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The Enchytraeidae (Oligochaeta) of streams of Southern England

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The authors present a list of aquatic Enchytraeidae for the streams of Southern England. They examine the distribution of the species.

Les Enchytraeidae (Oligochaeta) des eaux courantes du sud de l'Angleterre.

Mots clés : Enchytraeidae aquatiques, Angleterre.

Les auteurs dressent un inventaire de la faune des Enchytraeidae aquatiques du sud de l'Angleterre. Ils envisagent la répartition des espèces.

Introduction

While most families of Oligochaeta have been relatively well studied in ecological investigations of running-water habitats in Britain (e.g. Ladle & Bird 1980), the Enchytraeidae have received little attention. They have not usually been identified beyond the level of family (e.g. Aston 1971, Ladle & Bass 1981). This has not been so in other European countries where the extensive revision of the group carried out by Nielsen & Christensen (1959, 1961, 1963) has encouraged the accumulation of basic knowledge (e.g. Wachs 1967 ; Kasprzak & Szczesny 1976, Giani & Lavandier 1977, Healy 1979, Martinez-Ansemil & Giani 1980).

This study provides information on the enchytraeids of some streams of Southern England.

1. The sampling sites

Most sampling sites are located within the area influenced by the chalk geology of the region (fig. 1). The physical and chemical features of the water studied are given in Table I. Some headwaters sampled were known to be winterbournes. They are characteristic of the catchment areas of chalk streams, and typically cease to flow in summer when the watertable falls below the spring line, either every year or only in drier than average years. The particular chemistry and biology of such streams have been studied by Casey & Ladle (1976) and by Ladle & Bass (1981).

2. Methods

Samples were taken using a 50 mm diameter brass corer pushed 100 mm into the substrate. Where a site was visibly differentiated into silt and gravel areas, these sub-sites were considered separately. Between 4 and 12 cores were taken in total at each site. Some sites were sampled more than once.

Samples were sorted unpreserved as soon as possible after being taken. Light organic material was elutriated and passed through a sieve. Preliminary work showed that many enchytraeids were small enough to pass through sieves normally used for invertebrate studies, and as a result a small mesh

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size of 125 μm was selected. All Oligochaeta were removed from the residue in the sieve under magnification of × 20. They were identified alive using the monograph of Nielsen & Christensen (1959, 1961, 1963) and more recent descriptions where necessary.

In addition, between 3 and 5 cores were taken from the substratum at each site (or sub-site) for particle size determination using a Wentworth series of sieves (2 mm, 1 mm, 500 μm, 250 μm, 125 μm, 63 μm). The dry weights of each component fraction were determined after drying at 60° C for 24 hours.

3. Comments on the taxonomy and distribution of individual species

Many of the populations sampled consisted of individuals deviating in one or more respects from the species diagnosis. It is possible that these represent undescribed species, but this could not be resolved without further study. A high level of intraspecific variation has been previously noted within the Enchytraeidae (e.g. Lasserre 1971, Healy 1979) and the taxonomy of enchytraeids remains unstable (Coates 1984). The variants observed during the current study are described below. Where the size of mature individuals is concerned, there is a tendency for the Dorset enchytraeids to be smaller than those described by Nielsen & Christensen. Why this should be is unknown. Where a species is listed without comment, the specimens examined were as in the species description. The site where each species was recorded are listed. Two are new records for Britain.

Achaeta bohemica (Vejdovsky)

In the specimens examined, minor deviations in the form of the setal sacs and sperm funnels were noted. The former structures were smaller than given by Nielsen & Christensen (1959), who state their lengths to be about half the width of the body. In the present study their relative lengths were only half of this stated length. The sperm funnels were elongate : a length/width ratio of 5-6 was observed compared to the 2-3 given in Nielsen & Christensen (1959). Healy (1979) observed sperm funnels similar to those described here in Irish populations and stated that more than one closely related species were probably involved.

A. bohemica has been recorded predominantly from terrestrial habitats and was also present in soil adjacent to sampling site 1 in the current study.

Recorded at : site 1.

