Technitella (Norman, 1878) from Plymouth Sound, South Devon, U.K.

PAUL CASTIGNETTI, MALCOLM B. HART and CATHERINE J. MANLEY
Department of Geological Sciences, University of Plymouth, Drake Circus, Plymouth PL4 8AA, U.K.

ABSTRACT

A total of 150 surface samples were collected from Plymouth Sound during December 1993 to November 1994 as part of a doctoral research study. A total of 141 taxa, the majority of which were identified to species or variety level, were recorded. The hyaline tests were most abundant (81 taxa), whilst porcellaneous and agglutinated forms comprised 30 taxa each. The agglutinated foraminifera were present living and dead in all environments, although they typified the low energy muds and very high energy gravel environments. The most abundant agglutinated species are common British species such as *Eggerelloides scabrum, Textularia sagittula* and *Clavulina obscura.*

Several species (live and dead) of technitellids were recorded from the high energy sand and gravel environments of Plymouth Sound. These include *Technitella legumen* whose elongate cyclindrical or conical tests were often found attached to large pebbles and shell fragments, *Technitella teivyensis* whose spherical, free, tests were observed in a range of sediment types and two unidentified species of technitellids which were also recorded in the sand and gravel environments. All are constructed, almost exclusively, of sponge spicules. This group of taxa exhibits reasonable abundance and diversity within the high energy shell gravel environments of Plymouth Sound. The technitellids, however, comprise a relatively small proportion of the Plymouth Sound fauna, but exhibit excellent potential for further study both to establish their biology and a clearer taxonomy for the various species/varieties recorded.

INTRODUCTION

Technitella (Norman, 1878) is a genus of benthic foraminiferid characterised by a wall constructed with sponge spicules and some quartz gains. Records in the literature indicate a world-wide distribution in marine sediments. In the paper defining the genus, Norman (*op.cit.*) also described a number of species of *Halyphysema* Bowerbank (1862) and another new genus, *Marsipella.* In recent years Haman (1966, 1967) and Haynes (1973) have discussed *Technitella* and its relationship with *Halyphysema.* New, beautifully preserved material has now been found in samples from Plymouth Sound and this is now described, together with a review of the genus.

Physiography of Plymouth Sound

Plymouth Sound is the drowned estuary (ria) of the River Tamar which forms much of the border between the counties of Devon and Cornwall in Southwest England. It is located immediately to the south of the city of Plymouth (Figure 1).

The shores of Plymouth Sound are characterised by steeply dipping slates, sandstones and limestones with only occasional, small, gravelly or sandy coves. The exceptions to this are the estuaries of the Plym and Lynher (tributaries of the Tamar) which are fringed with mud flats. The average water depth of the Sound is about 8 metres. The western side of the Sound is shallower, particularly at 'The Bridges', where it is less than 5 metres while eastern and southern areas are 8-15 metres deep. At the northern end of the Sound the water depth increases to 40 metres over the palaeo-Tamar rock channel. The tidal range for Plymouth Sound is 4.7 metres for the Mean Spring Tides and 2.2 metres for the Mean Neap Tides (Admiralty Hydrographic Office figures).

Two rivers flow into Plymouth Sound, the largest being the Tamar with a recorded maximum flow of 321.56 m^3s. and minimum flow of 0.58 m^3s. The Plym, which enters from the north-east, has a maximum recorded flow of 31.01 m^3s. and a minimum flow of 0.12 m^3s. (South West Water, 1979 records). The Tamar contributes some fine sediment and minerals in solution (Butler & Tibbitts, 1972). No published information is available for the River Plym; its size and the nature of the catchment area suggest that little natural sediment is associated with it but because it drains many of the china clay pits of south-west Dartmoor considerable sedimentation of china clay has occurred both in the estuary and the adjacent part of the Sound. Whitepatch, an area on the eastern side of the Sound, takes its name from

In: Hart, M.B., Kaminski, M.A., & Smart, C.W. (eds) 2000. Proceedings of the Fifth International Workshop on Agglutinated Foraminifera. *Grzybowski Foundation Special Publication,* 7, 81-88.

