THE MARINE INTERSTITIAL CILIATES OF BERMUDA WITH NOTES ON THEIR GEOGRAPHICAL DISTRIBUTION AND HABITAT (1)

by

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Résumé

Ciliés marins interstitiels (les Bermudes avec des précisions sur leur distribution géographique et leur habitat.

L'étude de 17 stations eulittorales et sublittorales de prélèvements, provenant des sables marins des Bermudas, a permis l'identification de 45 espèces de Ciliés interstitiels. Des descriptions de leur morphologie et de leur distribution méso-psammique sont présentées, Une nouvelle espèce ***Euplotidium helgae*** est décrite. L'auteur montre la parfaite conformité avec la faune interstitielle des Ciliés de la côte Est du continent américain et la discute en rapport avec la position géographique des Bermudes. Les caractères écologiques des stations d'échantillonnage sont étudiés avec une référence particulière à l'instabilité du sédiment et à l'apport de matériel détritique par les restes de plantes et d'animaux (source d'énergie dans la chaîne de détritus alimentaires).

Introduction

From the marine waters of the Bermudas, a group of small oceanic islands in the Northwest Atlantic nearly 800 miles off the east coast of North America, the ciliate fauna is so far poorly investigated. Amongst descriptions of ciliates living parasitically in sea urchins (Biggar, 1932; Lucas, 1934, 1940) leading papers on the ciliates of the lacunar system of marine sediments are existing (Hartwig, 1977; Hartwig, Gluth and Wieser, 1977). This paper describes a comprehensive study on the systematics and ecology of the interstitial ciliates of the Bermudas with notes on their geographical distribution.

Methods

The investigation was carried out at 17 entirely marine sampling stations (Fig. 1)—intertidal beaches as well as sublittoral sediments

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from areas between reef-formations—during September 1976. Qualitative samples were collected from different sites of the beaches and the sublittoral areas by scaping off the top layers of the sediment up to about 5cm depth. Sub-samples were analysed for grain size composition using the following sieve sizes: 63, 125, 180, 250, 355, 500, 710, 1 000 and 2 000μm. The median grain size (determined

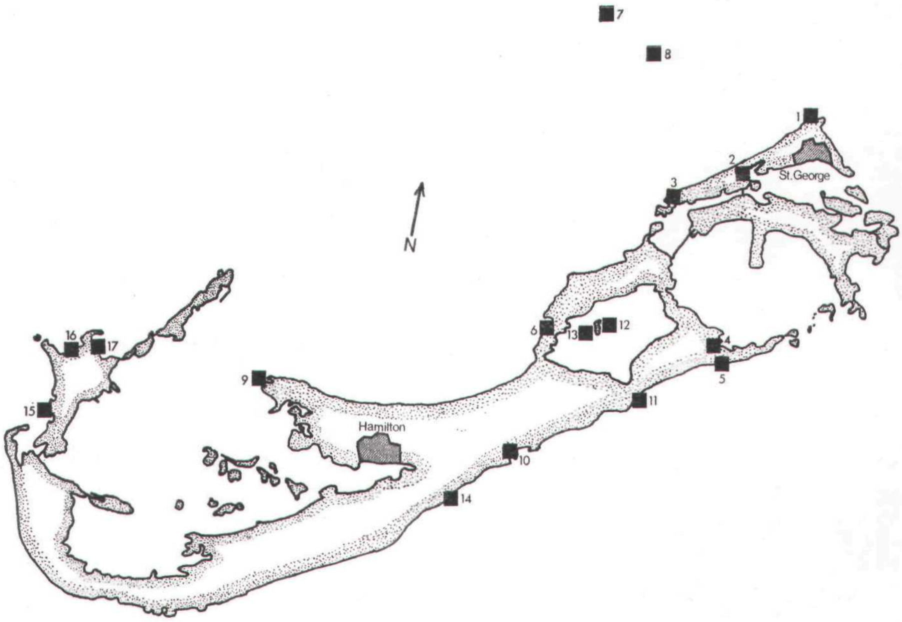

FIG. 1
Bermuda Islands, location of sampling stations.

according to Hartwig, 1973 b) is used to describe the composition of the nearly 100 per cent calcareous sediment.

The relative amount of organic matter was determined visually from a suspension of sediment in sea water and decantering the suspension of detritus into a petri dish after the sediment having settled at the ground, and by observing the colour of the sediment which—according to Adshead (1964)—may indicate the amount of organic matter considerably well.

The ciliates were extracted from the sediment by the sea-water-ice method (Uhlig, Thiel and Gray, 1973). The drawings were made from both living material and stained specimens.

The species were identified with the help of papers by Agamaliev (1967, 1968), Borror (1963 a, 1972), Dragesco (1960, 1963 a, b, 1965), Hartwig (1973 a), Hartwig and Parker (1977) and others. Furthermore the publication of Kahl (1930-35) was consulted.