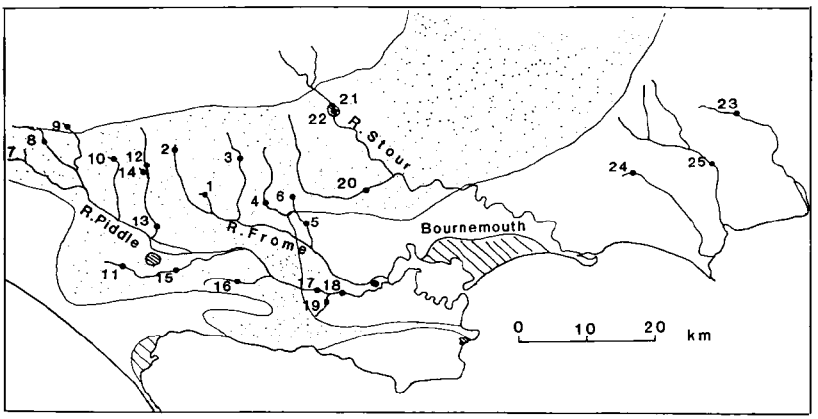

Fig. 1. The location of the sampling sites. Stippling denotes the extent of the chalk geology.

Table I. Characteristics of the sampling sites.

Site No. (W = Winterbourne)	Grid Ref.	Width (m)	Depth (m)	pH	Calcium (mg l^{-1})	Nitrate (mg l^{-1})	Phosphate (µg l^{-1})
1 (W)	SY 742 953	2-3	0.1-0.4	7.3	100.4	5.16	40.1
2	SY 698 023	4	0.15-0.20	-	-	-	-
3	ST 775 007	2-3	0.30-0.40	8.3	100.0	2.0	52.0
4 (W)	SY 813 955	3-3.5	0.30-0.40	-	-	-	-
5	SY 857 925	4-8	0.30-0.80	8.0	105.7	5.8	51.3
6	SY 958 836	1-1.5	0.15-0.20	7.7	99.4	5.3	0.02
7	ST 518 015	3-4	0.08-0.10	8.1	94.0	1.59	88.0
8	ST 558 026	0.8-0.8	0.07-0.10	8.1	83.6	2.18	113.0
9	ST 576 046	0.5-0.6	0.04-0.06	8.2	94.8	1.86	197.0
10	ST 627 015	2-2.5	0.10-0.15	8.2	96.2	2.34	60.3
11	SY 641 891	3-3.5	0.20-0.30	8.0	91.1	3.29	147.0
12	ST 661 018	1.2-2.5	0.15-0.25	-	-	-	-
13	SY 676 939	3.5-4.5	0.30-0.45	8.2	100.2	3.79	132.3
14 (W)	ST 662 033	0.2-0.5	0.10-0.30	-	-	-	-
15 (W)	SY 712 889	3.5-4.5	0.30-0.35	8.0	89.5	3.61	121.0
16	SY 798 873	3.0-4.0	0.40-0.60	7.9	86.5	4.71	113.1
17	SY 857 925	3.0-4.0	0.20-0.30	8.0	94.8	4.17	133.3
18	SY 890 866	10.0-15.0	0.30-1.50	-	-	-	-
19	SY 894 867	2.5-3.5	0.80-1.00	-	-	-	-
20	SY 965 876	0.8-1.0	0.20-0.30	-	-	-	-
21	ST 885 062	3.0-4.0	0.30-0.60	8.0	99.0	2.84	175.2
22	ST 885 063	3.0-4.0	0.50-1.00	8.0	99.0	-	-
23	SU 355 085	2.0-3.0	0.30-0.40	-	-	-	-
24	SU 224 015	2.0-3.0	0.1-0.3	7.1	15.5	0.23	6.0
25	SU 302 031	6.0-10.0	0.3-0.5	6.9	14.4	0.31	12.0

Achaeta indet.

Sites : 13, 14, 15.

