PROTOZOA OF SIGNY ISLAND FELLFIELDS

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Abstract. Twenty-one species of Protozoa (eleven flagellates, nine ciliates, one testate rhizopod) were identified in samples of twelve materials from four fellfield sites on Signy Island. The numbers of species in each material were positively correlated with percentage loss on ignition and, in the materials with low moisture and organic content, with pH also. Using similarity coefficient analysis it proved possible to ordinate the materials in a sequence which represented a series of protozoan communities of increasing species diversity and composed of species of increasing average dimensions.

Introduction and Methods

In February 1981 seven sites on Signy Island, South Orkney Islands, each occupying an area of at least 5000 m^2, were selected for investigation of the processes of biological colonization, adaptation and ecological succession in Antarctic fellfields (BAS, 1981, 1982). Protozoa are known to be a major component of the heterotroph communities of continuous moss-dominated ecosystems in the maritime Antarctic (Davis, 1980) and are also amongst the pioneer colonizers of newly deposited volcanic tephra (Smith, 1974), where their species diversity is correlated with the moisture and organic content of the habitat. It seems likely, therefore, that Protozoa will have a significant role in the biotic processes occurring in Antarctic fellfields, reflecting the degree of development of the physical structure of the habitat and of the microflora on which they graze. This paper reports initial observations on the protozoan fauna of materials collected from four of the Signy Island fellfield sites on 29 and 30 January 1982 (Fig. 1). At each site, three types of material were sampled: one was of fines lacking macroscopic vegetation, the other two included lichens or moss cushions as well as underlying organic material and mineral matter (Table I). The materials were stored in polythene containers at 4°C during transport to the United Kingdom.

The moisture, loss on ignition and pH of the twelve were measured; the composition of the protozoan fauna determined by direct microscopy of cultures of the materials on non-nutrient agar, with *Aerobacter aerogenes* (NCIB 418) as food supply, flooded with ¼-strength Ringer solution. Full details of the methods are given by Smith (1978).

The matrix of presence–absence of species in the materials was analysed by calculating Sørenson's similarity coefficient for all pairs of materials:

$$\text{Percentage } S = \frac{2c}{a + b} \times 100$$

where: a = total number of species in material a,
b = total number of species in material b,
c = number of species common to materials a and b.

A similarity matrix of the twelve materials was thus produced. The sequence of the materials along the similarity matrix axes was then progressively altered by

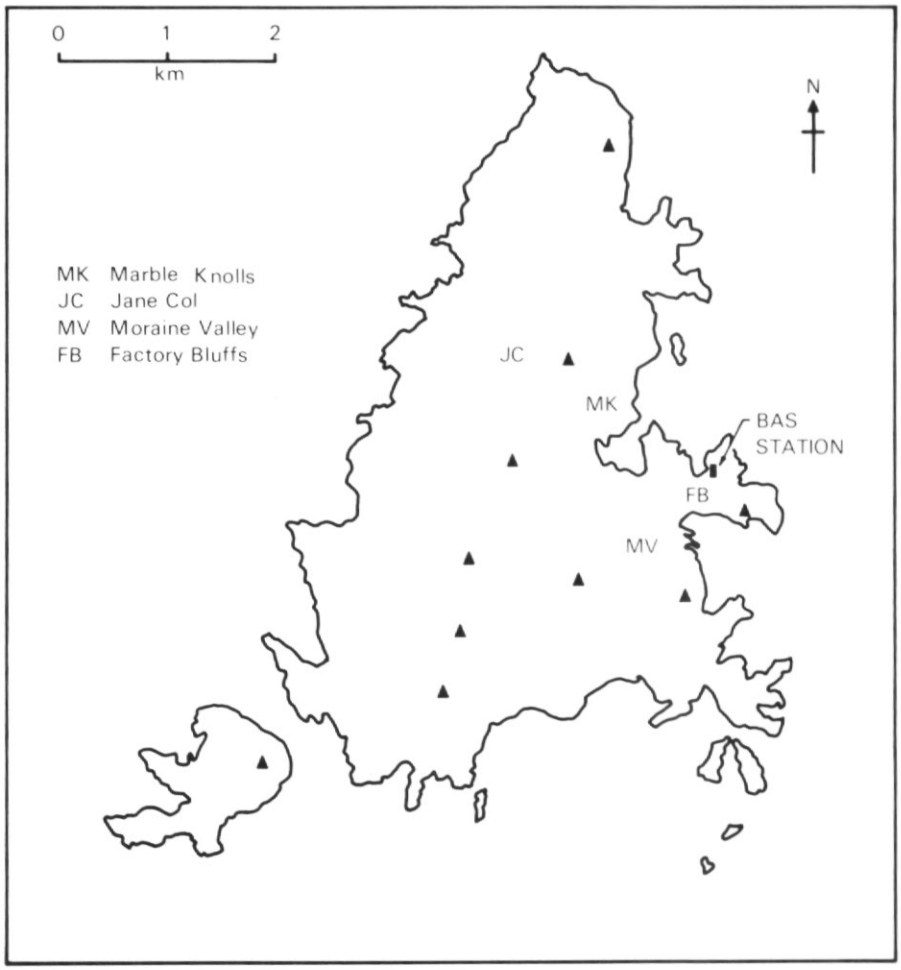

Fig. 1. Map of Signy Island, South Orkney Islands, showing the location of fellfield sites sampled. ▲: hill >60 m a.s.l.

