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THE MEIOFAUNA OFF THE COAST OF NORTHUMBERLAND

I. THE STRUCTURE OF THE NEMATODE POPULATION

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(Text-figs. 1–7)

The nematode fauna of three areas off the Northumberland coast has been examined both qualitatively and quantitatively. The three stations differ from one another in their sediment composition. The population density at the inshore station was considerably lower than that of the middle and offshore stations, and the density at these last two stations compared favourably with values obtained from similar habitats in Buzzards Bay and from two Scottish grounds. Some species are shown to be eurytopic over the range of habitats studied, whilst others have an affinity for either silt or sand. The faunal heterogeneity is higher in the sandy sediments than the silty ones, and the two extreme habitats with regard to granulometric composition have the least faunal affinity. Species composition depends on the sediment type rather than the water depth. Plots of the frequency distribution of species at all three stations follow quite closely the logarithmic series, and Williams's Index of Diversity (α) has been calculated. It is highest at the sandiest station and lowest at the most silty one. The species frequency, however, shows a slightly closer fit to the log normal distribution, at least for two of the stations. The distribution of species in replicate cores from the same station is shown to follow closely the logarithmic series, and an index of specific variability between replicates has been calculated which is again much higher at the sandy station. A decrease in diversity with an increase in the silt-clay fraction is explained on the theory that more ecological niches are present in sandy habitats. The distribution of feeding types is roughly the same at all three stations. A *Dorylaimopsis punctatus—Leptolaimus elegans—Sabatieria cupida* community is thought to be of common occurrence in silty sediments round Northern Britain.

INTRODUCTION

Although nematodes form the dominant meiofaunal group in almost all marine sediments, ecological investigations have been confined mainly to littoral or shallow water habitats. Among these studies may be included those of Wieser (1959), Gerlach (1953, 1954), Capstick (1959), King (1962), Riemann (1966) and Hopper & Meyers (1967). The qualitative distribution of the nematode fauna of various types of substrates in Kiel Bay and from the

Chilean Coast have been discussed by Gerlach (1958) and Wieser (1959*a*). The only work which contains both qualitative and quantitative data from offshore substrates is that of Wieser (1960), which concerns the shallow sediments (12–30 m) in Buzzards Bay, Massachusetts, and contains a review of the purely quantitative results of previous authors. He found that two distinct meiofaunal communities were present; one characteristic of sandy

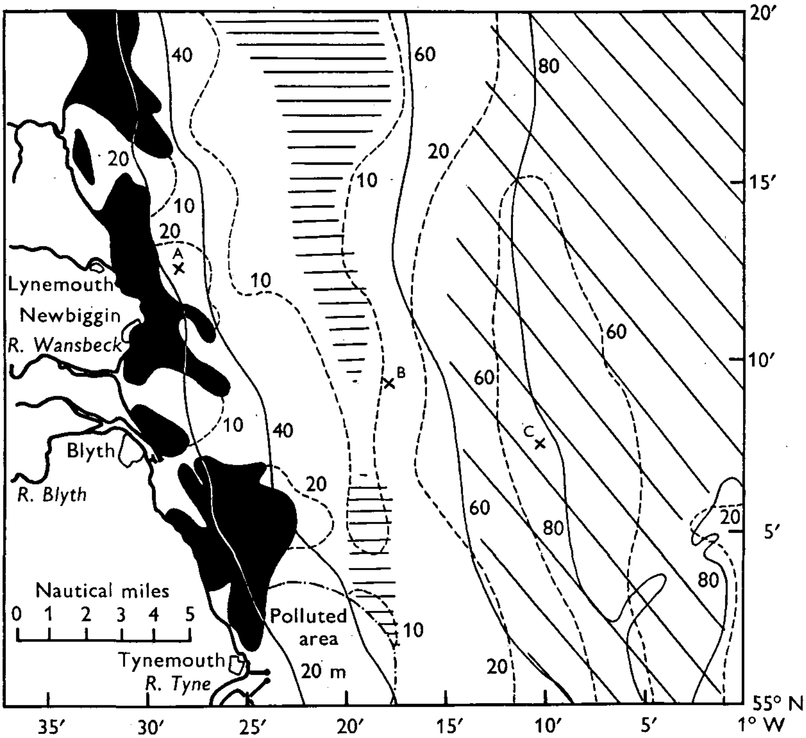

Fig. 1. Map of the area showing positions of the sampling stations. The broken lines join points of equal silt-clay percentage, and the solid lines indicate the depth contours (at 20 m intervals). Rock, ■; very fine sand (62–125 μ), ▧; (fine sand (125–250 μ), □; medium sand (250–500 μ), ▤(Based on Buchanan, 1963).

habitats, the *Odontophora-Leptonemella* community, and one of silty habitats, the *Terschellingia longicaudata-Trachydemus mainenesis* (Kinorhynch) community. In terms of numbers, nematodes represented 89–99% of the total fauna. McIntyre (1964), in a study of the meiobenthos of the muddy Fladen and Loch Nevis grounds off the Scottish coast, found that nematodes comprise 61–97% of the total. He did not identify any nematodes but in an earlier paper (1961) stated that the families Oncholaimidae and Comesomatidae comprised more than half the individuals, and in the latter family *Dorylaimopsis punctatus* Ditlevsen and *Sabatieria cupida* Bresslau and Schuurmans Stekhoven were prominent. Recently the ecology of the benthic meiofauna has been reviewed by McIntyre (1969).

In view of the large total biomass of the nematodes and the possibility that they may produce several generations in a year, it seems important that their production should be studied. To this end a qualitative and quantitative survey of three stations off the Northumberland coast was begun in October 1968 and in this paper the results are presented of a preliminary survey to determine the structure of the communities. Many species proved to be either new or poorly known, and for this reason many identifications are to genus or family level only. One new species from the area has already been described as *Synonchiella riemanni* (Warwick, 1970), and a more detailed taxonomic account of the remainder will be given in a later publication.

This paper is the first of a series resulting from the benthic productivity programme being conducted at this laboratory with financial support from the Natural Environment Research Council. It is intended that this series will cover general aspects of meiofaunal distribution as well as more detailed accounts of individual groups of animals.