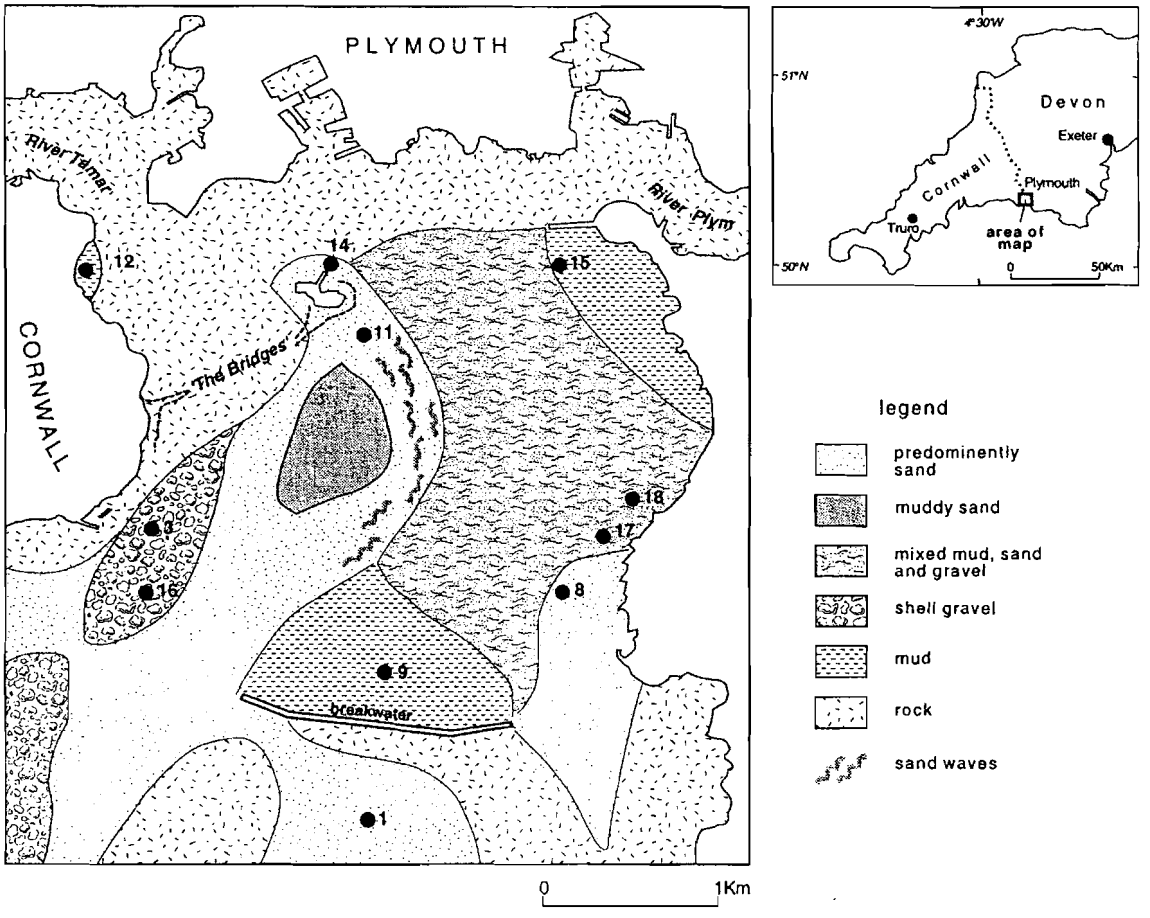

Figure 1. Sediment distribution map of Plymouth Sound and the position of some of the sampling locations used on a regular basis during the investigation (1994-1996). Location 15 is 'Whitepatch', so named because of the abundance of china clay in the area.

the china clay particles often seen in suspension in that area.

In 1812, because of the continual hazard to shipping, the construction of the breakwater began and this was completed in 1827. In subsequent years the lighthouses were built, concrete shields were added and gabions were dropped to reinforce the Breakwater (Merratt, 1980). The 1.7 km breakwater wall restricts the amount of energy received by the Sound, particularly behind the Breakwater where muddy sediments have accumulated.

The salinity of the Sound exhibits a small amount of variation (a maximum of 5% or 6%) both spatially (from the estuary mouths to the Breakwater) and temporally (as a result of seasonality). The lowest salinity readings are generally in the winter after heavy rain and particularly at stations closest to the estuaries; Barn Pool near the mouth of the Tamar recorded a salinity of 29.5‰ in November 1994. The average salinity of the Sound during a recent survey (in 1994) was 34.5‰.

Sea temperature in Plymouth Sound lags behind that of the open sea (it warms and cools slightly after that outside the Breakwater). Temperatures within the Sound have a slightly higher maximum and lower minimum during summer and winter (Lee & Ramster, 1981). The last recorded temperatures from Plymouth Sound in 1971 reached a maximum summer temperature in July of 17°C and a minimum winter temperature of 8.7°C in February (Southward & Butler, 1972). During this present study temperatures varied little over the 12 stations used, reaching a peak at the end of July 1994 of 16.7°C and a low in February 1994 of 8.8°C.

