Range of seasonal variation, March–September.
‡ From Heal (1964).

numbers of Testacea in Antarctic and temperate soils are in the same range and no significance can be attached to the differences because of lack of seasonal sampling. The Antarctic samples also contain a higher proportion of small species. Fewer samples were examined from the other Antarctic soils but the number of full tests recorded in the moss samples (Series D and N) were of the same order: $10–29 \times 10^3$ and $10–150 \times 10^3$/g. dry soil, respectively. The marble soil (Series K) gave very low figures for both live individuals and empty tests ($0–2 \times 10^3$/g. dry soil). Numbers of empty tests in the *Deschampsia* grassland were of the order of 100×10^3/g. dry soil or 2×10^9/m.^{2}. Similar numbers occur in the temperate soils mentioned above.

From the above information it is possible to obtain an approximate estimate of the biomass (live weight)/m.^{2} (Table V). These results are obviously tentative, particularly because the

TABLE V. ESTIMATES OF BIOMASS (LIVE WEIGHT) OF TESTACEA FROM *Deschampsia* GRASSLAND

	Number/m.$^2 \times 10^6$	*Estimated Biomass* (mg.) *of* 10^6 *Individuals**	*Biomass* (mg.)/m.^{2}
Corythion dubium	641	1·1†	705
Euglypha laevis	134	0·9‡	120
Phrynganella hemispherica	36	0·9§	32
Centropyxis aerophila	18	16·7‖	601
C. aerophila sphagnicola	18		
Euglypha ciliata v. *glabra*	18	16·0¶	576
E. strigosa v. *glabra*	18		
TOTAL	883		2,034

* Based on volume of protoplasm $= \frac{4}{3} \pi abc$, where a, b, c are radii of the axes of the protoplasm. Diameters (in μ) of individual species are: † $24 \times 10 \times 9$; ‡ $22 \times 10 \times 8$; § $12 \times 12 \times 12$; ‖ $40 \times 40 \times 20$; ¶ $24 \times 16 \times 10$.

presence or absence of rare species can greatly affect the estimate, the common species being relatively small in size (Table V). The biomass of 2·0 g./m.^{2} is slightly lower than preliminary unpublished estimates from temperate soils, again because small species form a larger proportion of the population than they do in temperate soils.

DISCUSSION AND CONCLUSIONS

The results indicate that the soils of Signy Island contain slightly fewer species of Testacea than temperate woodland and moorland soils. Although this difference is not very marked, the dominance of a single species, *Corythion dubium*, is outstanding. In his Antarctic studies, Penard used direct observation rather than culture methods and similarly noted fewer species than he found in temperate samples. He recorded 24 species in a wide range of samples collected from sites in the South Shetland Islands–Graham Land area, in some of which climatic conditions were slightly more severe than those in the present study area (Penard, 1913). Only 13 species of Testacea were recorded in soil and moss from much more extreme climatic conditions at Ross Island, southern Victoria Land (Penard, 1911).

The total number of live animals in Signy Island soils did not differ significantly from those in north temperate samples. This is contrary to Penard (1911, 1913), who commented on the small numbers of individuals, especially in the extreme conditions at Cape Royds, Ross Island (Penard, 1911). Janetschek (1963) also records low animal biomass but again the conditions (at McMurdo Sound) are more extreme than those in the present area surveyed.

The fact that all the species of Testacea recorded in the present survey are known from north temperate regions suggests a lack of geographical zonation, but the results also indicate

that certain species are missing from the fauna. Because of their small size and ability to form resistant cysts, most Protozoa, especially soil forms, are readily transported throughout the world. There is therefore little or no zonation resulting from geographical barriers, although Elliott and others (1962) found zonation in American and European ciliate varieties and mating types. It is, however, possible that geographical zonation exists because of physiological differences such as stenothermy or ecological differences in the availability of habitats such as mature soils. Provasoli (1958) also suggests that nutritional requirements may vary in relation to temperature, which may cause Protozoa to live in different habitats in different parts of their geographical range. The patterns of geographical distribution within the Testacea are therefore probably too subtle to be recognized in our present state of knowledge and technique.

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