Buchholzia fallax Michaelsen

Dorset specimens were considerably smaller than described by Nielsen & Christensen (1959). The range in length of mature worms (mean live length in water) was 7-10 mm. Nielsen & Christensen quote a range of 12-14 mm. The range in segment number at maturity was also slightly lower ; 26-45 ($\bar{x}$ = 36.5) compared 32-48 (Nielsen & Christensen 1961). One of the sampled populations (that at site 5) was composed of individuals with sperm funnels of a slightly deviant shape. While those of typical individuals are cup-shaped, in this population they were evenly cylindrical and about three times as long as wide, their total length around half the width of the worm.

B. fallax is largely terrestrial and was also found in samples taken from the soil adjoining several sites.

Sites : 1, 14, 15.

Cernosvitoviella atrata (Bretscher)

The spermathecal ampulla in this species is known to take two forms ; one almost spherical, and the other cylindrical (Nielsen & Christensen 1959, Wachs 1967, Healy 1979, Martinez-Ansemil & Giani 1980). Both were seen in the population sampled at site 1 in the current study. Nielsen & Christensen (1959) raised the possibility that *C. atrata* is a complex of more than one species, but this has not been resolved.

Records of *C. atrata* are almost entirely from aquatic or semi-aquatic sites : Britain (references in Nielsen & Christensen 1959), Ireland (Healy 1979), France (Giani & Lavandier 1977), Spain (Martinez-Ansemil & Giani 1980), Germany (Wachs 1967), Poland (Dumnicka 1976) and the Lebanon (Giani, Martinez-Ansemil & Moubayed 1982).

Sites : 1, 7, 10.

Cernosvitoviella goodhui Healy

The first records of this species for Britain. Previously known only from Ireland (Healy 1975, 1979).

Sites : 9, 11, 13.

Cernosvitoviella indet

Sites : 13, 14, 15, 18, 24, 25.

Cognettia sphagnetorum (Vejdovsky)

In this study, individuals had coloured (faintly pink) blood compared with the colourless blood observed in Danish populations (Nielsen & Christensen 1959). Populations with coloured blood have also been noted in Ireland (Healy 1979) ; and where the species diagnosis gives 5 as the number of pairs of septal glands, some worms were seen to have only 4 in this study.

C. sphagnetorum is often abundant in forest-soil and bogland (e.g. Abrahamsen 1972, Springett 1972). It is also recorded in aquatic sites in Germany (Wachs 1964), Poland (Dumnicka 1976), France (Giani & Lavandier 1977), Ireland (Healy 1979), and Spain (Martinez-Ansemil 1982). It is said to have a preference for acidic conditions (Healy & Bolger 1984).

Site : 1.

Enchytraeus buchholzi Vejdovsky

Dorset specimens were smaller and had fewer segments than given in the species diagnosis ; mature worms ranged from 3-7 mm in length and the mean number of segments observed at maturity was about 26. In common with *M. argentea*, this latter feature varied between sites ; the mean at site 15 was 27.2 ($n = 88$, $SD = 3.9$), while at site 4 the mean was 25.1 ($n = 19$, $SD = 3.5$). A Mann-Whitney U test showed that these were significantly different ($p = 0.03$).

E. buchholzi has been widely recorded in terrestrial habitats in Europe (e.g. Nielsen & Christensen 1962, Dózsa-Farkas 1970, Kasprzak 1976, Gavrilov 1977, Healy 1979, Standen 1984). It was described as occurring « practically everywhere » in Denmark by Nielsen & Christensen (1959). The species was found in soil adjoining many of the aquatic sites listed below.

Sites : 1, 2, 4, 9, 10, 12, 13, 15, 17, 18, 20.

Fridericia bulboides Nielsen & Christensen

The specimens examined had weak, rather than pronounced, ental hooks and few loose setae were seen in the coelom, otherwise they were as in the species diagnosis. Healy (1979) noted a large degree of variation between Irish populations, and suggested that further study would reveal the existence of more than one species.