MATERIALS AND METHODS

The three stations selected for sampling were an inshore station 2 miles east of Lynemouth (Station A, depth 35 m), a middle station 7½ miles east of the mouth of the River Wansbeck (Station B, depth 54 m), and an offshore station 11 miles east of Blyth (Station C, depth 80 m). The positions of these stations are shown on a map of the area (Fig. 1) in which the distribution of sediment types is indicated. The composition of the sediment at the three sampling stations is graphed in Fig. 2. At Station A the sediment has a median diameter of 0·103 mm ('very fine sand' on the Wentworth grade scale), but is rather peculiar in that much of the coarser fractions consist of coal dust and broken shell fragments. It is a poorly sorted sediment with a Phi quartile deviation (QDϕ) of 0·915, and the Phi quartile skewness (SKqϕ) is strongly positive (+ 1·19) indicating that the coarser particles are much better sorted than the finer ones. Station B has a much coarser sediment with a median diameter of 0·145 mm ('fine sand'). It is the best sorted of the three sediments (QDϕ = 0·495) and is only slightly skewed in the positive direction (SKqϕ = + 0·15). Station C has the finest of the three sediments, with a median particle diameter of 0·056 mm ('silt'). The degree of sorting is fairly good (QDϕ = 0·64), but the graph is again positively skewed (SKqϕ = 0·52). The organic content of the sediments could not be determined accurately because of the considerable amounts of coal dust present, particularly at Station A.

The nematode samples were collected with a heavy brass corer round which were fixed four detachable metal tubes about 30 cm long and each with an internal diameter of 1 cm, covering a surface area of 0·78 cm^2. The lower edges of these tubes were sharpened to give better penetration and the upper ends were covered with rubber valves which closed under pressure. The cores of sediment were pushed out of the tubes with a graduated plunger immediately after collection into screw top jars, the top 7 cm only being retained since extremely few nematodes are found below this level. Two sets of cores were taken each time, giving eight replicates in all. The samples were preserved in 4% formalin. Two series of samples have been collected from Stations A and B in October, 1968 and January, 1969, and three series from Station C in October and December, 1968 and March, 1969.

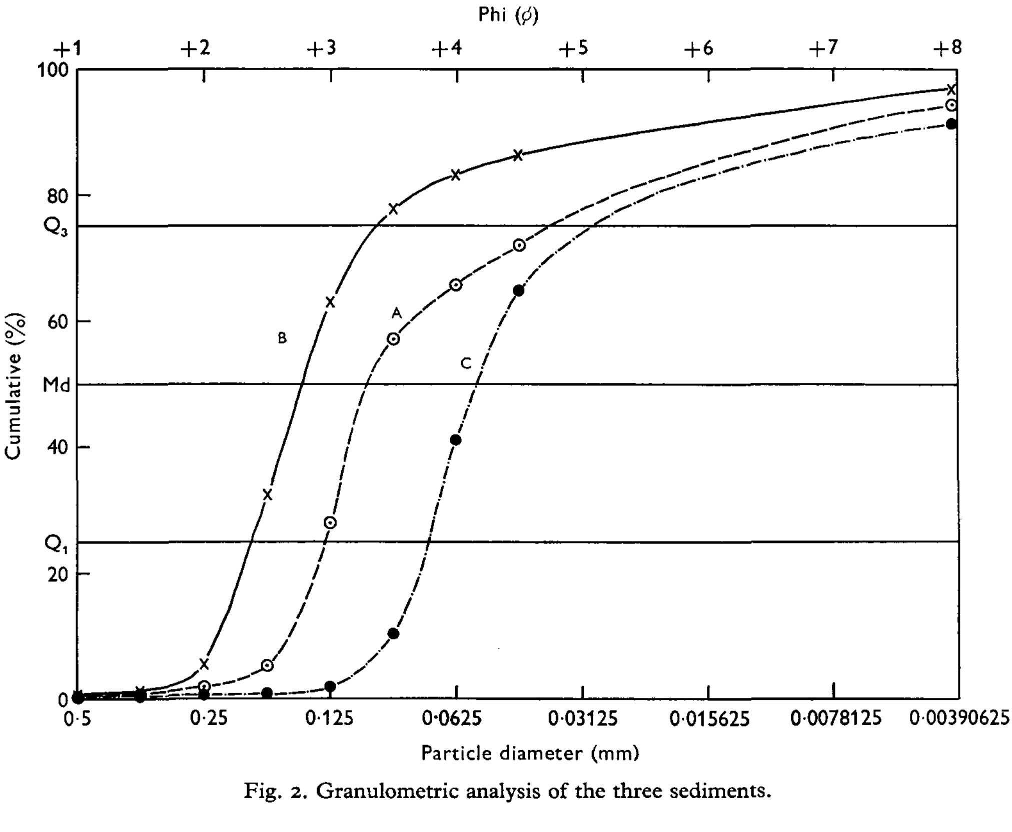

Fig. 2. Granulometric analysis of the three sediments.

Nematodes were extracted from the substrate by a combination of decantation and sieving. A few drops of 1% Rose Bengale solution were added to the preserved samples, which were then thoroughly agitated and left overnight, during which time the nematodes stained red. The sample was then washed into a litre stoppered measuring cylinder and made up to 800 ml. with the tap water to give a sedimentation height of 30 cm. The cylinder was inverted several times to put the sediment in suspension and then left to stand for 60 sec, allowing the heavier particles present to sediment out. The supernatant was then decanted off through a 37 μ sieve, through which all the very fine particles passed, leaving the nematodes and other meiofaunal animals together with a variable amount of detritus. The cylinder was then refilled and the decantation process repeated another four times. The material was washed off the sieve with 4% formalin solution into a Petri dish and then transferred, a small amount at a time, to a counting dish where the red stained nematodes could be counted and picked out. Examination of the filtrate and the residue in the measuring cylinder showed that this method of extraction was always > 95% efficient. More sediment could have been removed from the sample by using a larger meshed sieve, but in this case the efficiency of extraction would have been seriously reduced. Bougis (1946) estimated that 20% of preserved nematodes will pass through a 200 μ mesh, whilst with living material Wieser (1960) found that 10–60% passed through a 160 μ sieve and McIntyre (1964) that 38% passed through a 76 μ sieve. Both these latter authors have examined the subsieve fraction of living material and estimated its nematode population by means of subsamples. In the present study, however, it was necessary to make reliable species counts of even the smallest animals, and it was desirable therefore that counts should not rely on small subsamples. The use of a small meshed sieve was therefore inevitable, although a large amount of sediment was retained. Moreover, the extraction of preserved material in this way is more efficient than if living material is used. Although McIntyre (1964) found no difference in the sieving characteristics of living and preserved material, it is evident that the decantation of preserved material is more efficient. Hopper & Meyers (1966) have tested the rate of descent of the marine nematode *Metoncholaimus* sp. in a 22 cm column of sea water at room temperature, and found that 50% of living animals fell within 60 sec but the same percentage of preserved specimens took 145 sec.

