

# THE POLYCHAETA OF THE COAST OF NORFOLK.

by

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## Résumé

L'auteur présente un inventaire complet des Polychètes des côtes de Norfolk (Grande-Bretagne). Aux 48 espèces déjà signalées il en ajoute 91. Leur distribution est brièvement indiquée. Quelques renseignements sont fournis sur les variations de couleur, le mode de reproduction, la nourriture, les variations morphologiques, la taxinomie, le commensalisme et le parasitisme. Certaines espèces, inconnues dans le Norfolk mais déjà citées des côtes avoisinantes, sont également inventoriées.

## INTRODUCTION

This paper is the seventh of a series dealing with the marine fauna of the coast of Norfolk, and summarises all previous records of polychaetes found there as well as all my own records in the intertidal and offshore habitats listed by me (Hamond, 1963a and in press).

### Previous investigations

Polychaetes have been recorded from Norfolk waters by Möbius (1875), Garstang (1901), Serventy (1934), Gilson, Hollick & Pantin (1944), and Pantin, Hollick, Joysey & Bidder (1960); between them these authors found 48 species, of which 11 are not included in the 128 species taken by me between 1955 and 1965, giving an overall total of 139 species. All, except for *Scolecoplepis ciliata* (Keferstein), are included in the 458 British species listed by Clark (1960).

Of the material collected by these authors, all that is now extant is a small part of the collections made at Scolt Head in 1959 (Pantin & al., 1960) and kept at Cambridge; a representative collection of my own finds is housed in my own museum.

### Abbreviations

A.H.P. denotes extracts from the unpublished notes of the late Arthur Henry Patterson, who collected in the Yarmouth area between 1878 and 1934.

J.F. refers to specimens collected by John Fisher and identified by me.

The stations fished are referred to as follows:—

D., S. and W., followed in each case by a number, refer respectively to dredge, shrimptrawl and whelkpot stations worked by me; stations where polychaetes were taken are listed in Table 14 (for a complete station list see Hamond, 1963a and in press).

P., followed by a number, denotes a station fished by the "Pommerania" (Möbius, 1875); the stations P.105 to P.115 lie within the area under consideration (Hamond, 1963a).

Q., followed by a number, refers to material collected by divers (the local branch of the British Sub-Aqua Club).

Tables 4 to 12 are arranged according to the types of ground at the various stations; the naming of these types is explained in Table 13.

Table 1 has its own set of abbreviations, explained therewith; in the other tables the following abbreviations are used:—

"Ca." (circa) refers to an approximate count, within ten percent of the probable true value either way;

"few" to a number which was not counted exactly, but was probably less than 20;

"p." to the presence of a species at one of the "Pommerania"'s stations (Möbius does not give the numbers of each species taken);

$\infty$  to a very large number, not counted but probably in excess of one hundred;

> to a number in excess of that stated;

x (only for *Nicolea zostericola* at D.40, see Table 11) refers to large numbers of masses of spawn, apparently of that species, but unaccompanied by the worm itself. Likewise, at D.33, there was a single mass of spawn, but no worms, of *Phyllodoce maculata*.

### Systematic list

The taxonomy of some of the Syllidae (the genera *Autolytus*, *Proceraea* and *Procerastea*) is based on the findings reported in my Ph.D. thesis (Hamond, unpubl.); otherwise the classification and identification follows Fauvel (1923, 1927) and Clark (1960). Of the 36 families and 214 genera listed as British by Clark, 29 families and 91 genera are represented in Norfolk waters; in the account of each species the present name is given, followed by the names used by previous workers on local polychaetes.

## Family APHRODITIDAE

*Aphrodite aculeata* (L.).

*A. aculeata* Möbius (1875); Garstang (1901); A.H.P.

Frequent in shrimptrawls, and sometimes cast ashore; off the north Norfolk coast it seems to be most common near the Blakeney Overfalls Buoy and on the whelkgrounds (the areas where the whelk, *Buccinum undatum* L., is fished commercially, see Hamond, 1961). Off the east coast of Norfolk it is most abundant off Yarmouth, off Winterton, and near Cromer Knoll; the stomachs of cod (*Gadus callarias* L.) caught in the two latter localities are often filled with *Aphrodite* (A.H.P.).

Breeding; one, ca. 7 cm. long, from a whelkpot at 53°07'20"N. 00°48'E. on 16.10.1960, shot its sperm when put into formalin.

*Hermione hystrix* (Savigny).

*Aphrodite hystrixcella* A.H.P.

"Met with perfect specimen of this sea-porcupine, or porcupine sea-mouse" in a shrimptrawl off Yarmouth (A.H.P., 11.5.1906). Probably this species, since "sea-mouse" is the common name for *Aphrodite*, which *Hermione* much resembles.

*Gattyana cirrosa* (Pallas).

*G. cirrosa* Hamond (1962).

Since my previous discussion of this species, Pettibone (1963) has clarified the distinctions between *G. cirrosa* and *G. amondseni*; the Norfolk specimens are all quite clearly the former. In *G. amondseni* the elytral spines are without exception two-pronged, whereas in *G. cirrosa* they vary from one-pronged to four-pronged as described and figured by me.

Fairly frequent in dredgings; the six so far taken between tide-marks include the two largest yet found locally, one of 35 mm length under rocks at extreme low water, half a kilometre west of Sheringham Lifeboat House, on 5.8.1962, and one 27 mm long in an old bivalve burrow in the submerged forest between Brancaster and Titchwell (equivalent to locality "a" of Pantin & al., 1960; see also Hamond, 1963a) on 22.11.1961.

*Lepidonotus squamatus* (L.).

*Polynöe squamata* Möbius (1875);

*Lepidonotus squamatus* Garstang (1901); Serventy (1934); Gilson & al. (1944); Pantin & al. (1960); Hamond (1963a).

Common and very widely distributed out to sea; plentiful in the Threshold and in the Freshes Lays, less so in the "Hjördis" (where a specimen 6 cm. long was collected among a clump of *Mytilus edulis* on 23.6.1955) and at West Runton. It also occurs, though not in large numbers, on Hunstanton Scaup, under Wells Rocks, and in the Strond Pool Dam.

Breeding: of two specimens from D.4 one released active sperm, while the single specimen taken at W.23 shed ova; these were in May and July respectively.

*Eunöe nodosa*, M. Sars.

*E. nodosa* Pantin & al. (1960).

I suspect that Pantin's record really refers to *Harmothöe impar*, which in Norfolk waters either lacks warts entirely or has small warts usually resembling those in Fauvel (1923), fig. 18b (*E. nodosa*) rather than those in his figs. 21b and c (*H. impar*). The above specimen was identified by a student, and is now no longer extant; my own material, resembling it in the principal features of the warts, is otherwise clearly of *H. impar*.

*Harmothöe imbricata* (L.).

*Polynöe cirrata* Möbius (1875).

Apparently rare here; my two records are both from muddy sand with great numbers of dead *Ostrea*-shells and a rich invertebrate fauna.

*Harmothöe impar* (Johnston).

*H. impar* Hamond (1963a).

Almost ubiquitous, especially out to sea, but also found in small numbers near low-water mark on all Norfolk shores wherever there is a little shelter. Even the largest specimens rarely have warts on the posterior margins of their elytra, so that the key in Fauvel (1923, p. 54) tends to be somewhat misleading through placing too much emphasis on this variable feature.

*Harmothöe lunulata* (Delle Chiaje).

*H. lunulata* Gilson & al. (1944).

Only four of the hosts listed by Davenport (1953) occur in Norfolk waters; the starfish *Astropecten* is found rather rarely off Yarmouth (A.H.P.), while in the following table the finds of *H. lunulata* relative to those of its three polychaete hosts are given.-denotes the absence of the species in question, X denotes the presence of *H. lunulata*, x denotes the presence of a suitable host having *H. lunulata* associated with it on that occasion, and (x) denotes an apparently suitable host with or without *H. lunulata* in the same haul, or in the same area, but their association not then and there observed.

TABLE 1.

	<i>Harmothoe lunulata</i>	<i>Amphitrite johnstoni</i>	<i>Lanice conchilega</i>	<i>Arenicola marina</i>
Plymouth (Fauna List, 1957) .....	×	×	(×)	×
Dinard (de Saint-Joseph, 1888) .....	×	—	×	×
Essex (Nisbet, 1960) ....	×	×	—	—
Lincolnshire (Young, 1955) .....	×	—	×	—
Norfolk :				
Scolt Head (Gilson & al., 1944) .....	×	(×)	×	(×)
Brancaster (M. Hornsey Esq.) .....	×	—	× or (×)	—
Offshore finds in dredgings or in whelkpots :				
D.6, D.14, D.35 .....	—	—	(×)	—
D.15, D.17, D.26, D.45 ..	×	—	(×)	—
D.18, D.19, D.20, D.22, W.27 .....	×	—	—	—
W.32 .....	—	×	—	—

Of the known hosts, therefore, only *Lanice* has been found offshore with *H. lunulata* and them only four times out of the twelve occasions offshore on which one or the other of them occurred. As all my *H. lunulata* were picked up loose while sorting the catch, it is probable that a more careful examination, by slitting open the *Lanice* tubes, would reveal *H. lunulata* far more often.

Of the varieties described by Fauvel (1923), the Norfolk specimens approach most nearly to the var. *typica*; the neurosetae are all distinctly bidentate, the accessory tooth being rather stout (except where it has been worn away in the two or three lowest setae of the bundle) and both it and the main tooth being sharply pointed (resembling Fauvel's fig. 26m rather than his fig. 26g or 26h). The elytra are pale greyish white with chestnut markings; the front five or six pairs have a stripe-like mark in the rear half, running parallel to the trailing edge, which in the other elytra (counting towards the tail) has become broad and faint, making an outwardly divergent V with a similar faint mark running from the forward and outer edge of the elytron to meet the first mark on the inner edge, above the median axis of the body. The Brancaster specimen and all those from the offshore stations showed this pattern; no details are available for those from Scolt Head, but Young (1955) refers her material to the varieties *andreapolis* and *marphysae*, though neither she nor I have any record of *Marphysa* from the coasts of Lincolnshire or Norfolk. Although mine approach most closely to form J of the forms mentioned in the Plymouth Fauna List (1957), no specimens have yet been found here with *Amphitrite johnstoni*.

*Lagisca extenuata* (Grube).

Common under rocks intertidally at West Runton, otherwise found once at Sheringham (under rocks), thrice near the Freshes Lays, once in the "Hjördis", once on Hunstanton Scaup, and subtidally at Q.2, but not so far on the usual offshore grounds.

*Scalisetosus pellucidus* (Ehlers).

*S. pellucidus* Pantin & al. (1960).

One, about 9 mm long, among sponges and other sessile organisms inside the "Hjördis" on 27.8.1961. On this occasion, the 390 *Ophiothrix fragilis* collected inside the "Hjördis" had no *Scalisetosus* among them, but on 13.10.1961 a further 311 *Ophiothrix* collected there harboured between them twenty-six *Scalisetosus*, all very small (mostly with three or four setigers, although a few had as many as eight setigers). Pantin and his party dredged it just off Scolt Head in a haul, of type E<sub>1</sub> or similar type (Hamond, 1963a), in which *Ophiothrix* was not taken.

*Sthenelais boa* (Johnston).

*Sigalion Idunae* [sic] Möbius (1875); *Sthenelais boa* Garstang (1901).

Moderately common round the Reef and the Freshes Lays, as well as in the Threshold; twice found at the base of the Freshes Stake (mid-tide level), once under a rock at West Runton (1.8.1957), and several times offshore. All my specimens have been searched in vain for the commensal endoproct *Loxomespilon perezii* (see Bobin et Prenant, 1953; Plymouth Marine Fauna, 1957, p. 344).

Breeding: of eight large ones taken at D.17 (in August) two or three released ova on rupturing. Two smaller ones taken with them were not mature.

*Pholoe minuta* (Fabricius).

*Pholoe* Hamond (1963a).

Often exceedingly abundant out to sea; it is relatively so scarce on the shore that the species is probably incapable of forming a resident population between tidemarks except under unusually favourable circumstances.

## Family PHYLLODOCIDAE

*Phyllodoce laminosa*, Savigny.

One, 15 mm long, on the Freshes Lays on 12.7.1956; and three, each about 8 cm long, under rocks at extreme low water at West Runton on 25.4.1963. Otherwise found exclusively offshore.

Breeding: a specimen about 45 cm long, from a whelkpot at 53°09'N.01°01'E. on 20.6.1952, burst and released vast quantities of pale green ova, while one of the Runton specimens released active sperm.

*Phyllodoce maculata* (L.).

*P. maculata* Gilson & al. (1944); Hamond (1963a).

Common everywhere in the western half of Blakeney Harbour below low water of neap tides, especially on the Freshes Lays; also in the sandbank south of Wells Lifeboat House, on Hunstanton Scaup and more rarely at West Runton. Very scarce out to sea. The colour and pattern are always as in McIntosh's figure (1908, pl. XLV, fig. 2), irrespective of the habitat.

Breeding: the familiar green gelatinous masses of spawn (commonly ascribed to the lugworm *Arenicola marina*) are abundant from March to June in all the places mentioned above, as well as on the Strond, where on 2.5.1964 the adults were found in great numbers (up to 500/sq.metre) in little shallow pools, not more than 5 or 6 cm deep, at the level of high water of neap tides, to the south and southeast of the Strond Pool. Normally, the worm is not found in these pools, so that I believe this to have been a genuine swarming before spawning; but I was unable either to induce members of the swarm to spawn in the laboratory or to visit the shore again to see whether they had spawned there. Offshore, one mass of spawn was found at D.33.

*Phyllodoce groenlandica*, Ørsted.

Common out to sea; the usual length is less than 2 cm, but the single specimen taken at D.45 was 5 cm long and 0.4 cm broad including the parapodia, and was at first mistaken for *P. laminosa* or *Notophyllum* because of its unusual size. A young one (ca. 5 mm long) in a holdfast of *Laminaria saccharina* in the Threshold, 8.7.1959, closely resembled that shown in fig. 21H of Thorson (1946, p. 53) but the dorsal cirri were not so rounded, being almost as acuminate as those shown in McIntosh's plate (1908, pl. LXVIII, figs. 5 & 6).

*Eulalia viridis* (O.F. Müller).

*E. viridis* Gilson & al. (1944); Hamond (1963a).

Generally distributed but seldom numerous; common among *Pomatoceros* in the Strond Pool, among *Laminaria*-holdfasts in the Threshold, and inside the "Hjördis", occasionally found at Hunstanton, at Wells and at West Runton (in both the last two localities named it is found under rocks). Offshore it prefers the rougher grounds.

The usual colour here is a yellow-green or grass-green, rarely a deeper green, but during 1961 and 1962 (and sometimes in 1965) the variety *ornata* (the *Eulalia ornata* of de Saint-Joseph) was at times not uncommon, usually occurring with the var. *viridis* (the ordinary variety). Seen side by side, the two varieties appeared almost identical except for the colour; the few slight structural differences are tabulated below.

TABLE 2.

<i>Eulalia viridis viridis</i>	<i>Eulalia viridis ornata</i>
Eyes very black, relatively large.	Eyes black, slightly smaller and not nearly so conspicuous.
Pharynx only slightly wider distally than proximally.	Pharynx much wider distally than proximally.
Papillae on surface of pharynx abundant, so closely set as to be almost touching.	These papillae sparser, separated by at least their own diameter.

In both varieties, the pharynx length bears the same relation to the body length for a given value of the latter and, in both, the distal end of the pharynx is crowned with about sixteen large papillae.

The colour pattern of *ornata* is well described by McIntosh, but neither he nor Fauvel mentions the dusky suffusion on the dorsal surface of the first segment, nor how the dorsal patches (almost black centrally and deep green laterally) are obsolete on the first few setigers, but from then on gradually deepen and strengthen in colour towards the middle of the body, becoming reduced in size and distinctness only in the last few setigers; both these reductions are very slight. The dorsal cirri have a thick sprinkling of little dark brown spots confined to their forward-facing surfaces, their rear surfaces being pale dull green. The tentacular cirri and the antennae are all of a dull ashy brown, not spotted as are the dorsal cirri.

Breeding: female *viridis* containing eggs have been found in May and August; female *ornata* in August only.

#### *Eulalia pusilla*, Ørsted.

Among tunicates under rocks at West Runton, 3.8.1958 and 29.7.1961; widely distributed on hard ground offshore. The colour of the Norfolk specimens is a watery pale green, with an almost black stripe running along the mid-dorsal line.

Parasites: all my specimens have been searched unsuccessfully for *Phyllodicola petiti* Laubier (1961) which is found on this species of worm in the Mediterranean.

#### *Eulalia bilineata* (Johnston).

The colour agrees closely with that of McIntosh's plate (1908, pl. XLIII, fig. 5). One large specimen was found in a crevice in the hard chalk at low water mark of spring tides, at West Runton on 14.10.1962; otherwise this species is found always offshore, where it is not uncommon on shelly and gravelly grounds with a certain amount of silt.