Table I. List of fellfield materials collected on Signy Island.

Code	*Location of site*	*Nature of material*
MK1	Marble Knolls	Polygon fines
MK2	Marble Knolls	*Andreaea* cushion
MK3	Marble Knolls	Lichens and moss in fines
JC1	Jane Col	Polygon fines
JC2	Jane Col	*Polytrichum alpinum* cushion
JC3	Jane Col	Lichen and *Drepanocladus* moss
MV1	Moraine Valley	Lichen and old *Andreaea* on solifluction lobe
MV2	Moraine Valley	Andreaea cushion in moist hollow
MV3	Moraine Valley	Fines from wet solifluction lobe
FB1	Factory Bluffs	Moist *Drepanocladus*
FB2	Factory Bluffs	*Andreaea* carpet
FB3	Factory Bluffs	Polygon fines

inspection so as to cluster the elements with the highest values of similarity coefficient along the principal diagonal. The sequence of materials so obtained was used to reconstruct the presence–absence matrix of species in materials such that the species were listed vertically in the order of their first occurrence in the horizontal sequence of materials.

Results and Discussion

Twenty-one protozoan species were identified from the fellfield materials:

MASTIGOPHORA
- *Oikomonas termo* Ehrenberg
- *Polypseudopodius bacterioides* Puschkarew
- *Petalomonas angusta* var. *pusilla* (Klebs) Lemmermann
- *Bodo edax* Klebs
- *Bodo saltans* Ehrenberg
- *Cercobodo agilis* Martin
- *Cercobodo vibrans* Sandon
- *Cercomonas crassicauda* Alexeieff
- *Cercomonas longicauda* Stein
- *Heteromita compressa* Lemmerman
- *Sainouron mikroteron* Sandon

RHIZOPODA TESTACIDA
- *Corythion dubium* Taranek

CILIATA
- *Enchelys* sp. Hill
- *Lacrymaria* sp. Ehrenberg
- *Leptopharynx sphagnetorum* (Levander) Mermod
- *Colpidium colpoda* (Ehrenberg) Stein
- *Glaucoma pyriformis* Ehrenberg
- *Euplotes* sp. Ehrenberg
- *Gonostomum affine* Stein
- *Pleurotricha lanceolata* (Ehrenberg) Stein
- *Tachysoma pellionella* (Muller–Stein) Ehrenberg

The similarity matrix of the twelve materials, based on the occurrence of protozoan species in them, is shown in Fig. 2. The sequence along the axes is such that, as far as possible, pairs of materials with high similarity are located adjacent to one another. The results indicate that the fauna of the three materials from Marble Knolls show strong mutual similarity, as do those of the three from Jane Col. At the Moraine Valley and Factory Bluffs sites, however, the fauna of the vegetation-free fines materials (MV3 and FB3) show little similarity to those of the materials at the same sites containing moss or lichen.

The species composition of each material is shown as a reconstructed presence–absence matrix in Fig. 3. The materials are ordinated horizontally in the sequence produced by the similarity analysis (Fig. 2), and the species are listed vertically in order of their first occurrence in the materials. Also shown in Fig. 3 are the pH, moisture content, loss on ignition and numbers of protozoan species for each material. It is apparent that there exists some measure of association between the species diversity and composition of the protozoan communities inhabiting these materials and the materials' physical properties. The sequence of materials represents a trend of increasing species diversity and, at the right hand end, of