The worms were picked out of the counting dish with a sharpened quill and transferred to a solid watchglass containing a solution of 9 parts 50% ethanol and 1 part glycerine. The ethanol and water were allowed to evaporate off slowly (Seinhorst, 1959) so that the nematodes were cleared and left in pure glycerine. During this process all or most of the Rose Bengale stain is removed by the alcohol, which makes taxonomic examination possible. The nematodes were identified and counted under the high power of the microscope, one edge of the cover-slip being propped up with lens tissue to prevent the worms from becoming flattened.

POPULATION DENSITIES

There is great variation in the density of nematodes in replicate cores from the same station, and thus mean densities can only be given within wide limits. Taking the average of the means from the three stations gives a density at A of $14{\cdot}5 \pm 6{\cdot}3$ nematodes/0·78 cm^2 and corresponding values at B and C of $64{\cdot}0 \pm 35{\cdot}9$ and $56{\cdot}0 \pm 20{\cdot}5$ respectively. These figures are equivalent to 184,730/m^2 at Station A, 815,360/m^2 at B and 713,440/m^2 at C. There is no significant difference at the 5% level between the average means obtained at B and C but these are both substantially higher than that found at A.

The results from B and C compare favourably with the 798,000/m^2 recorded from the silty R-stations in Buzzards Bay by Wieser (1960) and with values for the Loch Nevis ground (853,000/m^2) obtained by McIntyre (1964). However, the latter author records much higher values (1,845,000/m^2) for the Fladen ground. These are the only reliable data with which the present densities can be compared. They are much lower than the corresponding densities recorded for many littoral muds. For example, values of 10×10^6/m^2 have been found in a mud flat by Rees (1940), and up to $16.3 \times 10^6/m^2$ in a salt marsh by Teal & Wieser (1966).

TABLE 1. ABUNDANCE AND FREQUENCY OF THE COMMONER NEMATODE SPECIES AT STATION A

Species no.	Species	Total numbers	Identified total (%)	Cumulative (%)	Frequency of occurrence
1	*Sabatieria ornata* Ditlevsen	27	13·4	13·4	8/16
2	*Dorylaimopsis punctatus* Ditlevsen	20	9·9	23·3	7/16
3	*Actinonema pachydermatum* Cobb	15	7·4	30·7	9/16
4	*Mesacanthion* sp.	14	6·9	37·6	8/16
5	*Terschellingia longicaudata* de Man	11	5·4	43·0	6/16
6	*Sphaerolaimus* sp.	11	5·4	48·4	7/16
7	*Theristus* sp. 1	11	5·4	53·8	4/16
8	Monhysteridae sp. 1	11	5·4	59·2	7/16
9	Monhysteridae sp. 3	9	4·5	63·7	3/16
10	*Halalaimus isaitshikovi* (Filipjev)	7	3·5	67·2	5/16
11	*Sabatieria punctata* Kreis	7	3·5	70·7	4/16
12	*Axonolaimus spinosus* (Bütschli)	5	2·5	73·2	2/16
13	*Theristus* sp. 2	5	2·5	75·7	1/16
14	*Neotonchus* sp. 1	5	2·5	78·2	2/16
15	*Paralinhomoeus* sp.	3	1·5	79·7	2/16
16	*Polygastrophora* sp.	3	1·5	81·2	3/16
17	*Theristus tenuispiculum* Ditlevsen	3	1·5	82·7	2/16
18	*Oxyonchus* sp.	2	1·0	83·7	2/16
19	*Sphaerolaimus paradoxus* Ditlevsen	2	1·0	84·7	2/16
20	*Pselionema* sp.	2	1·0	85·7	2/16
21	*Campylaimus inaequalis* Cobb	2	1·0	86·7	2/16
22	*Theristus* sp. 4	2	1·0	87·7	1/16
23	*Amphimonhystrella* sp.	2	1·0	88·7	2/16
24	*Prochromadora orleyi* de Man	2	1·0	89·7	2/16
25	*Halalaimus longicaudata* Filipjev	2	1·0	90·7	2/16

SPECIES COMPOSITION

The numbers of each of the commoner species, comprising 90% of the total population, are recorded in Tables 1–3, and the dominance values of each species are graphed in Fig. 3. Species comprising the remaining 10% of each series of samples are too rare for anything significant to be inferred about their distribution. Wieser (1960) and Hopper & Meyers (1967), following

Gause's (1934) principle of animal exclusion, have suggested that more species will be present in a habitat which has a large number of ecological niches, and both authors conclude that the nematode fauna of marine sediments becomes more heterogeneous with a decrease in the silt-clay fraction. Areas of high heterogeneity have a large number of species each with a low numerical dominance whilst more homogeneous habitats have a smaller number of species, often with a few of these showing a marked dominance. In the Northumberland samples a greater number of species is present at Station B, but conversely the same station shows the emergence of a single dominant (*Sabatieria ornata*) more markedly than either of the other stations. The reason for such an anomaly is probably that differences in granulometric composition of the sediments are small enough to allow several species to be eurytopic over the range of habitats studied. As would be expected, the number of species which are common to both Buzzards Bay (Wieser, 1960) and Northumberland is small, but from the few that are found in both localities interesting conclusions can be drawn. For example *Terschellingia longicaudata* in Buzzards Bay was much more abundant at the siltiest R-stations, whereas in the Northumberland samples it is eurytopic. The same applies to *Sabatieria ornata*, but *Sabatieria hilarula* is commonest in the siltiest samples from Buzzards Bay and the most sandy ones off the Northumberland coast. Off the Northumberland coast, however, some species are sensitive to changes in substrate composition over the range studied, and follow the expected trend. For example, species of *Odontophora*, *Mesacanthion* and *Synonchiella* are commoner in the sandy habitat, whilst *Sabatieria cupida* and *Sphaerolaimus* sp. show an affinity for the silt. No data are available to compare with the distribution of other species, but those showing definite distributional trends in the area studied are given in Table 4 (p. 140).