F. bulboides is widely distributed in Denmark and Ireland (Nielsen & Christensen 1959, Healy 1979), and also recorded from terrestrial sites in Iceland (Christensen 1962), Spitsbergen (Nurminen 1965), Siberia (Nurminen 1973), Finland (Solhoy 1975), Poland (Kasprzak 1979) and Britain (Standen 1982, 1984). Recorded also from an aquatic site in Germany (Schwank 1982).

Site : 4.

Fridericia striata (Levinsen)

Compared with the species diagnosis, the individuals of this species were smaller and with fewer segments. Mature worms were between 5 and 6 mm in length and with 30-35 segments, whereas Nielsen & Christensen give 10-20 mm and 40-45 segments.

Recorded from aquatic sites in Germany (Brezeanu et al. 1974), France (Lafont & Juget 1976) and Poland (Dumnicka 1985). Also recorded in soil in Britain (Standen 1982, 1984).

Site : 14.

Fridericia sp.

At one site, specimens were examined which, while clearly being closely related to *F. bulboides*, did not conform to the description of that species in several important respects : they had fewer segments (19-31 compared with 30-38), the setae were larger (up to 90 μm compared with 45 μm), the pattern of gland cells on the clitellum was regular rather than irregular, and loose setae were absent from the coelom. Other important features were as for *F. bulboides*. Healy (1979) observed a high degree of variation within this species and it is possible that different species are involved.

Site : 15.

Fridericia indet

Sites : 1, 4, 7, 8, 12, 14, 15.

Henlea perpusilla Friend

This is a species known to occur in populations with individuals of different cytotypes (Nielsen & Christensen 1959). The type observed in the current

study was that termed 4x, MI by Nielsen & Christensen. This was found to be the commonest occurring in Ireland by Healy (1979).

H. perpusilla is known from a number of aquatic sites in Europe : (references in Nielsen & Christensen 1959), Germany (Wachs 1967), Poland (Dumnicka 1976), France (Giani & Lavandier 1977) and the Lebanon (Giani et al. 1982). It is also widespread in terrestrial habitats, and was observed in soil samples taken next to two of the aquatic sites listed below (1 et 4).

Sites : 1, 4, 15.

H. ventriculosa (Udekem)

Known from aquatic sites in Germany (Wachs 1964), Poland (Kasprzak 1976) and France (Giani & Lavandier 1977). Widespread in terrestrial habitats also.

Sites : 1, 4, 15.

Lumbricillus rivalis Levinsen

Mature specimens were smaller than described by Nielsen & Christensen (1959) ; none were more than 12 mm long.

L. rivalis is one of the enchytraeid species most commonly recorded in fresh-water habitats. It also may be found within sewage percolating filters where populations can be very dense (e.g. Learner, 1972). It is said to favour habitats that are organically enriched and also well oxygenated (Dumnicka & Pasternak 1978). Widely recorded from aquatic sites in Europe (Wachs 1964, Kasprzak 1973, Dumnicka & Pasternak 1976, Dumnicka 1978, Giani 1979, Martinez-Ansemil 1982, Giani 1984).

Sites : 17, 18.

Lumbricillus indet

Site : 15.

Marionina argentea Michaelsen

Mature worms of this species were more variable in size than described by Nielsen & Christensen (1959) ; the range of lengths observed here was 2-6 mm compared with 4-7 mm. Healy (1979) gives 2.5-5 mm as the range for Irish specimens and Chekanovskaya (1962) 2-5 mm for Russian material.

As was found for *M. argentea*, the number of segments was found to differ between population at different sites. At site 1, the observed mean was 21,3 (SD = 11.8, n = 175), while at site 15 the mean was 23,0 (SD = 2.0, n = 29). These were found to be significantly different ($t = 4.19$, $p < 0.001$). The time of year was not associated with segment number at maturity.

M. argentea is one of the enchytraeids most commonly recorded in aquatic studies where the family has been identified to species. It has a wide ecological range in other habitats. Aquatic records from Germany (Wachs 1967), Poland (Kasprzak & Szeczesny 1976), France (Giani & Lavandier 1977), Ireland (Healy 1979), Spain (Martinez-Ansemil & Giani 1980) and the Lebanon (Giani et al. 1982). Also recorded widely in terrestrial habitats in Europe.