The distribution of sediments within the Sound (Figure 1) has been investigated by FitzPatrick (1990, 1991) who used both airborne and satellite data backed up by direct sampling (by diving). The sample locations used in this survey are also indicated in Figure 1.

Original Definition of *Technitella*

The paper that originally defined *Technitella* was written by the Rev. A.M. Norman in 1878. It was, in fact, a paper on the genus *Haliphysema*, but Norman introduced *Technitella* with the heading: "On two new Genera perhaps related to *Haliphysema*". It must be noted that Norman (1878) always spelt the genus with an 'i' despite the original definition of *Halyphysema* by Bowerbank (1862) being spelt with a 'y'. *Technitella* was, therefore, from the outset defined as a genus closely

related to *Halyphysema*. The original definition of the genus *Technitella* (after Norman, 1878) is as follows:

> "Test elliptical, cylindrical, or subfusiform, composed of the broken fragments of sponge-spicula arranged parallel to the axis and enclosed entirely, or rarely only partially, in the body-wall. Unattached below and closed. A tubular mouth-opening formed by a contraction for a short distance of the body-walls so as to form a short tube."

In this initial description there are no comments as to the number of species included in the genus and no statement as to the identity of the type species. Norman (1878) lists two new species immediately after the description of the generic charateristics and everyone since that time (including Haman, 1967 and Loeblich & Tappan, 1987) have accepted *Technitella legumen* as the type species. The original description of the species is as follows (Norman, 1878, pp. 279-280):

> "The form of the test in this animal reminds one somewhat of the outline of the pod of the edible pea, being cyclindrical throughout the greater part of its length, with the aboral extremity slightly extruded, and that rather out of the central line, as is the distal point (style) of the pea-pod, while the mouth-opening is in the form of a contracted tube, representing about the same proportional length and width to the sylinder as the basal portion of the pea-pod, where it passes into the calyx, does to the pod itself."

> "The body-wall of *Technitella* is an exquisite specimen of perfect masonry: it is beautifully built up of the fragments of minute acerate spicula, laid in regular order side by side, and cemented with a mortar composed probably of the finest dust of quartz, so that the whole test is of exquisite snowy whiteness, corresponding in this respect to that of *H.Tumanowiczii*. Length 1.25 millim."

The habitat listed by Norman is that of "rich foraminiferous sand" dredged from a depth of 112 fathoms (approx. 200 metres) west of Valentia, Ireland. The type figures, unfortunately, are misidentified in Norman's paper. In his text he lists the illustrations of *Technnitella legumen* as plate 16, figs 3,4. Figure 3 of Norman, reproduced as Figure 2a, is - in fact - a specimen that fits perfectly his description of *Marsipella elonga*. Figure 4 of Norman, reproduced as Figure 2b is what most authors (Ellis & Messina, 1940 + supplements; Loeblich & Tappan, 1987) take to be the type illustration of the species (and, thereby, the genus). Figure 5 of Norman, which is supposed to be *Technitella melo* Norman, 1878, looks to be an enlargement of a part of his figure 4. This shows what Loeblich & Tappan (1987) believe is the terminal aperture with a "thickened border".

In the same paper Norman (1878) established the species *Technitella melo*, shown in Figure 2.b and 2.d. *Squamulina scopula* and *Halyphysema tumanowiczii* are two other adherent taxa that also use sponge spicules as materials for wall construction. In the 1987 classification of the Foraminiferida, Loeblich & Tappan clearly stated that *Technitella*, unlike *Halyphysema*, is free-living. This current research attempts to correct this view.

Taxonomy

As this is not intended as a full taxonomic summary of the whole group of adherent foraminiferids that construct their tests of sponge spicules the full supra-generic listing of the genus is not given. All material illustrated in this paper are curated in the micropalaeontological collections of the Department of Geological Sciences, University of Plymouth.

Genus ***Technitella*** Norman, 1878
Emendation, Haman, 1966

In the initial definition of the genus (Norman, 1878) it was suggested that, although *Halyphysema* and *Technitella* may be closely related, the latter could be separated by its free and un-attached character. This was perpetuated by Loeblich & Tappan (1964, 1984, 1987) despite a comprehensive emendation by Haman (1966, 1967). In that re-definition Haman (1967, pl. 6) showed conclusively that *Technitella* is an attached form and that the large openings seen in many specimens are not the aperture but the broken point of attachment. Loeblich & Tappan's (1987) view that the aperture "may be slightly produced on a neck or have a thickened border" reflects the breakage of this point of attachment from the substrate (normally shell fragments). It is clear however that in the majority of cases specimens of *Technitella* are found in a detached state. It is our opinion, therefore, that the description of the genus provided by Loeblich & Tappan (1987) be abandoned and that the emended description of the genus provided by Haman (1967, p. 28) be adopted.