#### *Eulalia fucescens*, de Saint-Joseph.

One small one among the sessile organisms carpeting the inside of the "Hjördis" on 10.6.1952; otherwise entirely offshore, mostly with *E. pusilla* and *E. bilineata*, less often with *E. viridis*.



Breeding: of six specimens taken at S.4, all were less than 1 cm long except for a female containing ova whose length was about 3 cm; this solitary record was in August.

*Eulalia (Eumida) sanguinea*, Ørsted.

*Eulalia sanguinea* Möbius (1875); *Eumida* Hamond (1963a).

Very widespread out to sea, where it is by far the commonest species of *Eulalia*; frequently taken around the Threshold, whence it extends up Blakeney Harbour as far as the Strond Pool and the seaward end of Morston Creek. It is found occasionally at Hunstanton, at Wells, in the "Hjördis" and at West Runton (under rocks and among *Corallina*).

The colour in Norfolk waters is usually green, sometimes with white or pale yellow patches behind the head as in the common grass-snake, but the variations that I have seen here include McIntosh's pl. XLIV, fig. 4, which is possibly of a young one, and more rarely his pl. XLVIII, fig. 1, but never fig. 2; occasionally the variety shown in pl. XLIII, fig. 9, is found. The everted pharynx is by no means always smooth except in complete extension, and a partially extended pharynx may lead to confusion with, for instance, *Eulalia punctifera*, whose head (Fauvel 1923, fig. 59a) is very similar to that of *E. sanguinea*. *E. punctifera* has not, however, been found in Norfolk waters as yet, and is easily distinguished from *E. sanguinea* by its sharply pointed parapodia and distinctive colour pattern.

*Notophyllum foliosum* (M. Sars).

*N. foliosum* Hamond (1962).

Two large individuals and one small one were taken at D.22.

*Eteone longa* (Fabricius).

Common in the western end of the Harbour in clean or muddy sand, below mid-tide level; also found in the mud of Stiffkey Freshes, among *Laminaria*-holdfasts in the Threshold, and in several places offshore. On calm summer evenings after dark, especially towards the time of high water, it swarms at the surface in Morston Creek in great numbers, and in smaller numbers in the less sheltered waters of the Pit.

Breeding: females containing the bright lemon-yellow ova have been found in February, March and April. This coincides with the appearance on the shore, in company with the green gelatinous eggmasses of *Phyllodoce maculata*, of smaller and more spherical masses of clear jelly with a mass of yellow embryos in the centre, about 8 mm in diameter and attached to the substratum by a slender thread of the same jelly. However, a very similar eggmass formed at the same time of year in Danish waters has been linked by Rasmussen (1956, p. 64 and fig. 20) with a capitellid, *Heteromastus*

*filiiformis* (Claparède), which so far has not been found here; Rasmussen's figure 21, also, closely resembles the larvae that on one occasion were hatched in my laboratory from this kind of spawn.

*Eteone picta*, de Quatrefages.

Two in surface plankton on 15.8.1965, close to the Blakeney Overfalls Buoy. The first, of length 4 cm, was taken in the plankton net and the second, 7 cm long, I caught by hand as it swam past at the very surface with exactly the same corkscrewing motion as *E. longa* has when swimming. The colour was bright yellow, with violet marks whose pattern agreed closely with the description and figures of Fauvel (1923); the parapodia also agreed with Fauvel, but the pharynx appeared smooth even when fully extended. During the next two days the larger specimen shed many ova while in captivity. *E. picta* is rare in the North Sea, but has been found in Holland by Korringa (1951) and in the Thames estuary, at Whitstable, by Newell (1954).

*Eteone flava* (Fabricius).

*E. flava* Möbius (1875).

Taken at P.105 (Möbius). According to Fauvel (1923) the *Eteone picta* of McIntosh (1908, p. 100, pl. XLV fig. 3 and pl. LXIX figs. 3 & 4) and the *Eteone depressa* of Malmgren, which McIntosh (1923) claims to have found at Scarborough (Yorkshire), are both synonyms of *E. flava*. This species has often been confused with *E. picta* and it is not now ascertainable which one Möbius had; the above records are quoted here, since the species may turn up in Norfolk waters again.

Family TOMOPTERIDAE

*Tomopteris helgolandica*, Greeff.

*T. onisciformis* Möbius (1875); *T. helgolandica* Hamond (1963 b).

In plankton outside the Point, where it tends to keep close to the bottom during daytime; sometimes it is brought into the Harbour on a flood tide. With *Aglantha digitale* var. *rosea* and abundant *Sagitta elegans*, *Tomopteris* is an indicator of water from further north (the deep water off Northumberland, Durham and north Yorkshire) which has pushed southwards with unusual strength, bringing its own plankton with it; such invasions never last for more than a week or two, being dispersed especially rapidly by warm weather and high water temperatures. *Tomopteris* is thus found here only during the colder part of the year, from August to February, and is not numerous except during October, November and December.

## Family HESIONIDAE

*Kefersteinia cirrata* (Keferstein).

*K. cirrata* Hamond (1963a).

Not abundant anywhere, but in Blakeney Harbour it is often found on the bound shingle of the Strond and, less commonly, on the Freshes Lays and among *Laminaria*-holdfasts in the Threshold; it is rare on other shores and has been found out to sea several times. At D.17, apart from five free-living adults, a small one was found in a tube of *Pectinaria koreni*, lying against the host's dorsal side with its head between the notopodia of the host's seventh and eighth setigers; as they were dead when found I was unable to observe the exact nature of their association.

Breeding: one of four adults collected on the Strond, 3.6.1961, was full of ova of a bright cinnabar pink, while four very small specimens were collected among *Laminaria*-holdfasts in the Threshold on 8.7.1959; these young worms were about 70  $\mu$  in body width and had only six pairs of tentacular cirri, but were in all other respects typical of the species.

*Nereimyra punctata* (O.F. Müller).

One under a rock among *Polyclinum* at West Runton, 10.8.1957; two small ones in the Threshold with young *Kefersteinia* (q.v.), and one inside the "Hjördis" on 14.9.1962; otherwise an offshore species, preferring rough shelly ground with some silt. The colour pattern consists of a white ground, with vivid green transverse dorsal stripes which are most intense just behind the head.

*Magalia perarmata*, Marion & Bobretzky.

*M. perarmata* Pantin & al. (1960).

A markedly southern species not otherwise known from Norfolk waters, although it has been found in Holland (Korringa, 1951) and in Denmark (Rasmussen, 1956). The specimen, which was identified by a student, no longer exists (according to Dr. Joysey) and may well have been misidentified; pending the discovery of further specimens, I suspect that there has been confusion with *K. cirrata*.

## Family SYLLIDAE

*Syllis gracilis*, Grube.

One among flakes from the mast-stump of the "Hjördis" on 3.9.1962; otherwise invariably (though by no means frequently) under rocks near low water at West Runton, and usually among polychaete ascidians there, except for a small specimen (among *Sabellaria* on 20.6.1961), which had brown transverse dorsal stripes as in *Trypanosyllis zebra* (Fauvel, 1923, fig. 101a).

*Syllis armillaris* (O.F. Müller).

*S. armillaris* Möbius (1875).

Very common on the rougher grounds offshore, but intertidally the only records are of two non-breeding adults among stones covered with *Pomatoceros* in the Strond Pool on 4.5.1964, and three small ones (one among *Corallina* at West Runton on 24.10.1960, one among tunicates and polyzoa there at extreme low water under a rock, 29.7.1961, and one among *Alcyonium* just below extreme low water on Hunstanton Scaup on 1.11.1963) which all bore a close resemblance to *Syllis hyalina* Grube as described and figured by Fauvel (1923).

Breeding: from June to September, mature worms are frequently found with the posterior one-third or one-quarter of the body filled with ripe ova; the sexual part is stouter and has more widely spaced setigers, slenderer dorsal cirri, and a much thinner body-wall than in the unmodified front part of the worm. At the junction, which is clearly marked, there is no sign of a head (cf. Fauvel's remark about "stolons acéphales", 1923, p. 265).

*Syllis variegata*, Grube.

In small numbers at several stations offshore, always on muddy sand with shells and small stones.

Fauvel (1923) considered that *S. variegata*, *S. hyalina* and *S. prolifera* Krohn were so closely related and so connected by intermediates, as perhaps to represent extreme forms of one species. Cognetti (1960) finds that the three species and two subspecies of the *Syllis prolifera*-group present in the Bay of Naples are clearly separable there, but are represented on the Breton coast (at Roscoff) by one species with two subspecies covering the same total range of variation in appearance and in habitat. The further south one goes the more clearly are the possible species demarcated, or, to put it another way, evolution within the group has been slower further north; table 3 shows the relationships between the various species and subspecies (in the table two species one above the other can interbreed if separated by a dotted line, but not if separated by a solid line).

TABLE 3

Norfolk	Roscoff	Naples
<i>S. variegata</i> (in the sense of Fauvel)	<i>S. atlantica lineata</i>	<i>S. variegata variegata</i>
		<i>S. variegata profunda</i>
		<i>S. prolifera</i>
" <i>S. hyalina</i> "	<i>S. atlantica atlantica</i>	<i>S. hyalina</i> with small red spots dorsally in the front part of the body.
		<i>S. hyalina</i> without such spots.
<i>S. armillaris</i>	<i>S. armillaris</i>	<i>S. armillaris</i>

Most of table 3 is reconstructed from Cognetti's paper; I have added an extra line below for *S. armillaris*, and on the left a column intended to show that the very few specimens of "*hyalina*" so far seen in Norfolk waters might equally well be considered as young specimens either of *S. variegata* (in the sense of Fauvel, 1923, = *S. atlantica lineata* of Cognetti) or, even more likely, of *S. armillaris* (q.v.), the latter being quite distinct from the others, at any size, both at Naples and at Roscoff. When adult, *S. armillaris* and *S. variegata* are clearly distinguishable in Norfolk waters.

Cognetti suggests that this progressive increase in speciation as one goes from north to south is due to the fact that the algal zone extends from the shore into much deeper water in the Mediterranean than it does in the Channel, and that this group of syllids therefore has a much greater range of habitats to choose from in the Mediterranean so that there is thus more chance of purely local variations becoming stabilised and evolving into separate species without the risk of serious genetic contamination from outside. In contrast to this, the narrow algal zone in the Channel means that the animals there are confined to a much smaller area, so that it is far more difficult to set up mating barriers within what is effectively a single population. My own data support this idea, since the algal zone along the Norfolk coast is even narrower than it is at Roscoff, and only two adult *S. armillaris* and two "*hyalina*" (?young *armillaris*) have been found in this zone here; a third "*hyalina*" has been found among *Alcyonium*, while all the specimens of *S. variegata* and the great majority of those of *S. armillaris* have been taken in dredgings, well away from the coast and entirely without algae. This ability on the part of *S. variegata* to live away from algae is noticeable at Plymouth (Marine Fauna, 1957) and to a lesser extent at Roscoff (Cognetti, 1961); in Norfolk waters *S. variegata* is probably unable to compete in the algal zone. A similar example is provided by the hydroid *Laomedea* (*Obelia*) *geniculata*, which at Plymouth is usually found on the blades of *Laminaria digitata* but in Norfolk waters is found entirely out to sea on floating corks and buoys, and on the polyzoan *Flustra foliacea* (Hamond, 1957); it is never found here on the blades of *Laminaria saccharina* although this large alga is quite common in Norfolk waters (Hamond, 1963 a).

The table apparently shows that *S. hyalina* needs a wide algal zone in which to evolve separately, and perhaps neotenously, from its parent species, the latter being potentially either *S. armillaris* or *S. variegata* in Norfolk waters but exclusively the latter in the Channel and the Mediterranean. Cognetti expresses this relationship by renaming the Roscoff form of *S. variegata*, *S. atlantica lineata*, and the Roscoff form of *S. hyalina*, *S. atlantica atlantica*; as far as the Norfolk examples are concerned this seems unnecessary at present, so that Fauvel's names are used here. It might be worth investigating this group of syllids in, say, Scottish and Scandinavian waters, in order to find out how far these apparent trends may be continued.

*Pterosyllis formosa*, Claparède.

Two little ones among *Sidnyum turbinatum* at West Runton on 10.8.1957.

*Pionosyllis serrata*, Southern.

*P. serrata* Hamond (1962).

One specimen, about 2 mm long, at D.18.

*Pionosyllis lamelligera*, de Saint-Joseph.

Among tunicates and other sessile organisms under rocks at West Runton on three occasions; not uncommon offshore on shelly grounds with a fair proportion of silt.

Breeding: from June to September inclusive. In ripe worms the gut degenerates in the posterior part of the body which becomes an almost structureless sac, with thin walls through which the lilac-coloured ova or the milky white sperm can be seen, and with very few setae which are all of the usual kind. As compared with that of *Syllis armillaris*, this sexual "tail" is physically so enfeebled that it is very doubtful whether it could ever detach as a freeswimming stolon; almost certainly it ruptures while still attached to the stock. However, Herpin (1925) found that, near Cherbourg, the worms shed their ova and sperm while swimming in the plankton, after which they cast off their swimming bristles and reverted to their former way of life, creeping on the bottom among hydroids and other organisms.

*Eusyllis blomstrandii*, Malmgren.

Though not uncommon in the Pit of Blakeney Harbour, and sometimes found on other shores, this species is par excellence a dweller among large hydroids offshore, especially *Hydrallmania falcata* and *Sertularia argentea*, up the outsides of whose stems it secretes transparent tubes, each made and inhabited by a single worm. *E. blomstrandii* is brilliantly luminescent; when stimulated by touching or shaking, waves of greenish-blue fire seem to rush along the body in close succession at the rate of several per second, starting from the head. The display continues for several seconds, being most intense if the worm (although moist) is exposed to the air, and if it has not been disturbed for some time previously. The light comes from yellowish-brown granules set in ill-defined patches on the sides of the worm, and the successive flashings of entire patches imply that the whole process is controlled by impulses from the brain passing down the central nervous system.

Breeding: March to August.

*Brania limbata*, Claparède.

Always at West Runton; twice among *Corallina*, twice among *Polyclinum*, and twice among a mixed collection of tunicates, *Salmacina* and other things.

Breeding: July and August.

*Brania pusilla* (Dujardin).

Also confined to West Runton, where two with very distinct glands in the dorsal cirri were found among *Polyclinum* on 10.8.1957, one among *Corallina* on 9.8.1959 (in both cases with *G. limbata*) and a very small one among *Sabellaria* on 20.6.1961.

*Sphaerosyllis hystrix*, Claparède.

Entirely an offshore species; of two taken at W.38 one had brilliant pink eyes, the other had deep red eyes.

Breeding: September.

*Sphaerosyllis bulbosa*, Southern.

A single female among *Polyclinum* at West Runton on 3.8.1958; otherwise an offshore species.

Breeding: August.

*Exogone gemmifera*, Pagenstecher.

The intertidal records of this species are all from West Runton, where it has been found several times among tunicates under rocks near extreme low water, and slightly higher up the shore among *Corallina* (a few times) and *Cladophora* (once). Offshore this species is plentiful, especially on muddy sand mixed with dead bivalve shells.

Breeding: June to September.

*Exogone verugera* (Claparède).

*E. verugera* Hamond (1962).

One at D.18.

*Exogone hebes* (Webster & Benedict).

One nearly complete specimen with red eyes, and five other incomplete specimens (each roughly equivalent to the front half only of a complete worm) with black eyes, at D.17; they were all definitely of this species and not of the very similar *E. fauveli* Cognetti (1961).

Genus *Autolytus* Grube.

The species of this genus are active and very contractile, making them exceptionally difficult to describe and draw; the literature is thus full of unhelpful descriptions and distorted figures which have

led to widespread confusion in identification and hence in nomenclature. One fruitful source of error is the apparent unwillingness of many authors to dissect out the trepan, the form and arrangement of whose teeth furnish what is probably the most reliable single specific character.

I follow here the unpublished interpretation of the taxonomy of the autolytoids of northern Europe (from France to Scandinavia, including the British Isles) due to Mr. Lennart Gidholm of Uppsala University. From my own experience this is a vast improvement on anything previously proposed, when it comes to the identification of species (e.g. Fauvel, 1923), but the autolytoids examined by him did not include a complex population such as that found here, in which the members of a group of species seem to fade away into one another. In Sweden (Kristineberg) and Brittany (Roscoff) he finds that this group (for which he has introduced the term "*prolifer-group*", since *Autolytus prolifer* is the best-known member of it) comprises a number of genuinely distinct, albeit closely allied, species; in Norfolk waters the group behaves as a single species in which the initial stages of the process of splitting into several species can be vaguely discerned, since the stocks, though presenting all the salient features of the separate species recognised by Gidholm, are connected by a complete series of intermediates. It also appears that the stolons reared from these various stocks in my laboratory are completely interfertile, but the results of mating trials are less conclusive than one would wish since the stolons of the *prolifer-group* are by no means hardy in captivity.