Species which are insensitive to differences in sediment composition over the range investigated may assume considerable dominance at all stations, and are not therefore good indicators of the degree of homogeneity of the habitats. If we ignore the two commonest eurytopic species (*Sabatieria ornata* and *Terschellingia longicaudata*) in Fig. 3, this has the effect of steepening the graph at Station C and making it more shallow at Stations A and B, bringing them more in line with the expected relationship between homogeneity and substrate composition.

The similarities in species composition between the three areas can be largely attributed to the commoner eurytopic species, and the differences to the commoner stenotopic species, listed in Table 4. The trellis diagram is a method of indicating relationships between communities of different areas in a semi-quantitative way, and has been recently applied to the study of benthic communities by Wieser (1960), Sanders (1960), King (1962) and Hopper & Meyers (1967*a*). For a discussion of the method reference may be made to these first two authors. In Fig. 4 a trellis diagram is given for the October

TABLE 2. ABUNDANCE AND FREQUENCY OF THE COMMONER NEMATODE SPECIES AT STATION B

Species no.	Species	Total numbers	Identified total (%)	Cumulative (%)	Frequency of occurrence
1	*Sabatieria ornata* Ditlevsen	138	19·6	19·6	14/16
2	*Odontophora longisetosa* (Allgén)	76	10·8	30·4	14/16
3	*Terschellingia longicaudata* de Man	50	7·1	37·5	14/16
4	*Mesacanthion* sp.	42	6·0	43·5	13/16
5	*Sabatieria hilarula* de Man	25	3·5	47·0	8/16
6	*Theristus setosus* (Bütschli)	24	3·4	50·4	9/16
7	*Microlaimus honestus* de Man	24	3·4	53·8	7/16
8	*Viscosia abyssorum* (Allgén)	23	3·3	57·1	11/16
9	*Neotonchus corcunda* (Gerlach)	23	3·3	60·4	11/16
10	*Desmodora norvegica* Allgén	13	1·8	62·2	5/16
11	*Rhabdocoma* sp.	13	1·8	64·0	8/16
12	*Synonchiella riemanni* Warwick	12	1·7	65·7	6/16
13	*Theristus* sp. 1	11	1·6	67·3	4/16
14	Cyatholaimidae sp.	11	1·6	68·9	7/16
15	*Axonolaimus spinosus* (Bütschli)	11	1·6	70·5	4/16
16	*Halalaimus isaitshikovi* (Filipjev)	10	1·4	71·9	7/16
17	*Theristus* sp. 5	10	1·4	73·3	2/16
18	*Pomponema* sp.	9	1·3	74·6	5/16
19	*Desmodora pontica* (Filipjev)	9	1·3	75·9	8/16
20	*Actinonema pachydermatum* Cobb	9	1·3	77·2	3/16
21	*Paramesacanthion* sp.	8	1·1	78·3	6/16
22	*Theristus* (*Pseudotheristus*) sp. 1	8	1·1	79·4	2/16
23	*Campylaimus inaequalis* Cobb	7	1·0	80·4	6/16
24	*Theristus* (*Pseudotheristus*) sp. 3	7	1·0	81·4	2/16
25	*Microlaimus* sp. 1	7	1·0	82·4	6/16
26	*Leptolaimus elegans* (Schuurmans Stekhoven & DeConinck)	7	1·0	83·4	4/16
27	*Bolbolaimus* sp.	5	0·7	84·1	4/16
28	*Theristus tenuispiculum* Ditlevsen	5	0·7	84·8	1/16
29	*Halalaimus longicaudata* Filipjev	5	0·7	85·5	3/16
30	*Microlaimus* sp. 2	5	0·7	86·2	3/16

Table 2. (cont.)

Species no.	Species	Total numbers	Identified total (%)	Cumulative (%)	Frequency of occurrence
31	*Sabatieria cupida* Bresslau & Schuurmans Stekhoven	5	0·7	86·9	2/16
32	*Theristus oxycerca* de Man	4	0·6	87·5	1/16
33	*Spirinia parasitifera* (Bastian)	4	0·6	88·1	4/16
34	*Dorylaimopsis punctatus* Ditlevsen	4	0·6	88·7	2/16
35	*Neotonchus* sp. 1	4	0·6	89·3	2/16
36	*Diplopeltula* sp.	3	0·4	89·7	3/16
37	*Viscosia viscosa* Bastian	3	0·4	90·1	1/16
38	*Leptolaimus* sp.	3	0·4	90·5	2/16

samples off the Northumberland coast. As expected, the faunal affinity is greater between replicate samples within stations than between stations. At Station C the affinity between replicates is high, whilst at Stations A and B it is much lower. This is a reflexion of the high degree of homogeneity found in the fauna of the silty station, and is considered a result of the smaller number of ecological niches present. Stations A and C have more in common with each other than either of them have with B, indicating that the species composition depends more on the substrate composition than the water depth. The most sandy station has its own distinct fauna, while the more silty ones have a higher proportion of common species.

An accurate index of faunal diversity within an area can be obtained if the numbers of rare and common species in the samples are compared. Fisher, Corbet & Williams (1943) have suggested that the frequency distribution of species in a random population represented by 1, 2, 3, etc. individuals may conform to the logarithmic series.

$$n_1, n_1 x/2, n_1 x^2/3, n_1 x^3/4, \ldots, n_1 x^{n-1}/n,$$

where x is a constant less than unity. The value of x depends on the size of the sample and can be obtained from the formula

$$\frac{S}{N} = \frac{1-x}{x}(-\log_e \overline{1-x}),$$

where S = the number of species in the sample and N is the total number of individuals. Approximate values of x can be found with the use of a conversion chart, e.g. in Williams (1964, fig. 125), and more accurate determinations can be made by successive approximations using the above equation.