This would, of course, create a supra-generic classification problem. *Technitella* is placed in the Subfamily Saccamminae Brady, 1884, and the Family Saccamminidae Brady, 1884, both of which include free-living taxa (Loeblich & Tappan, 1987, p.30). That *Technitella* has been illustrated (Haman, 1967, pl. 6) and seen by us as having an adherent life habit, probably indicates that the genus should be placed with *Halyphysema* in the Subfamily Halyphyseminae. It is clear that further work on this taxonomic issue remains to be done.

Technitella legumen Norman, 1878

Plate 1, Figures 1-5.

Technitella legumen Norman, 1878, pp. 270-280, pl. xvi, figs 3,4.
Technitella legumen Norman.- Haman, 1967, p. 28, pl. 6, figs 6,8.
Technitella legumen Norman.- Castignetti, 1997, pp. 33-34, pl. 7, figs 1-4.

Diagnosis. Test attached, simple, tubular, longer than broad, tapered towards each end. Apertural opening indistinct, masked by acicular sponge spicules that are wholly or partially embedded in

the thin wall. Specimens often show the circular, thickened, attachment base when broken from substrate.

Remarks. Haman's (1966, 1967) emendation of the genus and revised description of this species is followed here. Loeblich & Tappan (1987) identify *Technitella legumen* as the type species of *Technitella* but do not mention any other species. Haman (1967, pl. 6, fig. 2) illustrated a specimen that is broader than long as a "*Technitella* fragment", rather than *Technitella melo* Norman, 1878. Haman (1967, pl. 6) actually shows a complete range of specimens with variable length:breadth ratios, possibly indicating that all forms between the typical *T. legumen* and *T. melo* exist – and may simply be different growth stages of the one taxon. Haman (1967, p. 28) also indicated that "colonial" forms have been found, although nothing like his illustrations (*op. cit.* pl. 6, fig. 8) have been seen in the Plymouth Sound material. Heron-Allen & Earland and a number of other authors (see Ellis & Messina, 1940 + supplements) have recorded a range of other, Recent taxa, but no colonial forms are illustrated in the various publications.

Environment. The species is relatively rare in samples, with living forms only being recorded in shell-rich gravels and sands (Sample 3 on Figure 1). Dead (= unstained with Rose Bengal) specimens are also restricted to this environment.

Technitella teivyense Haynes, 1973

Plate 2, Figure 1

Technitella teivyense Haynes, 1973, p. 17, pl. 1, figs 1-4.
Technitella teivyense Haynes.- Castignetti, 1997, p. 32, pl. 6, fig. 4.

Diagnosis. Test unilocular, apparently free, sponge spicules arranged at approximately 45° to the growth axis; chambers appear to be cyclindrical and slightly tapered away from the aperture; aperture large and simple; overall, test has 'bushy' appearance.

Remarks. Haynes (1973), in his definition of the species, described it as "arising from an encrusting base". This base has not been seen in our material, despite the remainder of the specimen looking very similar to the type material. The overall "bushy" appearance is typical of the species. A similar, but much more open-meshed form, is also found in the same samples and, in Plate 2, Figs 3a,b, is illustrated as *Technitella* sp. aff. *T. teivyense*.

Environment. Live specimens were recorded in localities 3 and 16 (see Fig. 1), whilst dead specimens have been recorded from locations 9, 11 and 16. They are, therefore, predominantly found in the shell gravels and shell sands.

Technitella sp. (ear-bud form)

Plate 2, Figure 2a,b

Technitella sp. (earbud form) Castignetti, 1997, pp. 33-34, pl. 6, figs 5-6.

Diagnosis. Test agglutinated, (apparently) free, composed of an almost spherical mass of sponge spicules with smooth rounded, elongate bosses at either end; spicules arranged randomly, assumed to be unilocular.

Remarks. The ear-bud form described here may not be a foraminiferid. It is strange that no sediment infilling is recorded and that all the spiculaes are identical. *T. legumen* only shows acicular spicules (with hollow centres) while this taxon is always composed of the same, swollen-ended spicules.

Environment. Only recorded from the shell-rich sands and gravels of location 3 on Figure 1.

