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# New and little-known Komokiacea (Foraminifera) from the bathyal and abyssal Weddell Sea and adjacent areas

ANDREW J. GOODAY[1]*, OLGA E. KAMENSKAYA[2] and TOMAS CEDHAGEN[3]

[1]*National Oceanography Centre, Southampton, Empress Dock, European Way, Southampton SO14 3ZH, UK*
[2]*P.P. Shirshov Institute of Oceanology, Laboratory of Ocean Benthic Fauna, Russian Academy of Sciences, Nakhimovsky Pr. 36, Moscow 117997, Russia*
[3]*University of Aarhus, Biological Institute, Department of Marine Ecology, Finlandsgade 14, DK-8200 Aarhus N, Denmark*

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Based on samples from the south-east Atlantic and Southern Ocean collected during the ANDEEP III campaign we describe three new species, ***Ipoa pennata* sp. nov., *Septuma stellata* sp. nov.** and ***Skeletonia variabilis* gen. et sp. nov.**, of the enigmatic deep-sea foraminiferan superfamily Komokiacea. A further six species, *Ipoa fragila* Tendal & Hessler, 1977, *Komokia multiramosa* Tendal & Hessler, 1977, *Normanina conferta* (Norman, 1878), *Septuma ocotillo* Tendal & Hessler, 1977, *S. brachyramosa* Kamenskaya, 1993, and *S. komokiformis* Kamenskaya 1993, are redescribed. Together, these nine species occurred at 14 stations across the depth range 1549–4935 m. *Normanina conferta* was found at 11 stations (1579–4935 m); *S. ocotillo* (4526–4935 m), *S. brachyramosa* (1819–4730 m) and *S. stellata* (2603–4934 m) at six stations each; *I. fragila* (4649–4934 m) at five stations; *K. multiramosa* (4700–4935) and *S. variabilis* (4696–4932 m) at four stations each; *I. pennata* (4803–4934 m) at three stations and *S. komokiformis* (3103–4526 m) at two stations. Five species occur in both the North Atlantic Ocean and the Southern Ocean, suggesting that close faunal links exist between these areas. Three were first described from the North Pacific Ocean while others, including the three new species, are so far known only from the Southern Ocean. 

ADDITIONAL KEYWORDS: ANDEEP – Antarctica – bathymetric distribution – benthos – biogeography – deep sea – Protista – taxonomy.

## INTRODUCTION

Research on benthic Foraminifera in the Southern Ocean has a long history. Many of the earlier studies were taxonomic and based on material collected during major national expeditions. Among the important publications of this type are those of Pearcey (1914), Heron-Allen & Earland (1932) and Earland (1936) from the Weddell Sea, Wiesner (1931) from the Indian sector of the Southern Ocean, Earland (1933) from South Georgia and Earland (1934) from the Falklands area. These included some delicate agglutinated species, among them monothalamous forms such as *Vanhoeffenella*. Most subsequent studies, however, have been geological in nature and have focused on hard-shelled Foraminifera. Gooday & Pawlowski (2004) and Gooday *et al*. (2004) described new allogromiid species from the Weddell Sea, but only the recent paper of Cornelius & Gooday (2004) provides a quantitative account of the soft-bodied, single-chambered (monothalamous) Foraminifera that are often an important component of deep-sea assemblages (Gooday, 2002).

One very important, but frequently over-looked group of deep-sea, soft-bodied Foraminifera are the Komokiacea. These enigmatic organisms, in which the test consists of a system of branching tubules, are currently classified in the Suborder Astrorhiziina (Loeblich & Tappan, 1987, 1989), although there is no conclusive evidence that they are related to monothalamous Foraminifera. Despite the early description of *Halyphysema conferta* Norman, 1878, a species later recognized as a komokiacean (Tendal & Hessler,

*Corresponding author. E-mail: ang@noc.soton.ac.uk

1977), deep-sea biologists only became aware of these protists during the 1950s. They were first recognized in 1953 in the abyssal North Pacific during the 14th cruise of Russian research vessel *Vityaz.* Subsequent Russian expeditions established the widespread distribution of these ‘vetvistye komoktchki’ (branching lumps) at bathyal to hadal depths with their greatest diversity, density and biomass occurring on abyssal plains (Filatova, 1960, 1969). Thus, even before they were formally described, the importance of komokiaceans in deep-sea benthic communities was clearly recognized, first by Russian and later by American scientists (Hessler, 1974; Tendal & Hessler, 1977).

The superfamily Komokiacea and its two constituent families, the Komokiidae with four genera and seven species and the Baculellidae with two genera and four species, were established by Tendal & Hessler (1977) based on samples from the central North Pacific. These authors also examined material from the Atlantic, Pacific and Indian oceans in which they determined komokiaceans to generic level. With the exception of several from around 60°N in the Atlantic and Pacific Oceans, all Tendal & Hessler’s samples were from temperate latitudes. Since this landmark publication, only four papers (Mullineaux, 1988; Schröder, Medioli & Scott, 1989; Kamenskaya, 1993; Shires, Gooday & Jones, 1994) have described new komokiacean species. A few other studies provide information on komokiaceans from the Pacific Ocean (Kamenskaya, 1987, 1988, 1989), the Atlantic Ocean (Gooday & Cook, 1984; Gooday, 1987, 1990, 1994; Kuhnt & Collins, 1995) and the Arctic Ocean (Wollenburg & Mackensen, 1998). Yet despite being a dominant component of the deep-sea macrofauna, the group remains poorly known and contains many undescribed species.

Komokiaceans were discovered in the Southern Ocean during the 1980s, again during Russian cruises. They were found near the South Shetland Islands (Vinogradova *et al*., 1990), the Orkney Trench (Vinogradova *et al*., 1993a; Vinogradova, Zhivago & Detinova, 2000), the Weddell Sea and Bransfield Strait (Vinogradova *et al*., 1993b). However, although these studies established the occurrence of komokiaceans in the Weddell Sea and adjacent areas, there has been no detailed treatment of this group in Antarctic waters. This is not surprising, given the fact that the deep-water benthos around Antarctica remained relatively unknown until recently (Brandt *et al*., 2007). The ANDEEP project was the one of the first to undertake a concerted study of benthic organisms in this remote region (Brandt *et al*., 2004). The first and second ANDEEP cruises took place in 2001 (*Polarstern* Cruise ANT XIX/3-4) and the third campaign in 2003 (*Polarstern* Cruise ANT XXII/3). During the ANDEEP III cruise, numerous komokiaceans were picked out from the fresh sieved residues of samples collected with a box corer, multiple corer, epibenthic sledge and Agassiz trawl. These collections form the basis of the present study. We concentrate on selected genera, mainly within the family Komokiidae. Most are ‘bushy’ morphotypes consisting of tubules radiating from a central region. Our aim is to (1) redescribe and provide new records of several important but poorly defined species and (2) establish three new species and one new genus. In order to confirm the identity of komokiacean species first described by Tendal & Hessler (1977), we have examined and re-illustrated holotypes housed in the Zoological Museum, Copenhagen.

## MATERIAL AND METHODS

### Sampling

Most of the material was collected using either an epibenthic sledge or an Agassiz trawl (Table 1). The epibenthic sledge was equipped with two nets, a lower epibenthic net (500-μm mesh size) and an upper suprabenthic net (300-μm mesh size), each 1 m in width (Brandt & Barthel, 1995). The 3-m-wide Agassiz trawl had a cod end mesh size of 500 μm, except at Stations 74#7, 78#11 and 81#9 where a 10-mm mesh size was used. Both gears were trawled for 10 min across the seafloor with a mean velocity of 1 knot. The epibenthic sledge usually yielded a fairly clean catch whereas the trawl often recovered large quantities of mud. In both cases, small subsamples of the catches were removed as soon as possible after recovery and carefully transferred to a 1-mm sieve submerged in seawater. All subsequent sieving was done using sieves of mesh sizes 500, 300, 125 and 64 μm always submerged in chilled seawater (1–2 °C) in a cool room. Because of the fragility of the organisms, agitation of the sieves was always gentle and fairly slow. The samples to be picked were placed in a Petri or similar dish that in turn was placed in an outer dish with ice in order to keep it cold during sorting. All Foraminifera were picked from the samples with a pair of flexible forceps (‘entomological forceps’), a brush, or a fine pipette under a stereomicroscope (Wild M5 or Leica MZ6). Larger samples of sediment (5–10 L) from the Agassiz trawl were treated in a slightly less careful way in order to find large, rare forms. The sediment was put in a bucket and a saltwater hose was inserted. The water was allowed to flow over the edge and was collected in a series of sieves (2-, 1-, 0.5-mm mesh size). The residue was then treated as described above.

Additional komokiacean material was obtained from core samples (Table 1). In each case, the upper 1 cm of sediment collected using a multiple corer equipped with 57-mm internal diameter tubes or

**Table 1.** Station positions and other data. AT = Agassiz trawl; EPS = epibenthic sledge; GKG = box corer; MUC = multiple corer. Sediment types from Howe (2006)

| Station and deployment | Position °S | °E | Depth (m) | Gear | Sediment |
|---|---|---|---|---|---|
| Cape Basin | | | | | |
| 16#5 | 41°07.51′ | 9°56.30′ | 4723 | GKG | diatomaceous |
| 16#8 | 41°07.93′ | 9°55.95′ | 4722 | MUC | clay |
| 16#11 | 41°07.42′ | 9°54.92′ | 4694–4730 | AT | |
| Anguilas Basin | | | | | |
| 21#5 | 47°39.37′ | 4°15.65′ | 4566 | GKG | Sandy diatom-rich mud |
| East Weddell Sea off Neumayer Station | | | | | |
| 57#2 | 69°24.50′ | 5°19.37′ | 1812–1822 | AT | No data |
| East Weddell Sea Abyssal Plain, south of Maud Rise | | | | | |
| 59#5 | 67°31.00′ | 0°00.11′ | 4651–4656 | EBS | Stiff coherent sand with |
| 59#7 | 67°30.98′ | 0°00.12′ | 4649 | MUC | abundant mud clasts |
| 59#9 | 67°31.02′ | 0°00.21′ | 4649 | MUC | |
| 59#11 | 67°30.96′ | 0°00.02′ | 4653 | MUC | |
| Kapp Norvegica continental slope transect | | | | | |
| 78#9 | 71°56.0′ | 14°01.06 | 2147–2185 | EBS | Sandy mud |
| 80#5 | 70°39.40′ | 14°43.47′ | 3086 | GKG | |
| 80#9 | 70°39.23′ | 14°43.59′ | 3102–3136 | EBS | |
| 81#7 | 70°31.49′ | 14°34.89′ | 4408 | GKG | Sandy mud, |
| 81#8 | 70°30.85′ | 14°34.98′ | 4384–4420 | EBS | abundant Mn- |
| 81#9 | 70°31.49′ | 14°34.89′ | 4526 | GKG | coated clasts |
| Weddell Abyssal Plain transect | | | | | |
| 88#4 | 68°03.64′ | 20°27.84′ | 4932 | MUC | |
| 88#5 | 68°03.62′ | 20°27.87′ | 4932 | GKG | |
| 88#7 | 68°03.61′ | 20°27.99′ | 4934 | GKG | |
| 88#8 | 68°03.87′ | 20°31.81′ | 4927–4932 | EBS | |
| 88#9 | 68°03.64′ | 20°27.72′ | 4935 | MUC | |
| 94#5 | 66°37.42′ | 27°09.73′ | 4894 | MUC | |
| 94#7 | 66°37.41′ | 27°09.73′ | 4889 | MUC | Greyish brown mud |
| 94#11 | 66°36.08′ | 27°18.02′ | 4894–4895 | AT | with Mn-coated clasts |
| 94#14 | 66°39.32′ | 27°09.08′ | 4889–4893 | EBS | |
| 102#8 | 65°34.42′ | 36°31.31′ | 4803 | GKG | |
| 102#10 | 65°34.37′ | 36°31.22′ | 4801 | GKG | |
| 102#11 | 65°31.29′ | 36°36.40′ | 4794–4805 | AT | |
| 102#13 | 65°33.16′ | 36°33.32′ | 4803–4818 | EBS | |
| 110#6 | 64°59.98′ | 43°02.00′ | 4700 | MUC | |
| 110#8 | 64°58.95′ | 43°01.97′ | 4696–4698 | EBS | |
| Peninsula slope | | | | | |
| 121#7 | 63°37.43′ | 50°45.11′ | 2616–2620 | AT | Olive grey mud with burrows and phytodetritus |
| 133#2 | 64°58.95′ | 53°01.72′ | 1579–1584 | EBS | No data |
| Powell Basin | | | | | |
| 142#5 | 62°11.65′ | 49°27.68′ | 3404–3408 | EBS | Olive grey mud, vigorous |
| 142#7 | 62°11.08′ | 49°29.68′ | 3406 | GKG | current activity |

square subcores (10 × 10 cm) from a subdivided box corer was sieved as described above on 300- and 125-μm meshes and sorted for Foraminifera.

Picked specimens were treated in various ways. Some were frozen in liquid nitrogen or fixed in guanidine buffer for molecular analyses and a few were fixed in glutaraldehyde for ultrastructural work. The remainder were fixed in 10% formalin buffered with borax for morphological study. The present paper is based on this formalin-fixed material.

### LABORATORY METHODS

Komokiaceans were examined in the laboratory using a Leica binocular microscope. In order to study finer structures, for example septa and wall agglutination, selected specimens were mounted in a drop of glycerol in a glass cavity slide and viewed under an Olympus BH2 compound microscope equipped with Nomarski interference contrast optics. Photographs were taken using a Nikon CoolPix 4500 or Canon 350D SLR digital camera attached to a Leica binocular microscope or the Olympus BH-2 photomicroscope.

## SYSTEMATICS

We follow the higher level classification of eukaryotes proposed by Adl *et al*. (2005), which recognizes a series of supergroups within the Protista. Below this level, the new classification avoids assigning formal rank designations to groups such as the Foraminifera. However, we continue to refer to the superfamily Komokiacea, as this is a distinctive group currently placed within the Foraminifera, and to recognize the komokiacean families proposed by Tendal & Hessler (1977).

PROTISTA
SUPERGROUP RHIZARIA CAVELIER-SMITH, 2002
FORAMINIFERA D'ORBIGNY, 1826
SUPERFAMILY KOMOKIACEA TENDAL & HESSLER, 1977
FAMILY KOMOKIIDAE TENDAL & HESSLER, 1977
GENUS *KOMOKIA* TENDAL & HESSLER, 1977

*Type species: Komokia multiramosa* Tendal & Hessler, 1977

### *KOMOKIA MULTIRAMOSA* TENDAL & HESSLER, 1977 (FIGS 1, 2)

*Komokia multiramosa* Tendal & Hessler, 1977, p. 179, pl. 9, fig. A–B; pl. 11, fig. A–B; pl. 19, fig. F

*Komokia multiramosa* Tendal & Hessler, 1977. Gooday, 1990, p. 276, pl. 1, fig. A

*Diagnosis*: Test bush-like, consisting of tubules of essentially even diameter, radiating from central region. Length:width ratio of tubules typically 15–20. Tubules non-septate, somewhat crooked and rather stiff, branching dichotomously and with increasing frequency towards periphery. (Modified after Tendal & Hessler, 1977.)

*Holotype*: *Argo* H-30, central North Pacific, epibenthic sledge sample: 30°05′N, 156°12′W; 6065–6079 m water depth. Zoological Museum, Copenhagen; preserved in alcohol.

*ANDEEP material*: Stn 88#5, 1 specimen and 2 fragments; Stn 88#8, 6 specimens and 4 fragments; Stn 88#9, 1 specimen; Stn 94#11, 1 specimen; Stn 102#13, 2 specimens; Stn 110#6, 1 specimen.

*Description of holotype*

The holotype consists of one main piece (1.4 × 1.22 × 0.90 mm) and two fragments. The tubules radiate from near the base of the main piece, but the radiation is rather obscured by the crookedness and frequent branching of the tubules (Fig. 1A). The radial arrangement is more evident in the larger of the two fragments (Fig. 1B). The tubules are rather stiff and appear fairly brittle. They are typically ~50 μm in

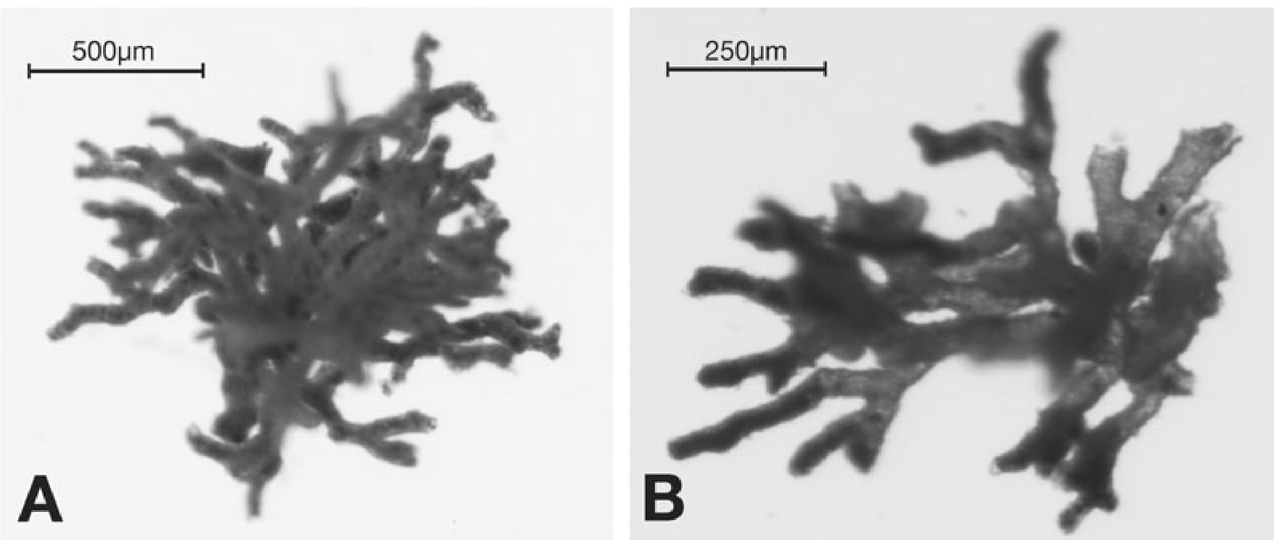


**Figure 1.** *Komokia multiramosa* Tendal & Hessler, 1977, holotype, Zoological Museum, Copenhagen. A, main piece; B, fragment.