With regards to the systematic classification, we followed the work of Corliss (1979).

RESULTS

Description of the sampling stations

Grain size composition for 16 sampling stations are shown in fig. 2. The sediment composition of Tuckers Town Beach was given by Hartwig, Gluth and Wieser (1977). The following grain size groups are used for sediment characterization of the sampling stations :

63 — 125µm — very fine sand
125 — 250µm — fine sand
250 — 500µm — medium sand
500 — 1 000µm — coarse sand
1 000 — 2 000µm — very coarse sand
>2 000µm — granules

A detailed description of each location is given below.

Tobacco Bay (Station 1)

Tobncco Bay is a small protected cove. It is isolated from the sea by an irregular ridge of eroded eolianite. This ridge effectively prevents both waves and sediment from entering the cove, except through a small channel at the northwest corner. The main part of the very shallow sublittoral was covered with beds of Turtle Grass. The sediment of the sampled beach (mean grain size 397µm) seems to contain little organic matter, and consisted of more than 62 per cent medium sand. Coarse sand accounted for 20.2 per cent and fine sand only for 8.6 per cent of the grains.

Mullet Bay (Station 2)

Mullet Bay, located along the northwestern extension of St. George's Harbor, is a protected intertidal mud flat. This bay is eutrophicated by the low water exchange of this basin with St. George's Harbor. The sediment seems to have a high content of particulatc organic material, and consisted of 51.3 per cent fine sand (mean grain size 243µm) and 26.8 per cent medium sand. The coarse sand fraction was 12.8 per cent, the very fine sand fraction only 2 per cent of the total.

Whalebone Bay (Station 3)

The semi-protected cove is located at the northern end of the Bermuda Islands. The grain size composition showed a high percentage of coarse and very coarse sand, 68.5 and 21.6 per cent respectively, with only 0.2 and 4.9 per cent of fine and medium sand. The mean grain size is 649µm. The content of organic material seemed to be low. The sorting ranged from well sorted to moderately well sorted.

Tuckers Town Beach (Station 4)

The beach is located in a small secluded bay which is well protected. A sand bar stretching across the entire beach greatly restricts the water movements at low tide. A stand of red mangroves (Rhizophora mangle) situated on the northwest side of the beach contributes substantially to the input of organic matter into the beach. The sediment, consisting of calcareous sands, was composed predominantly of medium sand (51.8 per cent). The coarse sand accounted for 23.5 per cent, and the fine-grained fraction for up to 20 per cent.