CONCLUSIONS

The species of *Technitella* recorded from Plymouth Sound are restricted to the shell-rich sands and gravels (see Figure 1). This appears to reflect the adherent life habit of the genus, the majority of individuals being found associated with small shell fragments. The delicate construction of the test would not be expected to survive in such an high energy environment if it was not adherent. There is still work to be done on the biology of this group of strange foraminifera and it is still possible that some of them (e.g., our ear-bud form) may be shown to belong in another group of organisms. The emended definition of the genus by Haman (1967), that appears to have been overlooked by Loeblich & Tappan (1987), should be re-instated as the best available description of the genus.

ACKNOWLEDGEMENTS

PC and CJM acknowledge receipt of University of Plymouth research studentships in support of this research. Mr John Abraham is thanked for producing the final versions of the figures and Dr. Roy Moate is thanked for his assistance with the electron microscopy work.

REFERENCES

Bowerbank, J.S. 1862. On the anatomy and physiology of the Spongiadae; Part III. On the generic characters, the specific characters, and on the method of examination. *Philosophical Transactions of the Royal Society*, **152**, 747-836 and 1087-1135.

Butler, E.I. & Tibbitts, S. 1972. Chemical survey of the Tamar Estuary; 1. properties of the waters. *Journal of the Marine Biological Association of the U.K.*, **52**, 681-699.

Carter, H.J. 1870. On two new species of the foraminiferal genus *Squamulina*, and on a new species of Difflugia. *Annals and Magazine of Natural History*, London, Ser. 4, **5**, 309-326.

Ellis, B.F. & Messina, A. 1940 (and supplements). *Catalogue of Foraminifera*. American Museum of Natural History, New York.

FitzPatrick, F. 1990. Remotely sensed sedimentology of Plymouth Sound. *Proceedings of the Ussher Society*, 7, 289-294.

FitzPatrick, F. 1991. *Studies of sediments in a tidal environment*. Unpublished PhD thesis, Polytechnic South West (now University of Plymouth), 279 pp.

Haman, D. 1966. *A taxonomic and ecologic study of the foraminifera of Tremadoc Bay, North Wales*. Unpublished PhD thesis, University College of Wales, Aberystwyth.