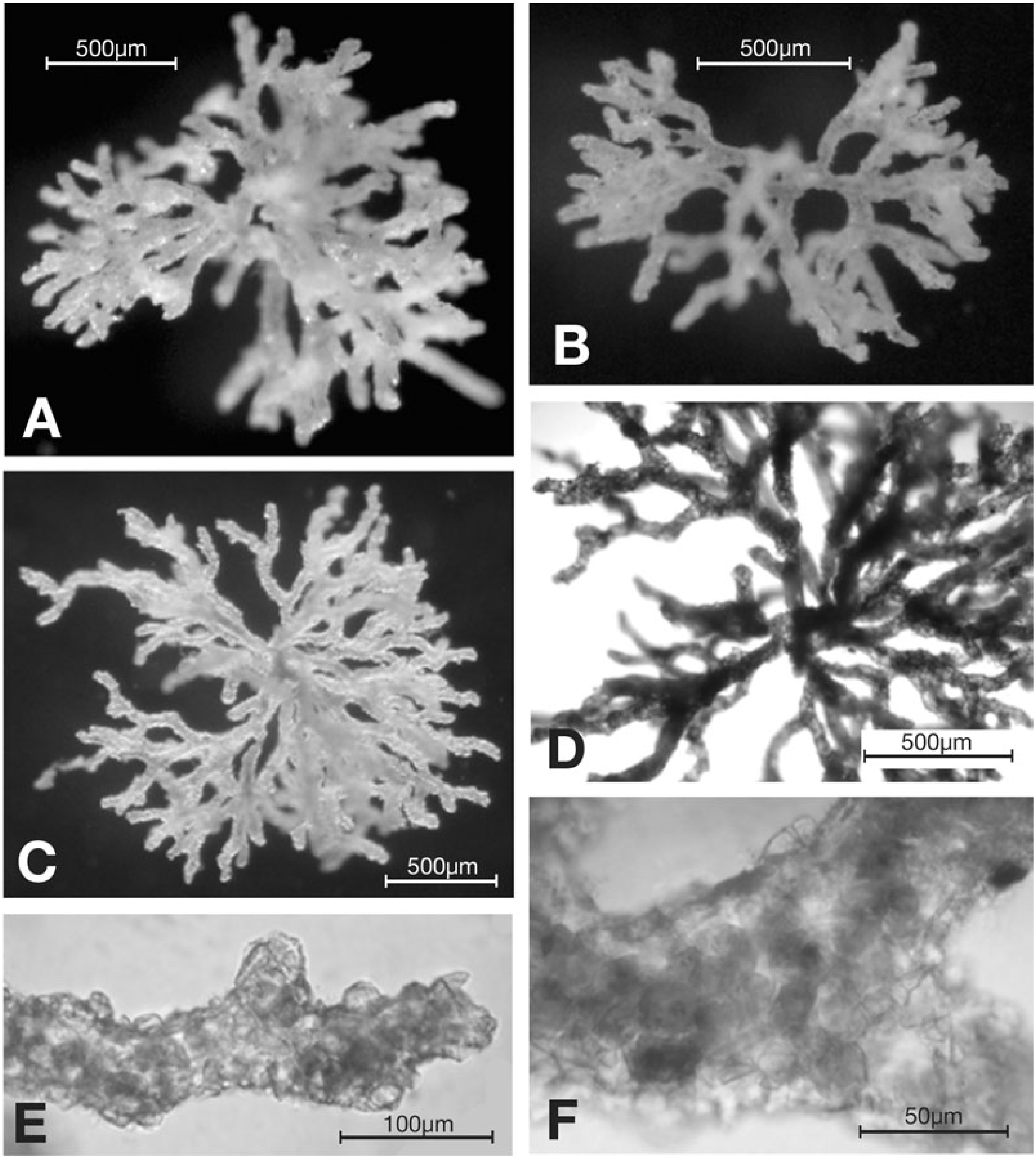


**Figure 2.** *Komokia multiramosa* Tendal & Hessler, 1977. A, B, Stn 88#5, two complete specimens; C–F, Stn 94#11; C, complete specimen; D, central part of test; E, detail of tubule; F, stercomata within tubule.

diameter, but 60–65 μm near the base, narrowing slightly to around 40 μm in the outer branches. The test wall is fine grained with only a few larger quartz grains and the interior filled with dark stercomata.

*Description of ANDEEP material*
Twelve specimens from different stations range from 1.2 to 2.1 mm in diameter. Apparently intact specimens measure 2.1 × 1.2 mm (Stn 88#5), 1.8 × 1.6 mm (Stn 88#8), 2.1 × 2.1 mm (Stn 94#11), 1.4 × 1.4 mm

and 1.6 × 1.2 mm (Stn 102#13). They have a bushy morphology, consisting of a number (10–15 in complete specimens) of main tubules that radiate outwards in all directions from the central region (Fig. 2A–D). The tubules are relatively stiff and branch dichotomously or sometimes trichotomously, 2–4 times; short, lateral processes (incipient branches) are sometimes developed (Fig. 2E). The branching interval tends to decrease towards the periphery. Between branches, the tubules follow a more or less straight or rather crooked course. They are non-septate, typically around 50–80 μm in diameter, reducing to 40–50 μm near the tips, and extend for a maximum distance of ~1 mm from the centre of organization of the test. The length/width ratio of the tubules is generally in the range 15–20.

All specimens agglutinate small grains of transparent quartz that glint in the light, giving the tests a sparkly, crystalline appearance under a low-power microscope. There is a scattering of black mineral grains of a similar size. Most grains are 6–25 μm in size and range in shape from rounded to angular. A few larger grains (> 40 μm, sometimes > 100 μm) also occur and some of these are dark. The test is full of stercomata that are spread more or less evenly throughout the interior and are easily visible through the test wall following immersion in glycerol (Fig. 2F). They are oval in shape and most are 13–22 μm in length.

*Remarks*

Our specimens generally resemble Tendal & Hessler's (1977) description as well as the type specimen. The radial arrangement of the tubules is more evident in the ANDEEP specimens than in the holotype and some of the ANDEEP specimens have longer branches. Also, the ANDEEP specimens agglutinate quartz grains that glint in reflected light and give the test a granular appearance when viewed under a compound microscope, whereas the holotype incorporates very few larger grains into the test wall. In other respects, notably the branching pattern, the crooked, stiff tubules and the tubule diameters, the ANDEEP specimens agree well with the holotype and the original description.

*Distribution*

First described from the Central North Pacific Ocean (6065–6079 m water depth) and subsequently from 6059 m on the Madeira Abyssal Plain (Gooday, 1990). In ANDEEP material, it occurs in the eastern Weddell Sea (4649–4656 m), the continental rise off Kapp Norvegica (4526 m) and the central Weddell Sea (4700–4935 m).

### GENUS *SEPTUMA* TENDAL & HESSLER, 1977

*Type species*: *Septuma ocotillo* Tendal & Hessler, 1977

### *SEPTUMA OCOTILLO* TENDAL & HESSLER, 1977 (FIGS 3, 4)

*Septuma ocotillo* Tendal & Hessler, 1977, p. 180, text-fig. 4; pl. 9, fig. C; pl. 10, fig. A–B; pl. 12, fig. A–B; pl. 19, fig. A; pl. 20, fig. A–F; pl. 21, fig. A–D

*Septuma ocotilla* Tendal & Hessler. Schröder, Medioli & Scott, 1989, pp. 33–34; pl. 2, fig. 5; pl. 8, fig. 1; text-fig. 12

*Septuma ocotillo* Tendal & Hessler. Kamenskaya, 1993, p. 78, fig. 2

*Septuma ocotillo* Tendal & Hessler. Kamenskaya, 1996, p. 220

*Diagnosis*: Test bush-like, consisting of tubules of essentially even diameter that usually radiate from central region; early stages involve narrow branches arising alternately from both sides of axial tubule. Length:width ratio of tubules very variable, but consistently > 10 and sometimes > 20. Tubules fairly flexible, branching more or less sparsely, dichotomously, divided internally by septa that are pierced by foramina. Single long, thin-walled, non-septate tubule sometimes developed. (Modified after Tendal & Hessler, 1977.)

*Holotype*: *Argo* H-30, central North Pacific, epibenthic sledge sample: 30°05′N, 156°12′W; 6065–6079 m water depth. Zoological Museum, Copenhagen; preserved in alcohol.

*ANDEEP material*: Stn 59#5, 3 specimens; Stn 59#7, 1 specimen; Stn 59#11, 9 specimens; Stn 81#9, 3 specimens; Stn 88#4+5 combined, 10 specimens; Stn 88#5, 1 specimen; Stn 88#7, 14 specimens; Stn 88#8, 156 specimens; Stn 88#9, 1 specimen; Stn 94#7, 1 specimen; Stn 94#11, 13 specimens; Stn 94#14, 21 specimens; Stn 102#8, 11 specimens; Stn 102#10, 6 specimens; Stn 102#13, 54 specimens; Stn 110#6, 2 specimens; Stn 110#8, 66 specimens.

*Description of holotype*

The holotype measures 2.40 mm in maximum dimension (2.90 mm including two rather longer tubules) and consists of numerous tubules of varying lengths, many of them gently curved (Fig. 3A, C). The longer tubules have a length/width ratio > 20, the shorter ones have a length/width ratio of < 20. They are generally 50–65 μm in diameter, decreasing to 35–50 μm near the thin-walled extremities, and branch 2–3 times. Branching is most common near the base of the tubules; the longer tubules have long, unbranched distal sections. Closely spaced septa are visible in some tubules, particularly towards their extremities (Fig. 3B). The tubules arise from a central area consisting of 3–4, short, wide branches, 85–125 μm in

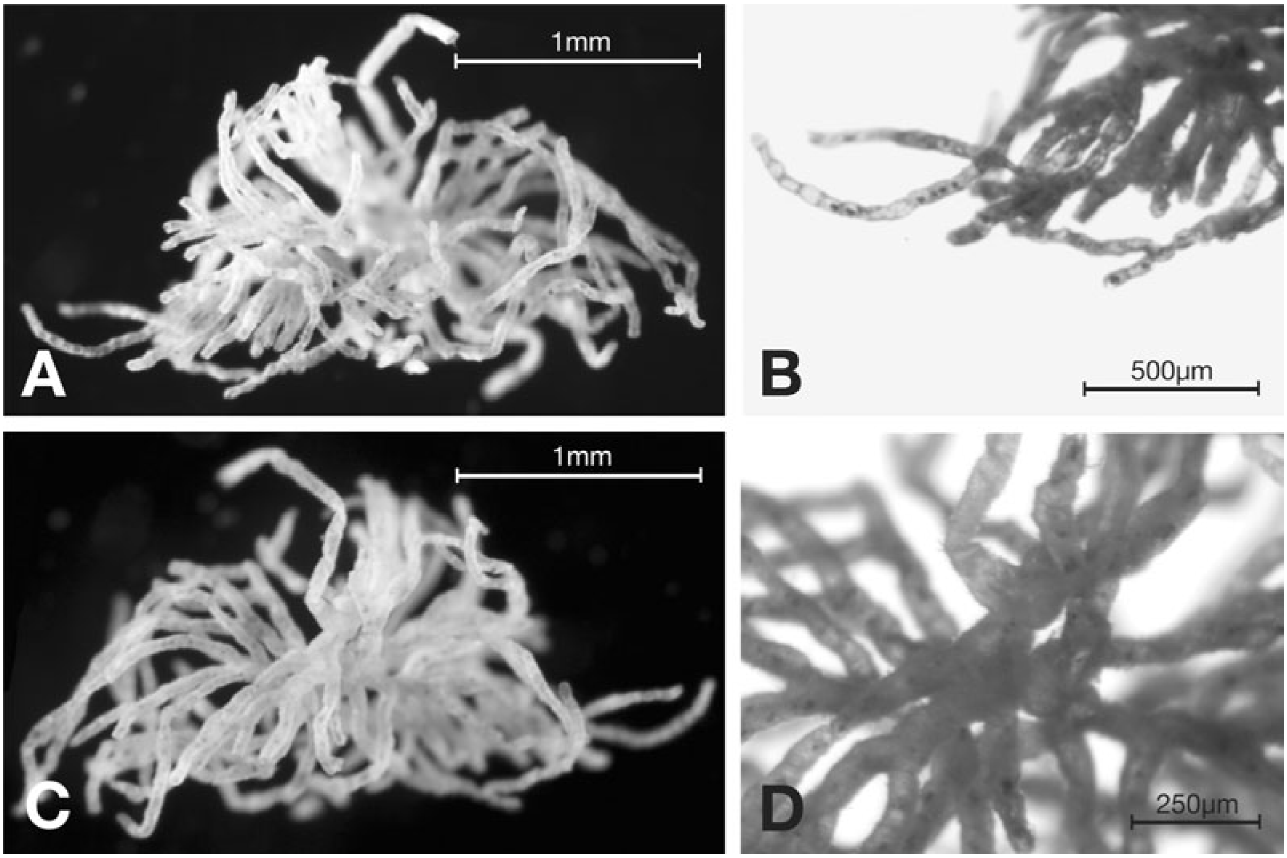


**Figure 3.** *Septuma ocotillo* Tendal & Hessler, 1977, holotype, Zoological Museum, Copenhagen. A, general view with focus on upper tubules; B, outer tubules with septa; C, general view with focus on central tubules; D, detail of wide central tubules.

width, which divide into a number of main branches, ~80 μm in width (Fig. 3D).

*Description of ANDEEP material*

Specimens that appear complete are rounded in overall shape and are slightly to strongly flattened. 'Bushy' specimens range from 1.7 to 3.1 mm (typically ~2.5 mm) long, 1.3–3.0 mm (typically 2.2 mm) wide and 1.0–2.4 mm (typically ~1.4 mm) thick. The largest spidery variants (see below) reach maximum dimensions of > 4 mm. The ANDEEP material reveals the following previously undescribed features.

1. Two general types of test can be distinguished (Fig. 4A). (i) Relatively compact, bushy tests composed of fairly broad (60–80 μm, up to 100 μm in the central part of the test) tubules with fairly thick, semi-opaque, finely agglutinated walls and length/width ratios generally < 15 (Fig. 4B). (ii) Rather untidy, 'spidery' tests consisting of tubules with long branching intervals and thinner, often semi-transparent walls. Centrally, the tubules may be fairly broad but they rapidly become narrower (30–50 μm) away from the centre. The length/width ratio of the tubules often exceeds 20. These two variants cannot be separated consistently. Both kinds of tubule are sometimes found within one specimen.
2. Part of the test is sometimes organized around a more or less linear tubule that gives rise to regularly spaced side tubules, arising alternately on either side of the test (Fig. 4D, E). The tubules are usually the thinner, semi-transparent type and may represent the earliest part of the test. Thicker tubules may be arranged in a similar manner in the central part of the test. Compact, bushy tests usually do not exhibit this feature.
3. A single, unbranched, thin-walled, non-septate tubule, usually longer than other tubules, arises from the central part of the test in some specimens (Fig. 4F). This tubule may also represent the initial part of the test.
4. The number of septa is quite variable, even within a single individual. They tend to be numerous and easily visible in the narrow, semi-transparent tubules (Fig. 4C) but sparsely developed in the wider, more opaque tubules.