Similar intergradations in Norfolk waters, between related species which appear to be totally distinct elsewhere, are found in *Syllis variegata*, *Polymnia* spp. and *Nicolea* spp.; *Ophelia borealis* intergrades with *O. limacina* in Alaskan waters, but is distinct from it here.

The taxonomy and biology of the Norfolk species of *Autolytus* are both dealt with more fully elsewhere (Hamond, unpubl.); the local members of the *prolifer-group* (*brachycephalus*, *prolifer*, *edwardsi*, *langerhansi*, and perhaps *Autolytus* sp.) will be dealt with below as if they were separate species, but it should be borne in mind that this measure is adopted purely for convenience.

#### *Autolytus brachycephalus* (von Marenzeller).

This is by far the commonest member here of the *prolifer-group*, extending from mid-tide level in the creek bottoms (where it is constantly immersed) down to low water mark, and offshore among dredgings of dead shells with hydroids growing on them. A completely intergrading series of varieties is found, from the extreme *brachycephalus*-type with long cirrophores, short cirri, strongly humped dorsal surfaces to the segments, and markedly unequal pharyngeal teeth, to those showing the literal opposites of all these characters and therefore almost indistinguishable from *prolifer* except for the longer and less rounded proventricle, the slightly different shape of the segments when crawling actively, and a tendency to a translucent pink rather than a cloudy orange as the general body colour; in all these respects transitional forms exist to connect *prolifer* with



moderate *brachycephalus*. Such transitional forms are, however, rare enough to enable one to speak of a range of *brachycephalus*-types without including the *prolifer*-type (dealt with below, as *A. prolifer*); between them the range of *brachycephalus*-types includes 95 per cent. of all *Autolytus* of the *prolifer*-group found in Norfolk waters. The above range of variation will be dealt with more fully in a future paper.

Breeding: stolons produced from March to December.

*Autolytus prolifer* (O.F. Müller).

Found occasionally in the Strond Pool but otherwise only at low water (Hunstanton Scaup, inside the "Hjördis" or on the Reef) and in dredgings, almost always together with various types of *brachycephalus*. Owing to the comparative rarity of this form, and the difficulty that one often encounters in distinguishing it from *brachycephalus*, it is impossible to give full records for the season during which the stolons are produced.

Breeding: stolons seen occasionally attached to their stocks, in summer.

*Autolytus edwardsi*, de Saint-Joseph.

Distinguished from *prolifer* only by the colour; of the six specimens seen here two had the typical colour pattern almost as strongly developed as it is in those areas (Kristineberg, Plymouth, Roscoff) where *edwardsi* and *prolifer* are accepted without question as distinct species, two had it faintly, and the last two only just perceptibly, being otherwise indistinguishable from *prolifer* as found here. *A. edwardsi* seems to be confined to near low water mark, since of the above specimens two were found on Hunstanton Scaup, one at position "a" with *Gattyana* (q.v.), one among *Laminaria*-holdfasts in the Threshold, and two near extreme low water mark at West Runton; there was no relation between provenance and intensity of colour. I have not found it here in dredgings. In these waters *edwardsi* and *prolifer* are not clearly separable; in places where they are, they prefer somewhat different although broadly overlapping habitats.

De Saint-Joseph dedicated this species to Milne-Edwards, and there is thus no justification whatever for the spelling *edwarsi*, which doubtless originated in a slip of the pen; the correct spelling is that adopted here.

*Autolytus langerhansi*, Gidholm.

Gidholm has shown (unpubl.) that this species has hitherto been embroiled in the synonymy of *A. brachycephalus*; both his and my observations, however, support the view that this is a good species with a very distinctive trepan. I have seen only one specimen here, of unknown provenance, and a few from trawl refuse near the Dogger

Bank (in which they outnumbered *A. brachycephalus*), as well as a few at Kristineberg and one at Naples; the characters of the species are very constant, and there is no sign of intergrading with other species. The above records suggest that, in the North Sea, it prefers deeper water than the other members of the *prolifer*-group.

Breeding: certain stolons, found commonly in the offshore plankton from July to September, 1965, are suspected of belonging to this species or to some other member of the *prolifer*-group which as yet is undiscovered locally. Structurally they resemble the stolons of *brachycephalus* very closely, but in both sexes the ground colour was straw-yellow or transparent with a pronouncedly pink, red, brown or rarely black, gut rudiment plainly visible all along the body; in *brachycephalus* the male varies from emerald green to colourless or even a very pale dull brown, the female is glassy clear with pink, buff or tan eggs (in the presumed *langerhansi* females the eggs are yellow or lilac), and in both sexes of *brachycephalus* the gut rudiment is the same colour as the surrounding tissues and is therefore by no means conspicuous, although visible under most conditions.

#### *Autolytus* sp.

Several at W.37 among eggs of the spider-crab *Hyas araneus*, and one at D.32 among hydroids. Although most resembling the members of the *prolifer*-group this does not quite agree with any known species of *Autolytus*, but more and older specimens (preferably producing stolons) are required before it can adequately be described and figured.

#### *Autolytus lugens*, de Saint-Joseph.

One at D.51. As in all those that I have seen from Kristineberg, Plymouth and Naples, the peculiar granules (white by reflected light and black by transmitted light) diagnostic of this species were confined to the median antenna and the two caudal cirri; such specimens were referred to a new variety, var. *mediterraneus*, by Cognetti (1953), which in fact seems to be the normal form of the species, the var. *lugens* (as described by Fauvel, 1923) being very rare and apparently confined to the English Channel.

#### *Autolytus alexandri*, Malmgren.

The largest Norfolk autolytoid (up to about 15 mm long) found only on shelly grounds with a fair amount of silt, and never nearer the north Norfolk coast than the Blakeney Overfalls Buoy (some 8 km. from land), near which it seems to be not uncommon.

Breeding: the large planktonic stolons are very restricted in their occurrence, from the end of March to the beginning of May; it is possible that they are produced, not by stolonisation but by an epitokous transformation of the normal animal. If so, this is the first record of epitoky in an autolytoid.

*Proceraea cornuta* (A. Agassiz).

In British waters this species has so far been found only at Plymouth (Okada, 1929, as *Autolytus cornutus*) and in the Thames Estuary near Southend (Dales, 1951, as *A. prolifer*); abroad it is known from Holland (Korringa, 1951, as *A. cornutus*), from Scandinavia, Arctic waters, and the east coast of North America. It is very common in the creeks of the North Norfolk marshes, ranging higher up the shore than any other autolytoid; it prefers (as does *A. brachycephalus*) the small algae, covered with hydroids (*Laomedea* spp.), that grow on shells and stones in the bottoms of the creeks where they are always covered by running water. Out to sea, very small ones are sometimes found; these are probably stunted due to unfavourable conditions. Near low water mark the species is not so common as it is higher up, except where there is plenty of *Laomedea* (any species except *L. flexuosa*).

Breeding: stolons are produced almost the whole year round, with a maximum from late March to early July.

*Proceraea picta*, Ehlers.

Three specimens only, all of them offshore, and all apparently the true *picta* and not *P. scapularis* (Claparède) (see Okada, 1929).

*Procerastea halleziana*, Malaquin.

*P. halleziana* Hamond (1963 a).

From 1953 to 1956 this species was quite common, but since then it has become rather rare; the stocks occur on gymnoblast hydroids (*Eudendrium ramosum*, *E. rameum*, *Tubularia larynx*, *T. indivisa*, and *Sarsia eximia*) inside the "Hjördis", on Hunstanton Scaup, in dredgings and cast ashore.

Breeding: the stolons, whose connection with this species is proven only in the male (Allen, 1921) although strongly suspected in the female (Okada, 1929), are found in the plankton in small numbers from June to October, with a pronounced maximum in August.

## Family NEREIDAE

*Nereis pelagica* (L.).

*N. pelagica* Möbius (1875); Gilson & al. (1944); Hamond (1963 a).

At West Runton it is fairly common in cracks in the hard chalk, and occurs more rarely loose under rocks; it is found occasionally on other shores, and commonly out to sea among sessile animals growing on shells and stones, especially among the matted hydro-rhizae of *Nemertesia antennina*.

*Nereis zonata*, Malmgren.

Found several times offshore, and once in the Threshold (8.7.1959) when two specimens were found among *Laminaria*-holdfasts.

*Nereis diversicolor*, O.F. Müller.

*N. diversicolor* Garstang (1901); Gilson & al. (1944); Pantin & al. (1960); Hamond (1963 a).

Especially common in the muddy floors of creeks and pools in all the North Norfolk salt-marshes, but less abundant in the exposed parts of Blakeney Harbour except at a high level, just below high water of neap tides, where it may be numerous. It is also plentiful in the mud of Breydon and other estuaries.

*Nereis fucata* (Savigny).

Once between tidemarks (3.5.1959) when two large adults were collected on the Freshes Lays; according to the Wells whelkers it is very common all the year round in shells of *Buccinum undatum* and *Neptunea antiqua* inhabited by adult *Pagurus bernhardus*.

*Nereis virens*, M. Sars.

*N. virens* Gilson & al. (1944); Pantin & al. (1960); Hamond (1963 a).

Numerous at a depth of from 20 to 40 cm in the thick black mud which forms the base of a large part of the Freshes Lays; known to the fishermen as "King Rag" ("Rag" or "Ragworm" being their term for all nereids, and "Silver Rag" being used by them for *Nephtys*, mainly if not all *N. hombergi*), and considered one of the finest of all baits for sea-angling.

Breeding: two large male heteronereids were found on the sand, on the north side of the Pit opposite the Strond, on 27.4.1963.

*Nereis longissima*, Johnston.

*N. longissima* Pantin & al. (1960); Hamond (1963 a).

This species was not found by Serventy (1934), as erroneously stated by Pantin & al. (1960); it is the dominant nereid on Hunstanton Scaup and in the submerged forest at Brancaster (including position "a" with *Gattyana*, q.v.), and has also been dug among *Lanice* at Snettisham, in gravel on the Reef, and under *Mytilus* on the Freshes Lays. At extreme low water at Hunstanton it can be seen extending up to half its length (the total length being about 25 cm) from its burrow, in order to pull off pieces of *Ulva* in its jaws for food; one small piece of *Ulva* was found wedged in the entrance to a burrow.

The two offshore specimens, only 1.5 cm long, were at first confused with *Leptonereis glauca* Claparède, since in both species the paragnaths are inconspicuous or absent (Ramsay, 1914); however, they may easily be distinguished by the languets of the parapodia, which in *N. longissima* are very long and conically tapering in the adult, and in the young extend (especially the lowest languet) far beyond the neuropodium, whereas in *L. glauca* the lowest languet hardly overreaches the neuropodium and all the languets are much shorter in proportion to the height of the parapodium (cf. Fauvel, 1923, figs. 129 b and 138 b).

Breeding: a heteronereid, 9.5 cm long and deep flesh-pink in colour, was found poking its head out of the sand at the level of high water of neap tides (the tide then being out) on Stiffkey sands south of the Freshes Lays, on 3.5.1959 (see Addendum).

*Nereis succinea* (Leuckart).

*N. succinea* Gilson & al. (1944).

Pantin & al. (1960) quote Gilson's record as *Perinereis marioni*, following McIntosh (1910, p. 296); Fauvel (1923, 1936) keeps them separate, and is followed here. The Scolt Head material is no longer extant; the nearest authentic modern records outside Norfolk of this species appear to be those of Newell (1954) from Whitstable and Korringa (1951) from Holland, whereas no record exists of *P. marioni* from nearer than Plymouth (Fauna List, 1957).

*Perinereis cultrifera* (Grube).

*P. cultrifera* Gilson & al. (1944); Hamond (1963 a).

Found at East Runton and at West Runton in the same habitat as *Nereis pelagica*, but much more seldom.

Breeding: two heteronereids were found, with one or two atoqueous individuals, at East Runton on 23.5.1959 (J.F.), and one heteronereid at West Runton by me on 13.5.1964.

*Platynereis massiliensis* (Moquin-Tandon).

Not uncommon in the Threshold among *Laminaria*-holdfasts; found occasionally under Wells Rocks and in the Strond Pool Dam, in the lowest reach of Morston Creek, and once at West Runton among *Corallina*. Southward (1956) has shown that *P. dumerili* auct. (e.g. Fauvel, 1923) includes this species and the next; the somewhat complex taxonomy of this group of species is further analysed by Pettibone (1963).

Breeding: four, ranging in length from 2.0 to 3.5 cm, the largest releasing masses of nearly ripe ova, were found in the Threshold on 8.7.1959.

*Platynereis dumerilii* (Audouin & Milne-Edwards).

One peagreen female heteronereid, about 3.5 cm long, was taken in plankton near the tip of Blakeney Point at about 2.0 a.m. on 29.7.1963. The eyes were jet-black and so large that they nearly touched; the body cavity was crammed with ova comparable in size to those mentioned by Southward (1956).

Breeding: the Victoria County History of Suffolk (quoted by Morley, 1941) states that "something like a million were swimming in Harwich harbour early on 16th. July 1898. One laid some 10,000 eggs in a few minutes"; A.H.P. states that the Harwich worms were one and a half inches long, which is about the same size as mine.

#### NEREIDAE, spp. indet.

Swarms of heteronereids, of unidentified species, are recorded as follows, all by A.H.P.:

(1) in Breydon Water, near Yarmouth, on calm evenings in May and early June (e.g. on 5.6.1899);

(2) an immense swarm in the Wash on the evening of 7.6.1919, eagerly preyed upon by *Squalus acanthias* and observed from the fisheries vessel "Protector" while lying at anchor "about half a mile from the Sunk Sand, in the lower part of Lynn Well" (i.e. somewhere near 52°59'N.00°26'E.—R.H.);

(3) "a similar sight was seen from the "Protector" on a previous occasion in the locality of Mablethorpe, the devouring fish being mainly flatfish". For locality, Patterson should perhaps have written vicinity; Mablethorpe is on the coast of Lincolnshire at about 53°20'N., and lies well north of the Wash.

In all three cases the worms were said to have been from 10 to 15 cm long, but apparently none were preserved.

#### Family NEPHTHYDIDAE

*Nephtys caeca* (O.F. Müller).

*N. caeca* Möbius (1875); Serventy (1934); Gilson & al. (1944); Hamond (1963 a).

Not uncommon at extreme low water on Hunstanton Scaup, in stony ground with a high proportion of black mud; also one on the Reef, 3.4.1957, and one on the Freshes Lays, 3.5.1959. A sting-ray (*Trygon pastinaca*) had about 20 partly digested *N. caeca*, and nothing

else, in its stomach; this fish, a female weighing 20 kilograms, was trawled on clean sand close inshore off Holme (on the north Norfolk coast, longitude 00°33'E.), in depths from 4 to 10 metres, on 22.6.1962. The fishermen who caught it informed me that it was the fourth out of five *Trygon* (one of which was the same size as this, the others being all much smaller) taken in the same spot in the course of a single week; I was unable to examine the others, which had been cut up for bait before I was informed of their capture.

*Nephtys hombergi*, Lamarck.

?*Nephtys* sp. Garstang (1901); *N. hombergi* Gilson & al. (1944); Pantin & al. (1960); Hamond (1963 a).

Very common in muddy sand all round the Harbour; frequent on the Reef and on the Freshes Lays, also found on Hunstanton Scaup, at Burnham Overy Staithe (20.5.1959, J.F.), at Holkham, and twice out to sea. This species does not burrow so deeply as does *Arenicola marina*, and therefore the great majority living on the shore between Wells and Cley were killed by the severe frosts of January and February 1963, while the *Arenicola* found there were only slightly affected (see Addendum).

The *Nephtys* sp. mentioned above is described by R.A. Todd (in Garstang, 1901) as follows:—"Body flattened, a sickle-shaped gill under the upper lobe of each foot; colour yellowish white, with a pearly lustre. Size 3 to 4 inches. Burrows in sand. Hasborough" (i.e. Happisborough, in north-east Norfolk). The size and colour are more like *hombergi* than any of the other species found here, but in the absence of preserved material it is impossible to be sure.

Breeding: the Burnham Overy Staithe specimen released eggs which may not have been ripe.

*Nephtys longosetosa*, Ørsted.

Scarce in the sandy floor of Wells Channel, the Reef, the Threshold among *Laminaria*-holdfasts, in sand on the south side of the Freshes Lays, and among *Lanice*-tubes in Stiffkey Freshes Backwater Creek; one at West Runton, 2.8.1959 (J.F.). The only offshore record is of seven, none more than 1 cm long, at D.17.

*Nephtys cirrosa*, Ehlers.

*N. cirrosa* Gilson & al. (1944); Pantin & al. (1960); Hamond (1963 a).

Common in the cleanest and most wave-beaten sands which retain a fair amount of moisture at low tide; north of Brancaster Golf Club, in Holkham Bay, all along the outside of the High Sands from Wells Bar to Blakeney Bar, and (east of the latter Bar) in the sands on the outside of the Point; less frequent in Blakeney Harbour itself,

where the wave action is much less and the proportion of silt in most sands is much higher.

Breeding: March and July.

### Family SPHAERODORIDAE

*Ephesia gracilis*, Rathke.