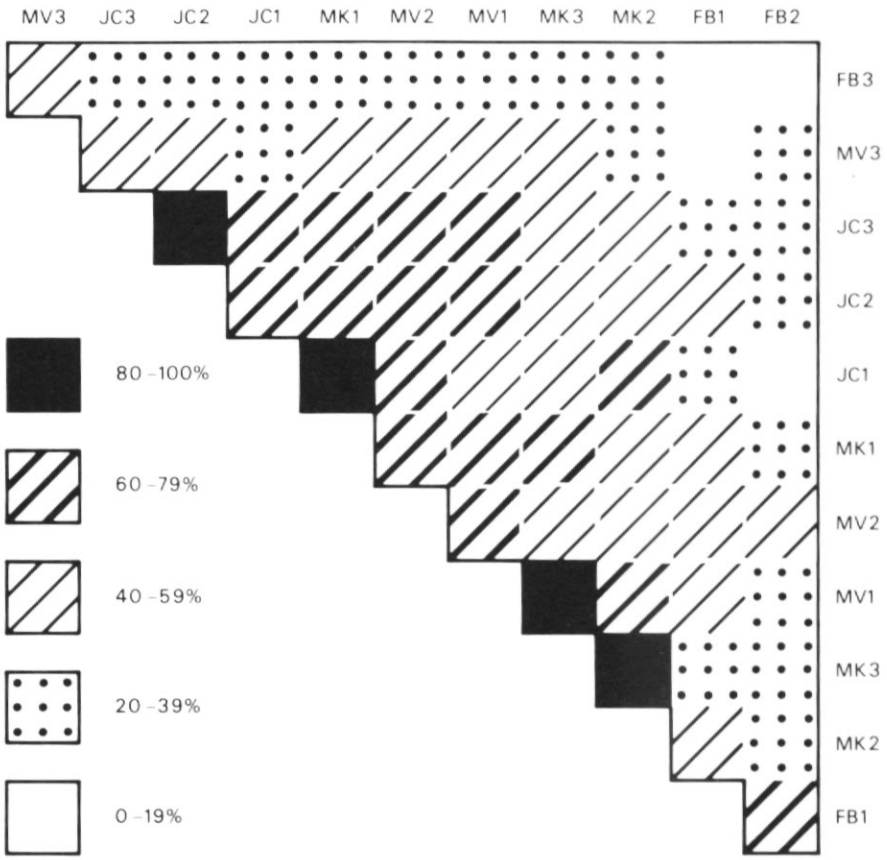

Fig. 2. Similarity coefficients matrix of twelve fellfield materials based on their protozoan fauna.

increasing moisture content and loss on ignition. pH shows initially an increasing trend, then decreases in the materials with higher moisture content and loss on ignition. The degree of association between numbers of species and the physical variables is indicated by values of Spearman's rank correlation coefficient:

With percentage moisture:	$r_s = 0.568$, $P < 0.1$	NS
With percentage loss on ignition:	$r_s = 0.860$, $P < 0.001$	***
With pH (all materials):	$r_s = 0.390$, $P < 0.03$	NS
With pH (materials with $\leq 10\%$ loss on ignition):	$r_s = 0.762$, $P < 0.05$	*

These values suggest that in free-draining fellfield materials with very low organic content, pH is an important factor determining protozoan species composition, but that as organic matter accumulates and water retention capacity increases, so moisture and organic content become important influences. These results are consistent with observations made on the numbers of species colonizing volcanic tephra on Deception Island, South Shetland Islands, where similar relationships were found (Smith, 1974).