 

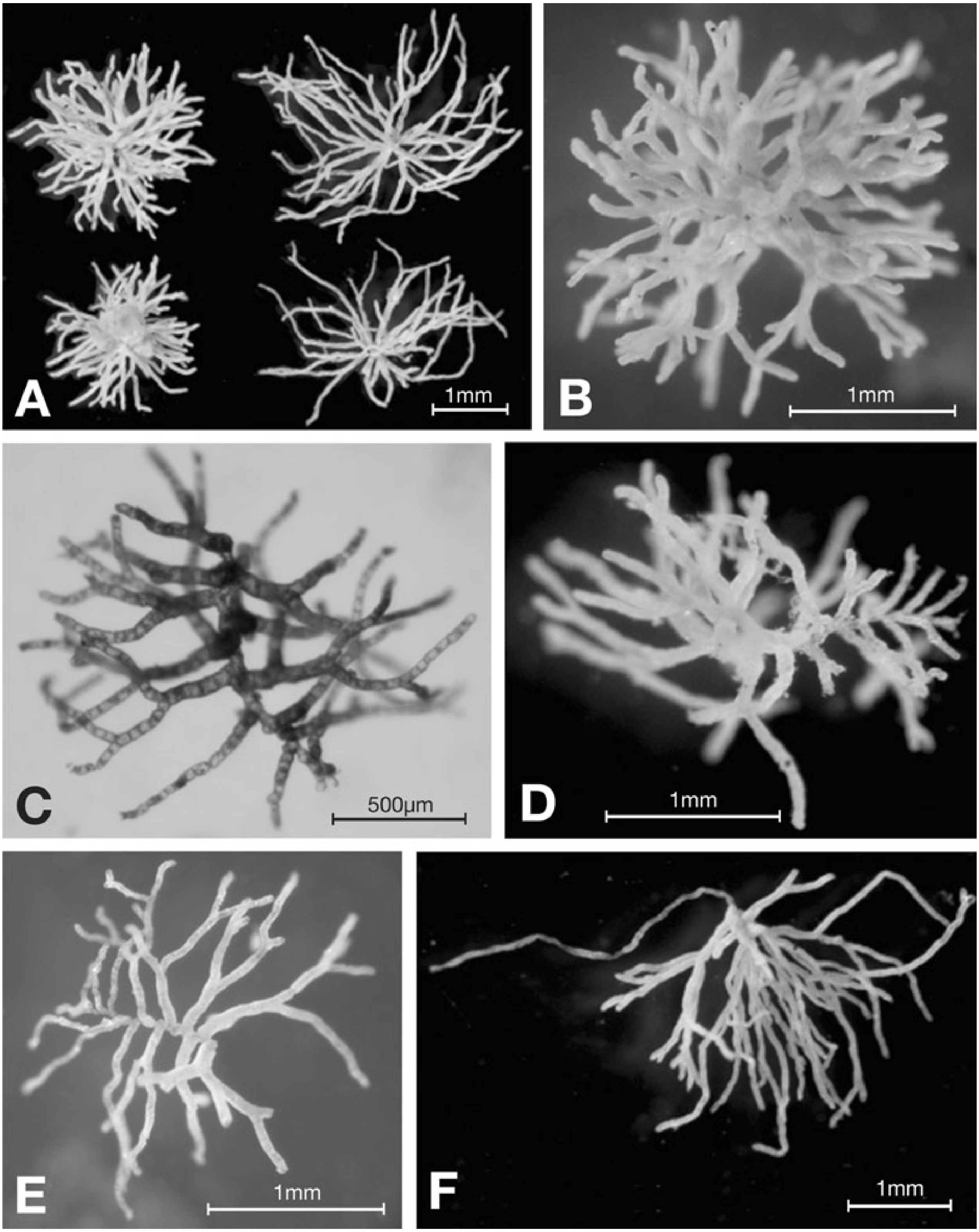


**Figure 4.** *Septuma ocotillo* Tendal & Hessler, 1977. A, Stn 88#8, two compact morphotypes and two 'spidery' morphotypes; B, Stn 88#8, compact morphotype; C, Stn 88#8, specimen viewed with transmitted light showing closely spaced septa; D, Stn 59#11, specimen with central tubule giving rise to lateral tubules. E, Stn 88#8, specimen with central tubule giving rise to lateral tubules. F, Stn 102#8, specimens with long, unbranched, non-septate tubule.

*Remarks*
This is one of the most common komokiaceans in ANDEEP samples. The holotype (possibly the specimen illustrated by Tendal & Hessler, 1977: p. 9, fig. C) is generally similar to the 'spidery' ANDEEP morphotype, although it has more branches than most specimens and the central tubules are distinctly thicker.

To some extent, the wide range of morphologies represented in the ANDEEP material of *Septuma ocotillo* is mirrored in published illustrations of this species. The 'spidery' morphotypes are similar to pl. 10 of Tendal & Hessler (1977) as well as Schröder *et al*. (1989: pl. 8, fig. 1). The 'bushy' morphotypes resemble the illustrations of Schröder *et al*. (1989: text-fig. 12) and Kamenskaya (1993: fig. 2). One of Tendal & Hessler's SEM photographs (1977, pl. 10, fig. B therein) appears to show the axial tubule with lateral branches observed in some of our specimens, although the view of this feature is not clear.

*Distribution*
First described from the abyssal Central North Pacific (Tendal & Hessler, 1977), subsequently from ~5770 m water depth on the Nares Abyssal Plain, north-west Atlantic (Schröder *et al*., 1989) and at two stations in the Cape Basin (2790 and 4912 m) (Kamenskaya, 1993). Its occurrence at the 'Komsomolets' wreck site in the Barent Sea (73°44′N, 13°16′E, 1700 m depth) provides the most northerly record (Kamenskaya, 1996). In our material, *S. ocotillo* is common in the eastern and central Weddell Sea (4526–4934 m).

### *Septuma brachyramosa* Kamenskaya, 1993
### (Fig. 5A–G)

*Septuma brachyramosa* Kamenskaya, 1993, p. 78, fig. 3
*Septuma* sp. Gooday, 1990, pl. 2, fig. B
*Septuma* sp. Gooday, 1994, fig. 1g

*Diagnosis*: Test fairly compact, bush-like, composed of relatively short tubules that branch dichotomously 2–3 times and have a length/width ratio of around 10. Septa thin but clearly developed. Long, non-septate tubule occasionally present.

*Material*: Stn 16#11, 1 specimen; Stn 57#2, 4 specimens; Stn 78#9, 4 specimens; Stn 80#9, 2 specimens; Stn 81#9, 3 specimens; Stn 121#7, 3 specimens and several fragments.

*Description*
The 17 specimens range in maximum dimension from 1.1 to 2.4 mm. The test is compact, bush-like and pale brown or tan in colour (Fig. 5A, B). The dark contents can only be seen faintly through the wall when specimens are examined in water. In a few cases, the inner region of the test is obscured by sediment (Fig. 5D). The test comprises relatively short, branched, more or less cylindrical tubules of generally even diameter (60–100 μm, typically 80 μm), sometimes narrowing slightly towards the tips and with rounded ends. Where the tubules are visible to their full extent, they typically branch dichotomously 2–3 times and have a length/width ratio of ~10. The tubules follow a relatively even course and are not crooked. Some specimens have a long, non-septate tubule that extends up to more than 2 mm from the main part of the test (Fig. 5F).

The test wall is composed of fine-grained material and has a fairly smooth surface except for scattered larger mineral grains (Fig. 5C, E, G). These are mainly clear quartz but also include black, green and brown particles, usually up to 70–80 μm, sometimes 150 μm (e.g. Stn 81#9) in size. Where these grains are more numerous (e.g. Stn 121#7), the branches have a rather knobbly appearance. Radiolarian and occasionally planktonic foraminiferan tests may also be incorporated into the walls of the tubules. One small individual is attached to a large *Cyclammina* test. The wall is typically 6–15 μm thick, sometimes thinning to 3–4 μm at the tips where the agglutinated layer is weakly developed or even absent (Fig. 5G). In specimens from Stn 81#9, however, the wall is distinctly thicker (13–25 μm) and there is no obvious thinning at the tips of branches. The tubule interiors are divided by very thin septa (Fig. 5C, E, G). These are usually fairly numerous but are more sparsely developed in specimens from Stn 121#7. The sections of the tubules between the septa are largely filled with numerous small, oval stercomata, 6.5–13 μm in maximum dimension.

*Remarks*
The single example in the ANDEEP collection of *Septuma brachyramosa* from the Cape Basin (Stn 16) is very similar to the type and other specimens of Kamenskaya (1993), which originated from the same area. However, a few specimens from the Weddell Sea (e.g. Stn 57) have a long, unbranched, non-septate tubule (pl. 5, fig. G), a feature not observed in the original material.

In our samples, *S. brachyramosa* is distinguished from *S. ocotillo* mainly by its more compact shape and the shorter, relatively wider tubules that have a length/width ratio of around 10. We have recently examined an extensive collection of *Septuma* material from the Porcupine Abyssal Plain (north-east Atlantic) in which *ocotillo*-like morphotypes and more

 

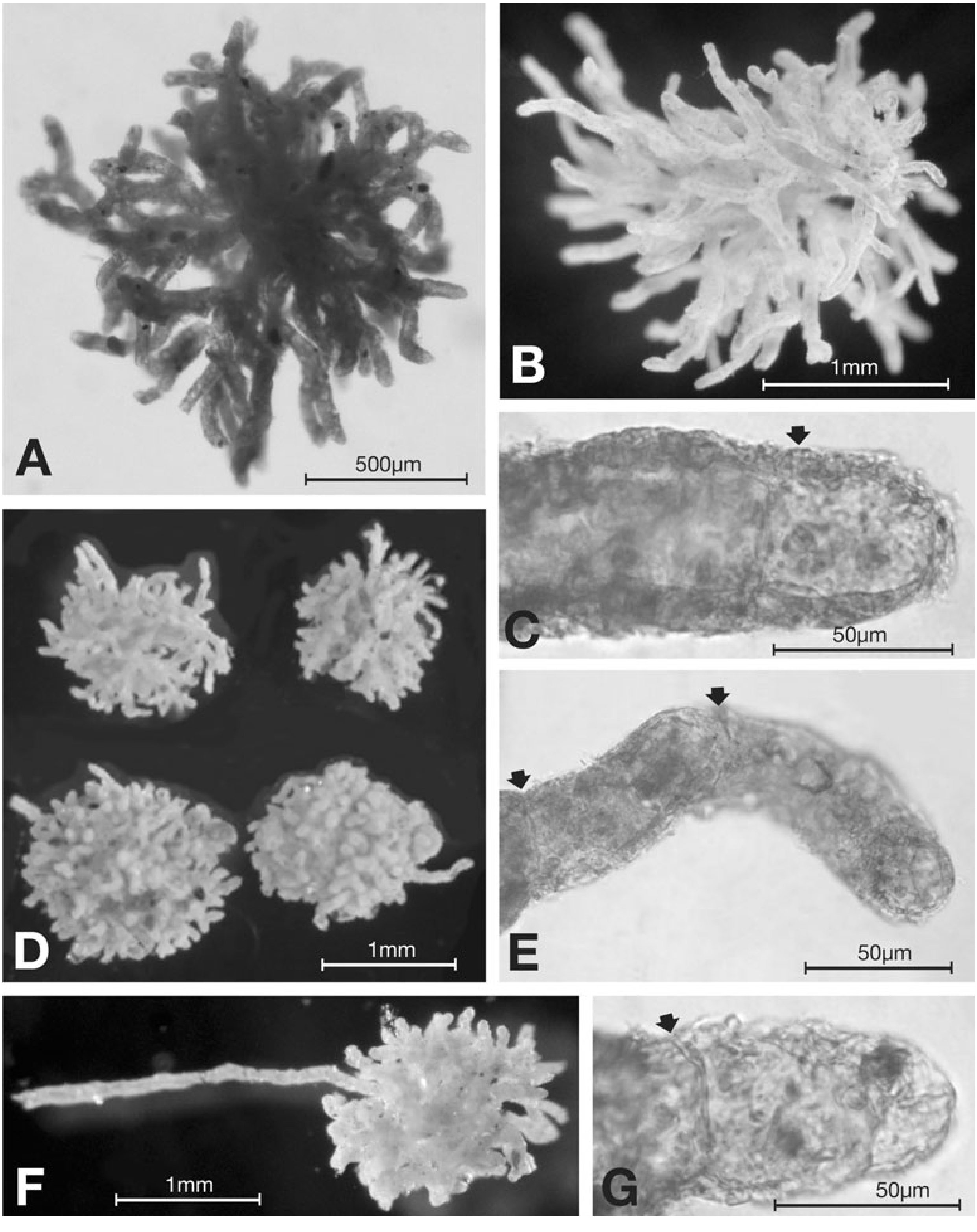


**Figure 5.** *Septuma brachyramosa* Kamenskaya, 1993. A, Stn 78#9, general view, transmitted light; B, Stn 16#11, general view, reflected light; C, same specimen, detail of tubule with septum (arrowed); D, Stn 78#9, upper two specimens without sediment between tubules, lower two specimens with sediment filling between tubules; E, Stn 78#9, detail of tubule with septa (arrowed); F, Stn 52#7, general view of specimen with long, non-septate tubule; G, same specimen, detail of tubule with septum (arrowed).

compact, *brachyramosa*-like morphotypes are linked by intermediate forms. We suspect therefore that these two types may represent a single, morphologically variable species. However, until this problem can be studied further, we prefer to treat them as separate species.

*Distribution*: First described from the Cape Basin (4910 m water depth) and also present in our material from Stn 16 in the same area (4694–4730 m). We report it for the first time from the eastern Weddell Sea, off Neumayer Base and Cap Norvegica (1812–4420 m), and the north-west Weddell Sea near the tip of the Antarctic Peninsula (2616–2620 m). There are additional records from the north-east Atlantic Porcupine Abyssal Plain (4841 m) (Gooday, 1994) and the Madeira Abyssal Plain (6059 m) (Gooday, 1990).

### *SEPTUMA KOMOKIFORMIS* KAMENSKAYA, 1993 (FIG. 6)

*Septuma komokiformis* Kamenskaya, 1993, pp. 78–79, fig. 4.



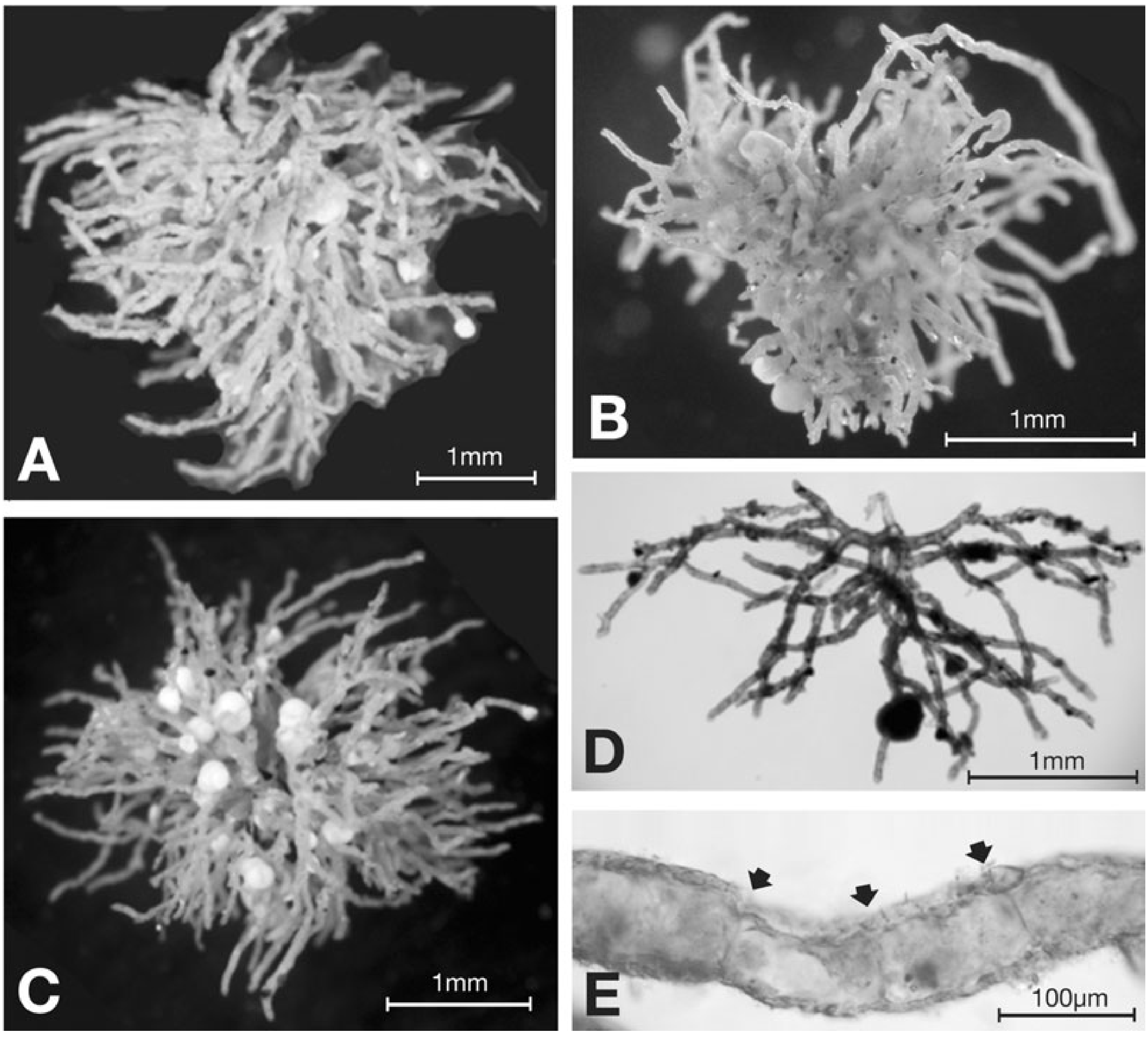


**Figure 6.** *Septuma komokiformis* Kamenskaya, 1993. Specimens from Stn 80#9, photographed in water. A–D, complete specimens; E, detail of tubule with septa (arrowed), photographed in glycerol.

*Diagnosis*: Test bush-like, composed of long, crooked, in some cases flattened tubules, branching 2–3, sometimes four times, usually dichotomously but sometimes trichotomously. Number of branches and degree of 'bushiness' vary. Many tubules terminate in fairly long, unbranched sections. Test may agglutinate scattered larger grains. Length:width ratio of tubules typically 15–20 but may exceed 20. Septa numerous.

*Material*: Stn 80#9, 24 specimens; Stn 80#5, 1 specimen; Stn 81#7, 1 specimen; Stn 81#8, 1 specimen; Stn 81#9, 2 specimens.

*Description*

The 29 specimens range in size from 1.6 to 3.8 mm. The test is bush-like (Fig. 6A–C), light greyish in colour, consisting of long crooked tubules which branch 2–3, sometimes four times, in most cases dichotomously but on occasions trichotomously. The width of the tubules tends to decrease from 80 μm near the base to 40–60 μm in the periphery; some narrower tubules have a more consistent diameter (50–60 μm) along their length.

The number of branches and the corresponding degree of 'bushiness' vary considerably. A specimen (2.4 × 1.6 mm) from Stn 81#8 has only seven main branches, which are crooked, especially in the distal part, up to 1.4 mm long, with length/width ratios of ~20–22. A bushier specimen (2.4 × 2.2 mm) from Stn 81#7 has more than 20 branches, about 1.2 mm long, with length/width ratios in the range 15–20. Three specimens from Stn 80#9 (2.4 × 2.2, 2.2 × 2.1, 1.8 × 2.6 mm) have 7–12 long, crooked branching tubules (Fig. 6D). Another 17 specimens from the same sample range in size from 3.8 × 3.2 to 2.0 × 1.8 mm. They are bushier with more than 30 closely spaced tubules in the largest individual (Fig. 6A–C). The tubules are long, crooked and sometimes flattened with length/width ratios of ~15–20; fairly long, unbranched sections are developed at the ends of many tubules.