TABLE 3. ABUNDANCE AND FREQUENCY OF THE COMMONER NEMATODE SPECIES AT STATION C

Species no.	Species	Total numbers	Identified total (%)	Cumulative (%)	Frequency of occurrence
1	*Dorylaimopsis punctatus* Ditlevsen	174	15·9	15·9	21/24
2	*Leptolaimus elegans* (Schuurmans Stekhoven & De Coninck)	148	13·6	29·5	22/24
3	*Sabatieria cupida* Bresslau & Schuurmans Stekhoven	141	12·9	42·4	22/24
4	*Sabatieria ornata* Ditlevsen	100	9·2	51·6	21·24
5	*Terschellingia longicaudata* de Man	68	6·2	57·8	18/24
6	*Pomponema* sp.	37	3·4	61·2	15/24
7	*Oncholaimus skawensis* Ditlevsen	36	3·3	64·5	14/24
8	*Longicyatholaimus* sp.	36	3·3	67·8	9/24
9	*Sphaerolaimus* sp.	34	3·1	70·9	15/24
10	Monhysteridae sp. 1	31	2·8	73·7	9/24
11	*Axonolaimus spinosus* (Bütschli)	29	2·7	76·4	15/24
12	*Richtersia* sp.	21	1·9	78·3	9/24
13	*Campylaimus inaequalis* Cobb	19	1·7	80·0	12/24
14	*Neotonchus* sp. 1	16	1·5	81·5	6/24
15	Monhysteridae sp. 2	15	1·4	82·9	7/24
16	*Halalaimus isaitshikovi* (Filipjev)	14	1·3	84·2	9/24
17	*Neotonchus corcunda* (Gerlach)	12	1·1	85·3	8/24
18	*Microlaimus* sp. 2	12	1·1	86·4	6/24
19	*Desmodora pontica* (Filipjev)	11	1·0	87·4	10/24
20	*Desmoscolex minutus* Claparède	9	0·8	88·2	4/24
21	*Paracanthonchus* sp.	8	0·7	88·9	6/24
22	*Amphimonhystrella* sp.	8	0·7	89·6	6/24
23	*Theristus* sp. 1	8	0·7	90·3	6/24
24	*Actinonema pachydermatum* Cobb	8	0·7	91·0	5/24
25	*Theristus* (*Pseudotheristus*) sp. 2	8	0·7	91·7	4/24

In a random sample of a population the ratio of n_1 to x is a constant, and if we divide n_1 by x and call the result α we get a simpler expression of the logarithmic series αx, $\alpha x^2/2$, $\alpha x^3/3$, $\alpha x^4/4$ etc.

The value of x depends on the size of the particular sample, but the value of α is a property of the population sampled, and has been called the 'Index of

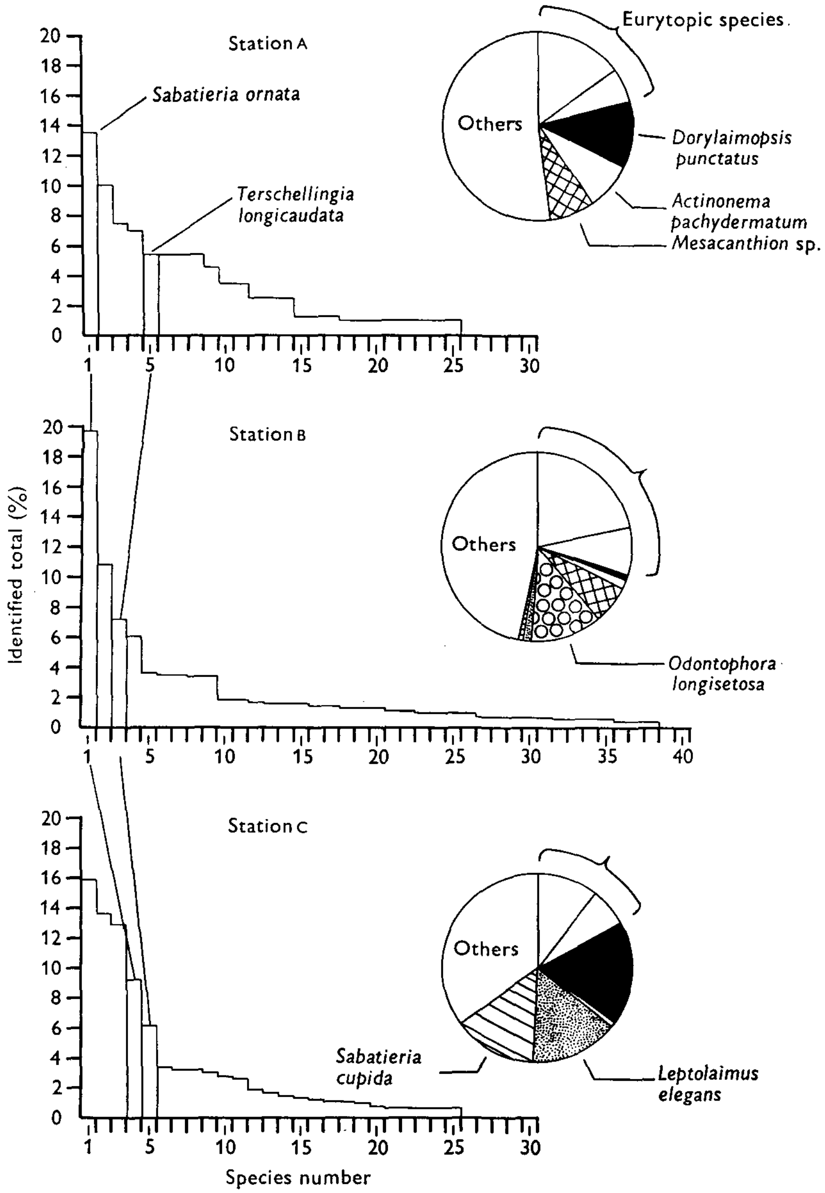

Fig. 3. Graph showing the relative abundance of the commoner species at the three stations (computed from Tables 1–3). The two common eurytopic species are indicated on the histograms, and the relative abundance of the dominant species at the three stations is shown by pie diagrams.

Diversity' by Williams (1947). It is low when the numbers of species are low in relation to the number of individuals, and high when the number of species is high.