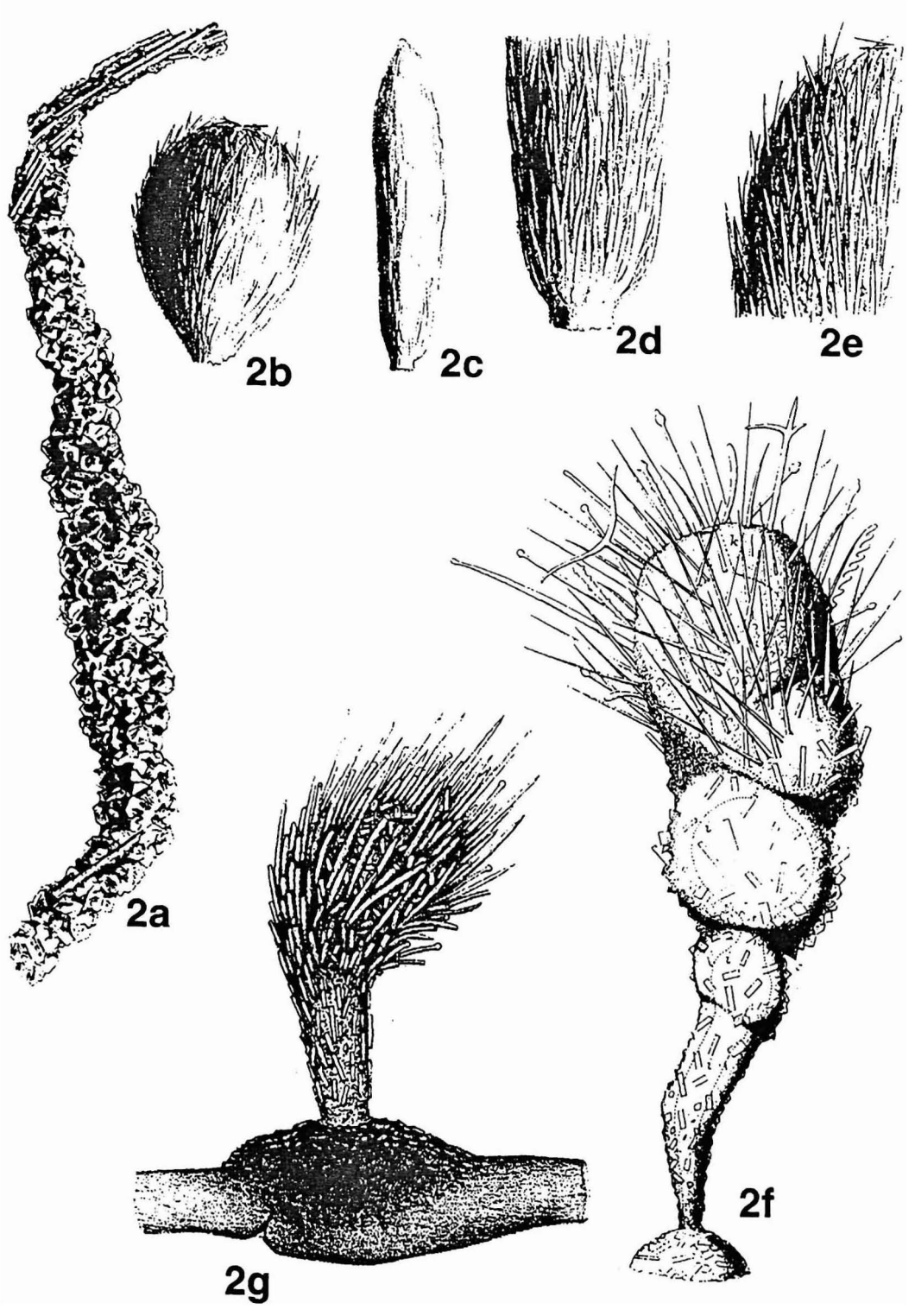

Figure 2. Original figures of *Technitella* and related taxa: **a.** *Marsipella elonga* Norman (1878, plate XVl, fig.3), originally mislabelled as *Technitella legumen;* **b.** *Technitella melo* Norman (1878, plate XVl, fig. 6); **c.** *Technitella legumen* Norman (1878, plate XVl, fig. 4), probably meant to be the holotype in the original paper; **d.** *Technitella melo* Norman (1878, plate XVl, fig. 5); **e.** *Technitella* sp., possibly *Technitella legumen* following the mislabelling noted in **a.** above; **f.** *Squamulina scopula* Carter (1870, plate IV, fig. 3); **g.** *Haliphysema tumanowiczii* Bowerbank (1862, plate LXXlll, fig. 3).

Haman, D. 1967. A taxonomic re-interpretation and emendation of the genus *Technitella* Norman 1878. *Contributions from the Cushman Foundation for Foraminiferal Research*, **18**, 27-29.

Haynes, J.R. 1973. Cardigan Bay Recent Foraminifera (Cruises of the R.V. Antur, 1962-1964). *Bulletin of the British Museum (Natural History), Zoology*, Supplement **4**, 245 pp.

Hedley, R.H. & Wakefield, J.St J. 1967. A collagen-like sheath in the arenaceous foraminifer *Haliphysema* (Protozoa). *Journal of the Royal Microscopical Society*, **87**, 475-481.

Lee, A.J. & Ramster, J.W. 1981. *Atlas of the Seas around the British Isles*. Ministry of Agriculture, Fisheries and Food, Lowestoft.

Loeblich, A.R. & Tappan, H. 1964. Protista 2, Sarcodina chiefly 'Thecamoebians' and Foraminiferida. *In*: Moore, R.C. (ed.), *Treatise on Invertebrate Paleontology*, Geological Society of America and University of Kansas Press, Kansas, Part C, 2 volumes, 900 pp.

Loeblich, A.R. & Tappan, H. 1984. Suprageneric classification of the Foraminiferida (Protozoa). *Micropaleontology*, **30**, 1-70.

Loeblich, A.R. & Tappan, H. 1987. *Foraminiferal genera and their classification*. Van Nostrand Reinhold, New York, 2 volumes, 970 pp. and 847 plates.

Merratt, L.H. 1980. Smeatons Tower and the Plymouth Breakwater. Reprint, *Maritime History*, 5, un-numbered, Devon.

Norman, A.M. 1878. On the genus *Haliphysema* with a description of several forms apparently allied to it. *Annals and Magazine of Natural History*, London, Ser. 5, **1**, 265-284.

Parfitt, E. 1878 On the structure of *Haliphysema tumanowiczii*. *Annals and Magazine of Natural History*, London, Ser. 5, **1**, 265-284.

Southward, A.J. & Butler, E.I. 1972. A note on the further changes of sea temperature in the Plymouth area. *Journal of the Marine Biological Association of the U.K.*, **52**, 931-937.