The organic base of the tubule wall is overlain by a layer of fine agglutinated particles that create a smooth surface finish. The wall is well defined and rather even in width (6–10 μm) (Fig. 6E). Agglutinated particles may be largely absent near the tips of the branches, leaving the organic layer exposed. All specimens also incorporate scattered larger particles, mainly clear quartz and dark mineral grains. These vary widely from small particles ~40 μm in size to large grains up to several hundreds of micrometres in diameter. Specimens from Stn 80 are adorned with an attractive combination of white planktonic foraminiferan tests, dark mineral grains and clear quartz grains. The tubules are divided by numerous septa (Fig. 6E) and the chambers between the septa are filled with small (6–10 μm) stercomata.

*Remarks*

Specimens of *Septuma komokiformis* from the Weddell Sea, particularly those from Stn 80#9, are very close to the type material from the flanks of the Valdivia Seamount. They have similar overall dimensions, long, crooked, sometimes flattened branches, and incorporate large agglutinated particles. The crooked branches and unbranched distal parts of many tubules distinguish this species from *S. ocotillo* and *S. brachyramosa*.

*Distribution*

First described from the flanks of the Valdivia Seamount (1758 m) and also found in the Angola Basin (2370–4770 m) (Kamenskaya, 1993). Ours is the first report of this species from the Weddell Sea, where it occurs at depths of 3103–4526 m.

## *SEPTUMA STELLATA* SP. NOV.

(FIGS 7–9)

*Diagnosis*: Test compact, relatively small (up to 1.6 mm in diameter), consisting of tubules radiating out from central region that is usually obscured by sediment. Most tubules fairly stiff, branching dichotomously, somewhat irregular in width (30–50 μm), crooked and often with bead- or knob-like lateral swellings and protuberances, sometimes extending into short side branches. Length : width ratio of tubules typically 10–15. Septa fairly numerous. Few narrower, more or less straight, parallel-sided tubules, devoid of septa, extend for variable distance beyond the main tubules.

*Type material and locality*: The holotype and three paratypes were collected from Stn 94#11 using an Agassiz Trawl; 66°38.05′S, 27°5.90′W to 66°38.10′S, 27°5.46′W; 4894–4995 m water depth. They are preserved in 4% buffered formalin and deposited in the ForschungsInstitut Senckenberg, Frankfurt am Main, under reg. nos. SMF XXVII 7529 (holotype) and SMF XXVII 7530 (three paratypes).

*Other material examined*. Stn 88#4+5 (combined), 6 specimens; Stn 88#7, 1 specimen; Stn 88#8, 6 specimens; Stn 102#13, 4 specimens; Stn 110#8, 5 specimens; 121#7, 2 specimens; 142#5, 2 specimens; Stn 142#7, 1 specimen.

*Derivation of name*: Latin *stella* = star; alluding to the star-like, radiating arrangement of the test branches.

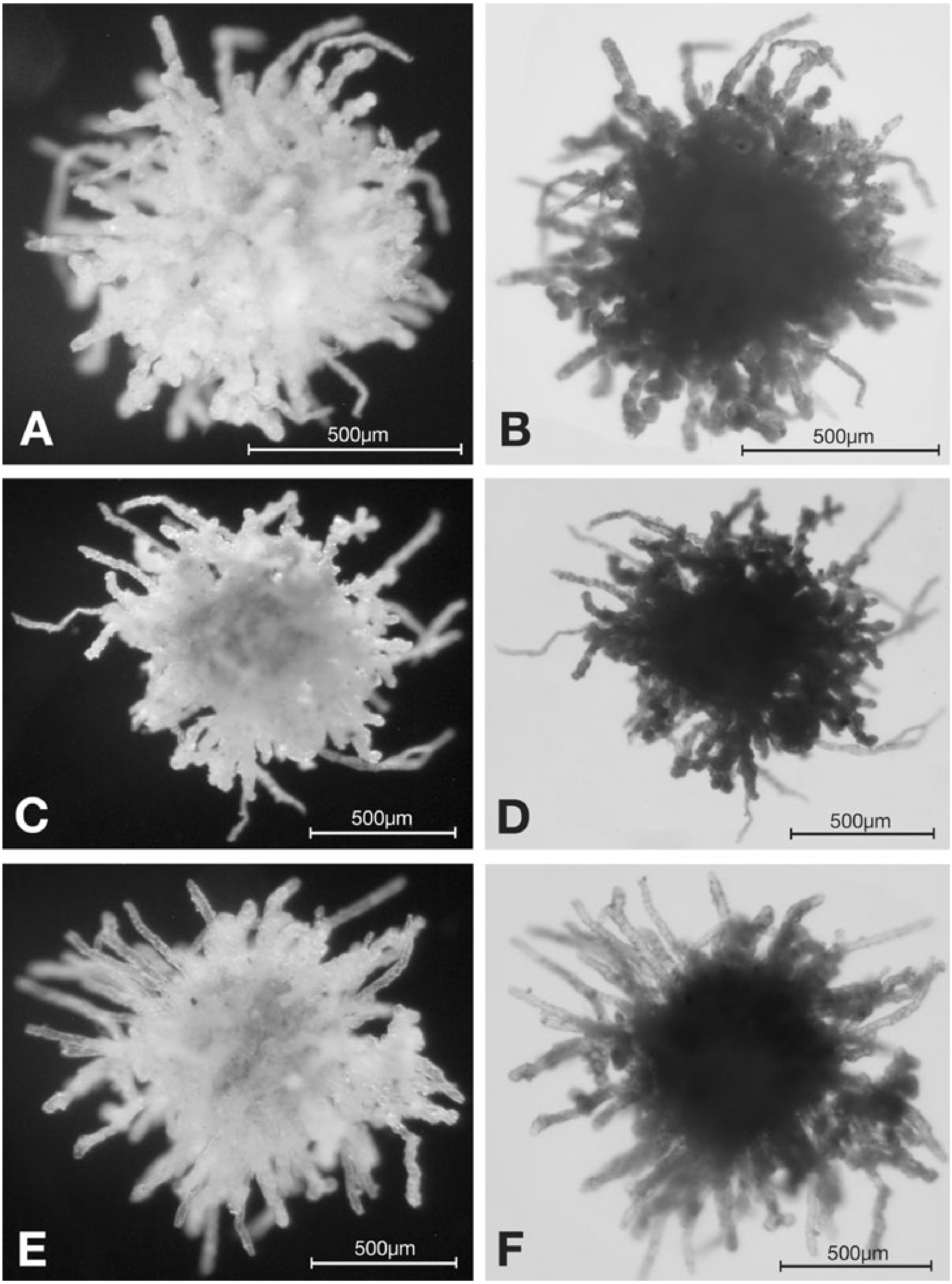


**Figure 7.** ***Septuma stellata* sp. nov.**, type specimens from Stn 94#11, photographed in water. A, holotype, reg. no. SMF XXVII 7529, reflected light; B, same specimen, transmitted light; C, paratype, reflected light; D, same specimen, transmitted light; E, second paratype, reflected light; F, same specimen, transmitted light. Both paratypes are registered under SMF XXVII 7530.

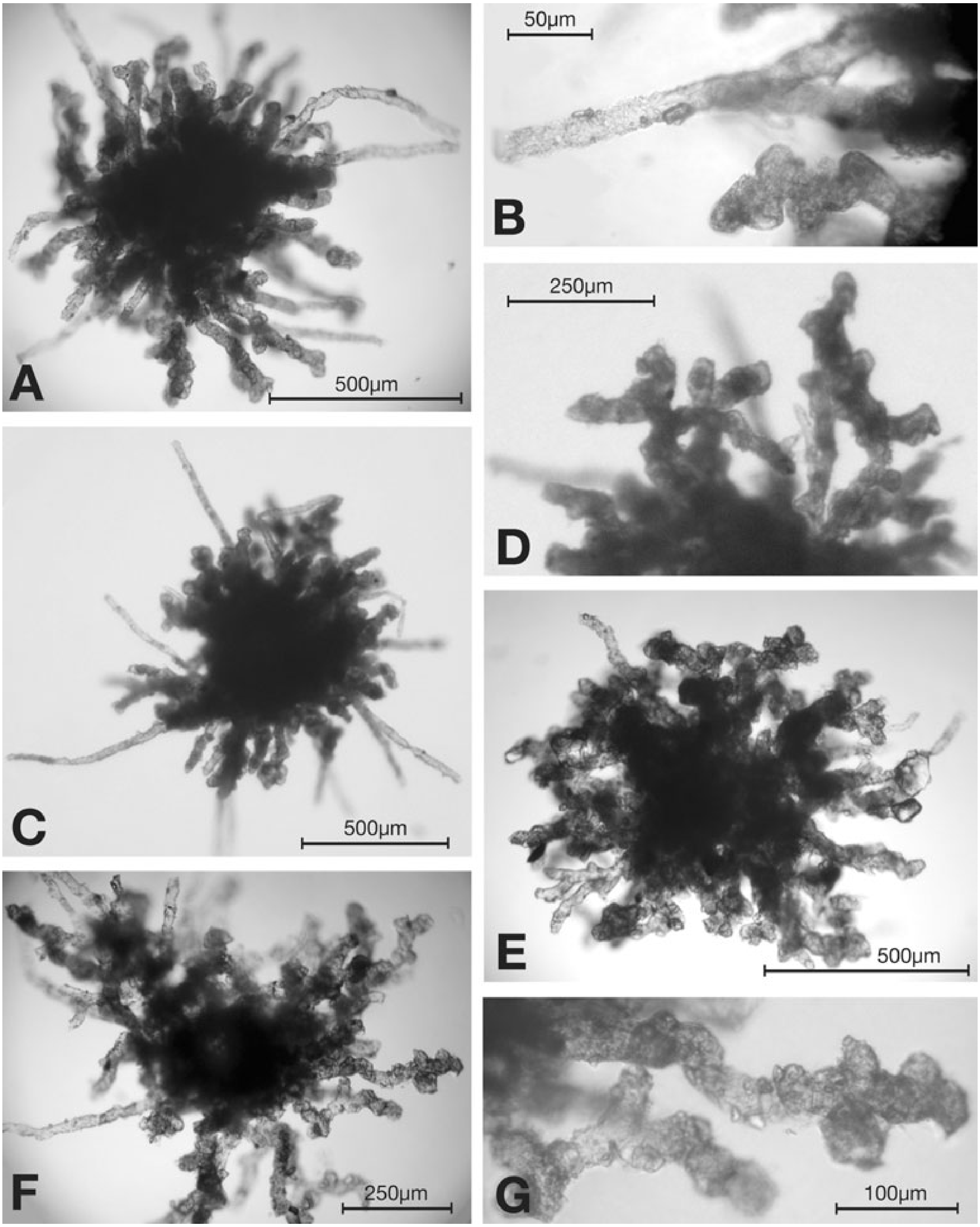


**Figure 8.** ***Septuma stellata*** **sp. nov.** Specimens photographed in glycerol, transmitted light. A, Stn 102#13, general view; B, detail of longer, straight, non-septate tubule and adjacent crooked tubule; C, Stn 94#11, paratype, general view; D, detail showing crooked tubules; E, Stn 102#13, general view of specimen which lacks long tubules; F, Stn 88#8, general view of specimen with relatively long crooked tubules; G, same specimen, detail of crooked tubule with lateral swellings. Paratype registered under SMF XXVII 7530.

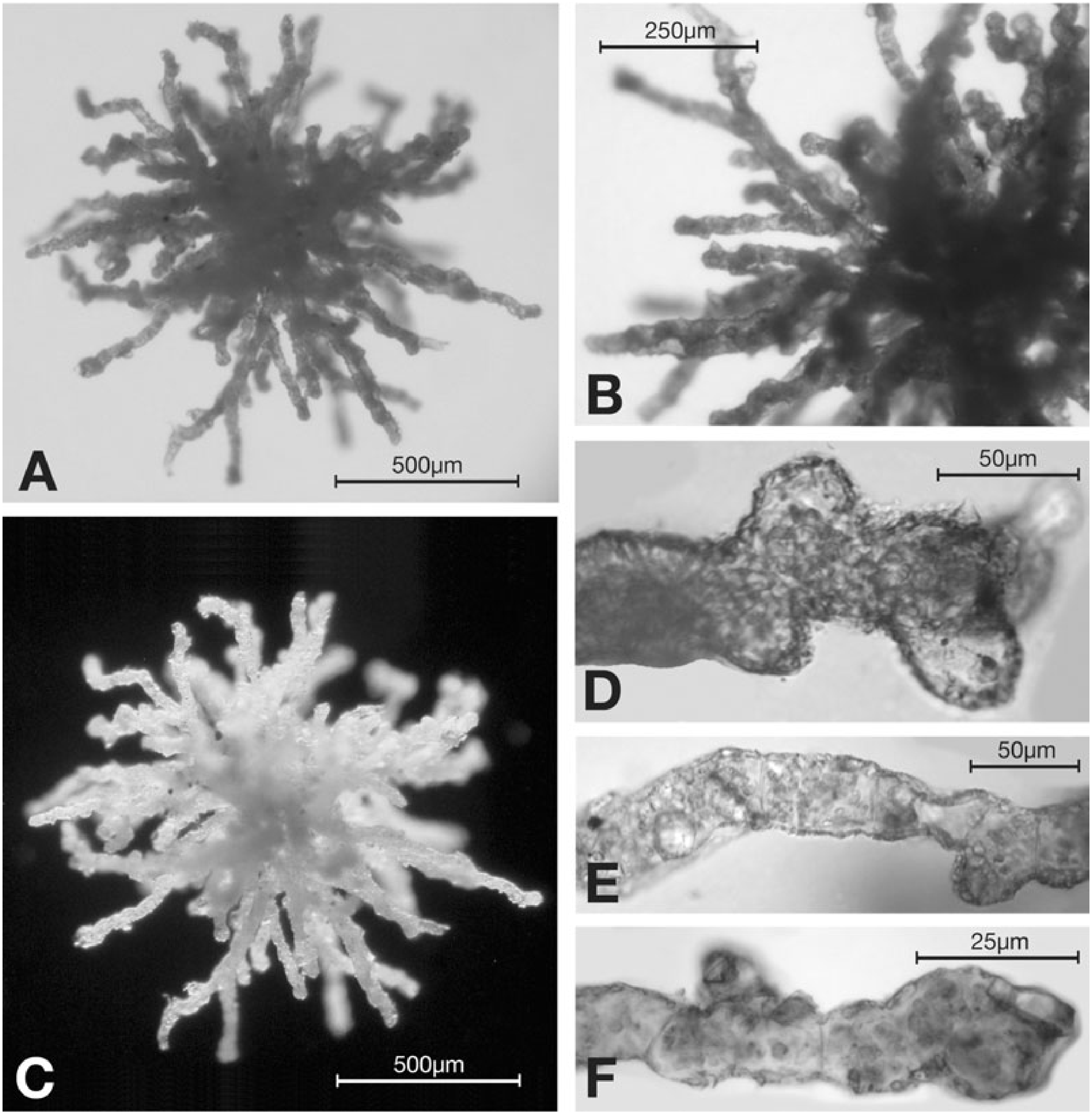


**Figure 9.** ***Septuma stellata*** **sp. nov.**, specimen from Stn 88#8 photographed in glycerol. A, general view, transmitted light; B, detail showing crooked tubules; C, dark-field illumination; D, detail showing end of tubule with lateral swellings; E, F, details of tubules with septa.



*Description of type specimens.*

The holotype and three paratypes are generally similar (Figs 7, 8C). The test is 1.10–1.60 mm in diameter (0.76–1.55 mm discounting the occasional longer tubules) and occupies a more or less spherical or somewhat flattened space. It consists of fairly stiff tubules that radiate outwards. The inner region from which the tubules arise is usually obscured by a dense mass of sediment. Occasionally, the sediment is lacking and the tubules are seen to originate from the core of densely packed tubules in which it is difficult to discern the branching pattern.

There are usually two kinds of tubules (Fig. 8C). The majority are relatively short, more or less crooked and somewhat irregular in width (30–50 μm). Because the centre of the test is usually obscured, the length/

 

width ratio of the tubules is difficult to estimate, but assuming that they originate in the central region, it is typically 8–15. The tubules usually give rise to bead- or knob-like lateral swellings and protuberances, sometimes extending into short side branches (Fig. 8D). They branch dichotomously, occasionally trichotomously. The walls are 3–5 μm thick and consist of an organic layer overlain by a layer of small mineral grains. Scattered across the surface of the wall are some much larger mineral grains, several hundreds of micrometres in size, usually quartz but also some dark grains. A minority of tubules are narrower, more or less straight, parallel sided and tapering from 30–35 μm to 15–18 μm in width at their distal ends. Some of these narrower tubules can be traced into the inner part of the test but most of them develop as extensions of the main tubules. They often extend out for a variable distance beyond the main tubules; the longer ones have a length/width ratio of 15–20. The wall is thinner (1–2 μm thick) than that of the main tubules and predominantly organic with few agglutinated particles.

The crooked, wider tubules have obvious transverse septa, < 1 μm wide and generally spaced 15–35 μm apart. The interior of these tubules is partly filled with small, oval stercomata, 6–10 μm in diameter. The longer, narrower tubules are devoid of septa and typically empty.