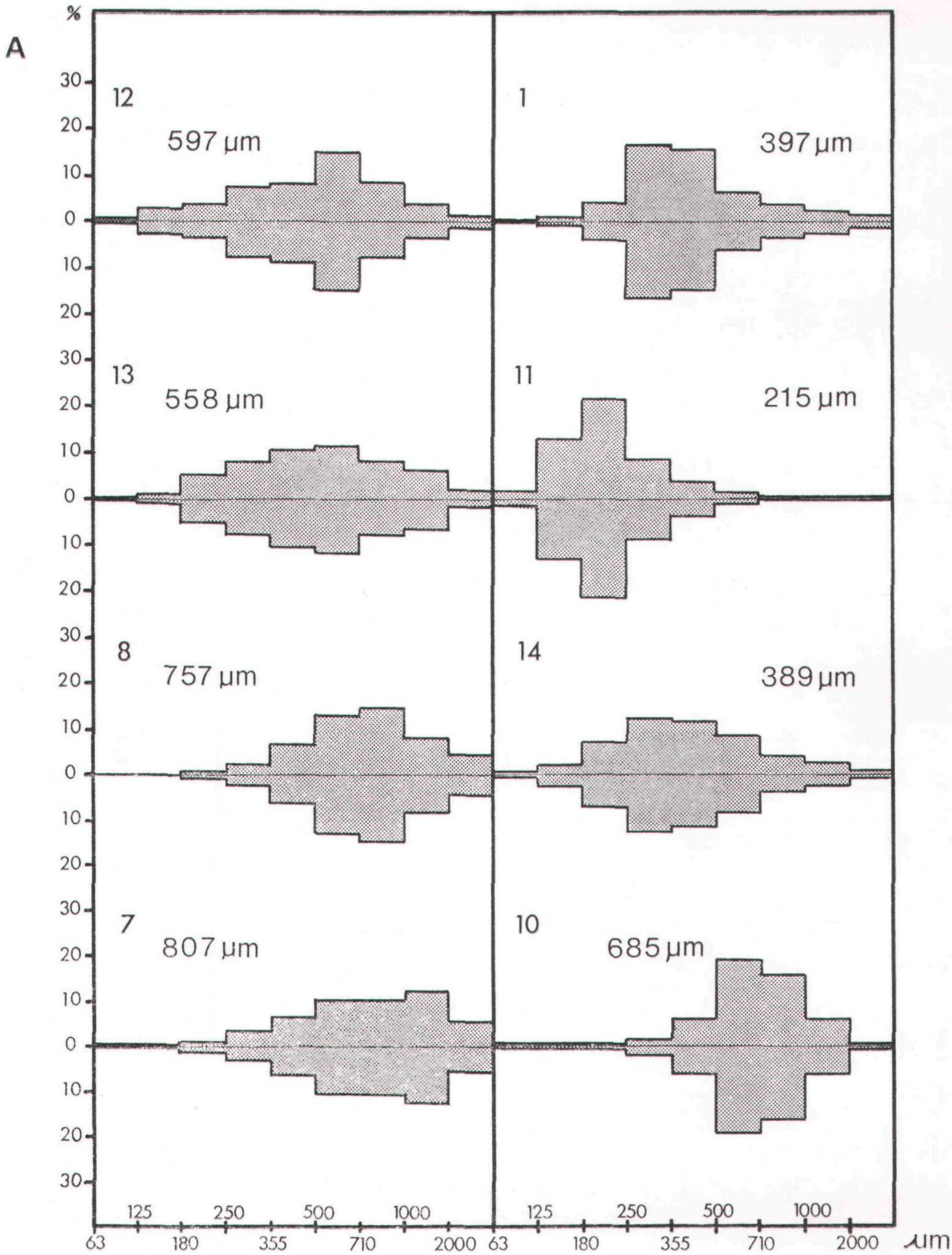

FIG. 2 A

(A, *B)* grain size compositions of **sampling** stations (expressed as weight per cent of sample; mean grain size is indicated).

Windsor **Beach** (Station **5)**

This is a gently sloping, wide and highly exposed **beach on** the south side of **the Bermuda** Islands. The **sediment** seems to have a very low