TABLE 4. DISTRIBUTIONAL TRENDS EXHIBITED BY THE NEMATODE SPECIES

Eurytopic	Affinity for silt	Affinity for sand
Sabatieria ornata	*Dorylaimopsis punctatus*	*Odontophora longisetosa*
Terschellingia longicaudata	*Leptolaimus elegans*	*Mesacanthion* sp.
Axonolaimus spinosus	*Sabatieria cupida*	*Sabatieria hilarula*
Campylaimus inaequalis	*Oncholaimus skawensis*	*Theristus setosus*
Halalaimus isaitshikovi	*Longicyatholaimus* sp.	*Microlaimus honestus*
	Sphaerolaimus sp.	*Viscosia abyssorum*
	Monhysteridae sp. 2	*Desmodora norvegica*
	Richtersia sp.	*Rhabdocoma* sp.
		Synonchiella riemanni
		Cyatholaimidae sp.

To test whether the three populations sampled followed the logarithmic series distribution, graphs have been plotted of the number of species against the number of individuals per species (Fig. 5), and the theoretical curve of the logarithmic series distribution fitted to the data. The March figures from Station C have been omitted so that the sample sizes at the three stations are comparable. The two parameters S and N are known and from these the value of x has been obtained as described above. Then n_1 has been determined by $n_1 = N(1-x)$ and α from $\alpha = n_1/x$. The theoretical curve fits the data moderately well, so that it is possible to obtain a valid index of diversity for each of the three stations. Diversity is lowest at the siltiest station ($\alpha = 15{\cdot}3$) and highest at the sandiest station ($\alpha = 22{\cdot}5$) with Station A intermediate ($\alpha = 16{\cdot}1$). This is as expected if the number of niches is greater in the sandier habitat.

Preston (1948) has suggested that the frequency distribution of species may be better represented by a log normal distribution rather than a log series. The present data have therefore been tested against this theory. To do this the number of individuals per species have been divided into $\times 3$ log classes (see Williams, 1964) and plotted against the cumulative percentage of species on a probability scale (Fig. 5). It will be noted that the log normal distribution of geometric classes, if present, is truncated before its peak at Stations A and B, and thus a zero term cannot be estimated from the symmetry of these graphs. Plots have therefore been made on the assumption of no zero value. It is evident that, in spite of the small number of $\times 3$ classes, the fit to a straight line of log normal distribution is fairly close. Williams (1964, p. 294) states that 'It is still uncertain whether the close fit of the log series to many frequency distributions, especially when the number of units per group is low, is a fundamental departure from the log normal, or whether it is due to the small samples from a log normal differing so little from a log series that the data may not be critical enough to distinguish'. At Station A it is impossible to determine which distribution provides the better fit, since the number of individuals sampled was so small that only four ×3 geometric classes were present. At Stations B and C where seven geometric classes are

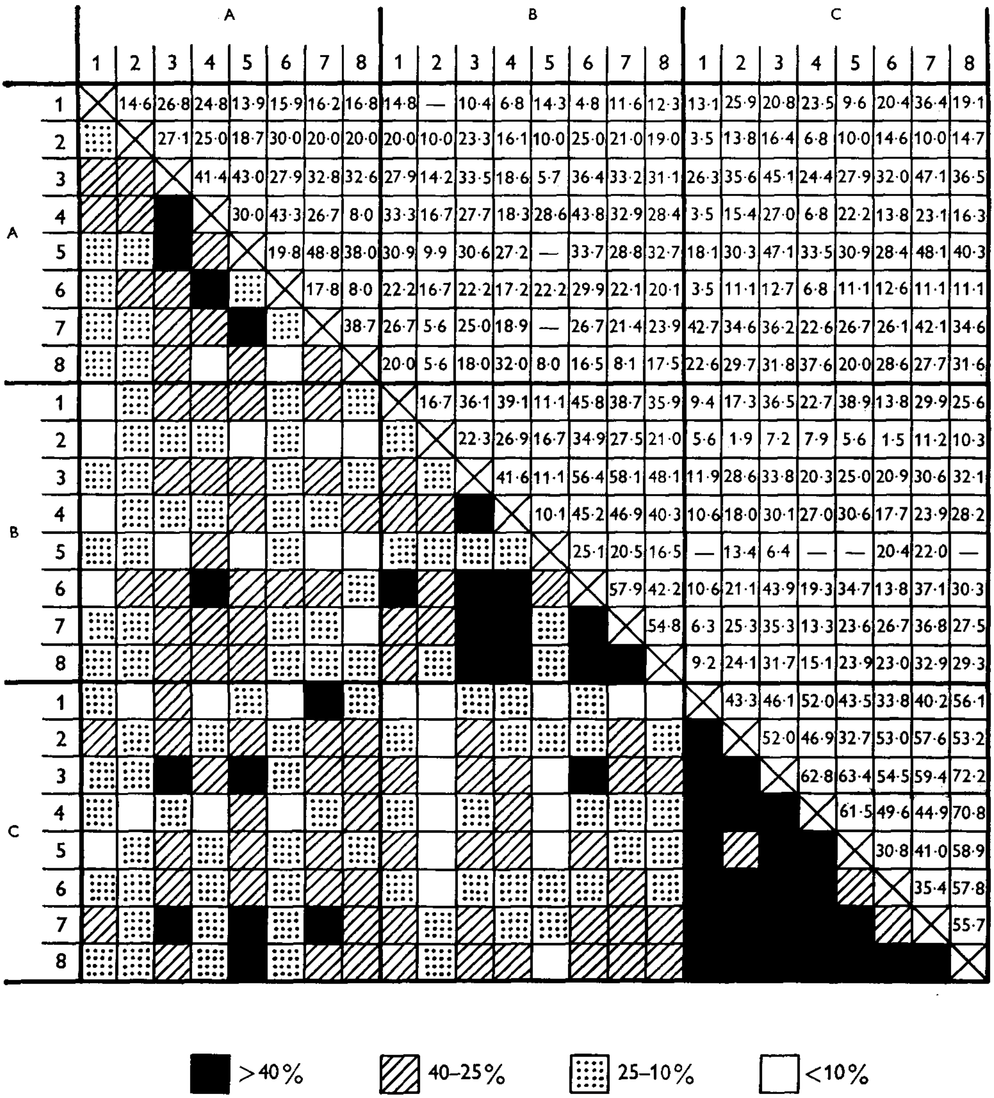

Fig. 4. Trellis diagram for the October samples, showing the degree of faunal affinity between the three stations.