*Other ANDEEP material*

Specimens from other samples are generally similar to the types (Figs 8A, B, F, G, 9). Diameters range from 0.86 to 1.23 mm without the longer tubules and up to 1.60 mm including them. The longer tubules are well developed in some specimens (Stns 94#11, 102#13, 142#5) but are not always present. The core region of the test is usually, but not always, obscured by sediment. In one specimen from Stn 110, the wall of the tubules is overlain by a layer of flocculent material, resulting in a fuzzy appearance.

*Remarks*

We place this distinctive species in *Septuma* based on the presence of radiating tubules with clearly developed septa. It is distinguished from other *Septuma* species by the relatively small size of the test, the development in most specimens of a sediment core that obscures the central region of the test, and the presence in many specimens of parallel-sided, non-septate extensions to some tubules. Longer, non-septate tubules are sometimes found in *S. brachyramosa* and *S. ocotillo* but individuals of these species never have more than one such tubule. Unlike other *Septuma* species in which the tubules are approximately parallel-sided, the main tubules in *S. stellata* give rise to lateral swellings that impart a rather crooked, knobbly appearance.

*Distribution*: This new species is most common on the Weddell Abyssal Plain (4696–4934 m). A few specimens occur at shallower depths off the north-west peninsula slope (2603 m) and in the Powell Basin (3406 m).

## GENUS *IPOA* TENDAL & HESSLER, 1977

*Type species*: *Ipoa fragila* Tendal & Hessler, 1977

## *IPOA FRAGILA* TENDAL & HESSLER, 1977 (FIGS 10, 11)

*Ipoa fragila* Tendal & Hessler, 1977, p. 181, pl. 9 fig. D, pl. 11, fig. C–D

*Ipoa fragilis* Tendal & Hessler. Schröder, Medioli & Scott, 1989, p. 24, 28; pl. 1, fig. 1–3; pl. 8, fig. 4; text-fig. 7

*Ipoa fragila* Tendal & Hessler. Kamenskaya, 1993, p. 79

*Diagnosis*: Test periphery contained within a rounded, often oval, slightly flattened envelope. Central tubule often discernible; irregular in width, and typically constricted where it gives rise to a relatively small number of primary branches. These main trunks radiate from central part and break up into burst of tightly spaced peripheral branches, giving them tree-like appearance. Diameter of tubules decreases markedly with each branching. Tubules non-septate. (Modified after Tendal & Hessler, 1977.)

*Holotype*: *Argo* H-30, central North Pacific, epibenthic sledge sample: 30°05′N, 156°12′W; 6065–6079 m water depth. Zoological Museum, Copenhagen; preserved in alcohol.

*ANDEEP material*: Stn 59#9, 1 small fragment; Stn 59#11, 2 fragments; Stn 88#5, 1 specimen; Stn 88#7, 1 specimen; Stn 88#8, 4 complete, 10 fragments; Stn 94#5, 1 specimen; Stn 94#11 4 larger ?complete, 18 fragments; Stn 94#14, 4 complete specimens, 2 fragments; Stn 102#10, 1 small piece; Stn 102#13, 1 specimen; Stn 110#8, 12 complete, 3 fragments.

*Description of holotype*

The holotype is light brownish in colour and consists of one large and numerous tiny fragments (Fig. 10). It is much less complete than shown in the photograph of Tendal & Hessler (1977: pl. 9, fig. D). The large piece measures 1.67 × 1.33 mm and consists mainly of the inner branches that are 120–140 μm in diameter. These main branches give rise to narrow tubules, end-

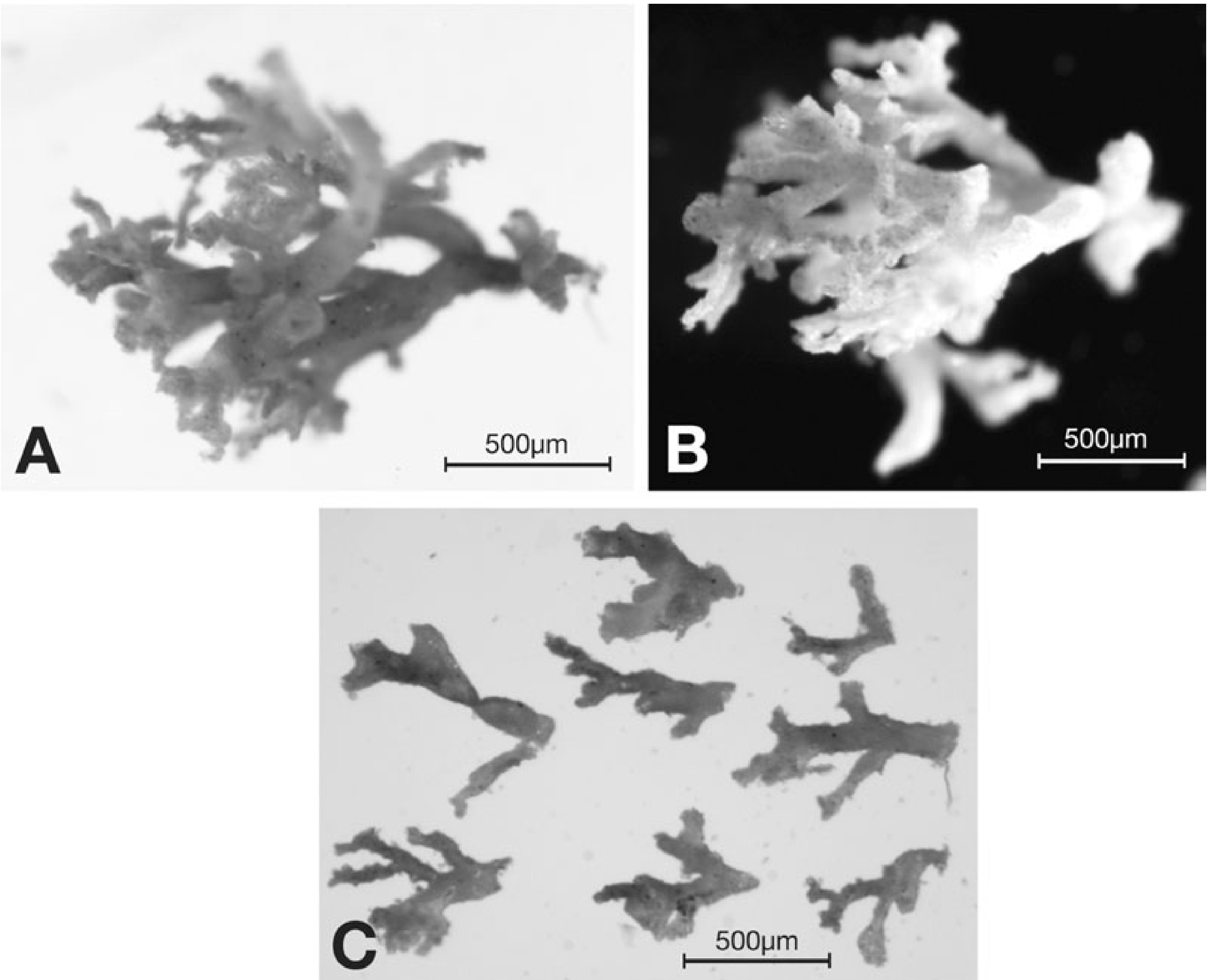


**Figure 10.** *Ipoa fragila* Tendal & Hessler, 1977. Holotype, Zoological Museum, Copenhagen. A, general view of main fragment, photographed using transmitted and reflected light; B, other side of same specimen, reflected light; C, smaller fragments.

ing in twig-like branches 40–50 μm in diameter. Many of the branches are broken.

*Description of ANDEEP material*

A number of specimens from Stns 88, 94 and 110 appear to be complete. They have a generally rounded, sometimes oval and usually more or less flattened shape (Fig. 11A–F). The largest is 3.1 mm long, 2.5 mm wide and 2.0 mm high. Other specimens that we judge to be more or less complete measure 1.7–2.5 mm long, 1.0–2.5 mm wide and 0.8–1.6 mm high. The central tubule is irregular in width (100–140 μm), and often constricted one or more times where it gives rise to the relatively small number of primary branches, typically ~80 μm in diameter. It is not always possible to distinguish clearly between the central and the primary tubules. In one complete specimen, the central tubule has a closed end, presumably the initial part. The broader inner tubules branch repeatedly into a profusion of narrow outer branches, 30–60 μm in diameter. The walls of the tubules are composed of fine-grained particles studded with small, often angular quartz grains (20–40 μm in diameter). Some specimens incorporate a few large mineral grains or planktonic foraminiferal tests.

*Remarks*

The ANDEEP material includes a larger number of complete individuals than were available to Tendal & Hessler (1977). In the largest holotype fragment, the inner primary branches are prominent and rather wider than in typical ANDEEP specimens.

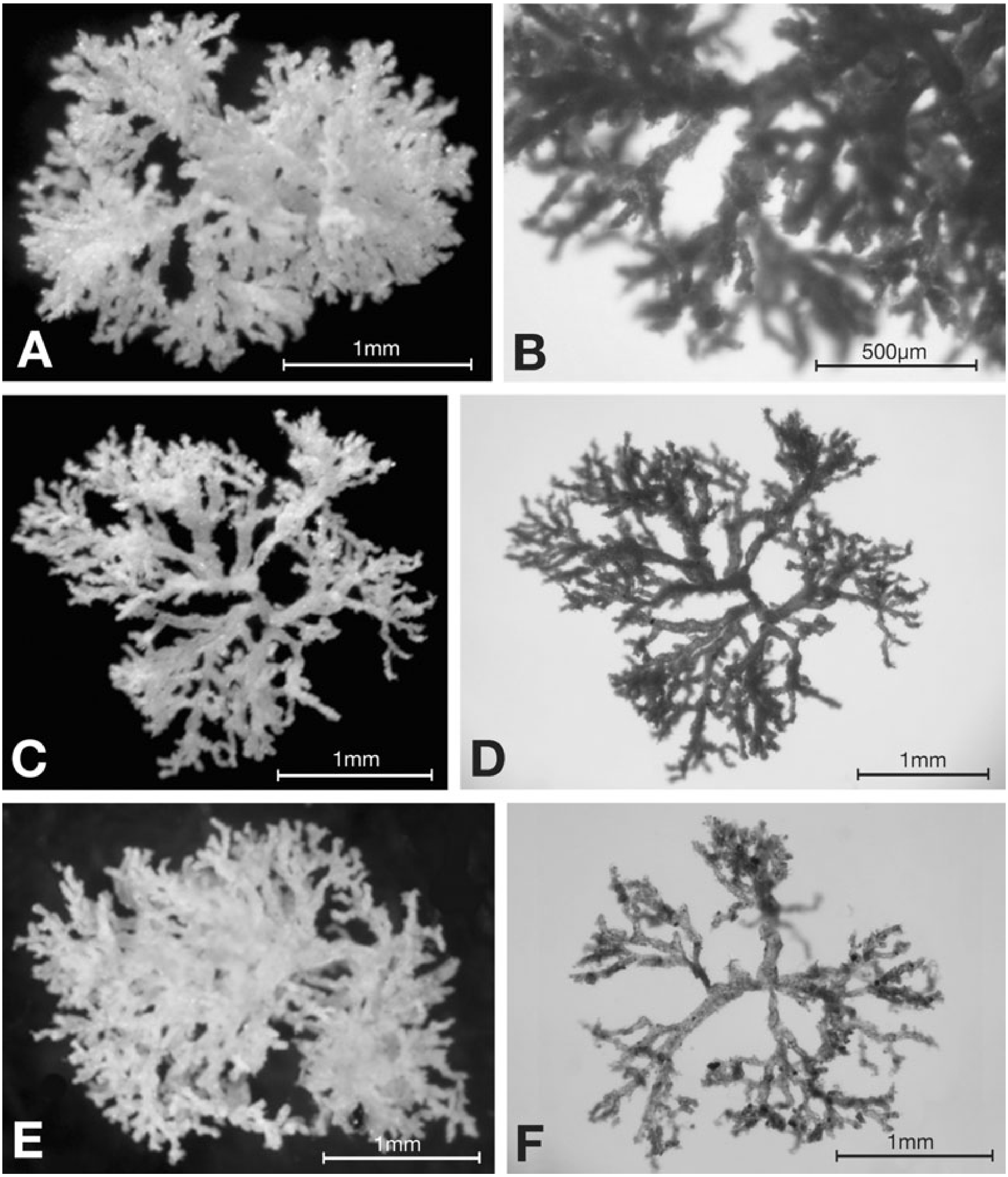


**Figure 11.** *Ipoa fragila* Tendal & Hessler, 1977, photographed in water unless stated otherwise. A, Stn 94#11, general view, reflected light; B, detail of outer branches, transmitted light; C, Stn 94#11, general view, reflected light; D, same specimen, transmitted light; E, Stn 88#8, general view, reflected light; F, Stn 94#11, general view, transmitted light in glycerol.

Tendal & Hessler give diameters of 150–190 μm for these primary branches compared with 100–140 μm in our specimens. In other respects, however, our specimens conform closely to Tendal & Hessler's (1977) description.

*Distribution*
First described from the Central North Pacific (Tendal & Hessler, 1977), subsequently from ~5770 m water depth on the Nares Abyssal Plain, north-west Atlantic (Schröder *et al*., 1989) and at two stations (2790 and 4912 m) in the Cape Basin (Kamenskaya, 1993). In our material it occurs in the eastern and central Weddell Sea (4649–4934 m).

### *IPOA PENNATA* SP. NOV.
(FIGS 12, 13)

*Diagnosis*: Test bush-like; inner part consists of wide primary tubules that divide into narrower peripheral branches. These outer branches follow a more or less crooked course and give rise to short side branches, usually either more or less tubular or, less commonly, bead-like in shape. Tubules non-septate.

*Type material and locality*: The holotype and two paratypes were collected from Stn 88#7 using a large boxcorer (Grosskastengreifer); 68°3.61′S, 20°27.99′W; 4934 m water depth. They are preserved in 4% buffered formalin and deposited in the ForschungsInstitut Senckenberg, Frankfurt am Main, under reg. nos. SMF XXVII 7531 (holotype) and XVII 7532 (two paratypes).

*Other material examined*: Stn 88#8, 24 specimens; Stn 94#7, 1 specimen; Stn 102#8, 2 specimens; Stn 102#13, 26 larger specimens and 15 obvious fragments.

*Derivation of name*: Latin *pennatus* = with feathers, alluding to the sometimes feathery appearance of the test branches.

*Description of type specimens.*
*Holotype*: The test measures 1.80 × 1.30 mm and is rather flattened (Fig. 12B). It forms a bush-like structure with branches radiating out from a central region. Individual tubules can be seen clearly only around the periphery of the test. The inner part consists of a compact cluster of branches that obscures the central structure. The individual branches become clearer in the outer half of the test. They have an irregular and complex form in which a more or less tubular shaft, 60–80 μm in diameter, gives rise to short, unevenly spaced side branches. Many of these are also tubular in form but the shorter ones are more bead-like. On one branch, short, paired, forward-pointing side tubules create two arrowhead-like sections joined by a narrow neck (Fig. 12D).

*Paratype 1*: The test measures approximately 2.0 × 1.7 mm and is somewhat flattened and rather less compact than the holotype (Fig. 12A, B). The structure of the branches is similar to that seen in the holotype. Neck-like constrictions between some sections of the branches create chain-like formations.

*Paratype 2*: The second paratype measures 1.95 × 1.45 mm and is distinctly flattened (Fig. 12E). The structure is more open than that of other two type specimens. The inner part of the test has several short, thick branches, 100–160 μm in diameter, which merges into the narrower, peripheral branches. These outer branches are crooked with short, mainly tubular side branches (Fig. 12F).

In all three type specimens, the wall is off-white in colour. It is opaque, soft, fine grained but with scattered small quartz grains (usually no more than 20 μm in size) which glint in reflected light, and small dark grains. Large agglutinated particles are not present. The test interior is occupied by large, oval stercomata, most of them 25–40 μm in maximum dimension. There are no septa.

*Description of other material.*
*Stn 88#8*: Specimens range in size from 1.20 × 1.00 mm to 1.30 × 1.80 mm. In many cases, the thicker central branches are clearly developed. These sometimes consist of several lobate sections separated by constrictions (Fig. 13B). The branching pattern of the narrower peripheral branches is often difficult to discern but seems to be largely dichotomous. The available material exhibits some variation, particularly in the development and form of the side branches of the main peripheral branches (Fig. 13C, D). The side branches are often more or less tubular (cylindrical) but some of the shorter ones taper and are more conical in shape. In places, the branches are interrupted by necks to create one or more irregularly shaped segments. One specimen has a compact test and distinctly thicker side branches which give it a less delicate appearance than typical specimens.