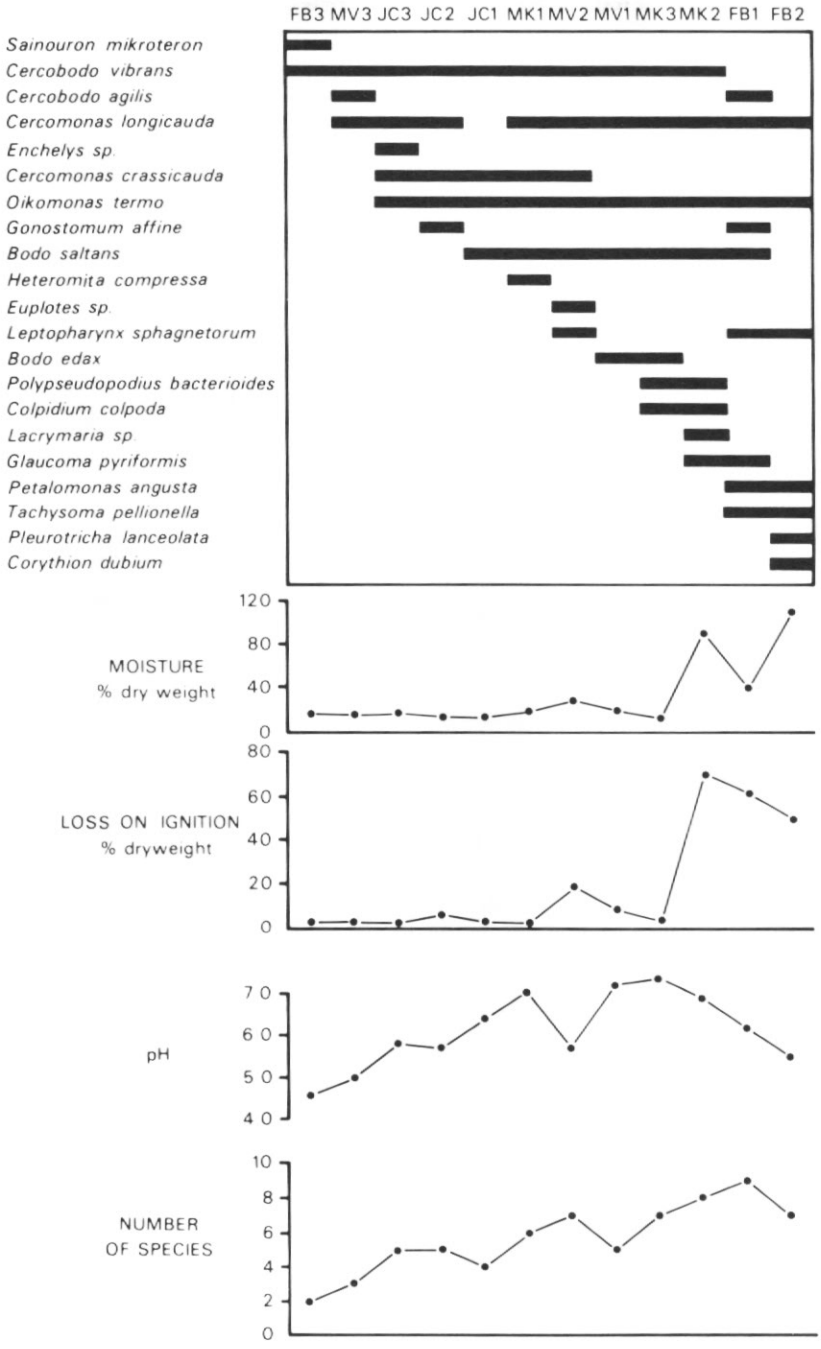

Fig. 3. Reconstructed presence–absence matrix of 21 species of Protozoa in twelve fellfield materials, with their physical properties.

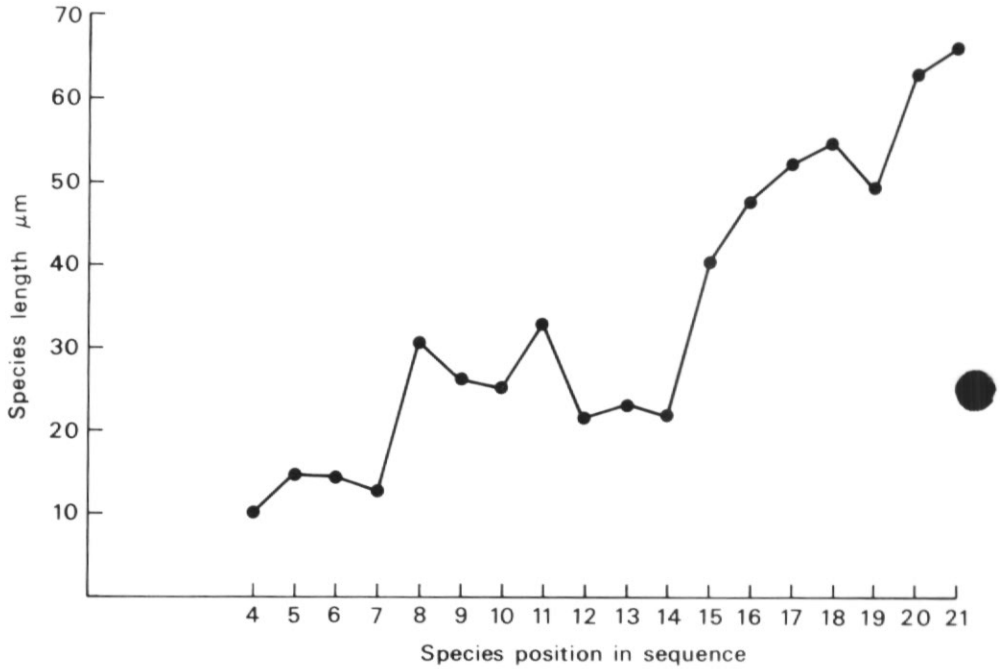

Fig. 4. Relationship between protozoan species' dimensions (four-species running mean) and their position in vertical sequence derived from the similarity analysis.

The vertical sequence of species (Fig. 3) indicates the manner in which the species composition, as well as diversity, of the protozoan communities of the materials varies. The dimensions of consecutive species show irregular variation, but if these are smoothed by plotting four-species running mean lengths against position in the sequence (Fig. 4), a trend is apparent. The general pattern is for the smaller flagellate and ciliate species to be concentrated at the top of the list and the larger ones, together with the single species of testate rhizopod observed (*Corythion dubium*), at the end.

It is thus possible that the sequence of fellfield materials, produced by the similarity analysis, represents a successional series from raw materials with very little moisture and negligible organic matter, inhabited by very few protozoan species, through gradients of increasing moisture and organic matter accumulation, characterized by increasingly diverse protozoan communities composed of species of increasing average dimensions.

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