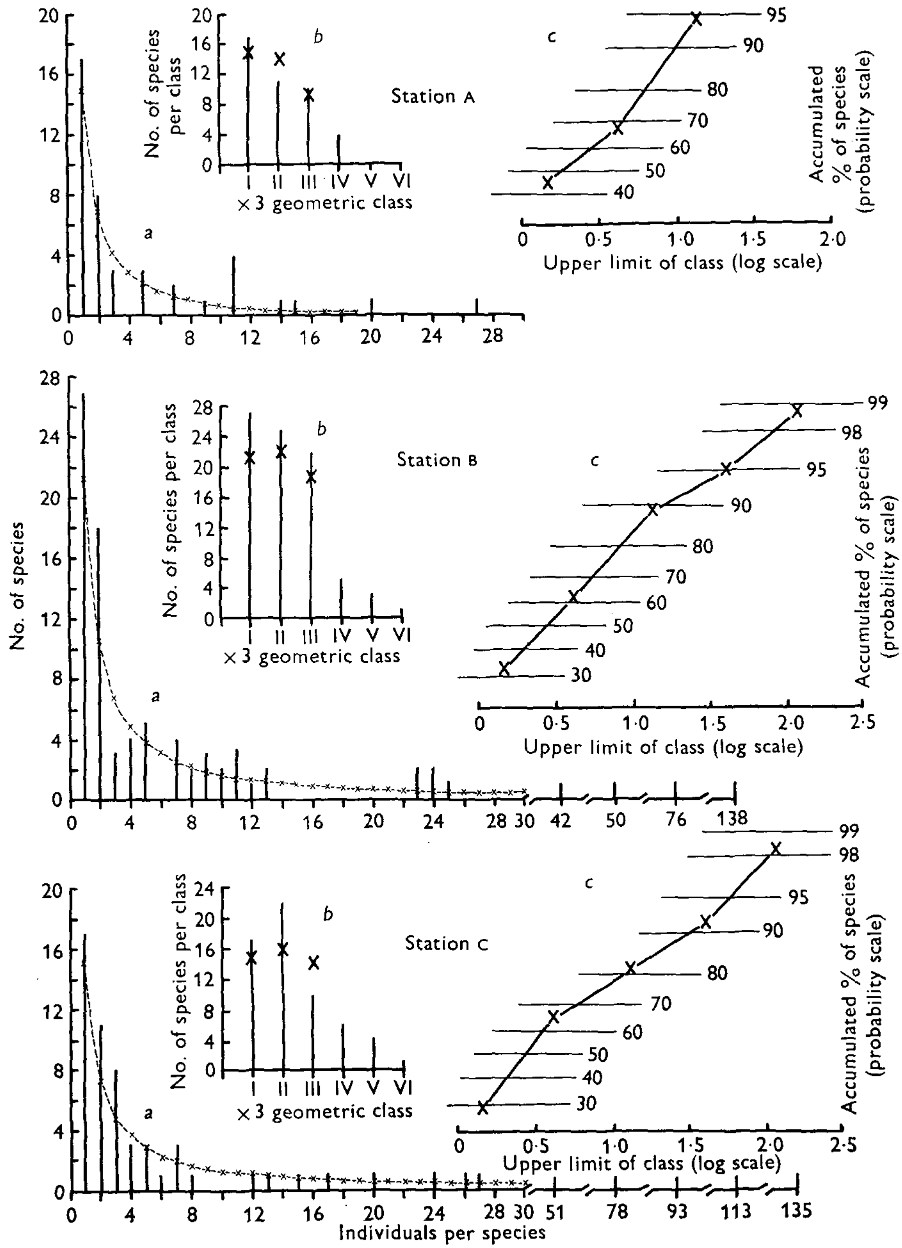

Fig. 5. Frequency distribution of species at the three stations. (*a*) Frequency plotted on arithmetic scale, vertical lines indicating the observed distribution and the crosses joined by a broken line showing the theoretical log series distribution. (*b*) Distribution of ×3 geometric classes, the crosses again indicating the theoretical distribution based on the log series. (*c*) Abundance plotted against accumulated percentage on a probability scale, showing the relationship to the log normal distribution.

present the fit to the long normal distribution is much closer. The log series underestimates classes I–III at Station B, whilst at Station C classes I and II are underestimated and class III overestimated. It thus appears that the log normal provides a slightly closer fit than the log series at these stations.

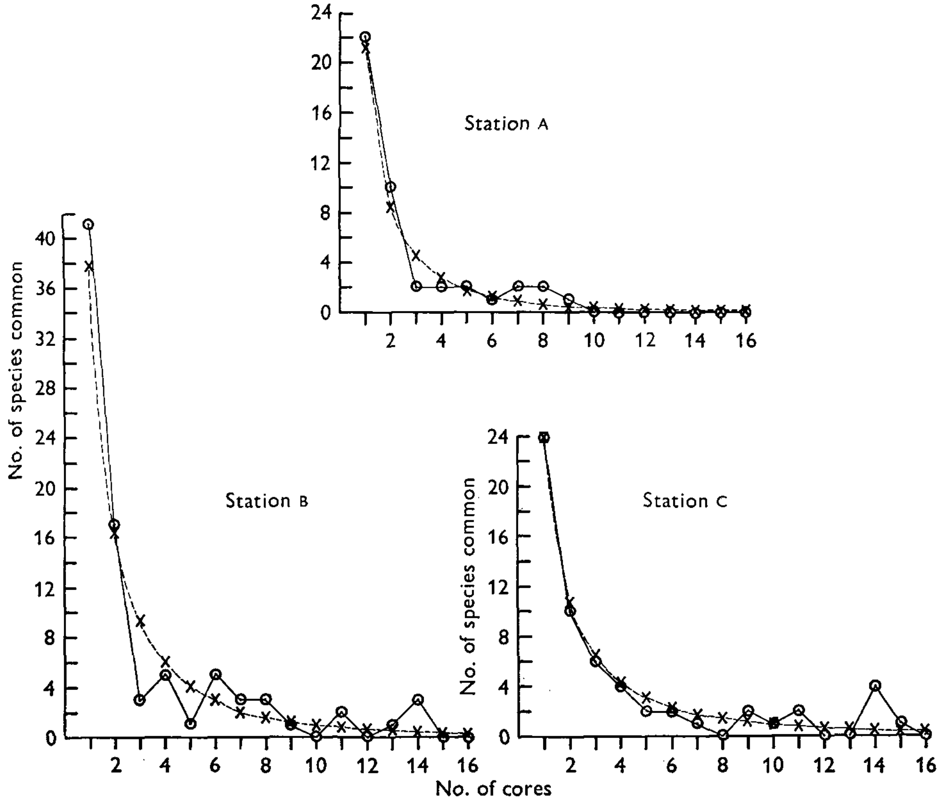

Fig. 6. Species distribution throughout all 16 cores, at the three stations. Circles joined by solid lines indicate the observed distribution and the crosses joined by broken lines show the theoretical log series distribution.