*Stn 102*: Specimens measure from 1.20 × 1.30 mm to 1.80 × 2.00 mm. The thicker central branches are often clearly developed and rather irregular in width (80–140 μm) (Fig. 13A, E, F). The side branches are usually 40–60 μm in diameter and similar in shape to those of the type specimens. However, in one case, they form rather elongate, finger-like projections while in another they are rounded and bead-like in form. The

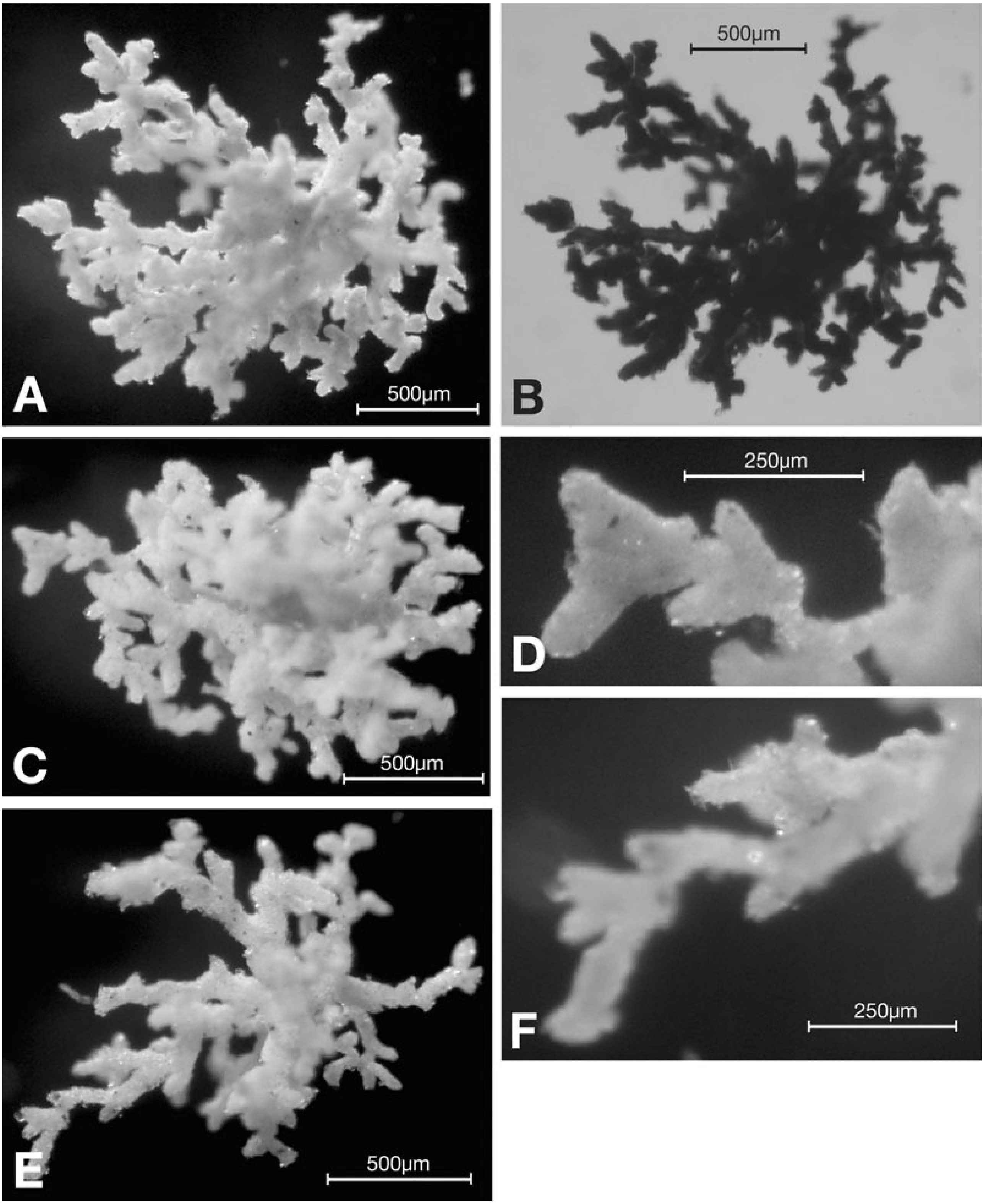


**Figure 12.** ***Ipoa pennata*** **sp. nov.** Type specimens from Stn 88#8 photographed in water. A, paratype, general view, reflected light; B, same specimen, transmitted light; C, holotype, reg. no. SMF XXVII 7531, general view, reflected light; D, detail of outer part of tubule with arrowhead-like sections; E, second paratype, general view, reflected light; F, detail of outer part of tubule. Paratypes registered under SMF XXVII 7532.

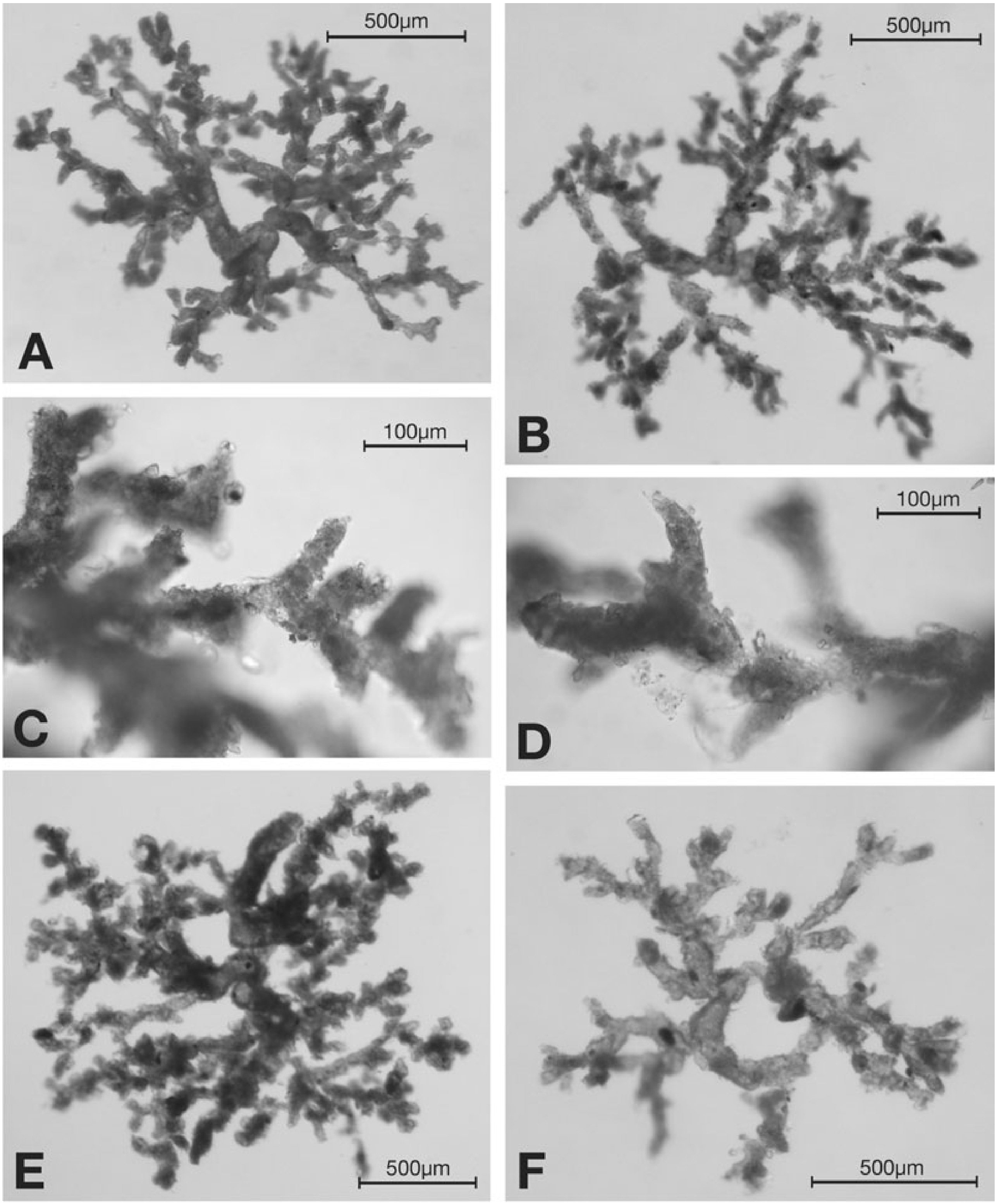


**Figure 13.** ***Ipoa pennata* sp. nov.** Specimens photographed in glycerol using transmitted light. A, Stn 102#8, general view; B, Stn 88#8, general view; C, D, same specimen, details of tubules and side branches; E- F, Stn 102#13, general views.

test wall is ~15–30 μm thick and similar in colour to specimens from Stn 88. The wall incorporates a few fairly large particles (100–200 μm), in addition to numerous tiny quartz grains.

*Remarks*
We place this species in the genus *Ipoa* based on the presence of thick, radiating, basal branches which occupy the inner part of the test and divide to form narrower, peripheral branches. A distinctive feature of the new species, which distinguishes it from *Ipoa fragila*, is that the peripheral branches give rise to short, irregularly developed lateral processes, tubular, conical, or less commonly bead-like in form. The branches are also sometimes interrupted by narrow constrictions that divide them into one or more short, distinct sections. Interestingly, these sections resemble parts of some chain-like komokiaceans, notably *Arbor multiplex*, as illustrated by Schröder *et al.* (1989), as well as the chambers of *Edgertonia floccula*, as illustrated by Shires, Gooday & Jones (1994). However, the fine 'fibres' present in these species have not been observed in specimens of *Ipoa pennata*.

*Distribution*
The new species occurs in the central Weddell Sea (4803–4934 m water depth).

## *NORMANINA* CUSHMAN, 1928

*Type species*: *Halyphysema conferta* Norman, 1878

## *NORMANINA CONFERTA* (NORMAN, 1878) (FIGS 14A–D, 15A, B)

*Halyphysema conferta* Norman, 1878, p. 279, pl. 16, figs 1, 2
*Normanina conferta* (Norman). Cushman, 1928, p. 7
*Normanina conferta* (Norman). Loeblich & Tappan, 1964, C192, fig. 108.8a
*Normanina conferta* (Norman). Schröder, Medioli & Scott, 1989, p. 30; pl. 1, fig. 5, text-fig. 9
*Normanina conferta* (Norman). Shires, 1995, p. 65, pl. 3.4, fig. 5
*Normanina tylota* Tendal & Hessler, 1977, p. 182; text-figs 5, 6; pl. 11, fig. E, F; pl. 12, figs C, D, F; pl. 19, fig. B; pl. 22, fig. A, B
*Normanina conferta* (Norman). Loeblich & Tappan, 1987, p. 41, pl. 30, figs 4, 5
*Normanina tylota* Tendal & Hessler, 1977. Gooday, 1994, fig. 1, fig. h

*Diagnosis*. Test approximately spherical in overall form, typically up to 1–1.7 mm in diameter, fragile, consisting of variable number of unbranched, radiating tubules, each bearing club-shaped to irregular swelling, subdivided internally by septa. Between these tubules with swellings, there radiate a smaller number of simple, easily broken, unbranched tubules, which may reach lengths up to several times the diameter of the main part of the test.

*Syntype of Halyphysema conferta*. A specimen labelled 'lectotype', collected in August 1875 from *Valorous* Stn 9, 59°10′N, 50°25′W, 1750 fm = 3027 m water depth, south of Greenland. Natural History Museum, London, reg. no ZF 3657; mounted dry on a cardboard slide. The writing on the slide indicates that this is the specimen illustrated by Norman (1878) and by Loeblich & Tappan (1964, 1987). The illustration of Loeblich & Tappan has features in common with Norman's original figure but not with the specimen as it now appears (compare Loeblich & Tappan, 1964: fig. 108a with our Fig. 14A, B). However, Norman (1878) found only two examples of this species and one of them was devoid of club-like swellings. Loeblich and Tappan's 'holotype' must be the specimen that we examined but it has clearly been damaged and lost many of its tubules and swellings. The specimen is a figured syntype, not a holotype or lectotype (Adams, Harrison & Hodgkinson, 1980).

*Type specimen of Normanina tylota*. *Argo* H-30, central North Pacific, epibenthic sledge sample: 30°05′N, 156°12′W; 6065–6079 m water depth. Zoological Museum, Copenhagen; preserved in alcohol.

*ANDEEP material*: Stn 21#5, 1 specimen; Stn 59#9, 1 specimen; Stn 78#9, 1 specimen; Stn 80#9, 1 specimen; Stn 81#8, 14 specimens; Stn 88#5, 8 specimens; Stn 88#7, 7 specimens; Stn 88#8, 38 specimens; Stn 88#9, 2 specimens; Stn 94#5, 3 specimens; Stn 94#7, 1 specimen; Stn 94#11, 1 specimen; Stn 94#14, 12 specimens; Stn 102#8, 4 specimens; Stn 102#11, 6 specimens; Stn 102#13, 22 specimens; Stn 110#8, 65 specimens; Stn 121#7, 1 specimen; Stn 133#2, 1 specimen.

*Description of Halyphysema conferta syntype*
The test forms a rather compact brownish mass, measuring 1.1 × 0.75 mm (Fig. 14A, B). It is incomplete and the tubules and terminal swellings are intact only on one side of the test. Comparison with illustrations of the same specimen by Norman (1878) and Loeblich & Tappan (1964, 1987) suggest that the tubules have been broken off around most of the test periphery. The surviving tubules are rather thick (30–40 μm) and the terminal swellings 120–230 μm wide and 140–215 μm long. The wall incorporates tiny

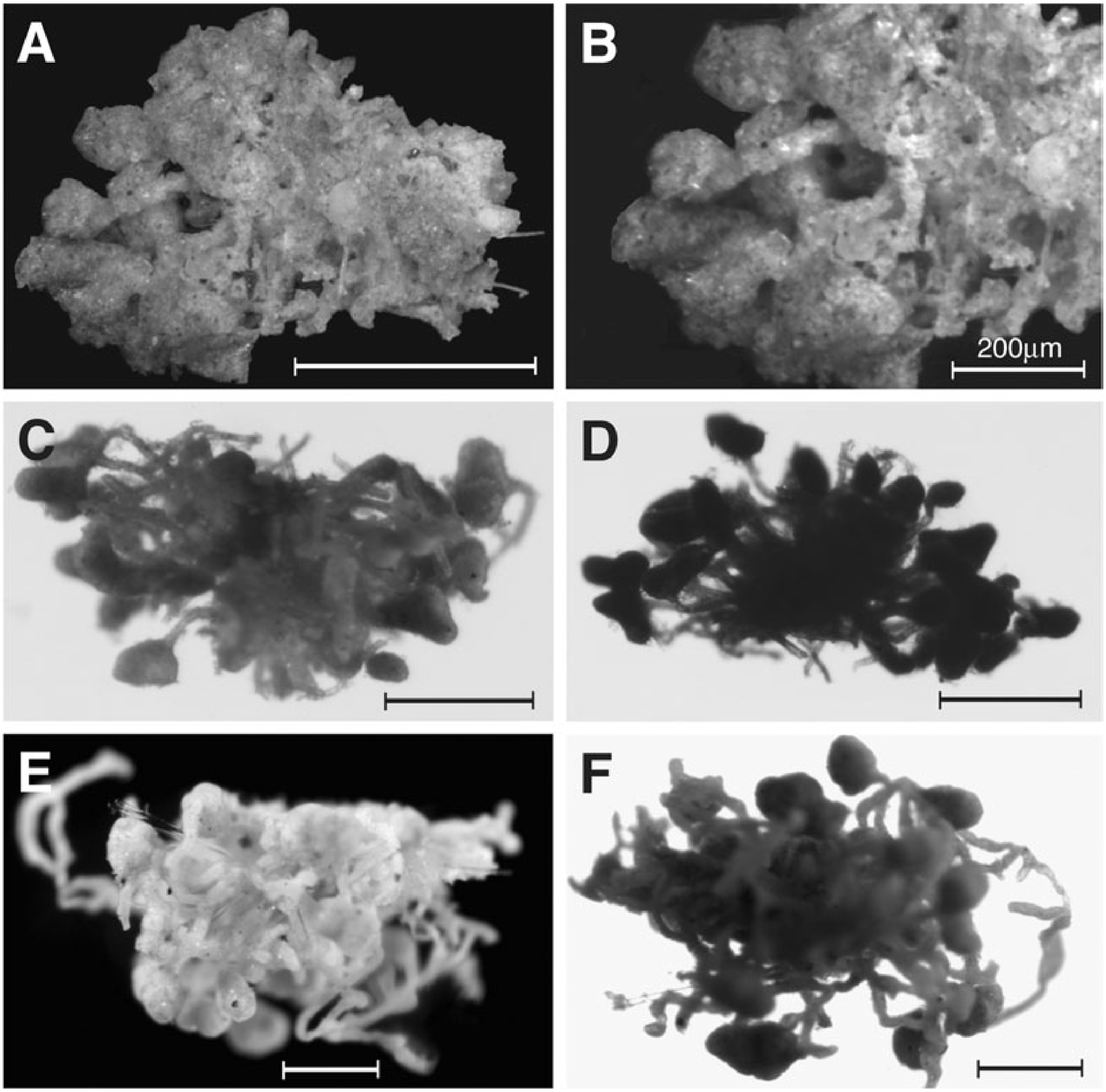


**Figure 14.** A–D, Type specimens of *Normanina* species. A, B, Damaged syntype of *Haliphysema confertum* Norman, 1878, Natural History Museum, London, reg. no. ZF3657, confocal light photographs showing entire specimen (A) and detail of tubules and terminal swellings (B); C, holotype of *Normanina tylota* Tendal & Hessler, Zoological Museum, Copenhagen, photographed in alcohol using combination of reflected and transmitted light; D, opposite side of same specimen, transmitted light. E, F, *Normanina* sp. from Stn 142#5. E, general view by reflected light; F, different view using combination of reflected and transmitted light.

sediment grains that can be resolved under a low-power dissecting microscope, set in a matrix of finer material. Because the specimen is dried and mounted on an opaque background, nothing can be seen of its internal structure.