One among colonies of *Scrupocellaria scruposa* inside the "Hjördis", 14.9.1962, and one in bottom plankton outside Blakeney Bar, 19.4.1963; otherwise exclusively offshore, on hard grounds.

*Sphaerodorum minutum* (Webster & Benedict).

Among *Corallina* at West Runton (one on 21.12.1956 and two on 6.4.1959), one in bottom plankton outside the Point on 30.10.1961, and one at D.17.

### Family GLYCERIDAE

*Glycera convoluta*, Keferstein.

Not uncommon in the shelly mud substratum of the Freshes Lays; also found in the submerged forest at Brancaster, on Hunstanton Scaup, in bound shingle on the Strond, and at West Runton (one specimen in each of the last four localities).

*Glycera capitata*, Ørsted.

*Glycera capitata* Möbius (1875); Hamond (1963 a).

McIntosh (1910, p. 481) and Fauvel (1923) consider that *G. lapidum* may be only a variety of *G. capitata*, although Clark (1960) gives them separate status.

*Glycera lapidum*, de Quatrefages.

Rare, in dredgings; definitely this species rather than *capitata*, on the basis of Fauvel (1923).

*Glycera alba*, Rathke.

Occasionally in dredgings; less rare than *G. lapidum*.



## Family EUNICIDAE

*Dorvillea kefersteini* (McIntosh).

One small one at D.18.

*Ophryotrocha puerilis*, Claparède & Mecznirow.

Two adults among tunicates under rocks near extreme low water at West Runton, one on 11.7.1956 and the other on 10.9.1961.

Breeding: the first one contained ova.

## Family ARICIIDAE

I follow Fauvel & Rullier (1959, part 2, p. 951, footnote) in preferring *Aricia* to *Orbinia* or to *Phylo*, and Ariciidae to Orbiniidae.

*Scoloplos armiger* (O.F. Müller).

*S. armiger* Serventy (1934); Gilson & al. (1944); Pantin & al. (1960); Hamond (1963 a).

Extremely common in muddy sand all over the Harbour and along the whole North Norfolk coast to the west of it, from the level of high water of neap tides downwards. Sometimes taken in dredgings, mostly in Blakeney Deep.

Breeding: February and March.

## Family SPIONIDAE

*Scolecopsis fuliginosa* (Claparède).

One small one on Hunstanton Scaup, 7.9.1955, and one in rotten wood among *Bowerbankia imbricata* under Wells Rocks on 17.9.1955.

*Scolecopsis ciliata* (Keferstein).

Not mentioned in the British List (Clark, 1960) although it has been found in the Isle of Man (Southward, 1956). I have found two in the Freshes Lays, 10.8.1955, one in the sandbank south of Wells Lifeboat House, 29.3.1956, and many females in sand on the south and east sides of the Freshes Lays, 3.4.1957.

Breeding: the females mentioned contained numerous ova.

***Nerinides cantabra*, Rioja.**

*N. cantabra* Hamond (1963 a).

Moderately common in clean sand with *Nephtys cirrosa* (q.v.); three were taken at East Runton on 23.5.1959 (J.F.). It grows to a length of 6 to 9 cm, and is easily recognised by its brilliant deep green body, blood-red gills, and pale pink prostomium which tapers to a sharp point. *N. tridentata* Southern (1914) is probably identical with *N. cantabra*, since at Wells on 29.3.1956 three small ones were found, in sand south of the Lifeboat House, whose bidentate hooded hooks, body size and colour agreed with *cantabra* but whose heads were exactly like Southern's figure (copied by Fauvel, 1927, fig. 10 f) of *N. tridentata*. The name *tridentata* has priority by five years but, since it was used for very small specimens whose connections with adult *Nerinides* have not yet been tested by rearing, Rioja's name is used here.

Breeding: one of the East Runton specimens was full of ova. Larvae, probably of this species, were taken in the Harbour plankton in July 1956 (two on the 19th and eleven on the 22nd), in company with the larvae of *Sabellaria spinulosa* which they devoured greedily. This is one of the very few recorded instances of one polychaete larva feeding on another, and is also of interest because these worms, when adult, live in such widely separated habitats that it would seem to be impossible for either species to influence the other in any way (see Addendum).

***Nerine cirratulus* (Delle Chiaje).**

*N. cirratulus* Gilson & al. (1944).

One in sand at high water mark of neap tides with the heteronereid of *N. longissima* (q.v.); it closely resembled the very fine drawing in Wesenberg-Lund (1951, p. 67, fig. 5).

Breeding: the above specimen released many ova with clearly marked nuclei.

***Spiophanes bombyx* (Claparède).**

*S. bombyx* Hamond (1963 a).

One small one among *Laminaria*-holdfasts in a pool on the Freshes Lays, 4.8.1963; one adult in the sandbank south of Wells Lifeboat House, 29.3.1956; and many large and bright red adults in very clean sand at low water neaps northwest of Brancaster Golf Club House, 2.8.1961.

Breeding: larvae taken in September (several years) in Blakeney Harbour plankton.

***Spio filicornis* (O.F. Müller).**

*S. filicornis* Serventy (1934); Pantin & al. (1960).

Two among *Corallina* at West Runton, 9.8.1959, a large one at

D.29, and 12 small ones at D.47; otherwise confined to clean sand near low water mark (off the mouth of Morston Creek, in the floor of Wells Channel, and on the open foreshore halfway between Brancaster and Titchwell). This is exceedingly active for a spionid, swimming when disturbed with rapid corkscrewing movements rather as does *Eteone longa*, but less convulsively.

*Pygospio elegans*, Claparède.

In vast numbers all over the flat shore of hard sandy mud at mid-tide level in Holkham Bay; also at high water neaps level about sixty yards south of Blakeney Point Lifeboat House on 4.7.1956, and a tiny one among *Corallina* at West Runton on 21.12.1956. Taken offshore only twice.

Breeding: larvae on Harbour plankton, March to September.

*Polydora ciliata* (Johnston).

*P. ciliata* Hamond (1963a).

In enormous numbers in the submerged forest at Brancaster and in the hard chalk at West Runton; also very abundant among dead shells at low water mark on all Norfolk shores, so long as the shells are not polished clean by wave action and by the abrasion of the sand. Sometimes plentiful offshore.

Breeding: larvae in May, July and August; it is not known whether there are two populations here that breed at different times, as Dorsett (1961) found at Whitstable.

*Polydora giardi*, Mesnil.

Two among washings from 165 live *Buccinum* at W.34.

*Polydora caeca* (Ørsted).

Always offshore, where it appears to be fairly common.

Breeding: June and August.

*Polydora flava*, Claparède.

Always offshore; at W.33 the great majority were found tunnelling in rotten *Buccinum*-shells tenanted by *Pagurus bernhardus*.

Breeding: at W.33 a female had a mass of embryos adhering to her dorsal surface between setigers 20 and 40, resembling a miniature heap of barley; this is probably a form of brood-protection.

## Family MAGELONIDAE

*Magelona papillicornis*, Fritz Müller.

*M. papillicornis* Hamond (1963a).

Several large adults with large *Spiophanes* (q.v.) at Brancaster, and one adult in the sandbank off the mouth of Morston Creek on 16.4.1956; these were all definitely *M. papillicornis* and not *M. alleni* Wilson (1958) nor *M. filiformis* Wilson (1959).

Breeding: *Magelona*-larvae, apparently all of one species, are common in the Harbour plankton from May to August with a maximum in July; they are also numerous in the offshore plankton at this time, though perhaps less so than inshore. They probably belong to *papillicornis*, but it is impossible to be certain of this so long as the larvae of the other two species remain undescribed.

## Family POECILOCHAETIDAE

*Poecilochaetus serpens*, Allen.

*Poecilochaetus* Hamond (1961).

Hitherto this species has been observed only as large larvae in the summer plankton, from July to October.

## Family CHAETOPTERIDAE

*Chaetopterus variopedatus* (Renier).

Pieces of tube are sometimes seen cast ashore among masses of hydroids, but the living animal has not yet been seen here.

## Family CIR RATULIDAE

*Audouinia tentaculata* (Montagu).

*A. tentaculata* Gilson & al. (1944); Hamond (1963a). *Audouinia* Hamond (1961).

Common wherever there is stagnant black mud below half-tide level, especially in old bivalve burrows in the submerged forest west

of Brancaster, in muddy shell-gravel in the Freshes Lays, under rocks at West Runton, and once under Wells Rocks; offshore it is restricted to the siltiest grounds.

*Heterocirrus bioculatus* (Keferstein).

*H. bioculatus* Hamond (1962).

Twice among *Laminaria*-holdfasts in the Threshold (one on 18.12.1956 and one on 3.4.1957) and five times out to sea.

*Heterocirrus caput-esocis*, de Saint-Joseph.

*H. caput-esocis* Hamond (1962).

Three among algae and *Bowerbankia imbricata* under Wells Rocks, 20.12.1956; two among flakes from the mast-stump of the "Hjördis" (one on 3.9.1962 and one on 25.2.1963). Also found at three offshore stations.

*Heterocirrus alatus* (Southern).

*H. alatus* Hamond (1962).

One at S.4; the winging of the crochets is exactly as in Fauvel's fig. 34b, but is very difficult to see except under oil immersion.

*Tharyx marioni* (de Saint-Joseph).

*T. marioni* Hamond (1963a).

One in a *Laminaria*-holdfast in the Threshold on 13.3.1955; otherwise found entirely offshore, where it seems to grow to a large size since the thorax alone of the specimen from D.20 was about 1 cm long.

*Dodecaceria concharum*, Ørsted.

On three occasions at West Runton; offshore, two at W.33 and three among *Ampelisca*-tubes at D.17.

Breeding: three West Runton specimens (among *Corallina* on 6.4.1959) were of the sedentary epitokeous form (form C of Fauvel, 1927), whereas all the others, from West Runton and from offshore, were of the normal atokeous form A.

*Streblospio shrubsolei* (Buchanan).

*S. shrubsolei* [sic] Pantin & al. (1960).

One rather doubtful one with *Manayunkia* (q.v.) on 7.3.1955, and several at various times in the Stepping Stones of Bluejacket

Creek (the main westward tributary of Morston Creek, running into Morston Marshes).

*Zeppelinia monostyla* (Zeppelin).

*Z. monostyla* Hamond (1961, 1962).

Of the two specimens found among *Corallina* at West Runton on 21.12.1956, the smaller was lost and the larger has now been presented to the British Museum of Natural History, regd. no.BM (NH) 1965.26.1.

### Family CHLORHAEMIDAE

*Flabelligera affinis*, M. Sars.

*F. affinis* Pantin & al. (1960).

One among algae in the lowest reach of Morston Creek, 16.8.1962, and three enormous ones among *Bugula plumosa* inside the "Hjördis" on 14.9.1962. Two large ones were seen on a sea-urchin (*Psammechinus miliaris*) on the Freshes Lays, 15.10.1962, and one large one on *P. miliaris* at D.44. *F. affinis* and *P. miliaris* also occurred simultaneously (but, so far as was seen, not associated) at Pantin's station "q", at D.17, and at D.20; however, soaking 30 or 40 dredged *P. miliaris* at a time in tapwater, or in seawater with added formalin or magnesium sulphate, has never yielded a single *F. affinis* on the various occasions when it has been tried.

*Stylarioides plumosa* (O.F. Müller).

*S. plumosa* Hamond (1962).

Not common; confined to the rougher grounds offshore. All the specimens have been small except for the head of one (estimated complete length ca. 4 cm) at D.50, and a complete one, 8 cm long, among a group of large *Modiolus* at D.51 (see Addendum).

### Family SCALIBREGMIDAE

*Asclerocheilus intermedius* (de Saint-Joseph).

*A. intermedius* Hamond (1962).

Exclusively an offshore species, preferring to nestle among clumps of tunicates on shells; the specimen from W.26 was among the matted hydrorhizae of a large *Nemertesia antennina*.

## Family OPHELIIDAE

*Ophelia borealis*, de Quatrefages.

*O. limacina* Möbius (1875); *O. borealis* Hamond (1963a).

At almost all the stations where this species was caught the ground was of clean sand with large quantities of dead waterworn shells, mostly of *Ostrea*, which had been eroded by *Cliona*, in some cases to paper-thinness; the substratum had a strikingly barren appearance, and every species of animal found there except *O. borealis* (and in some cases, the hydroid *Tubularia indivisa*) could be assumed to have strayed in from the much richer grounds nearby. Möbius, however, found it with a fair number of other species, as if the "Pommerania" had pulled her dredge across at least two adjacent types of ground, with a consequent intermingling of the catch. The specimen from D.35 (where the substratum was of thick mud) may have been entangled in the meshes of the dredge from the previous haul, D.34, which was on sand and shells (see Addendum).

The numbers of segments with or without gills in my specimens support the conclusion of Tebble (1952) that *O. borealis* and *O. limacina* are good species in European waters; Pettibone (1954) finds that they are connected by intermediates in the Alaskan population studied by her.

*Ophelia rathkei*, McIntosh.

*O. rathkei* Hamond (1963a).

Not uncommon at high-water neaps level on the North side of Blakeney Harbour near the Lifeboat House; also two in the sandbank about fifty yards southeast of Wells Lifeboat House on 29.3.1956.

Breeding: on 4.7.1956 four, out of 29 collected at the first-named locality, contained ova. Early post-larval opheliids have been seen in the plankton in March, April, and May.

*Ammotrypane aulogaster*, Rathke.

*A. aulogaster* Möbius (1875); Hamond (1963a).

Not found again locally since its capture at P.105.

*Travisia forbesi*, Johnston.

One at D.46, where it was the only polychaete. The living worm, brownish pink with coral-red gills, was encased in a thin close-fitting sheath of slime, evenly encrusted with sand; it was about 2 cm long, and as stout as an *O. borealis* of about 3 cm long. In life the body was more or less sausage-shaped, with bluntly rounded head and

tail, and with a distinct though faint ventral gutter; after preservation the shape shown by Fauvel (1927, fig. 48g) is attained, with both the head and the tail much more sharply pointed than in life, and with no trace of the ventral gutter.

### Family CAPITELLIDAE

*Notomastus latericeus*, M. Sars.

*Notomastus* Hamond (1961); *N. latericeus* Hamond (1963a).

Sometimes common in the Freshes Lays, especially where muddy shell-gravel predominates, with *Lanice* and *Audouinia*; also several large ones in muddy bound shingle on the Strond south of the Strond Pool just below high water neaps level on 3.5.1959, one in gravel on the Reef, 24.3.1962, and one at Wells in sand south of the Lifeboat House on 29.3.1956.

Commensals: adult *Notomastus*, from the Freshes Lays on 13.3.1955 and from the Strond on 3.5.1959, were covered with *Loxosoma singulare*. This is the type of the genus *Loxosoma* (see Bohin & Prenant, 1953); its typical host is *Notomastus rubicundus* Keferstein, which is probably the same species as *N. latericeus* (Fauvel, 1927, footnote on p. 143).

*Capitella capitata* (Fabricius).

One under the base of a colony of *Botrylloides* growing on a *Buccinum*-shell tenanted by *Pagurus bernhardus* at W.33; also five among algae in Bluejacket Creek Stepping Stones on 9.9.1962, and one among *Laomedea flexuosa* on *Fucus* in the mouth of Morston Creek on 15.12.1962.

Breeding: all those seen have been females with ova, in August, September and December respectively.

*Capitellides giardi* (Mesnil).

Sofar found only offshore; those from W.33 were among the washings from crushed *Buccinum*-shells which had formerly contained *Pagurus bernhardus*.

### Family ARENICOLIDAE

*Arenicola marina* (L.).

*A. marina* Garstang (1901); Serventy (1934); Gilson & al. (1944); Pantin & al. (1960); Hamond (1963a).



Very common all along the North Norfolk coast from Blakeney Harbour westwards; it is severely overcollected by the lugworm diggers, both amateur and professional.

Breeding: young ones less than a centimetre long are frequent in the Harbour plankton from February to July.

*Arenicola ecaudata*, Johnston.

One collected near extreme low water at East Runton on 11.7.1959, burrowing in black mud under rocks (J.F.).

### Family MALDANIDAE

*Clymene (Praxillella) praetermissa* (Malmgren).

*Praxilla praetermissa* Möbius (1875); Garstang (1901).

One, very small and slightly damaged, among gritty sand in a plankton haul during which the net accidentally touched bottom, at 53°01'N.00°58'30"E. on 13.9.1962. The colour was pale greenish brown, with red blood-vessels.

Möbius describes the general colour of the body as a yellowish red, with the trailing edges of the middle setigers outlined in a clearer red, the blood also being red. The slender notosetae were delicately feathered "as in *Axiothella catenata* Malmgren", which suggests *Clymene affinis* M. Sars rather than *C. praetermissa*, but the size and colour agree with the latter species as described by Fauvel. Of the anal cirri the most ventral might, on occasion, be three times as long as any of the others; the tube was thin-walled as in "*Leiocephalus lumbricalis*" (now *Nicomache lumbricalis*.—R.H.).