Sites : 1, 4, 7, 11, 13, 14, 15, 18.

M. riparia Bretscher

The epidermal glands of individuals were observed to vary in colour from one population to another ; they could be conspicuous orange or yellow or be entirely without colour. This has also been noted in Denmark and Ireland (Nielsen & Christensen 1959, Healy 1979).

M. riparia has been widely recorded in Europe, chiefly in aquatic habitats e.g. Wachs (1967), Juget (1967), Giani & Lavandier (1977), Dumnicka (1978), Giani & Martinez-Ansemil (1981), Healy (1987).

The current study provides the first records for Britain.

Sites : 1, 4, 5, 11, 13, 15, 18.

Mesenchytraeus armatus Levinsen

Recorded from several aquatic sites in Europe e.g. Wachs (1967), Giani (1976), Kasprzak (1976), Kasprzak & Szczesny (1976), Lafont (1977), Sporka (1984). Also recorded widely in terrestrial sites.

Sites : 14.

Propappus volki Michaelsen

This species has recently been re-classified in the single genus family, the Propappidae (Coates 1986). Unlike enchytraeids, *P. volki* is entirely aquatic ; commonly found in sandy substrata of the streams of central and Eastern Europe (references in Bird, 1982 b).

Sites : 16, 17.

4. Relative abundance of Enchytraeidae in samples

The proportion of total Oligochaeta composed of Enchytraeidae varied between 0 and 100 % (Table II). Overal, this figure was not related to any aspect of the available physical and chemical data, as tested by use of the Spearman Rank Correlation Coefficient (r_s). At individual sites, however, there was some evidence that the type of substratum was associated with distinct enchytraeid faunas. At sites 14 and 18, where fine sediment and gravel were sampled separately, the fine sediment contained predominantly Tubificidae while Enchytraeidae were dominant in the gravel.

There was also evidence that the predominances of Enchytraeidae was related to flow regime. The proportion of total Oligochaeta composed of Enchytraeidae at intermittently flowing sites was compared to that at permanent sites by means of a Mann-Whitney U test (sites of uncertain flow regime were excluded). A significant association between enchytraeids and intermittent flow was demonstrated ($U = 13{,}5$, $n_1 = 6$, $n_2 = 11$, $p = 0.05$).

5. Associations of Enchytraeidae

The associations of species of Enchytraeidae at different sites were classified using cluster analysis. Czekanowski's Dissimilarity Coefficient was used to classify the data, an index which has been recommended for use with benthic invertebrate data (Hellawell 1977). The group-average method was used on the presence-absence matrix (Boesch 1977). Where a genus included a proportion of species which were not identified to species, the genus was considered as a single taxon for the purposes of this analysis.

Three groups can be defined at a CDC of about 0.5 (Fig. 2), labelled A, B and C. Four of the five sites in group A are winterbournes. The species associated with this group are *M. argentea, Enchytraeus buchholzi* and *Henlea perpusilla. M. riparia* was common to three of these sites. Values of the Shannon-Wiener index of diversity were calculated for the Enchytraeidae alone at each site (Table II). It can be seen that the diversity of sites in this group is relatively high ; all values are > 1.0. Group B sites have less diverse enchytraeid associations. *M. argentea* was present at all sites within this group. Those in Group C

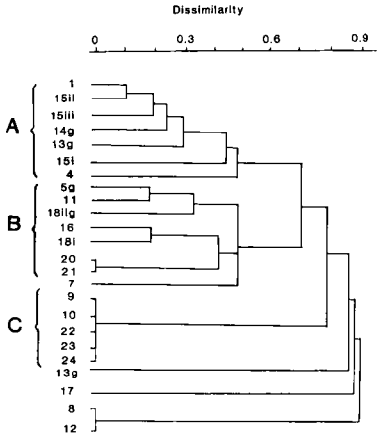

Fig. 2. Cluster analysis of the enchytraeid associations at the sampling sites. Roman numerals denote different dates.

are clustered at maximum association (1.0) because all had only one genus recorded (*Cernosvitoviella*).