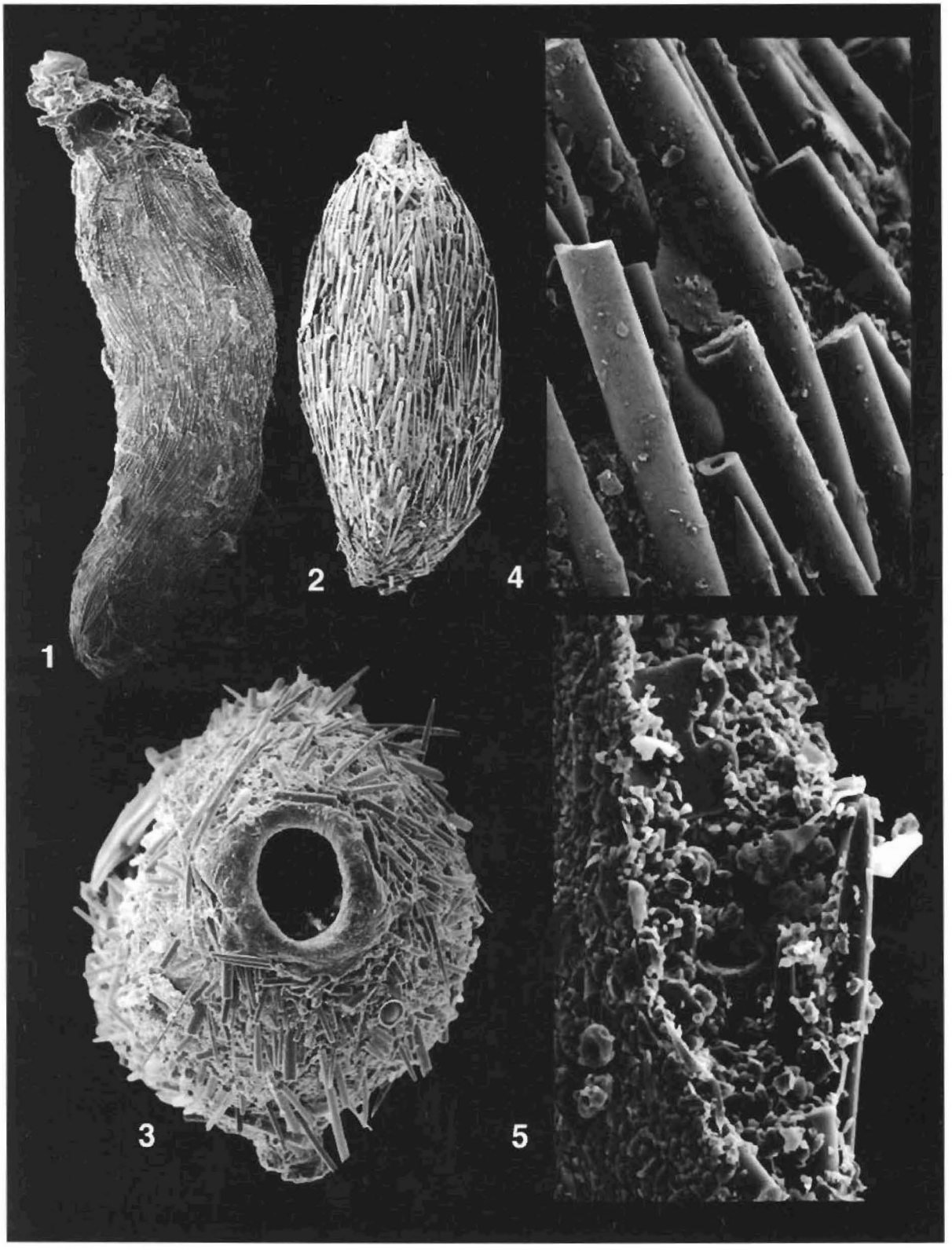

Plate 1. *Technitella legumen* Norman, 1878. 1. Complete specimen (total length 1600 μm); 2. Complete specimen showing typical external appearance of the sponge spicules (total length 900 μm); 3. End view of a complete specimen showing the basal disc that the individual is thought to use for attachment. This shows how easy it was for previous workers to assume that this was the aperture. Maximum diameter of the specimen is 500 μm. 4. View of overlapping sponge spicules on the outer surface. Behind the sponge spicules there is, just visible, the fine-grained material that comprises the remainder of the wall. Field of view is 900 μm. 5. Cross-section of the wall showing the outer layer of sponge spicules (top surface) embedded in a mixture of fine quartz and shell sand. Maximum diameter of photograph is 620 μm.