Garstang also gives a brief description, but does not state whether this was based on Möbius's specimens or on material from somewhere else.

*Nicomache maculata*, Arwidsson.

Three adults near extreme low water at West Runton, one among *Corallina* on 21.12.1956 and the other two in a patch of mud under a rock on 2.11.1963.

*Micromaldane ornithochaeta*, Mesnil.

Twenty-one specimens were found among *Polyclinum* under rocks at West Runton on 10.8.1957. Although these specimens agree perfectly with Fauvel's description and figures, they might on structural grounds equally well have been the young of *Nicomache maculata*, which was found only a few yards away. These same two species

are also found intertidally in the Isle of Man (Southward, 1956), while *Micromaldane* has been found near *Nicomache lumbricalis* at Salcombe (Plymouth Marine Fauna, 1957) and near *N. trispinata* at Cherbourg (Fauvel, 1927).

### Family OWENIIDAE

*Owenia fusiformis*, Delle Chiaje.

*Ammochares assimilis* Möbius (1875); *O. fusiformis* Hamond (1963a).

Not seen here since its capture at P.105, nor has the *Mitraria*-larva (Wilson, 1932) been found in the local plankton.

### Family SABELLARIIDAE

*Sabellaria spinulosa*, Leuckart.

*S. alveolata* Möbius (1875); *S. spinulosa* Garstang (1901); Hamond (1963a); *Sabellaria* Hamond (1957, 1961).

Extremely widespread out to sea, where at D.5, D.8, and D.10 it formed great fist-sized masses on stones and shells, while at D.19 (and at a discarded station about half a kilometre northwest of D.19) it formed hard crusts of a more or less even thickness over the outside of pebbles; this latter facies would seem to presuppose a relatively stable substratum, analogous to the bound shingle found intertidally. Small isolated groups of worms are frequent on stones, bivalve-shells, *Buccinum*-shells, *Hyas*-carapaces, and on the bases and in the forks of the branches of large hydroids. It is also exceedingly abundant off Yarmouth, where it is known as "ross" (a name given in the Channel to the polyzoan *Lepralia foliacea*, which has never been found here) and in Norfolk waters, as in the Thames Estuary, appears to form the principal food of the pink shrimp *Pandalus montagui* (Mistakidis, 1957). Intertidally it has been found a few times on the Freshes Lays, in the Threshold, inside the "Hjördis"'s boiler, and at West Runton, always near low-water mark; some of these were initially determined as *alveolata* but have all, on re-examination, been found to be *spinulosa*.

Breeding: specimens on *Mytilus* on the Freshes Lays, shedding gametes from which artificial fertilisations were made and reared to blastulae, January 1950; adults full of gametes can be found offshore all the summer and were collected at West Runton on 8.2.1955 and on 29.7.1961; larvae in Harbour plankton in July (see under *Nerinides*) and in September. It probably breeds all the year round with a maximum in summer.

## Family AMPHICTENIDAE

*Pectinaria belgica* (Pallas).

*P. belgica* Möbius (1875); Hamond (1963a).

Taken on muddy ground at P.105 (Hamond, 1963a); Garstang states that his *P. belgica* is "common in sandflats", and I have therefore referred his record to the next species (q.v.).

*Pectinaria koreni* (Malmgren).

*P. auricoma* and *P. belgica* Garstang (1901); *P. koreni* Pantin & al. (1960).

Occasionally at extreme low water at Snettisham, on Hunstanton Scaup, at Brancaster, at Holkham, on Stiffkey High Sand and on the Freshes Lays; on the open sandy shores it may sometimes be cast up in large numbers. On 31.7.1961, on Hunstanton Scaup, there were near low water about 15 live *Buccinum*, one of which had wrapped its foot around a small *P. koreni* as though about to attack it.

Mr. Birkett informs me that, along the east side of Smith's Knoll (lying off the east coast of Norfolk), there is a narrow strip of brown sand overlying tenacious black mud; in the sand, but not in the mud, *P. koreni* and *P. auricoma* live together in enormous numbers literally touching one another. Off North Norfolk, besides some fairly large specimens at D.14 and S.5, two small ones were taken on 13.9.1962 with *Clymene* (q.v.), and a slightly larger one at D.40; *P. koreni* seems to prefer clean or slightly muddy sand from between tidemarks to small depths close inshore, while *P. belgica* and *P. auricoma* prefer substrata with a much higher proportion of mud, in deeper water and well away from the coast (cf. Southward, 1956, 1957).

*Pectinaria auricoma* (O.F. Müller).

*P. auricoma* Möbius (1875); Hamond (1963a).

At P.105 with *P. belgica* (q.v.) and at Smith's Knoll with *P. koreni* (q.v.); there are no other local records, but the find at Smith's Knoll suggests that this species may be capable of living nearer the Norfolk coast than is at present suspected.

## Family AMPHARETIDAE

*Ampharete acutifrons* (Grube).

*Ampharete grubei* Möbius (1875); Serventy (1934).

In the mouth of Morston Creek among stones and shells in sandy mud (one on 13.8.1962 and one on 2.5.1964; the latter specimens

swam with spasmodic sideways kicking movements, the whole body being bent into an arc before each "kick"); also a large and a small specimen at D.23.

*Amphicteis gunneri* (M. Sars).

*A. gunneri* Möbius (1875); Hamond (1963a).

Not seen here since its capture at P.105.

#### Family TEREHELLIDAE

*Amphitrite johnstoni*, Malmgren.

*A. rubra* Gilson & al. (1944); *A. johnstoni* Pantin & al. (1960); Hamond (1963a).

Large specimens are sometimes common in thick black mud under the Freshes Lays, in company with *Nereis virens* at a depth of about 30 cm; small ones are occasionally plentiful among *Laminaria*-holdfasts in the Threshold, and in smaller numbers on Hunstanton Scaup, in the submerged forest at Brancaster, under Wells Rocks, inside the "Hjördis", in the Strond Pool Dam and under rocks near extreme low water at West Runton. A very small one was found offshore, concealed in a crevice in a colony of *Botrylloides* at W.32.

The species is widely distributed in British waters, whereas the very closely related *A. rubra* has not been found for certain nearer Norfolk than the Mediterranean coast of France (Fauvel, 1927); this, added to the fact that Gilson and his colleagues do not record *A. johnstoni*, make it seem almost beyond a doubt that their *rubra* was really *johnstoni*.

*Lanice conchilega* (Pallas).

*L. conchilega* Garstang (1901); Serventy (1934); Gilson & al. (1944); Pantin & al. (1960); Hamond (1963a); *Lanice* Hamond (1961).

One of the commonest shore polychaetes, growing thickly matted on the lower part of the shore wherever there is a firm substratum of slightly muddy and shelly sand, exposed to a moderate amount of current and wave action; it is also abundant in old bivalve burrows in the submerged forest at Brancaster, but is scarce at West Runton. Offshore it was abundant at D.14, D.15, D.17, D.26 and D.45, while one was found at D.6; at all these stations the worms were exactly like the intertidal specimens. At D.35, however, 12 small ones were taken, living apparently without tubes in thick black mud, and of a bright yellow colour without the characteristic broad red stripe on the ventral surface of the thorax. The larvae are very common in summer plankton.

*Polymnia nebulosa* (Montagu).

Adults are not uncommon near extreme low water at West Runton, and have also been found at D.17 and in bottom plankton with *Clymene praetermissa* (q.v.). Enormous numbers of young ones were taken among *Laminaria*-holdfasts in the Threshold on 18.12.1956, among *Corallina* at West Runton (higher up the shore than the adults) on 21.12.1956 and 11.7.1963, and among *Polyclinum* at West Runton on 1.8.1957.

The specimen taken with *Clymene* had uncini as in *nebulosa*, but the tube, the relatively tough and firm body, and the uniform ochreous yellow colour without any white spots, were all more like *Polymnia nesidensis* (Delle Chiaje); even in the most typical Norfolk *nebulosa*, however, the white spots are never very conspicuous.

*Nicolea venustula* (Montagu).

Common under rocks near low water at West Runton; a small one collected there on 21.12.1956 had 16 thoracic setigers and no white spots on the body, but in other respects agreed with *venustula*. On 9.8.1959 three were found unusually high up the shore there, among *Corallina*. Offshore, one was taken at D.22 and one at Q.2.

Breeding: at West Runton individuals were seen to shed gametes in July and August.

*Nicolea zostericola* (Ørsted).

Very widespread out to sea, where its rather small and very neatly built tube (closely resembling that of *Pista maculata*, especially in young specimens) is often seen attached to large hydroids and branching polyzoa; young ones were found at West Runton (about 20 among *Corallina* and two among *Salmacina*) on 14.10.1962, and four adults under rocks at low water there on 27.3.1963. A large female full of pink ova at D.5 had 16 thoracic setigers, no white spots on the body, uncini as in Fauvel (1927, fig. 90, k, l, and m) and a thorax shaped as in fig. 90h; the branchiae were missing, but on the whole it is best regarded as an abnormal *zostericola*.

Breeding: the abnormal female was taken in June. Gelatinous masses of spawn, similar to those described by Thorson (1946, p. 126) were found in great numbers among *Hydrallmania falcata* at D.40.

*Pista maculata* (Dalyell).

*P. maculata* Hamond (1961).

Apparently not as rare as I believed at first; three adults were found among *Corallina* at West Runton on 18.1.1961 and a half-grown specimen among *Hydrallmania falcata* at W.38. Their tubes were almost perfectly circular in section and built with a high percentage of black particles, giving a striking "pepper-and-salt" appearance. The body colour is greenish with black marks.

Breeding: gametes shed at West Runton in January.

*Thelepus cincinnatus* (Fabricius).

*T. circinatus* [sic] Möbius (1875).

Common out to sea, and very often cast ashore; a favourite habitat is among the matted hydrorhizae of *Nemertesia antennina*.

Breeding: females containing ova have been seen in March, June and August.

*Polycirrus caliendrum*, Claparède.

This is easily recognised by its brilliant pale saffron-yellow colour, in contrast to the orange, pink, or brownish-yellow of other Norfolk terebellids (except *Pista*, q.v.). Ecologically it is closely restricted to the lowest part of the shore, having been found several times at West Runton, twice among *Laminaria*-holdfasts in the Threshold, and once each under Wells Rocks, inside the "Hjördis", in the Strond Pool, and in bottom plankton with *Clymene* (q.v.). The largest specimen (3 cm long, at West Runton on 29.8.1961) had tentacles which on stimulation luminesced brilliantly in the dark; the light died away almost instantly, and after five or six stimulations in as many minutes was very much fainter than it had been initially.

## Family SABELLIDAE

*Sabella pavonina*, Savigny.

*S. penicillus* Möbius (1875); Garstang (1901); *S. pavonina* Hamond (1963a).

Abundant and of large size on the Reef and in the Threshold from 1950 to 1953, since when it has been scarce in, or absent from, both these localities. It was formerly common inside the "Hjördis", and on 20.10.1960 many large specimens were seen under Wells Rocks (where, however, none at all could be found on 22.3.1961). In July 1965 a few occurred in the Strond Pool. These large intertidal specimens have a tube up to 15 or 20 cm long; dredged examples are usually much smaller (from 2 to 6 cm tube length), but this may be due to inadequacy of sampling, since tubes of up to 40 cm in length are sometimes cast ashore in numbers, a few with the worm still alive inside.

Parasites: out of 16 *Sabella* collected under Wells Rocks on 20.10.1960 one bore a copepodid, and another an adult female without eggsacs, of the cyclopoid *Sabelliphilus elongatus*, clinging to the branchial crowns of the worms exactly as described by Gotto (1960).

*Potamilla torelli*, Malmgren.

One, about 1 cm long, in washings from crushed *Buccinum*-shells formerly tenanted by *Pagurus bernhardus*, at W.33.

*Dasychone bombyx* (Dalyell).

Occasionally offshore; the larger of the two specimens from D.22 had a brilliant deep yellow body 3 cm long, with a plum-coloured branchial crown on whose filaments the dorsal processes were picked out in milky white.

*Fabricia sabella* (Ehrenberg).

At Wells this species is common in the rotten wood of posts under the Quay, along under the Rocks, and in enormous numbers in the outflow from Abraham's Bosom (the brackish boating pool behind the seawall); it is also found at West Runton (among *Polyclinum* and *Sidnyum* on 10.8.1957, and among *Corallina* on 9.8.1959), and has sometimes been found offshore. In all those examined for this character, some of the thoracic notosetae were spatulate as described by Wesenberg-Lund (1941) for *Fabricia dubia*, now considered a synonym of *F. sabella* (Thorson, 1946).

Breeding: of the twelve taken at D.18, two contained ova.

*Manayunkia aestuarina* (Bourne).

About 50 in the surface mud on the seaward side of the Freshes Sluiceways on 7.3.1955, and three in a plankton haul in Morston Creek on 19.7.1956. The latter specimens had undoubtedly been whirled up off the bottom nearby, but it is rather curious that this particular plankton haul contained hardly any algae, of which large quantities are always present in suspension in the Harbour if the weather has been at all rough within the preceding few days.

Breeding: one of the three in the plankton was an adult female with two young ones, about a quarter her own size, sharing the tube with her.

*Jasmineira elegans*, de Saint-Joseph.

Nine at D.18, all full-grown or nearly so.

Breeding: of the nine, three contained ova.

## Family SERPULIDAE

*Serpula vermicularis*, L.

*Serpula* Hamond (1963 a).

The only record (at D.15) would seem to be doubtful; there is no preserved material extant, and later dredgings in the same area have revealed only the next two species, of which my alleged *Serpula* may in fact consist.

*Hydroides norvegica* (Gunnerus).

Seven at W.33, three at D.44, one at D.47 and a single operculum at S.4. *Hydroides* usually occurs together with *Pomatoceros*, but never in numbers and not nearer the coast than about 8 kilometres (at D.47), becoming relatively more numerous further offshore.

Breeding: the above stations were all in August, and at all of them *Hydroides* was found shedding gametes.

*Pomatoceros triqueter* (L.).

*Pomatoceros* [sic] *triqueter* Möbius (1875); *Pomatoceros triqueter* Serventy (1934); Gilson & al. (1944); Pantin & al. (1960); Hamond (1963 a).

Extremely common all along the north Norfolk coast from Blakeney Harbour westwards, wherever there is a firm substratum of dead shells or living mussels (*Mytilus*) near low-water mark, or even higher up as in the Strond Pool; found under Wells Rocks and at West Runton, but not numerous at either. It is plentiful on shells and stones on most offshore grounds, and on flints at Q.2.

Breeding: probably all the summer, since fertile individuals have often been seen. At W.33 there were some, on empty *Buccinum*-shells, which were shedding gametes at an unusually small size.

*Filograna implexa*, Berkeley.

*F. implexa* Möbius (1875); Garstang (1901).

Not seen here since, and there is nothing to show that these specimens were not in fact the next species, with which *Filograna* is constantly confused.

*Salmacina dysteri* (Huxley).

This is sometimes very common under rocks at West Runton, in pools at extreme low side, from July to September; offshore colonies included a large mass all over the spire of a *Buccinum* tenanted by *P. bernhardus* at D.20, some small colonies inside old *Modiolus*-valves at D.15 and D.22, and a few colonies under flints at Q.2.

Breeding: the colonies from West Runton on 3.8.1958 and 29.7.1961, as well as that from D.20, were full of gametes and larvae, neither of which could be found after a careful search among colonies collected at West Runton on 10.9.1961.

*Spirorbis spirillum* (L.).

*S. spirillum* Hamond (1957).

Fairly common on *Abietinaria abietina*, both in dredgings and cast ashore; also a few cast up at Hunstanton on *Hydrallmania*



*falcata*, 23.3.1952, and many inside the mouth of an old *Buccinum*-shell tenanted by *P. bernhardus* at W.11.

### Other species recorded nearby.

The following species have been recorded from the coasts of neighbouring counties, and may well occur in Norfolk waters:

County	Species	Authors
Yorkshire	<i>Paraonis fulgens</i> and <i>Nerine foliosa</i> .	Colman & Segrove (1955)
Lincolnshire	<i>Goniada maculata</i> .	Young (1955)
Suffolk	<i>Nerine foliosa</i> , <i>Cirratulus cirratus</i> , <i>Melinna cristata</i> , <i>Polycirrus aurantiacus</i> , <i>Terebellides strömi</i> and <i>Spirorbis borealis</i> .	Morley (1941)
Essex	<i>Marphysa sanguinea</i> .	Nisbet (1960)
North Kent	<i>Lepidonotus clava</i> , <i>Glycera tessellata</i> , <i>Marphysa sanguinea</i> , <i>Nerine foliosa</i> , <i>Heteromastus filiformis</i> , <i>Caesicirrus neglectus</i> and <i>Clymenella torquata</i> .	Newell (1954)

I have not myself examined any of this material.