*Description of Normanina tylota holotype*

The type specimen, preserved in alcohol, measures 1.53 × 0.82 mm and is rather compressed as a result of having been confined within a small vial (Fig. 14C, D). It has lost some of the swellings and the two long

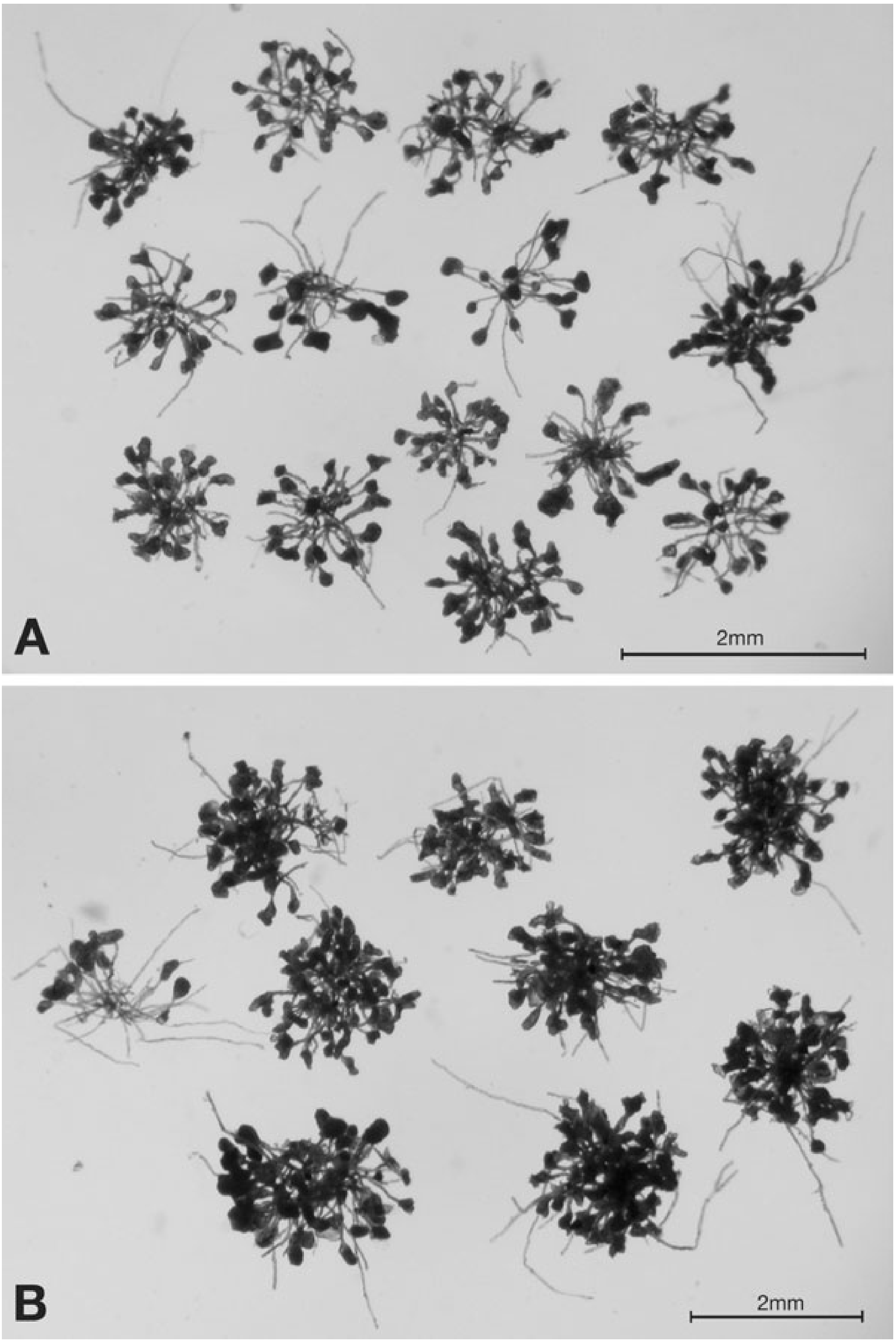


**Figure 15.** *Normanina conferta* (Norman, 1878). Specimens photographed in water using transmitted light. A, Stn 88#8; B, Stn 102#13.

tubules shown in Tendal & Hessler's (1977: fig. 5) illustration. The tubules are 20–30 μm in diameter and the bulb-like swellings measure 240–330 μm in maximum dimension. Two bulbs arising from different tubules have fused together, a feature sometimes seen in ANDEEP specimens. The test is brownish in colour and the wall is composed of fine-grained particles, some of which glint in reflected light.

*Description of ANDEEP material*

Forty-five individuals from Stns 88 and 94 range in diameter (excluding long tubules) from 0.90 to 2.0 mm; most (35 individuals) are between 1.25 and 1.65 mm diameter. The test is whitish in colour. Relatively short tubules, 25–50 μm (typically 35–40 μm) in diameter, radiate from the central region and end in bulb-like swellings up to 350 μm (typically 150–250 μm) in diameter. These range from simple oval swellings to more complex, sometimes bilobed structures. There is considerable variation in the number of tubules that end in swellings. In some individuals they are sparsely developed, numbering ten or fewer; in others from the same sample, they are more numerous. However, specimens from Stn 88 (Fig. 15A) tend to have sparser tubules than those from Stn 102 (Fig. 15B). A single individual from the Anguilas Basin (Stn 21) has numerous terminal swellings arising from an extensively branched tubule system, but nevertheless falls within the range of variation exhibited by the Weddell Sea material.

The central part of the test is entirely devoid of sediment in all ANDEEP specimens. It is occupied by tubules that branch frequently, apparently dichotomously, and occasionally anastomose. The complexity of this inner region varies considerably, from having relatively few branches to being a tightly structured mass of tubules. Arising from the inner part of the test are longer, unbranched tubules that extend for a sometimes considerable distance beyond the main part of the test. In the ANDEEP material, the longest of these tubules measures 2400 μm from its base. Others are up to 1600 μm in length but most are much shorter and possibly broken. They are often narrower (~25 μm) than the other tubules and never end in a distal swelling.

The test wall is finely granular but also incorporates some larger grains. A few large mineral grains (usually quartz but sometimes dark minerals) up to 200–300 μm in diameter, or (at Stn 21) fragments of globigerinacean shells, are sometimes present. The swellings and tubules of the Stn 21 specimen have a darker filling than those from other sites.

*Remarks*

We follow Schröder *et al*. (1989) in identifying this species as *Normanina conferta.* Our extensive material is closely similar to Schröder *et al*.'s (1989) figured specimens from the Nares Abyssal Plain. In both cases, the inner part of the test is devoid of sediment. The syntype of *N. conferta* in the Natural History Museum, London, appears more compact than the ANDEEP specimens and lacks the long, unbranched tubules. This probably reflects the dried and damaged condition of the specimen. Nevertheless, the diameters of the tubules in the syntype are similar, and the shape of the swellings falls within the range of variation observed in ANDEEP specimens.

Based on a re-examination of the type specimens, we consider *N. conferta* to be conspecific with *N. tylota*. Tendal & Hessler (1977) acknowledged the close relationship between the two species but distinguished them based on the presence in *N. tylota* of two types of tubules and the large variation in the shape of the swellings. As indicated above, the long tubules may be missing because of damage in the syntype of *N. conferta* and the surviving swellings in this specimen exhibit some variation in shape.

One notable difference between the ANDEEP specimens and the types of both *N. conferta* and *N. tylota* is the absence of any sediment in the central region of the test. Typical Weddell Sea specimens are also pure white in colour compared with the brownish appearance of *N. tylota* and the dirty grey colour of the *N. conferta* syntype (possibly due to the age of the dried specimen). The ANDEEP material exhibits considerable variation in the number of tubules, even within the same sample (Fig. 15). To some extent, this variation mirrors the 'compact' and 'spidery' morphotypes of *Septuma ocotillo.*

*Distribution*

*Normanina conferta* was first described from the Davis Strait, off Greenland (3202 m water depth) (Norman, 1878), and subsequently reported from the Nares Abyssal Plain (~5775 m) (Schröder *et al*., 1989). *Normanina tylota* was described from the abyssal central North Pacific (Tendal & Hessler, 1977) and later reported from the Porcupine Abyssal Plain (4841 m) (Gooday, 1994; Shires, 1995). In our material this species occurs in the Anguillas Basin (4566 m), eastern Weddell Sea, slope and abyssal plain (2147–4649 m water depth), central abyssal Weddell Sea (4695–4934 m), and north-east Peninsula slope (1579–2620 m).

## *Normanina* sp.
(Fig. 14E, F)

*Material examined*: A single individual from Stn 142#5, Epibenthic sledge.

*Description*

The specimen, which appears to be somewhat distorted, measures 2.1 × 1.3 mm. One side consists of a tangle of branching tubules, partly obscured by sediment. This part forms a kind of base from which other, longer tubules arise. These tubules are 45–70 μm wide and branch dichotomously. Many of the branches end blindly but some terminate in bulbous swellings. In total, there are ~12 of these swellings, measuring 280–380 μm in maximum diameter and oval to lobate in shape; a few other tubules end in much smaller swellings, 90–100 μm in diameter. Long, unbranched tubules are not present, although one tubule, which branches several times but lacks swellings, extends further than the others from the main part of the test. The tubules have finely agglutinated, translucent walls. The walls of the bulbs are thicker and opaque. In both cases, larger grains are absent.

*Remarks*

This single individual is larger and more robust than the common ANDEEP form of *Normanina conferta.* The tubules are also wider, branch more frequently and often end blindly rather than being expanded into swellings. The swellings themselves tend to be larger than in *N. conferta.* Also, long, unbranched tubules are absent, and some sediment is present between the tubule interstices. This form also differs from the type specimens of *N. tylota* and *N. conferta* in many of the above-mentioned features, although it resembles them in having some interstitial sediment. It probably represents an undescribed species.

*Distribution*

Powell Basin (2404–3408 m).

KOMOKIACEA *INCERTAE SEDIS*

***SKELETONIA* GEN. NOV.**

*Diagnosis*: Test consisting of initial (proximal) cluster of globular, grape-like or more elongate chambers followed by small number of relatively wide, stiff, crooked, tubular processes, typically 80–100 μm in diameter. These usually arise from either side of the longitudinal growth axis and increase in length from proximal to distal; however, the growth axis is sometimes compressed, obscure or lacking. Tubular processes are sometimes interrupted by internal septa.

*Type species*: *Skeletonia variabilis* gen. et sp. nov.

*Derivation of name*: The generic name reflects the skeletal appearance of the test, which is particularly apparent in specimens with a distinct direction of growth.

*Remarks*

The test of this new genus comprises a series of elongate elements, usually with length/width ratios < 5. We term these 'tubular processes' because they are relatively wider than the tubules of typical komokiaceans. This raises the question of whether *Skeletonia* is a true komokiacean. However, the general disposition of the tubular processes, the frequent presence of a proximal cluster of grape-like chambers and the development of septa are reminiscent of members of this superfamily. The basically elongate morphology, the frequent development of tubular processes from a more or less irregular central axis and the initial cluster of globular chambers are all reminiscent of the genus *Baculella*. Unlike species of this genus, however, there is no axial tubule. Instead, the axis, where present, is created by the bases of the lateral tubular processes and the short, stolon-like necks that link them together. The tubular processes are also much larger and more robust than the bead-like chambers of *Baculella.* Because the relationship of *Skeletonia* to other komokiaceans is presently unclear, we hesitate to place it in any particular family.

An undescribed species of *Skeletonia* occurs in the Porcupine Abyssal Plain (north-east Atlantic) (A.J.G. & O.E.K., unpubl. observ.). It differs from the type species described below in having rounded rather than tubular lateral processes.

***SKELETONIA VARIABILIS* GEN. ET SP. NOV.**

(FIGS 16–18)

*Diagnosis*: As for genus.

*Type material and locality*: The holotype and three paratypes were collected from Stn 88#8, using an epibenthic sledge; 68°3.61′S, 20°27.52′W to 68°3.85′S, 20°31.42′W; 4927–4932 m water depth. They are preserved in 4% buffered formalin and deposited in the Forschungsinstitut Senckenberg, Frankfurt am Main, under reg. nos SMF XXVII 7533 (holotype) and SMF XXVII 7534 (paratypes).

*Other material examined*: Stn 88#8, 11 additional specimens; Stn 94#11, 3 specimens; 102#13, 13 specimens; 110#8, 2 specimens.

*Derivation of name*: Latin *variabilis* = variable, alluding to the variable appearance of the test.

*Description of type material*

*Holotype*: Length 1.45 mm, width 0.20 mm at the proximal end widening to 1.20 mm at the distal end (Fig. 16A, C). The test is flattened and the height (with the test orientated so that the height is at a minimum) is 0.65 mm. The initial part consists of an irregular cluster of globular to droplet-shaped chambers, each ~80 μm in diameter (Fig. 16B). These are succeeded by a series of stiff, tubular processes (in effect, broad tubules), which increase in length and width along the

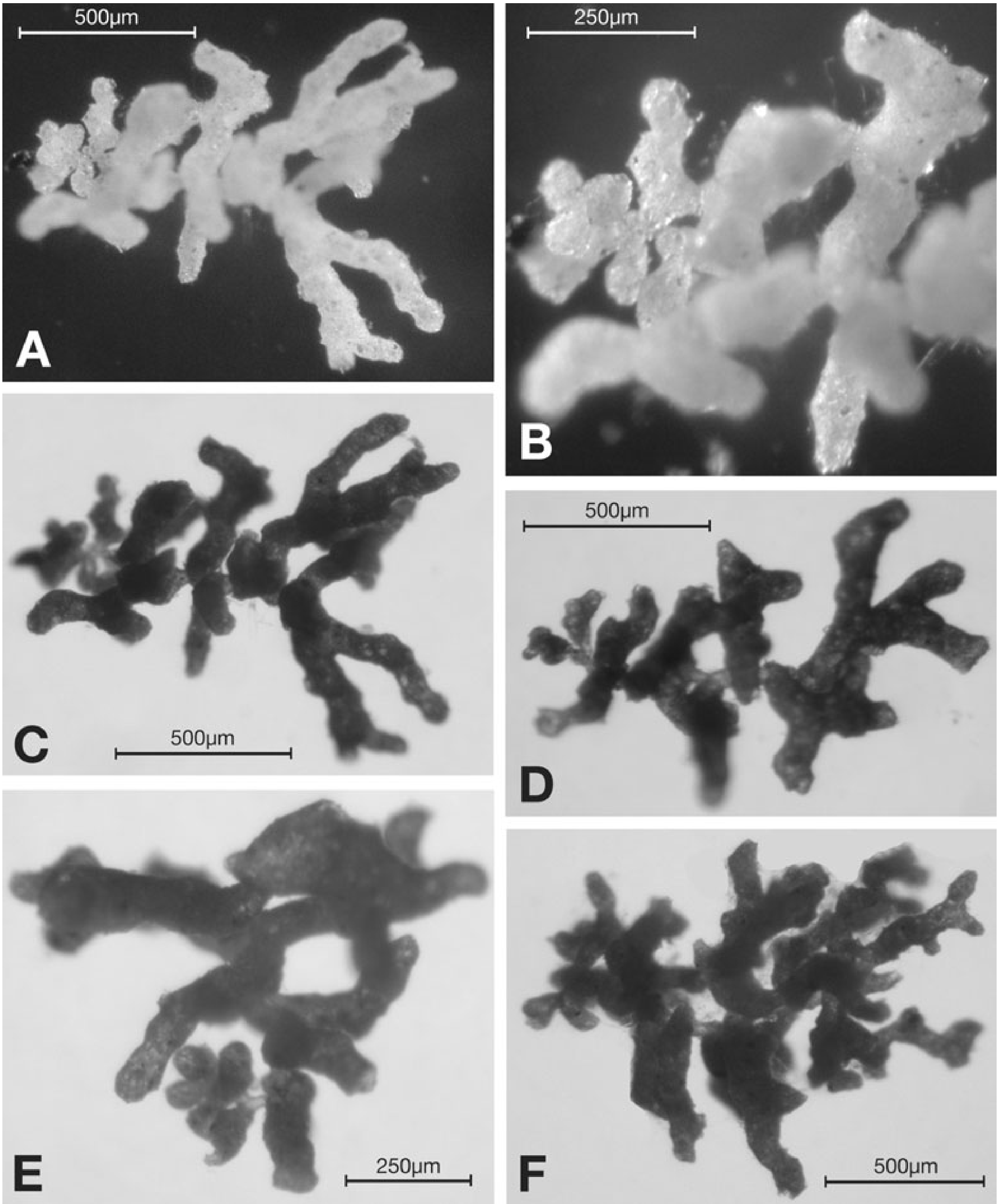


**Figure 16.** ***Skeletonia variabilis*** **gen. et sp. nov.**, Stn 88#8, type specimens, photographed in water. A, holotype, reg. no. SMF XXVII 7533, general view, reflected light; B, detail of holotype showing proximal cluster of globular chambers; C, holotype, transmitted light; D, paratype, general view, transmitted light, note two elongate proximal chambers; E, second paratype, general view of specimen with compressed axis of growth, note distinct proximal cluster of globular chambers linked to rest of test by short neck; F, third paratype, general view, transmitted light. Paratypes registered under SMF XXVII 7534.