A Kruskall-Wallis analysis of variance was carried out for each of the physical and chemical variables to determine whether any were associated with the defined groupings. For this purpose, a fourth group (D) was defined. This was constituted of those sites at which no enchytraeids were sampled (sites 2, 3, 5s, 6, 14s, 18s and 20). Of the chemical data, only water nitrate concentration yielded a significant result ($H = 12.45$, $p = 0.005$). This is due to the presence of three New Forest sites in group C, where the streams are nutrient poor by comparison with those on the chalk.

No single size-fraction of the sediment was significantly related to the classification. However, if an index of sediment coarseness is derived comprising the log of the ratio of the largest size fraction (> 2 mm) to the proportion of the finest fraction (< 0.063 mm), this is found to be influential ; this is because sites in group D (enchytraeids absent) tend to have low values of this index. If the values of the

Table II. Values of diversity (Shannon-Wiener index) of the enchytraeid association at each sampling site.

Site	Total No. of Oligochaeta sampled	Proportion of Enchytraeidae %	Diversity of Enchytraeidae (S-W index)
1	1417	90	1.2
2	20	0	-
3	67	0	-
4	23	100	1.3
5g	40	8	0.6
5a	10	0	-
6	0	0	-
7	22	18	1.0
8	2	50	0
9	41	12	0
10	18	6	0
11	140	36	0.5
12	43	5	0
13g	29	76	0.7
13a	10	70	0
14g	59	100	1.4
14a	32	0	-
15	557	89	1.6
16	116	79*	0.1
17	8	50	1.0
18g	65	14	1.3
18a	5	0	-
19	15	0	-
20	18	0	-
21	69	1	-
22	65	1	-
23	?	-	0
24	?	-	0
25	?	-	0

* Mainly P. volki

index of sites in this group are compared with those of sites in the other groups (by means of Mann-Whitney U tests), these sites are found to be significantly more silty than those in groups A or C.

6. Discussion

The Enchytraeidae have been described as being a terrestrial family with some aquatic tendencies (Healy & Bolger 1984). The family is rarely found to be predominant among Oligochaeta in typical flowing water situations, and this was so in the current study. It is probable that many records of unidentified enchytraeids in streams and rivers are the result of « accidentals », derived from adjacent terrestrial populations.

Some species, however, notably those of the genus *Cernosvitoviella*, are found mainly in aquatic and semi-aquatic situations (Healy & Bolger 1984, Healy 1987), and species of this genus were among the most commonly recorded in the current study. The observation that temporary streams tended to have a high diversity of enchytraeids may be owing to the ability of both semi-aquatic and terrestrial enchytraeids to successfully colonise these sites, while the rapidly changing conditions are too severe for other Oligochaeta. Published studies which described enchytraeids as being the dominant Oligochaeta include a high proportion concerning temporary streams (e.g. Cowx et al. 1984, Wright et al. 1984).

Enchytraeids generally have been described as being dependent on well oxygenated conditions

(Giere, 1973). This may be the cause of their relative scarcity in fine compared with coarser sediments, where the large interstices and relative lack of organic material promote such conditions (Whitman & Clark 1982). Permanent aquatic sites reported as having an abundance of Enchytraeidae are mainly mountain streams with fast flowing water and coarse substrata (e.g. Kasprzak & Szczesny 1976, Giani & Lavandier 1977) ; both these characters are likely to be associated with a high level of oxygenation within interstitial water. Aston (1971) reported that unidentified enchytraeids were abundant in some mountain streams of Wales.

The available evidence suggests that most Enchytraeidae adopt a « generalist » ecological strategy compared with the more « specialist » aquatic oligochaetes. As well as the observation that many species appear able to inhabit a wide range of environments, it is known from laboratory studies that some species are able to tolerate a wide range of values of single isolated ecofactors, such as salinity and temperature (e.g. Tynen 1969, Giere & Hauschildt 1979). The absence of enchytraeids from many habitats may be the result of competitive pressure from more specialised species.

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