### The ecology of the Norfolk polychaetes.

Tables 4 to 12 attempt to indicate the patterns of distribution shown by polychaetes locally; the number of individuals captured is given for every species at every station at which polychaetes were collected. Table 13 recapitulates the salient features of the various types of grounds, and Table 14 gives details of all stations where polychaetes were collected; a complete list of stations is given elsewhere (Hamond, 1963 a and in press). Although all grounds graded as C<sub>2</sub> look more or less the same, they fall into two groups with few ("poor C<sub>2</sub>") and many ("rich C<sub>2</sub>") species of polychaetes respectively (Tables 10 and 11). Although these two groups appear to be distinct at present, and are kept apart for convenience, they may quite possibly be merged into a single entity by the results of further collecting; moreover, defining a ground with regard to its polychaete fauna gives no exact indication of its richness or poverty in other kinds of animals.

The hauls richest in numbers of species are by no means those richest in individuals of any given species, although such hauls will tend to have several species in abundance rather than merely one or two species. The picture presented is that of a limited fauna whose common species can live in most places in the offshore area under consideration; if several of these common species, whose methods of feeding, of reproduction and of avoidance of enemies are probably widely different, are able to flourish simultaneously, then the habitat is a broad one offering a wide range of opportunities and hence the rarer species also tend to be found here rather than anywhere else. The effect of the polychaetes themselves on their environment is probably slight, apart from their use as fishfood; the massed tubes of *Lanice*, or the thick growth of *Pomatoceros* over shells and stones,

may alter the nature of the substratum over a limited area by, for instance, increasing the amount of microshelter available either by an increase in the formation of nooks and crannies due to the presence of the tubes themselves or by small accumulations of detritus on the lee sides of the tubes. The former method will tend to attract species which prefer to lie in crevices from which they emerge to feed, and the latter to attract species which feed on the detritus itself; in either case the attracted species may form the first links in a variety of food chains whose higher members will also be attracted thither, to assist in the development of a rich fauna.

Any small invertebrate which, either as an adult or as a larva, is attracted into the habitat will run the risk of being eaten by the worms themselves. In this connection it is very noticeable that almost no animals at all are revealed by digging in the hillocks of shelly and muddy sand which the massed tubes of *Lanice* tend to form around themselves, possibly because all larvae attempting to settle on the hillocks are caught by the far-flung tentacles of this species. On the other hand, the branchial crown of *Pomatoceros* occupies a fairly small volume, more or less fixed in position and extent, into whose embrace only the most feeble swimmers are drawn without attempting to escape; in consequence, many species succeed in settling among *Pomatoceros*-tubes, from which a rich fauna of small polychaetes (mostly phyllodocids and syllids), nemertines, and small crustacea emerges when shells and stones covered with *Pomatoceros*-tubes are left to stand in a basin of seawater for some hours or days.

One essential factor of which almost nothing is yet known is the selectivity of feeding of *Lanice*, *Pomatoceros*, and of many other polychaetes; a useful general account of various methods of feeding shown by polychaetes in relation to the habitat is given by Southward (1957), but there is no corresponding survey of experimental approaches to feeding efficiency or to feeding selectivity in a variety of polychaetes. It may be assumed that both *Lanice* and *Pomatoceros* have the ability to select palatable food and to reject everything else; any adaptation which made the larva of a given species either neutral or actively unpalatable would have a high survival value for that species, and it may be reasonably suspected that the larvae of *Harmothoe lunulata* have become immune to predation by *Lanice* in this sort of way, since it is otherwise difficult to understand how the *Harmothoe* can get into the tube of its host.

Many species, both filter-feeders and otherwise, are restricted in their habitats; thus, *Tomopteris* is confined to the plankton, many syllids to the hydroids whose polyps they eat, *Ophelia borealis* to clean dead oyster-shells on sand, *Nephtys cirrosa*, *Travisia*, *Spio* and *Nerinides* to various types of very clean sand, and *Audouinia* to black mud. These are the most marked examples, to which many other species approximate more or less closely. At the other extreme, most aphroditids and phyllodocids prefer a mixed habitat where shells, pebbles, sand, silt, and tufts or incrustations of sessile animals all combine to offer a great variety of microhabitat in or on the substratum. In such a habitat, of C<sub>2</sub> or F<sub>4</sub> grade, the members of these two families are usually accompanied by many other kinds of invertebrates, including many polychaetes (Tables 4-7, 11).

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## Summary

All the species of polychaetes known from Norfolk waters are listed; 48 were found here by previous authors and 91 are recorded in this paper for the first time. The occurrence of each species is briefly stated. Observations are made on colour patterns, reproductive biology, food, morphological variation, taxonomy, commensalism and parasites, and a list is given of other species which have been found on neighbouring coasts and may occur here.

## Zusammenfassung

Alle Arten von Polychaeten, die an der Küste Norfolks (Gross-Britannien) gefunden wurden, sind hier katalogisiert. 48 Arten wurden schon von früheren Autoren gefunden, und 91 andere sind hier erstmalig beobachtet worden. Das Auftreten jeder Art wird kurz bemerkt. Es werden auch Beobachtungen notiert über die Farbvariationen, die Fortpflanzungsbiologie, das Futter, die morphologischen Variationen, die Taxonomie, den Kommensalismus und die Parasiten und es wird eine Liste gegeben von anderen Arten, die an benachbarten Küsten gefunden wurden und die hier vorkommen könnten.

## REFERENCES

- ALLEN, E.J., 1921. — Regeneration and reproduction of the syllid *Procerastea*. *Phil. Trans. roy. Soc. London B*, 211, pp. 131-177.
- BOBIN, G. et PRENANT, M., 1953. — Deux Loxosomes nouveaux de Roscoff. *Arch. Zool. exp. gén.* 91, N. et R. 1, pp. 25-35.
- CLARK, R.B., 1960. — Polychaeta, in: The Fauna of the Clyde Sea Area. *Scot. mar. biol. Ass.*, Millport.
- COGNETTI, G., 1953. — Ricerche sui Sillidi del Golfo di Napoli. III. Osservazioni biologiche e reperti di forme nuove. *Boll. zool.* 20, p. 123.
- COGNETTI, G., 1960. — Différenciation spécifique et intra-spécifique, par rapport à l'habitat, de Syllidiens de la Manche et de la Méditerranée. *Cah. Biol. Mar.* 1, pp. 113-120.
- COGNETTI, G., 1961. — Les Syllidiens des côtes de Bretagne. *Cah. Biol. Mar.* 2, pp. 291-312.
- COLMAN, J.S. & SEGROVE, F., 1955. — The fauna living in Stoupe Beck Sands, Robin Hood's Bay (Yorkshire, North Riding). *J. Anim. Ecol.* 24, 2, pp. 426-444.
- DORSETT, D.A., 1961. — The reproduction and maintenance of *Polydora ciliata* (Johnst.) at Whitstable. *J. mar. biol. Ass. U.K.* 41, pp. 383-396.
- FAUVEL, P., 1923. — Polychètes errantes. *Faune de France* 5, pp. 1-488.

- FAUVEL, P., 1927. — Polychètes sédentaires. *Faune de France* 16, pp. 1-494.
- FAUVEL, P., 1936. — Remarques sur les Néréidiens, *Nereis succinea* (Leuckart) et *Nereis lamellosa* (Ehlers). *Bull. Soc. zool. France* 61, pp. 307-314.
- FAUVEL, P. et RULLIER, F., 1959. — Contribution à la faune des Annélides Polychètes du Sénégal et de Mauritanie. *Bull. Inst. Fr. Afr. Noire* 21, série A, 2 et 3, pp. 477-533 et 934-987.
- GARSTANG, W., 1901. — Marine Zoology, in: The Victoria County History of Norfolk.
- GILSON, H.C., HOLLICK, F.S.J. & PANTIN, C.F.A., 1944. — Additions to the marine fauna of the Scolt Head region. *Ann. Mag. nat. Hist.* (11) 11, pp. 231-236.
- GOTTO, R.V., 1960. — Observations on the orientation and feeding of the copepod *Sabelliphilus elongatus* M. Sars on its fanworm host. *Proc. zool. Soc. London* 133, 4, pp. 619-628.
- HAMOND, R., 1957. — Notes on the Hydrozoa of the Norfolk coast. *J. Linn. Soc. London* 43, pp. 294-324.
- HAMOND, R., 1961. — The marine fauna, in: *Norwich and its Region*. Norwich, Jarrold & Sons.
- HAMOND, R., 1962. — On some Polychaeta from the coast of Norfolk. *Ann. Mag. nat. Hist.* (13) 5, pp. 567-576.
- HAMOND, R., 1963 a. — A preliminary report on the marine fauna of the north Norfolk coast. *Trans. Norf. Norw. nat. Soc.* 20, 1, pp. 2-31.
- HAMOND, R., 1963 b. — Further notes on the Hydrozoa of the Norfolk coast. *Ann. Mag. nat. Hist.* (13) 6, pp. 659-670.
- KORRINGA, P., 1951. — The shell of *Ostrea edulis* as a habitat. *Arch. néerl. Zool.* 10, pp. 32-152.
- LAUBIER, L., 1961. — *Phyllocicola petiti* (Delamare et Laubier, 1960) et la famille des Phyllocicolidae, Copépodes parasites d'Annélides Polychètes en Méditerranée occidentale. *Crustaceana* 2, 3, pp. 228-242.
- MC INTOSH, W.C., 1900. — Monograph of the British marine annelids. *London, Ray Society*, 1, pt. 2. Also 2, pt. 1 (1908); 2, pt. 2 (1910); 3, pt. 1 (1915); 4, pt. 1 (1922); and 4, pt. 2 (1923).
- MISTAKIDIS, M.N., 1957. — The biology of *Pandalus montagui* Leach. *Fish. Invest.* (2) 21, 4, pp. 1-52.
- MÖBIUS, K., 1875. — Vermes, in: *Jber. Comm. wiss. Untersuch. dtsch. Meere*, II & III Jg.
- MORLEY, C. (edit.), 1941. — The worms of Suffolk; preliminary list. *Trans. Suffolk nat. Soc.* 4, 4, pp. 228-233.
- NEWELL, G.E., 1954. — The marine fauna of Whitstable. *Ann. Mag. nat. Hist.* (12) 7, pp. 321-350.
- NISBET, R.H., 1960. — Marine biology at Skipper's Island. *Essex Nat.* 30, 4, pp. 247-253.
- OKADA, Y., 1929. — Sacconereis of *Procerastea*. *J. mar. biol. Ass. U.K.* 16, pp. 325-328.
- PANTIN, C.F.A., HOLLICK, F.S.J., JOYSEY, K.A. & BIDDER, A.M., 1960. — The marine invertebrate fauna, in: *Scolt Head Island*, ed. J.A. Steers (2nd ed.). Cambridge, W. Heffer & Sons.
- PETTIBONE, M.H., 1954. — Marine polychaete worms from Point Barrow, Alaska, with additional records from the North Atlantic and North Pacific. *Proc. U.S. Nat. Mus.*, 103, pp. 203-356.
- PETTIBONE, M.H., 1963. — Marine polychaete worms of the New England region. *Bull. U.S. Nat. Mus.*, 227, 1. Aphroditidae through Trochochaetidae.
- PLYMOUTH MARINE FAUNA, 1957. — *Mar. biol. Ass.* (3rd ed.).
- RAMSAY, L.N.G., 1914. — On *Leptonereis glauca* Claparède and the genus *Leptonereis* Kinberg. *J. mar. biol. Ass. U.K.*, 10, pp. 244-253.
- RASMUSSEN, E., 1956. — Faunistic and biological notes on marine invertebrates III. The reproduction and larval development of some polychaetes from the Isefjord, with some faunistic notes. *Biol. Medd. Dan. Vid. Selsk.*, 23, 1, pp. 1-84.
- SAINT-JOSEPH, Baron de, 1888. — Les Annélides Polychètes des côtes de Dinard, II. *Ann. Sc. nat. zool.* 7, 5, pp. 141-338.
- SERVENTY, D.L., 1934. — The marine invertebrate fauna, in: *Scolt Head Island*, ed. J.A. Steers (1st edn.). Cambridge, W. Heffer & Sons.
- SOUTHWARD, E.C., 1956. — On some Polychaeta from the Isle of Man. *Ann. Mag. nat. Hist.* (12), 9, pp. 257-279.
- SOUTHWARD, E.C., 1957. — The distribution of Polychaeta in offshore deposits in the Irish Sea. *J. mar. biol. Ass. U.K.*, 36, pp. 49-75.
- TEBBLE, N., 1952. — On three species of the genus *Ophelia* (Polychaeta) from British and adjacent waters. *Ann. Mag. nat. Hist.* (12), 5, pp. 535-571.
- THORSON, G., 1946. — Reproduction and larval development of Danish marine bottom invertebrates, with special reference to the planktonic larvae in the Sound (Øresund). *Medd. Komm. Havundersøgg. Kbh., Ser. Plankt.*, 4, 1, pp. 1-523.

- WESENBERG-LUND, E., 1941. — Notes on Polychaeta, I. *Vidensk. Medd. Dansk. naturh. Foren.*, 105, pp. 31-47.
- WESENBERG-LUND, E., 1950. — Polychaeta. *Dan. Ingolf-Exped.*, 4, pt. 14, pp. 1-92.
- WESENBERG-LUND, E., 1951. — Polychaeta. The Zoology of Iceland, 2, 19, pp. 1-182.
- WILSON, D.P., 1932. — On the Mitraria-larva of *Owenia fusiformis* Delle Chiaje. *Phil. Trans. roy. Soc. London B*, 221, pp. 231-334.
- WILSON, D.P., 1958. — The polychaete *Magelona alleni* n. sp., and a re-assessment of *Magelona cincta* Ehlers. *J. mar. biol. Ass. U.K.*, 37, pp. 617-626.
- WILSON, D.P., 1959. — The polychaete *Magelona filiformis* sp. nov., and notes on other species of *Magelona*. *J. mar. biol. Ass. U.K.*, 38, pp. 547-556.
- YOUNG, M.R., 1955. — Some further records and observations on the macrofauna of the intertidal zone at Gibraltar Point. *Trans. Lincs. nat. Union*, pp. 221-229.

## ADDENDUM

*Nereis longissima*.—The heteronereid ascribed to this species should be referred to *N. pelagica*, because two exactly similar heteronereids (both female) were formed by atonous individuals of *N. pelagica* which I collected in the Strond Pool Dam under stones, and kept in beakers of aerated seawater throughout the period of metamorphosis; during this period, each specimen formed a mucus tube in which it lay almost motionless, the tube being stretched like a tent between the floor and the side of the beaker and extending through an arc of a circle. When collected, both specimens had begun to show the modifications leading to the heteronereid state; one, collected on 8.3.1966, spawned by itself twenty days later, while the second, collected on 29.3.1966, is at present (1.6.1966) still lying quietly in its tube, although apparently mature.

The breeding season of *N. pelagica* in Norfolk waters thus appears to extend from mid-March to early June, and perhaps longer, so that it is possible that some at least of the unidentified heteronereids mentioned in the present paper belong to this species.

*Nephtys hombergi*.—After being almost exterminated by the severe winter of 1962-1963, this species is now larger and more plentiful than before on the lugworm grounds (information from Mr. M. Adcock, of Blakeney).

*Nerinides cantabra*.—One, about 6 cm long and full of nearly ripe ova, in slightly dirty sand in the channel leading to Burnham Overy Staithe, 23.4.1966 (T. Potts).

*Stylarioides plumosa*.—Three enormous specimens were found in the Strond Pool Dam on 29.3.1966, their respective lengths being 5.8, and 6 cm. The last-named specimen was tail-less, and was estimated to have attained 11 cm when complete, so that it must be one of the largest specimens of this species ever recorded; the two smaller specimens were complete.

*Ophelia borealis*.—One full-grown specimen in clean sand at extreme low water north of Brancaster Golf Club, 23.4.1966 (T. Potts), together with about a hundred *P. koreni*. This is the first *O. borealis* to be found in Norfolk waters in clean sand without any oyster-shells (cf. *Travisia forbesi*), and the first to be found intertidally.

TABLE 4  
Worms found at H<sub>2</sub>/C<sub>2</sub> stations.