The distribution of species throughout the range of 16 cores at a single station depends on many variables such as the dispersion patterns, difference in sediment composition between cores and the specific diversity. To illustrate this species distribution, the number of species common to 1, 2, 3, ... 16 cores has been plotted (Fig. 6). It has been noted that in all three cases the graphs followed closely a log series distribution where N = the total number of species occurrences in all 16 cores and S = the number of cores. By calculating n_1/x in the manner described previously, we therefore get an index of the specific variability between replicates, which reflects the total of the variables mentioned above. This index is much higher at Station B (n_1/x = 44·0) than at either A or C (n_1/x = 26·3 and 26·7 respectively). This is partly due to the fact that the specific diversity is highest at Station B, but further, the sandy habitat may be more variable in sediment composition and give rise to a more contagious distribution of species.

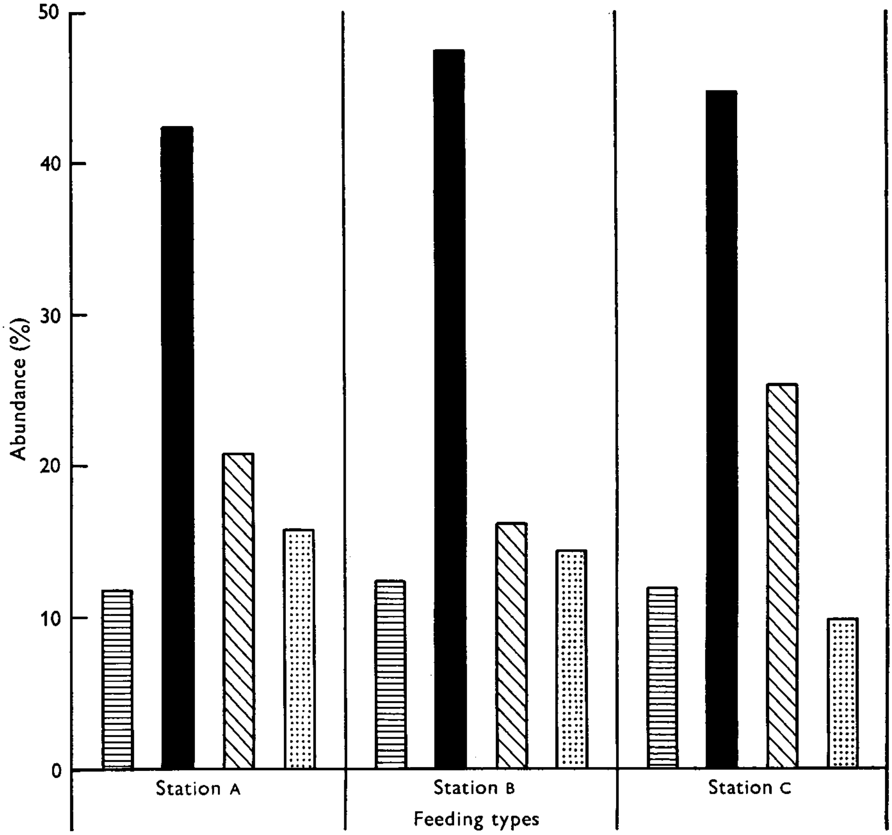

Fig. 7. The relative abundance of different feeding types at the three stations. 1A ▤, selective deposit feeders; 1B ■, non-selective deposit feeders; 2A ▧, epigrowth feeders; 2B ▦, omnivores.

DISTRIBUTION OF FEEDING TYPES

It has been thought that the differences in the fauna of sandy and silty habitats may in part be due to differences in the type of food source present, and several authors (Wieser, 1953, 1959*a*, 1960; King, 1962; Hopper & Meyers, 1967, 1967*a*) have studied the distribution of various feeding types in different habitats. The groups proposed by Wieser (1953) have generally been adhered to, and are used here with the proviso that species considered predatory by Wieser only possess the latent ability to feed in this manner. They may also feed on diatoms, bacteria, flagellates, etc. in a non-selective manner and are best considered omnivores (Perkins, 1958; Wieser, 1962; Hopper & Meyer, 1966). It will be seen from Fig. 7 that the distribution of feeding types does not vary greatly between the three sampling stations. Non-selective deposit feeders are always the dominant group, with epigrowth feeders second in importance. Selective deposit feeders and omnivores are scarce in all three areas.

DISCUSSION

Buchanan (1963) has shown that the macrofaunal communities of this area are poorly correlated with the granulometric composition of the bottom sediments, but depend largely on the water depth. This is clearly not the case with the nematode facies of the meiofauna, which appears to be more sensitive to changes in sediment composition. In view of the overlapping of a mud and sand fauna at the three stations it is difficult to determine communities, as Wieser (1960) has done in Buzzards Bay, in terms of their species composition. However, if we ignore the eurytopic species it appears that a definite mud fauna is present, characterized by *Dorylaimopsis punctatus*, *Leptolaimus elegans* and *Sabatieria cupida*. McIntyre (1961) reports that *D. punctatus* and *S. cupida* are prominent in mud samples from the Fladen and Loch Nevis grounds, and he may possibly have overlooked *L. elegans* because of its very small size. It is probable, therefore, that this community will prove to be characteristic of most muddy sediments of the continental shelf round Northern Britain. In the sandy habitat *Odontophora longisetosa* attains prominence, but it is not known whether this species is of general occurrence in such habitats.

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