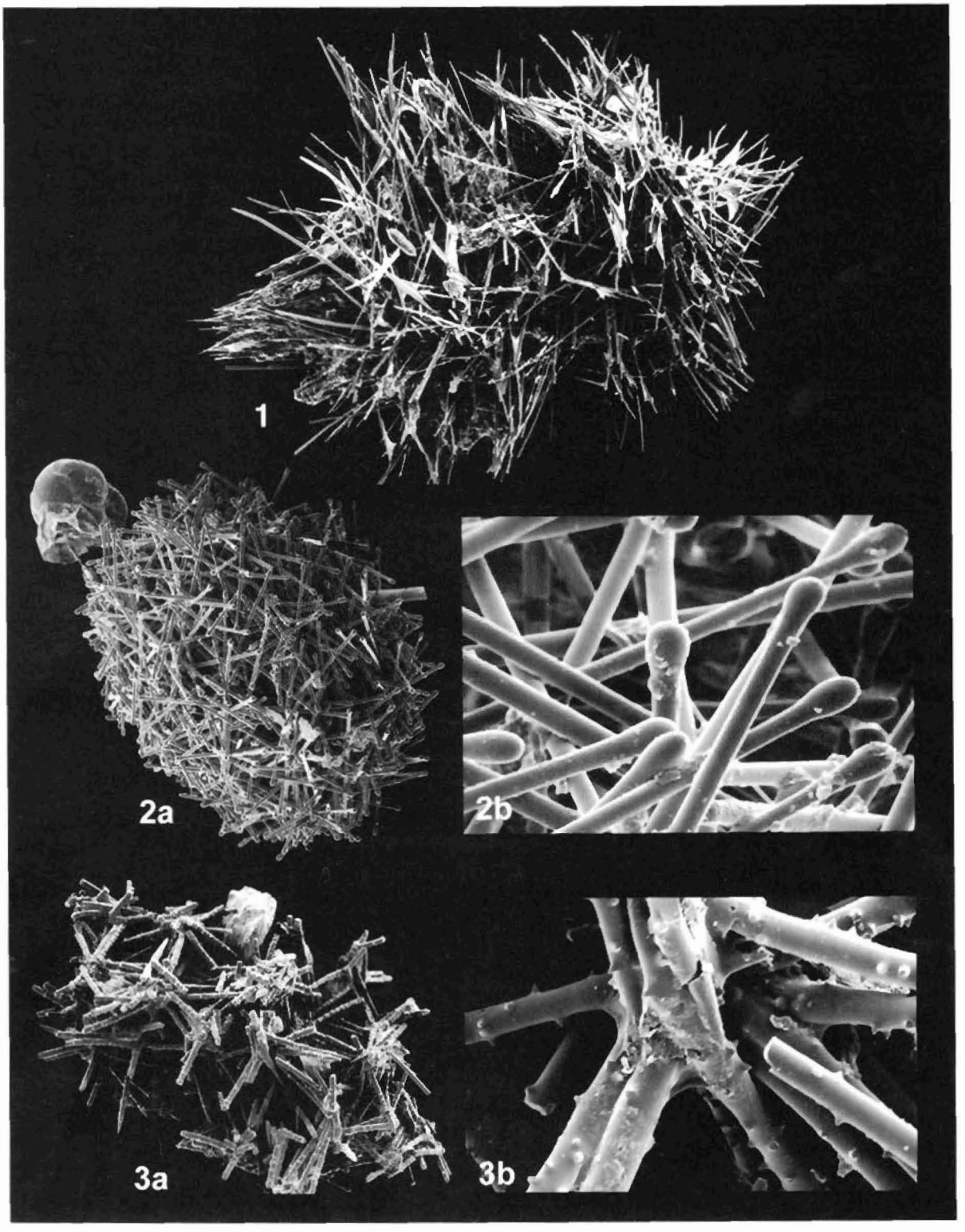

Plate 2. 1. *Technitella teivyense* Haynes, 1973, view of complete specimen (maximum diameter 780 μm) showing the interlocking mass of sponge spicules. Some fine-grained material is visible between the spicules in places (left extremity of the specimen), but this is quite rare, unlike *T. legumen* (see Plate 1). **2a,b.** *Technitella* sp. (ear-bud form) 2a. Complete specimen (maximum diameter 465 μm) showing the characteristic interlocking mesh of spicules and lack of any apparent sediment infilling. The spicules, in this case, show the typical rounded extremities. 2b. Enlargement of some spicules clearly showing the rounded endings (field of view 780 μm). **3a,b.** *Technitella* sp. cf. *T. teivyense* Haynes, 1973. This specimen (maximum diameter 800 μm) may be referred to Haynes' (1973) species. The sponge spicule network is much more open and there is little evidence of inter-spicular sediment forming a wall. 3b. Enlargement of a part of the spicular framework (field of view 120 μm) showing little sign of how the spicules are joined, or fused, together in these open meshwork specimens.