	P. 111	D. 15	D. 42	D. 49	D. 50
<i>Aphrodite aculeata</i>			1	1	
<i>Gattyana cirrosa</i>		1	2	4	1
<i>Lepidonotus squamatus</i> .....p.		9		1	1
<i>Harmothoe impar</i>		few			8
<i>Harmothoe lunulata</i>		1			
<i>Sthenelais boa</i>		1			
<i>Pholoe minuta</i>		4	ca. 100	160	few
<i>Phyllodoce maculata</i>			1		
<i>Eulalia viridis viridis</i>					1
<i>Eulalia pusilla</i>		1			
<i>Eulalia bilineata</i>		1		1	
<i>Eulalia sanguinea</i>		∞	3	3	1
<i>Kefersteinia cirrata</i>				1	1
<i>Syllis armillaris</i>		7			
<i>Syllis variegata</i>					1
<i>Pionosyllis lamelligera</i>		1			
<i>Eusyllis blomstrandii</i>		few	2	13	5
<i>Exogone gemmifera</i>		∞			
<i>Autolytus prolifer-group</i>		∞	65		3
<i>Autolytus alexandri</i>		1	2	4	8
<i>Proceræa cornuta</i>			1		1
<i>Nereis pelagica</i> .....p.		7			
<i>Nereis fucata</i>		4			
<i>Nereis longissima</i>		1			
<i>Scoloplos armiger</i>					1
<i>Polydora ciliata</i>		1		7	
<i>Polydora caeca</i>		5			
<i>Heterocirrus bioculatus</i>		1			
<i>Tharyx marioni</i>		1			
<i>Stylarioides plumosa</i>					1
<i>Sabellaria spinulosa</i> .....p.		few			
<i>Lanice conchilega</i>		few			
<i>Thelepus cinnatus</i> .....p.		ca. 30			
<i>Sabella pavonina</i> .....p.		2			
<i>Serpula vermicularis</i>		∞			
<i>Pomatoceros triqueter</i>		few			
<i>Salmacina dysteri</i>		few			
<i>Spirorbis spirillum</i>		few			
Total 38 spp.	5 spp.	30 spp.	9 spp.	11 spp.	14 spp.

TABLE 5  
Worms found at C<sub>2</sub>/F<sub>4</sub> stations.

	D. 44	D. 45
<i>Gattyana cirrosa</i>	3	8
<i>Lepidonotus squamatus</i>		3
<i>Harmothoe impar</i>	10	8
<i>Harmothoe lunulata</i>		12
<i>Sthenelais boa</i>		1
<i>Pholoe minuta</i>	6	5
<i>Phyllodoce maculata</i>		1
<i>Phyllodoce groenlandica</i>		1
<i>Eulalia viridis viridis</i>	few	17
<i>Eulalia viridis ornata</i>		2
<i>Eulalia bilineata</i>		11
<i>Eulalia sanguinea</i>	6	10
<i>Eteone longa</i>	1	
<i>Kefersteinia cirrata</i>		5
<i>Nereimyra punctata</i>	2	
<i>Eusyllis blomstrandii</i>	few	
<i>Autolytus prolifer-group</i>		5
<i>Autolytus alexandri</i>	10	
<i>Nereis pelagica</i>	2	1
<i>Glycera alba</i>	1	
<i>Scoloplos armiger</i>		2
<i>Flabelligera affinis</i>	1	
<i>Lanice conchilega</i>		∞
<i>Sabella pavonina</i>	1	
<i>Hydroides norvegica</i>	3	
<i>Pomatoceros triqueter</i>	few	∞
Total 26 spp.	15 spp.	18 spp.

TABLE 6  
Worms found at B stations.

	D. 14	D. 17
<i>Gattyana cirrosa</i>	2	11
<i>Lepidonotus squamatus</i>		5
<i>Harmothoe impar</i>	< 50	3
<i>Harmothoe lunulata</i>		1
<i>Sthenelais boa</i>	1	10
<i>Pholoe minuta</i>	few	ca 50
<i>Phyllodoce laminosa</i>	2	1
<i>Phyllodoce maculata</i>		2
<i>Eulalia pusilla</i>		1
<i>Eulalia sanguinea</i>	< 50	ca 100
<i>Eteone longa</i>		4
<i>Kefersteinia cirrata</i>		6
<i>Syllis armillaris</i>		5
<i>Exogone hebes</i>		6
<i>Autolytus prolifer-group</i>		few
<i>Nereis pelagica</i>		1
<i>Nephtys hombergi</i>		3
<i>Nephtys longosetosa</i>		7
<i>Sphaerodorum minutum</i>		1
<i>Glycera lapidum</i>		1
<i>Glycera alba</i>		2
<i>Scoloplos armiger</i>		∞
<i>Audouinia tentaculata</i>	1	ca 50
<i>Dodecaceria concharum</i>		3
<i>Flabelligera affinis</i>		1
<i>Capitellides giardi</i>		4
<i>Pectinaria koreni</i>	4	1
<i>Lanice conchilega</i>	∞	∞
<i>Polymnia nebulosa</i>		few
<i>Thelepus cinnatus</i>	few	few
<i>Sabella pavonina</i>		1
<i>Pomatoceros triqueter</i>		∞
32 species	10	32

TABLE 7  
Worms found at F<sub>4</sub> stations.

	D. 20	S. 4
<i>Gattyana cirrosa</i>	5	9
<i>Lepidonotus squamatus</i>	4	1
<i>Harmothoe imbricata</i>	2	1
<i>Harmothoe impar</i>		1
<i>Harmothoe lunulata</i>	1	
<i>Pholoe minuta</i>	∞	4
<i>Phyllodoce maculata</i>	1	
<i>Phyllodoce groenlandica</i>		3
<i>Eulalia viridis viridis</i>	1	1
<i>Eulalia pusilla</i>		1
<i>Eulalia fuscens</i>		6
<i>Eulalia sanguinea</i>	∞	4
<i>Eteone longa</i>		2
<i>Kefersteinia cirrata</i>	2	2
<i>Nereimyra punctata</i>	4	5
<i>Syllis armillaris</i>		1
<i>Pionosyllis lamelligera</i>		1
<i>Sphaerosyllis hystrix</i>	19	1
<i>Sphaerosyllis bulbosa</i>		∞
<i>Exogone gemmifera</i>	∞	7
<i>Autolytus prolifer-group</i>		16
<i>Autolytus alexandri</i>	8	3
<i>Procerastea halleziana</i>		2
<i>Nereis pelagica</i>	4	2
<i>Nereis zonata</i>	7	4
<i>Nereis fucata</i>	1	1
<i>Scoloplos armiger</i>	1	5
<i>Polydora flava</i>	∞	10
<i>Heterocirrus bioculatus</i>		1
<i>Heterocirrus caput-esocis</i>	1	
<i>Heterocirrus alatus</i>		1
<i>Tharyx marioni</i>	1	1
<i>Flabelligera affinis</i>	1	
<i>Stylarioides plumosa</i>	6	
<i>Asclerocheilus intermedius</i>	1	
<i>Sabellaria spinulosa</i>		∞
<i>Nicolea zostericola</i>		2
<i>Sabella pavonina</i>	3	6
<i>Hydroides norvegica</i>		1
<i>Pomatoceros triqueter</i>		6
<i>Salmacina dysteri</i>	few	
Total 41 spp.	25	33

TABLE 8  
Worms found at C<sub>1</sub> stations.

	D. 4	D. 6
<i>Gattyana cirrosa</i>	1	
<i>Lepidonotus squamatus</i>	2	
<i>Pholoe minuta</i>		few
<i>Eulalia fucescens</i>		5
<i>Eulalia sanguinea</i>	1	
<i>Eteone longa</i>		1
<i>Syllis armillaris</i>		8
<i>Pionosyllis lamelligera</i>		25
<i>Eusyllis blomstrandii</i>	∞	
<i>Autolytus prolifer-group</i>	∞	few
<i>Exogone gemmifera</i>		∞
<i>Procerastea halleziana</i>		2
<i>Nereis fucata</i>		1
<i>Polydora caeca</i>		3
<i>Tharyx marioni</i>		3
<i>Sabellaria spinulosa</i>		∞
<i>Nicolea zostericola</i>		1
<i>Thelepus cincinnatus</i>	ca 20	ca 10
<i>Sabella pavonina</i>	1	
<i>Pomatoceros triqueter</i>		few
<i>Spirorbis spirillum</i>		∞
21 species	7	16

TABLE 9  
Worms found at G stations.

	P. 108	D. 8	D. 10
<i>Aphrodite aculeata</i>	p.		
<i>Lepidonotus squamatus</i>	p.		1
<i>Harmothoe impar</i>		2	3
<i>Sthenelais boa</i>	p.		
<i>Eulalia sanguinea</i>	p.		
<i>Syllis armillaris</i>	p.		
<i>Exogone gemmifera</i>			3
<i>Nereis pelagica</i>		1	4
<i>Clymene praeterrimissa</i>	p.		
<i>Sabellaria spinulosa</i>	p.	∞	∞
<i>Thelepus cincinnatus</i>	p.	few	
<i>Pomatoceros triqueter</i>	p.		
<i>Filograna implexa</i>	p.		
13 species	11	4	5

TABLE 10  
Worms found at Polychaete-poor C<sub>2</sub> stations.

	P. 107	W. 8	W. 19	W. 28	W. 29	D. 6	D. 13	D. 48
<i>Lepidonotus squamatus</i>					2			
<i>Harmothoe impar</i>							2	
<i>Pholoe minuta</i>								3
<i>Phyllodoce groenlandica</i>				1				
<i>Eulalia sanguinea</i>					6			
<i>Syllis armillaris</i>					4			
<i>Eusyllis blomstrandii</i>					few			ca 15
<i>Exogone gemmifera</i>					few			
<i>Autolytus-prolifer-group</i>				2	1	2		ca 18
<i>Procerastea halleziana</i>						1		ca 40
<i>Sabellaria spinulosa</i>	p		few	few				
<i>Lanice conchilega</i>				1		1		
<i>Thelepus cincinnatus</i>						2		
<i>Sabella pavonina</i>		few						
<i>Pomatoceros triqueter</i>	p							
Total 15 spp.	2	1	1	4	6	4	1	4



TABLE 11  
Worms found at Polychaete-rich C<sub>2</sub> stations.

	W. 26	W. 27	W 30	D. 18	D. 22	D. 23	D. 26	D. 40	D. 61
<i>Aphrodite aculeata</i>						1		1	
<i>Gattyana cirrosa</i>				1	1	5	1		
<i>Lepidonotus squamatus</i>		4	1	9	14	15	3		
<i>Harmothoe impar</i>			few	2	> 50	13			
<i>Harmothoe lunulata</i>		1		1	5		3		
<i>Sthenelais boa</i>					1		1		
<i>Pholoe minuta</i>		2	3	2	∞	126	4		∞
<i>Phyllodoce groenlandica</i>				29	29	1			3
<i>Phyllodoce maculata</i>					5	4			
<i>Phyllodoce laminosa</i>				2					
<i>Eulalia bilineata</i>				19	5	3	4		1
<i>Eulalia fuscens</i>			9	2		32			
<i>Eulalia pusilla</i>			9	29	4	1			
<i>Eulalia viridis viridis</i>		1	2	1	4		11		1
<i>Eulalia viridis ornata</i>							32		
<i>Eulalia sanguinea</i>		2		10	12	35	ca 80		10
<i>Notophyllum foliosum</i>					3				
<i>Eteone longa</i>				9		2			
<i>Kefersteinia cirrata</i>									3
<i>Nereimyra punctata</i>				25	3				1
<i>Syllis armillaris</i>	4	9	15	26	4	7			
<i>Syllis variegata</i>	2	2	6	6	2	1			
<i>Pionosyllis lamelligera</i>			24	10	1	1			
<i>Pionosyllis serrata</i>				1					
<i>Eusyllis blomstrandii</i>			1	3	4			23	29
<i>Sphaerosyllis hystrix</i>			3		1				
<i>Sphaerosyllis bulbosa</i>				2	6	3			
<i>Exogone gemmifera</i>	6		> 14	9		25		7	
<i>Exogone verugera</i>				1					
<i>Autolytus prolifer-group</i>	2		ca 12	15	5	11		3	
<i>Autolytus lugens</i>									1
<i>Autolytus alexandri</i>				5	5	2			
<i>Proceraea picta</i>			1	3					2
<i>Nereis pelagica</i>	2	1			15				
<i>Nereis zonata</i>						24			
<i>Nereis fucata</i>					1				
<i>Nereis longissima</i>	1								
<i>Nephtys longosetosa</i>								1	
<i>Ephesia gracilis</i>						1	1		
<i>Glycera lapidum</i>				1		1			
<i>Glycera alba</i>									1
<i>Dorvillea kefersteini</i>				1					
<i>Scoloplos armiger</i>				1					
<i>Pygospio elegans</i>		1	10						
<i>Polydora ciliata</i>				1	∞				
<i>Polydora caeca</i>			4	3					
<i>Polydora flava</i>			14						
<i>Audouinia tentaculata</i>			2				1		
<i>Heterocirrus bioculatus</i>		1	1	1					
<i>Heterocirrus caput-esocis</i>				3		3			
<i>Tharyx marioni</i>				1		3			
<i>Dodecaceria concharum</i>				10					
<i>Flabelligera affinis</i>				1	1				1
<i>Stylarioides plumosa</i>		1		1	1				1
<i>Asclerocheilus intermedius</i>	1			19		2			
<i>Ophelia borealis</i>								1	
<i>Capitellides giardi</i>				1					
<i>Sabellaria spinulosa</i>	few			few				few	
<i>Pectinaria koreni</i>								1	
<i>Ampharete acutifrons</i>						2			
<i>Lanice conchilega</i>							∞		
<i>Nicolea venustula</i>					1				
<i>Nicolea zostericola</i>								x	
<i>Thelepus cincinnatus</i>	few	4		6	13	4			
<i>Sabella paponina</i>	few			3		1			
<i>Dasychone bombyx</i>				2	2	1			
<i>Fabricia sabella</i>				12		8			
<i>Jasmineira elegans</i>				9	2				
<i>Pomatoceros triqueter</i>	1			1		4	few		
<i>Salmacina dysteri</i>					few				
<i>Spirorbis spirillum</i>					few				
Total 71 spp.									
Total number of spp. at each station	11	12	19	45	33	31	13	9	13

TABLE 12

Worms found at other stations.  
Numbers of each species found are not available for the "Pommerania" stations.

Type	Station	Species taken
A	D.37	None.
softer than A	D.35	1 <i>Eulalia sanguinea</i> , 1 <i>Ophelia borealis</i> , 12 <i>Lanice conchilega</i> .
	P.105	<i>Gattyana cirrosa</i> , <i>Sthenelais boa</i> , <i>Eteone flava</i> , <i>Nereis pelagica</i> , <i>Nephtys caeca</i> , <i>Glycera capitata</i> , <i>Ammotrypane aulogaster</i> , <i>Owenia fusiformis</i> , <i>Pectinaria auricoma</i> , <i>P. belgica</i> , <i>Ampharete acutifrons</i> and <i>Amphiteis gunneri</i> .
C <sub>9</sub>	D.24	None.
C <sub>9</sub> /B	D.47	4 <i>Harmothoe impar</i> , 5 <i>Sthenelais boa</i> , 132 <i>Pholoe minuta</i> , 1 <i>Phyllodoce groenlandica</i> , 3 <i>Eulalia viridis viridis</i> , 1 <i>E.v. ornata</i> , 3 <i>Eulalia bilineata</i> , 8 <i>E. sanguinea</i> , 4 <i>Kefersteinia cirrata</i> , 5 <i>Autolytus alexandri</i> , 2 <i>Nereis pelagica</i> , 2 small <i>Glycera alba</i> , 12 <i>Spio filicornis</i> , 2 <i>Thelepus cinnatus</i> , 1 <i>Hydroides norvegica</i> and moderate numbers of <i>Pomatoceros triqueter</i> .
E <sub>1</sub>	D.7	1 <i>Eusyllis blomstrandii</i> (on <i>Hydrallmania falcata</i> ).
E <sub>1</sub> /B	P.113	<i>Gattyana cirrosa</i> , <i>Thelepus cinnatus</i> and <i>Pomatoceros triqueter</i> .
E <sub>2</sub>	D.9	A few <i>Nicolea zostericola</i> (on <i>Hydrallmania falcata</i> ), a few <i>Thelepus</i> (among <i>Vesicularia</i> ), and a few <i>A. prolifer</i> -group (among mixed hydroids).
	S.5	One <i>Pectinaria koreni</i> , with a <i>Mysella</i> .
	D.25	None.
	D.27	One large <i>Nephtys hombergi</i> .
	D.29	One large <i>Spio filicornis</i> .
	D.36, D.38	None.
	D.46	One <i>Travisia forbesi</i> .
E <sub>2</sub> /C <sub>1</sub>	D.39	One <i>Aphrodite aculeata</i> , one large <i>Gattyana cirrosa</i> .
E <sub>2</sub> /F <sub>1</sub>	P.106	<i>Aphrodite aculeata</i> , <i>Ophelia borealis</i> and <i>Thelepus cinnatus</i> .
E <sub>2</sub> /F <sub>2</sub>	S.7	A few <i>Pomatoceros triqueter</i> on a <i>Modiolus</i> -valve.
	D.30	None.
F <sub>1</sub>	D.2	1 <i>Ophelia borealis</i> , 1 <i>Pholoe minuta</i> .
	D.12	2 <i>O. borealis</i> .
	D.28	1 large <i>O. borealis</i> .
	D.31	1 small <i>O. borealis</i> .
	D.43	2 <i>O. borealis</i> .
F <sub>2</sub>	D.11	1 <i>Harmothoe impar</i> , 1 <i>Pholoe</i> , 1 <i>A. prolifer</i> -group.
	D.33	One mass of spawn of <i>Phyllodoce maculata</i> .
F <sub>2</sub> /F <sub>4</sub>	D.32	1 <i>Autolytus sp.</i> , 6 dwarf <i>P. cornuta</i> , 1 tiny <i>Procerastea halleziana</i> , and 70 <i>Eusyllis blomstrandii</i> (on <i>Sertularia argentea</i> and <i>Hydrallmania falcata</i> ).
	D.34	1 small <i>Eulalia sanguinea</i> and 2 dwarf <i>Procerastea cornuta</i> , all among <i>Sertularia argentea</i> .
F <sub>2</sub>	D.16, D.21	None.
H	D.19	At this station, and at about ¼ mile N.W. of it, <i>Sabellaria spinulosa</i> thickly all over bound shingle; 1 <i>Harmothoe lunulata</i> at D.19.
H <sub>1</sub>	D.41	A few <i>Pomatoceros triqueter</i> on stones and on <i>Modiolus</i> -valves.
H <sub>2</sub> /C <sub>2</sub>	W.9	None.