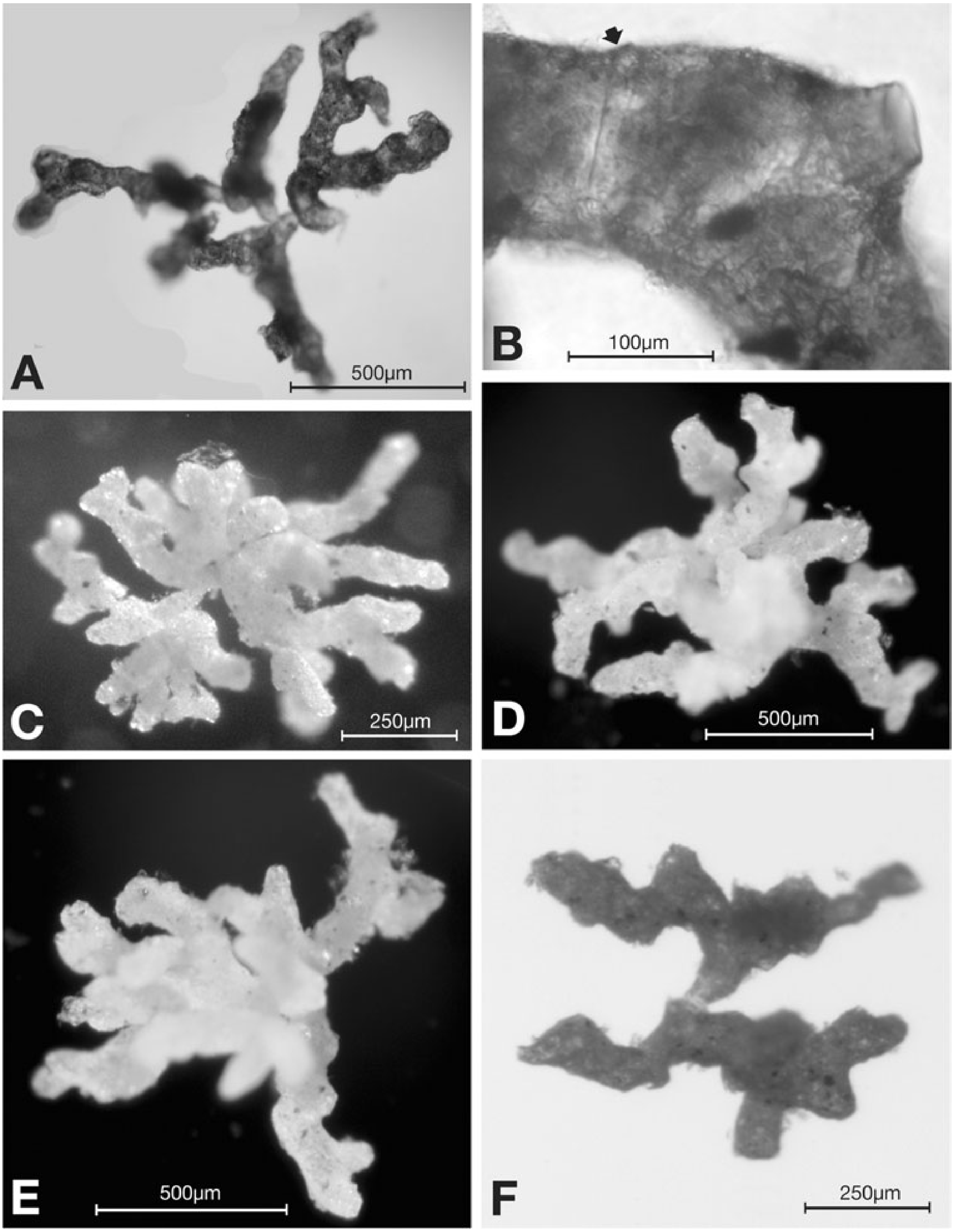


**Figure 17.** ***Skeletonia variabilis* gen. et sp. nov.**, Stn 88#8, specimens without distinct growth axis, photographed in water except where stated otherwise. A, general view of specimen in glycerol, transmitted light; B, detail of tubular process showing septum (arrowed); C, general view, reflected light, the proximal part of this specimen is to the left; D, E, general views, reflected light; F, specimen consisting of two tubular processes linked by neck, transmitted light.

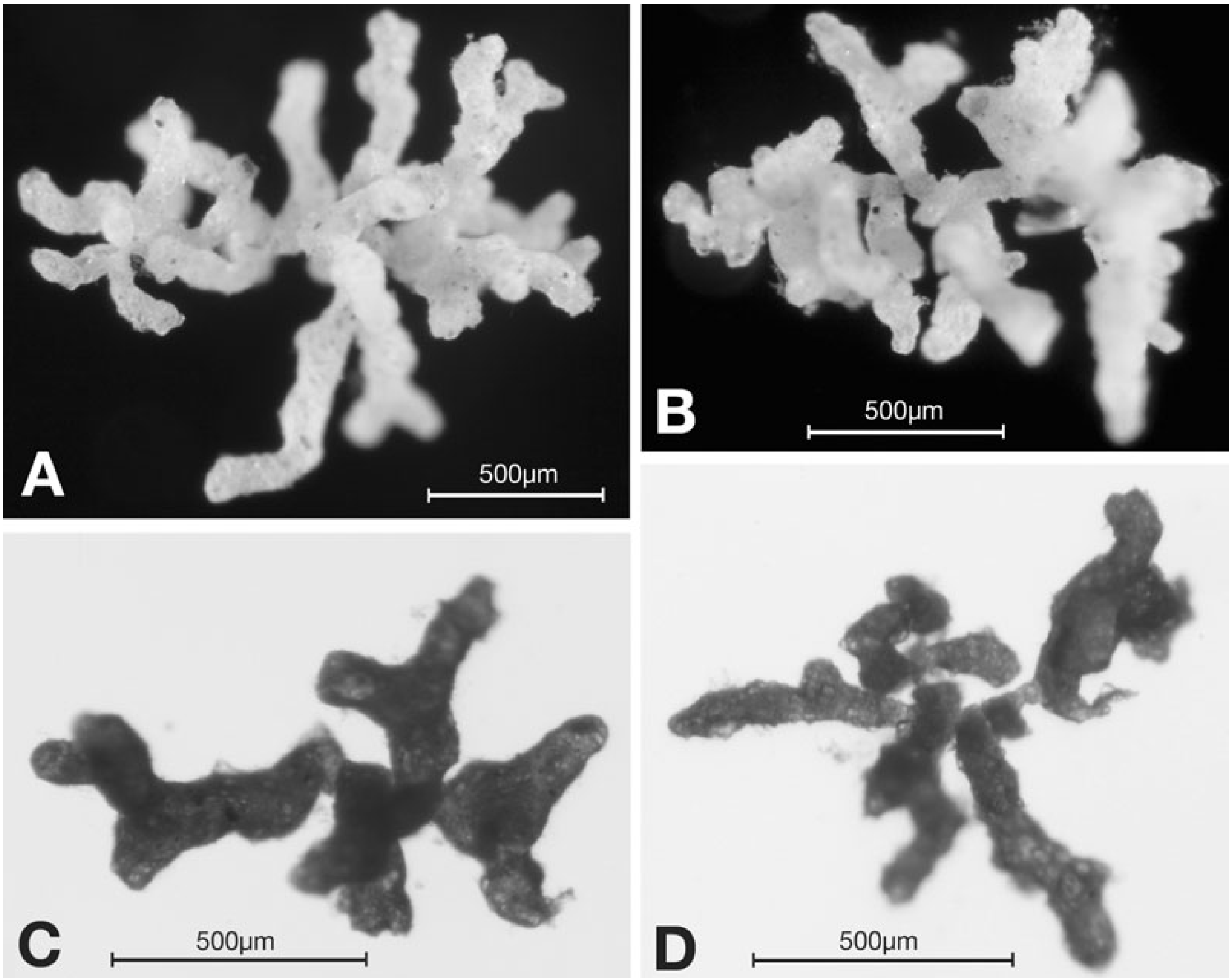


**Figure 18.** ***Skeletonia variabilis*** **gen. et sp. nov.**, Stn 102#13, specimens photographed in water. A, general view, note elongate, initial tubular processes; B, general view, note globular initial chambers; C, D, general views of specimens consisting of relatively few tubular processes.

length of the test. The test has a fairly distinct axis of growth created by the bases of the tubular processes, which are linked together by narrow constrictions or short, tubular, stolon-like necks, ~20 μm in width. At the proximal end of the test, the processes are 120–220 μm long and 60–80 μm wide with a length/width ratio of 4.5–6.5; at the distal end they are 600–700 μm long and 80–140 μm wide with a length/width ratio of 3–4. Most of them branch dichotomously once or twice. The processes project outwards from the central growth axis and slightly forwards. Some lie in a more or less horizontal plane while others extend upwards or downwards. They tend to arise alternately on either side of the test. However, the pattern is not regular and the general arrangement of the processes is somewhat haphazard. The ends of some processes are flattened, others are more rounded.

*Paratype 1*: Length 1.50 mm, width increasing from 0.50 mm at the proximal end to 1.20 mm at the distal end; height ~0.90 mm. This individual is larger than the holotype and has a rather more complex test (Fig. 16F). As in the holotype, the initial part comprises a cluster of globular chambers, each 75–100 μm in diameter. The tubular processes extend forward at an angle from the direction of growth and have a length/width ratio of 4–5. However, they are more numerous and rather less regular in form than those of the holotype; in most cases the processes branch dichotomously or have short lateral protuberances. The axis of growth is also more irregular than in the holotype and follows a somewhat curved course. The axis consists mainly of short, stolon-like necks which join together the bases of the tubular processes.

*Paratype 2*: Length 1.20 mm, width increasing from 0.40 mm at the proximal end to 0.80 mm at the distal end; height ~0.40 mm. This is a smaller and morphologically rather simpler individual than either the holotype or paratype 1 (Fig. 16D). The initial part consists of only two small, closely adjoining chambers (~75 μm in diameter), but in other respects the morphology is similar. The tubular processes are linked at their bases by stolon-like necks to form an irregular axis. The processes are ~100 μm in diameter, range in length from ~270 μm near the proximal end (length/width ratio ~3) to ~500 μm near the distal end (length/width ratio ~5). They are rather irregular and most branch or have lateral protuberances.

*Paratype 3*: Length ~0.80 mm, width 0.30–1.1 mm. A small specimen with a clearly developed cluster of about six small, globular chambers (50–100 μm in diameter) at the initial end; these are attached to the rest of the test by a short neck, ~20 μm in width (Fig. 16E). The short growth axis consists of similar, stolon-like necks. There are rather few tubular processes, ~80 μm in width (length/width ratio 3–5) and in some cases branched, extending out from the central axis.

### *Description of other specimens*

*Stn 88#8*: Eleven additional specimens from the type locality are 0.75–1.25 mm long, 0.62–1.14 mm wide with a length/width ratio of 0.96–1.68; the width/height ratio is 1.2–1.5. In six of the 11 specimens, the proximal cluster of small, grape-like chambers is clearly developed and contrasts with the latter part of the test. As in the type specimens, the main part of the test consists of thick, branched tubular processes, joined at their bases by short necks or constrictions. Four specimens have a distinct direction of growth, with the lateral processes arranged on either side of the axis. In other cases, however, the growth axis is either compressed and difficult to see (Fig. 17C), or there is no clear direction of growth (Fig. 17A, D–F). The tubular processes are typically ~100 μm wide, although the width varies in an irregular manner along the length; in smaller specimens they may be only 60 μm in width. The processes often branch dichotomously.

The test has a smooth outer surface. The wall is composed of a mosaic of angular grains, typically 10–40 μm in size, with the gaps between them filled by smaller grains. Most are composed of quartz, but dark grains of various sizes are also present. A few large quartz particles several hundreds of micrometres in diameter sometimes project from the surface of the wall. The interior of the tubular processes may be interrupted by transverse septa (Fig. 17B). These are difficult to visualize through the rather coarsely agglutinated test wall, even when specimens are examined in glycerol. However, careful examination sometimes reveals several septa within one tubular process. The test contains stercomata.

*Stn 94#11*: Three small specimens, ranging in length from 0.80 to 1.00 mm and broadly similar to those from Stn 88. All have a cluster of small chambers at the proximal end. The axis of the test along which the tubular processes join is irregular.

*Stn 102#13*: Six larger specimens are 1.04–1.53 mm long and 0.67–1.33 mm wide with a length/width ratio of 1.14–1.79; the height is generally less than the width of the test (width/height ratio = 0.92–1.80). Two of these six specimens have a clearly developed cluster of small chambers (60–80 μm) at the proximal end (Fig. 18B); in the others, the proximal part of the test consists of elongate, tubular elements (width ~60 μm) (Fig. 18A). Four specimens exhibit a more or less distinct direction of growth with elongate processes (tubes ~80 μm width) arranged on either side of the growth 'axis' formed by the bases of the processes (Fig. 18C, D). These are separated by constrictions rather than by the stolon-like necks developed in the type specimens. In one case, a tubular process extends along the axis between the branches. Another 12 specimens are smaller (length = 0.42–0.74 mm; width = 0.27–0.57 mm). Most have no clear direction of growth and consist of a few irregular tubular processes, which arise from a central area (Fig. 18C, D).

*Stn 110#8*: Two small specimens comprise a few tubular processes with no clear direction of growth. Stolon-like necks are clearly developed between the bases of some processes.

### *Remarks*

This species exhibits considerable variability. All specimens possess a series of relatively wide, tubular processes, but their disposition is not consistent. In some individuals, there is a more or less distinct direction of growth, the axis of which is usually formed by the bases of the tubular processes and the short, stolon-like necks that sometimes link them together. However, this axis often follows an irregular course and sometimes is very contorted, compressed or not discernible at all. The initial part, where visible, often consists of a cluster of globular chambers, but in some specimens these are replaced by small, tubular structures.

### *Distribution*

Central Weddell Sea (4696–4932 m water depth).

## DISCUSSION

The most productive sampling gear for collecting komokiaceans during the ANDEEP III cruise was the epibenthic sledge (EBS). Sample residues from the EBS were sometimes dominated by komokiaceans, particularly in the central abyssal part of the Weddell Sea. This is consistent with experience gained in the 1970s and 1980s during the Institute of Oceanographic Sciences's (IOS) sampling programme on the African and UK margins in the north-east Atlantic when the IOS-designed EBS yielded large collections of komokiaceans and other large agglutinated Foraminifera (Gooday, 1983, 1990). The core of Tendal & Hessler's (1977) material from the central North Pacific, including all the type specimens, was collected using an EBS. Numerous komokiaceans were also picked from sieved residues of ANDEEP Agassiz trawl samples, but these were generally muddier and more difficult to process than the sledge catches. The smaller amounts of sediment obtained in box corer and particularly multicorer samples yielded correspondingly fewer komokiaceans.

Within the study area, some geographical and bathymetric patterns are evident among the nine species that we describe (Table 2). *Septuma brachyramosa* and *S. komokiformis* were both found at stations on the continental margin (1812–4526 m) whereas *S. ocotillo*, *Ipoa fragila*, *I. pennata*, *Komokia multiramosa* and *Skeletonia variabilis* are typical of the central Weddell Sea abyssal plain. *Septuma stellata* also occurred in the central part of the Weddell Sea, as well as on the continental slope off the Antarctic Peninsula (Stn 121) and in the Powell Basin (Stn 142). *Normanina conferta*, found at 11 stations over a depth range of 1579–4935 m, had the widest distribution, both geographically and bathymetrically, in continental margin settings as well as in the central part of the Weddell Sea.

Six of the komokiacean species found in the ANDEEP samples were known from earlier studies. *Normanina conferta* was the first komokiacean to be described based on two individuals collected in the northern North Atlantic (Davis Strait off Greenland) during the *Valorous* expedition of 1875 (Norman, 1878). Subsequent records are from the Nares Abyssal Plain (Schröder *et al.*, 1989) and the Porcupine Abyssal Plain (Gooday, 1994; Shires, 1995). Tendal & Hessler (1977) described *I. fragila*, *K. multiramosa* and *S. ocotillo* from the North Pacific and these species were later reported from the North Atlantic by Schröder *et al.* (1989) and Gooday (1990). Two other species, *Septuma brachyramosa* and *S. komokiformis*, were established by Kamenskaya (1993), based on material from the Valdivia Seamount and Cape Basin in the South Atlantic. *Septuma brachyramosa* is clearly the same species as the *Septuma* sp. illustrated by Gooday (1990, 1994) and Shires (1995) from the Madeira and Porcupine Abyssal Plains. *Septuma stellata* sp. nov. has not been found in the North Atlantic. The fact that five of these six species occur in both the North Atlantic and the Southern Ocean suggests that close faunal links exist between these areas. A wide geographical distribution among other groups of abyssal Foraminifera has been noted previously (e.g. Schröder *et al.*, 1988; Gooday *et al.*, 2004). The three new species that we describe here, however, have not been encountered in samples from the North Atlantic. Their absence may mean that they are endemic to the Southern Ocean, but is more likely to be an artefact of undersampling, a widely recognized problem in the deep sea.

We identify several of Tendal & Hessler's Pacific species among the ANDEEP material, based on a re-

**Table 2.** Distribution of komokiacean species among ANDEEP stations

| Station | Depth (m) | *K. multiramosa* | *S. ocotillo* | *S. brachyramosa* | *S. komokiformis* | *S. stellata* | *I. fragila* | *I. pennata* | *N. conferta* | *S. variabilis* |
|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 4723–4730 | | | X | | | | | | |
| 21 | 4566 | | | | | | | | X | |
| 57 | 1812–1822 | | | X | | | | | | |
| 59 | 4649–4656 | | X | | | | X | | X | |
| 78 | 2147–2185 | | | X | | | | | X | |
| 80 | 3102–3136 | | | X | X | | | | X | |
| 81 | 4408–4526 | | X | X | X | | | | X | |
| 88 | 4927–4935 | X | X | | | X | X | X | X | X |
| 94 | 4889–4895 | X | X | | | X | X | X | X | X |
| 102 | 4794–4818 | X | X | | | X | X | X | X | X |
| 110 | 4696–4700 | X | X | | | X | X | | X | X |
| 121 | 2616–2620 | | | X | | X | | | X | |
| 133 | 1579–1584 | | | | | | | | X | |
| 142 | 3404–3408 | | | | | X | | | | |

examination of the type specimens. Although we are confident that the Antarctic and Pacific specimens are similar enough to be assigned to the same morphospecies, there are subtle differences. ANDEEP specimens of *N. conferta* have a pristine appearance, devoid of any associated sediment, whereas Tendal & Hessler's material of *N. tylota*, which we consider to be a synonym of *N. conferta*, has a core of sediment. The Pacific type of *Ipoa fragila* has rather wider central tubules than the ANDEEP specimens. *Septuma ocotillo* is a particularly problematic species that exhibits considerable variability in ANDEEP material. The Pacific holotype resembles the 'spidery' ANDEEP morphotype in having long, relatively thin tubules but the tubules are more numerous. There is no justification at present for establishing new species based on these differences.

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