TABLE 13

Classification of bottom deposits (after Hamond, 1963a and in press).

Type	Description
softer than A.	Probably quite a soft mud in part, but accidentally mixed with harder ground in the same haul. This category was erected, specifically for P.105, after type A had been formulated for grounds lying nearer the coast.
A.	Clayey mud with stones and/or shells, no <i>Ophiura albida</i> .
B.	Silty sand with some shells and stones, abundant <i>O. albida</i> . <i>Ampelisca tenuicornis</i> , although common elsewhere, reaches by far its greatest abundance here, equalling <i>O. albida</i> in numbers.
C <sub>1</sub> .	Muddy ground resembling garden earth, with fair or moderate numbers of dead shells of <i>Modiolus</i> and <i>Mya truncata</i> ; no <i>O. albida</i> .
C <sub>2</sub> .	Slightly muddy sand, less silt than the preceding grade (C <sub>1</sub> ), but with a much higher proportion of dead shells of <i>Modiolus</i> and <i>Mya truncata</i> , and with a rich fauna; no <i>O. albida</i> .
C <sub>3</sub> .	Clean or slightly muddy sand, with an abundance of small-sized shingle and some dead shells (mostly <i>Modiolus</i> ), a few <i>O. albida</i> , and not many other animals at all.

(The letter D is not used for a type of substratum, being already employed for dredge hauls as in Table 14).

- E. Clean sand with few shells:—
  - E<sub>1</sub>. *O. albida* common.
  - E<sub>2</sub>. *O. albida* absent.
- F. Masses of dead and waterworn *Ostrea*-shells, eroded by *Cliona*;
  - F<sub>1</sub>. Very clean sterile ground, apparently barren except for *Ophelia borealis*.
  - F<sub>2</sub>. Slightly dirty, hardly any animals at all, but no *O. borealis* and not as lifeless-seeming as F<sub>1</sub>.
  - F<sub>3</sub>. As for F<sub>2</sub>, but large numbers of *Psammechinus miliaris*.
  - F<sub>4</sub>. Slightly dirty, quantities of *Bugula plumosa* growing on the shells, varied and abundant fauna.
- G. Slightly dirty sand, relatively uneroded *Ostrea*-shells thickly covered by colonies of *Sabellaria*.
- H<sub>1</sub>. Small shingle uniformly coated with *Sabellaria*, very little free sand, a moderate amount of silt.
- H<sub>2</sub>. Clean angular pebbles (roughly 3 cm. in each direction) with a few broken shells (usually *Modiolus*), both shells and stones having a few *Pomatoceros* attached. The sub-type "C<sub>2</sub>+ gravel" (Hamond, 1963a) is redesignated as H<sub>2</sub>/C<sub>2</sub>, the description of it being (as before) C<sub>2</sub> with a high proportion of small stones, and a rich fauna similar to that on a normal C<sub>2</sub> ground.

As will be seen from Tables 4 to 12 inclusive, intermediate grades are frequent, but I have found, nevertheless, that practically all dredge hauls in the area in question can be satisfactorily referred to one of the types mentioned, or to a type which is clearly intermediate between two or (D.40) three of them.

TABLE 14.

Offshore stations where Polychaetes were collected.  
(For details of the "Pommerania" stations see Möbius 1875 and Hamond 1963a).

- W.8. 53°05'N.01°10'E., 26.6.1951. Clayey mud with some shells and stones, moderate numbers of *Hyas araneus* and *H. coarctatus*.
- W.19. 53°09'N.01°05'E., 13.5.1954. Fairly large quantities of dead bivalve shells.
- D.2. 53°00'20"N.00°56'E., 23.5.1955. Sandy, with masses of dead waterworn *Ostrea*-shells, extremely clean and practically lifeless except for one *Ophelia borealis*, and a few other animals which had probably strayed in from deeper water nearby.
- D.4. 53°03'N.01°00'E., same day. Silty sand with abundant dead shells, mainly of *Mya truncata* and *Modiolus modiolus*.
- D.5. 53°03'N.01°02'E., 6.6.1955. Rather muddy, dredge full of *Mya*- and *Modiolus*-shells, lumps of *Sabellaria*, hydroids and a few small stones.
- D.6. 53°01'N.01°01'E., 23.6.1955. Sand with a little mud, a few small stones and shell-fragments, many large dead *Modiolus*-shells, numerous colonies of *Halecium halecinum* and *H. beani*, and about 50 each of *Psammechinus miliaris* and *Pandalus montagui*.
- D.7. 53°00'30"N.00°59'E., same day. Sand with a few shells, abundant *Ophiura albida* and many tufts of *Vesicularia spinosa*.
- D.8. 53°03'30"N.00°58'E., 20.7.1955. Slightly dirty sand with abundant fist-sized lumps of *Sabellaria* (in many cases covered with *Botrylloides leachi*), and very numerous colonies of *Flustra foliacea* in which great numbers of *Porcellana longicornis* were hiding.
- D.9. 53°01'30"N.00°59'E., same day. Sand and shells, a large number of colonies of *Vesicularia* and almost as many of *Hydrallmania*, moderate numbers of *Crangon vulgaris*.
- D.10. 53°04'30"N.01°01'E., 5.8.1955. Masses of *Sabellaria* covered with small colonies of *Botrylloides*, *Bicellariella ciliata*, and *Bugula avicularia*.
- D.11. 53°03'N.01°01'E., same day. Sand with clean dead shells, quantities of *Vesicularia* and several large *Pandalus montagui*.
- D.12. 53°00'N.01°01'30"E., 25.8.1955. Substratum as in D.2, containing 2 *Ophelia borealis* and hardly any other animals at all.
- D.13. 53°00'30"N.01°03'E., same day. Masses of dead shells with hydroids, several fist-sized stones and many smaller ones.
- D.14. 53°00'15"N.00°54'E., 1.9.1955. Mudhole (roughly three parts of soft non-clayey mud to one part of sand) full of *Lanice*-tubes matted together, with hundreds of *O. albida* and about 50 each of *Eumida*, *Psammechinus*, *Ampelisca tenuicornis* and *Harmothoe impar*. Dr. J.B. Buchanan has kindly pointed out that the dredge must have fished over two types of ground, a muddy deposit whose principal inhabitants were *Ophiura* and *Ampelisca*, and a sandy deposit characterised by the abundance of the other species.
- D.15. 53°09'N.00°53'E., 20.9.1955. Dredge absolutely crammed with small stones and dead shells of *Modiolus*, *Mya truncata* and other species, all smothered with *Serpula*, a few *Sabellaria* and *Pomatoceros*; plenty of hydroids and many luxuriant colonies of *Flustra* and *Vesicularia*. Myriads of worms and crustacea in this very rich haul.
- W.26. 53°06'N.01°02'E., 26.7.1956. A large clump of living *Nemertesia antennina* brought home, with *Scrupocellaria reptans* and small *Flustra* all over its basal mat, and many small invertebrates living in and around it.
- W.27. Same place, 3.8.1956. A large living *Modiolus*, with some small ones and several *Microcosmus claudicans* living round it in a cluster, covered with tufts of *Bicellariella*.
- W.28. Same place, 7.8.1956. One old valve each of *Modiolus* and of *Ostrea*, a few other shells and some stones, all coated with sessile organisms, brought home.
- W.29. 53°06'N.01°07'E., 23.8.1956. Various tunicates and branching polyzoa brought home.
- W.30. 53°05'N.01°07'E., 3.9.1956. A large tuft of *N. antennina*, a live *Modiolus*, and a cluster of *Microcosmus*, brought home, with a rich associated fauna.
- D.16. 53°01'N.01°03'E., 17.7.1957. Slightly dirty ground, great numbers of large dead waterworn *Ostrea*-shells, 33 *Psammechinus* but hardly any other animals.
- D.17. 53°00'53"N.00°55'06"E., 12.8.1957. Muddy ground, of a consistency similar to garden soil, matted with the tubes of *A. tenuicornis* shared by *Corophium bonelli* (both these amphipods being present in hundreds); the dredge was also full of *Mya truncata*-shells, with hundreds of *O. albida* and small *Scoloplos*, at least 90 *Eumida* and many *Psammechinus* and *Audouinia*.

- D.18. 53°04'N.01°00'E. Bottom deposit like coarse garden earth, with many dead shells of *Modiolus* and a few of *Mya truncata*, as well as much friable black waterlogged wood (perhaps moorlog, or another outcrop of the submerged forest found intertidally at Brancaster) full of *Hiatella arctica*; dredge also full of large *N. antennina* and *Flustra*, and an immense variety of small animals, making this the richest of all my hauls.
- S.4. 53°03'N.00°56'E., 15.8.1958. Many large dead *Ostrea*-shells with abundant *Bugula plumosa* and many small invertebrates.
- D.19. 53°04'18"N.00°58'36"E., 1.9.1958. Dredge full of small shingle coated with *Sabellaria*; haul discarded, since the rather meagre fauna apparent at first sight did not seem to justify detailed analysis.
- D.20. 53°04'20"N.00°56'40"E., same day. Rough ground, dredge full of dead *Ostrea*-shells, many large colonies of *Hydrallmania* and *Vesicularia*, general facies very like that of S.4 but with fewer hydroids, polyzoa and molluscs (apart from *Ostrea*).
- S.5. 52°59'30"N.00°36'E., 7.9.1958. Moderately clean sand with abundance of large *Crangon*, many large and small *Gobius minutus*, 15 *Ophiura texturata*, and a few other organisms.
- D.21. 53°08'N.00°54'E., 17.8.1959. Rather barren ground resembling D.16 in that about half the bulk of the catch was composed of *Psammechinus*, the other half dead *Ostrea*-shells; haul later discarded.
- D.22. 53°07'N.00°57'E., same day. Masses of dead shells (*Modiolus* and *Mya truncata*), the former covered with balanids outside and polyzoa inside, as well as *Ascidella scabra* and *Actinothoe lacerata* on both sides; many small invertebrates.
- D.23. 53°03'45"N.01°00'E., 20.8.1959. General facies of haul very much as in D.22 but somewhat siltier, fauna very similar and equally rich.
- W.37. Mainly around 53°00'40"N.01°02'E. and 53°01'30"N.00°59'30"E., 16.11.1960. A series of hauls whose combined results were brought home, consisting of 196 *Hyas araneus*, no *H. coarctatus* at all, and various other animals. No bottom record.
- S.7. 53°00'N.01°00'20"E., 16.11.1961. An extremely poor haul, with a very few fishes, crustacea and other invertebrates.
- Q.2. About half a kilometre northwest of Sheringham Lifeboat House, 5.8.1962. Flints as large as a human head, covered with a *Plumaria*-like red alga on top and encrusted with sponges, serpulids and polyzoa underneath.
- D.24. 53°05'50"N.00°52'30"E., 6.8.1962. Haul mainly of clean shingle, some dead *Modiolus*-shells and about 50 *Psammechinus*; haul discarded except for a few species which were picked out.
- D.25. 53°01'N.00°55'E., same day. Clean sand with one live *Spisula solida* and a few other organisms.
- D.26. 53°00'45"N.00°55'E., same day. Like D.24 but with many smaller dead bivalve-shells in addition to the dead *Modiolus*-shells, and with numerous other organisms.
- D.27. 53°03'06"N.01°07'45"E., 26.4.1963. Clean hard sand in which the only organism was one large *Nephtys hombergi*.
- D.28. 53°03'N.01°07'45"E., same day. Sand with a few dead shells of *Ostrea*, *Macoma baltica* and *Spisula solida*; the only living organism was one *Ophelia borealis*.
- D.29. 53°03'N.01°06'30"E., same day. Coarse sand full of dead shells of *Macoma*, *S. solida*, *Abra prismatica* and *Cardium edule*, few animals.
- D.30. 53°03'N.01°05'15"E., same day. Ground as in D.29, with in addition a few large *Ostrea*-shells. The only animal present was a *Pagurus bernhardus* in a *Buccinum*-shell.
- D.31. 53°02'10"N.01°03'30"E., same day. Sand with a fair number of *Ostrea*-shells, very few animals.
- D.32. 53°03'15"N.01°00'15"E., same day. Sand with many *Ostrea*-shells, several colonies each of *Tubularia indivisa*, *Sertularia argentea* and *Hydrallmania*; moderate numbers of other invertebrates.
- D.33. 52°58'45"N.01°01'E., same day. As for D.31, with, in addition, some small stones.
- D.34. 53°01'35"N.00°55'10"E., 30.7.1963. Gritty sand with many dead *Ostrea*-shells, some colonies of *S. argentea*.
- D.35. 53°00'36"N.00°53'45"E., same day. Dark grey clayey mud, about 50 *O. albida*, some other animals.
- D.36. 52°58'54"N.00°55'45"E., 6.8.1963. Sand with a few bivalve shells, few animals.
- D.37. 53°00'12"N.00°54'18"E., same day. Lumpy mud; two *Asterias rubens* were the only animals.

- D.38. 53°02'30"N.00°52'42"E., same day. Sand with a few bivalve shells; three large *Portumnus variegatus* were the only animals.
- D.39. 53°03'15"N.01°00'10"E., same day. Sand with many shells, several invertebrates.
- D.40. 53°03'20"N.00°59'30"E., 29.3.1965. Muddy gritty sand with some dead, much eroded and often broken, *Modiolus*-shells; a fairly rich fauna including many *O. albida* and *Psammechinus*.
- D.41. 53°04'30"N.00°57'E., 3.4.1965. Clean shingle, angular but with the edges worn smooth, with some *Pomatoceros* and a few dead shells (mostly broken *Modiolus*), moderate numbers of *O. albida* and *Psammechinus* but no *Ostrea*-shells and no *Sabellaria*.
- D.42. Close to Blakeney Overfalls Buoy, same day. Masses of small stones as at D.41, plenty of broken *Modiolus*-shells, moderate numbers of *O. albida*, *Psammechinus* and other invertebrates (very much as at D.41).
- D.43. 53°09'N.00°56'E., 5.8.1965. Dead *Ostrea*-shells with *Ophelia borealis* and *Tubularia indivisa*.
- D.44. 53°08'40"N.00°55'E., same day. Masses of dead shells (mostly *Ostrea* but some of *Modiolus* and of *Mya truncata*), quite a lot of silt, very many *P. miliaris* and plenty of other animals but no *O. albida* and no *Bugula plumosa*.
- D.45. 53°01'30"N.00°58'40"E., 10.8.1965. Dead shells and silt as at D.44, masses of *Lanice*-tubes, ca.100 *O. albida* and ca.50 *A. tenuicornis*; *P. miliaris* somewhat less abundant than at D.44.
- D.46. 52°59'20"N.00°58'10"E., 22.8.1965. Clean sand, a few dead of *Abra alba*, *Cardium edule*, and waterworn *Ostrea*; very few animals.
- D.47. 53°04'15"N.01°02'E., 27.8.1965. Three hauls pooled; two of C<sub>2</sub> type (rough ground with fist-sized stones and clinkers, plenty of dead *Ostrea*-shells, moderate numbers of *Modiolus*-shells and *Mya truncata*-shells, several large tufts of *Bugula plumosa*, but no *P. miliaris* and no *O. albida*) and one of B type (matted muddy tubes of *A. tenuicornis* shared by *C. bonelli*, exactly as at D.14).
- D.48. Same place, 7.9.1965. Lots of dead shells (as in the C<sub>2</sub> type hauls at D.47) and some small stones; a few animals but no *P. miliaris*, *A. tenuicornis* or *O. albida*.
- D.49. Close to the Blakeney Overfalls Buoy, 23.9.1965. Shelly and stony ground, ca.100 each of *P. miliaris* and of *O. albida*, plenty of other animals.
- D.50. Same place, 12.10.1965. Same sort of ground as at D.49, ca.50 each of *P. miliaris* and *O. albida*, plenty of other animals.
- D.51. 53°03'35"N.01°02'30"E., 21.10.1965. Masses of dead shells, mostly *Ostrea* but a few of *Modiolus*, many colonies of *Nemertesia antennina* and quite a few of other hydroids, large numbers of small *A. tenuicornis* but no *P. miliaris* nor *O. albida*, plenty of other animals.