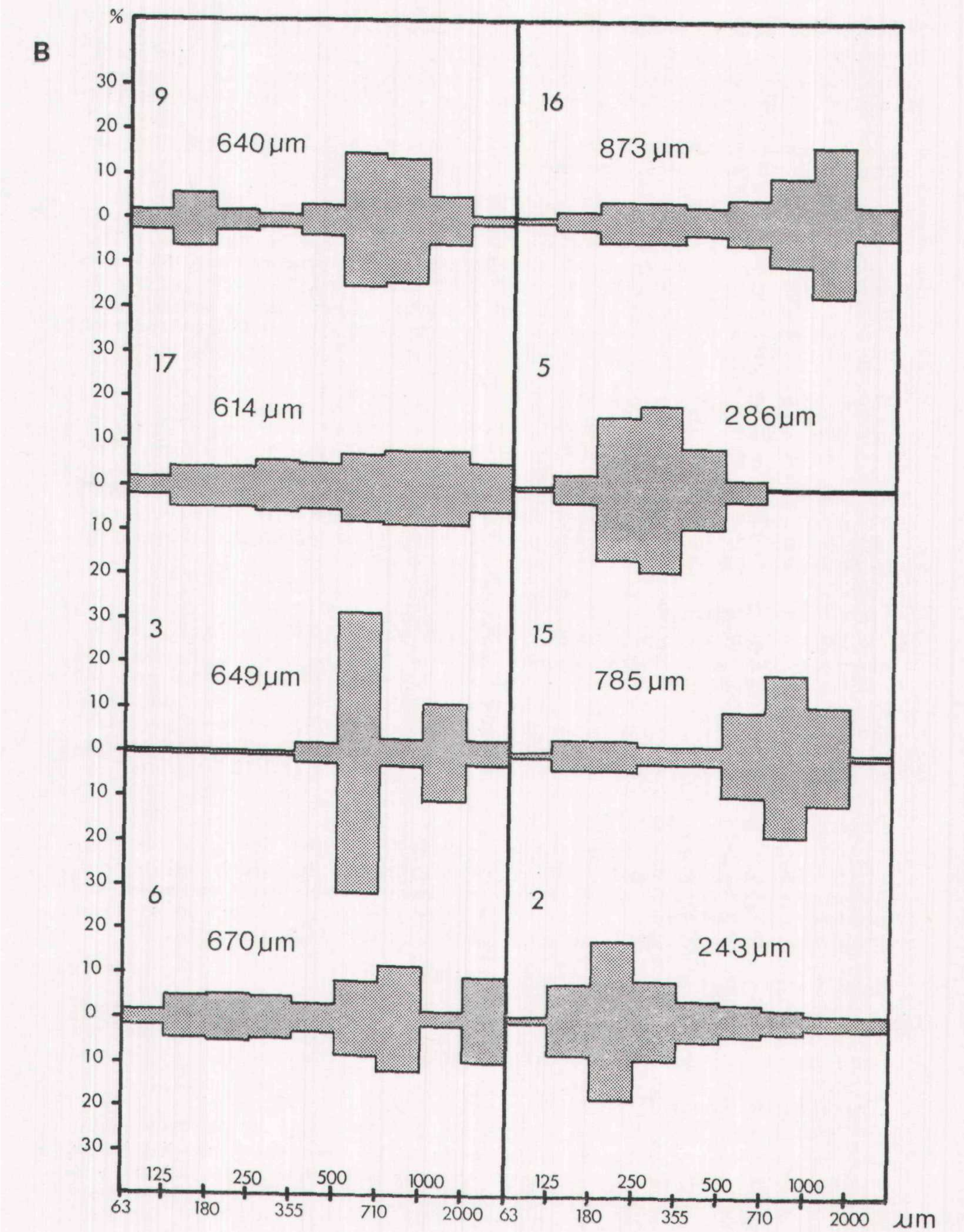

FIG. 2 B

content of particulate organic material. The sediment analysis showed 38.1 per cent fine sand an 54.9 per cent medium sand (mean grain size 286µm), with only 0.2 per cent very line sand and 6.1 per cent coarse sand.

Shelly Bay Beach (Station 6)

This is a semi-exposed beach on the north shore. The sediment, interspersed with shell fragments, appeared to contain little organic matter. The proportions of fine, medium and coarse sand were 19, 15.1 and 40.9 per cent respectively (mean grain size 670µm). Very fine sand and very coarse sand accounted for 2.2 per cent and 2.9 per cent, and the granule fraction for 19.7 per cent.

North Rock **Reef** (Station **7)**

This station was located nearly 7 miles off the north coast. The sediment, from a water depth of about 3 to 4m, was coarser, 66.7 per cent of the grains being between 0.5 and 2.0mm. Of this fraction, coarse sand accounted for 41.8 per cent of the grains (mean grain size 807µm). The fine sand and the medium sand fractions were 2.1 and 19.6 per cent of the total. The sediment contained a large amount of fine organic particles.

Three Hills Shoals (Station **8)**

The station was located in a sand-floored in an interarea with sandy bottom between coral knobs, nearly 3.5 miles off the north shore. The water depth was about 2.5m. The sediment analysis showed 18 per cent **medium** sand and 55.8 per cent coarse sand (mean grain size 757µm). 25 per cent of the grains were larger than 1000 µm. Fine sand accounted only for 1.2 per cent. The content of particulate organic material appeared to be high.

Stovell **Bay** (Station **9)**

The beach is situated in a cove opening to the west, and could be characterized as a sheltered one. The layer of oxidized sediment was only about 2cm thick, then reducing conditions prevail. The lack of a sufficient water exchange connected with a low oxygen input into the sediment may be the reason for this situation. The sediment consisted of 57.5 per cent coarse sand (mean grain size 640µm). The proportions of fine, medium and very coarse sand were 15.3, 10.3 and 10.7 per cent.

Devonshire **Bay** (Station 1**0)**

This beach on the south shore, although situated in a cove, can be characterized as exposed. The waves can reach the beach unhindered. The content of organic debris was very low. The sediment was composed predominantly of coarse fractions (83.7 per cent larger than 0.5mm; mean grain size 685µm). Medium sand accounted for 14.8 per cent.

John Smith's **Bay** (Station 11**)**

This wide beach with clean sediment was very exposed. Fine sand (at (58.7 per cent) was dominating (mean grain size 215µm). The medium sand fraction was 24.8 per cent of the total.

Trunk Island **Beach** (Station **12)**

Trunk Island is located in Harrington Sound, one of the four major marine inshore water basins of Bermuda. The sediment from this beach consisted of 47.3 per cent coarse sand (mean grain size 557µm) and 30 per cent medium sand. The proportions of fine and very coarse sand were 11.5 and 7.2 per cent respectively. The light coloured sediment appeared to contain a relatively low content of organic material.

Trunk Island/Rabbit Island (Station **13)**

This station, situated between Trunk Island and Rabbit Island in Harrington Sound, was at a water depth of about 2m. The content of particulate organic matter appeared to be high. Medium sand (at 36.2 per cent) and coarse sand (at 39.1 per cent; mean grain size 558µm) were dominating. Fine sand accounted for 6.6 per cent, and the very coarse fraction for 13.4 per cent.

Hungry Bay (Station **14)**

This bay, on the south shore, is a small cove with a narrow entrance. The bay is protected against strong wave action by rock formations behind the entrance. Tidal movements guarantee an exchange of water. Stands of red mangroves, bordering the bay, contribute to the input of detrital material into the cove. The samples were taken from a water depth of 1.2m. The sediment analysis showed 18.7 per cent fine sand, 48.4 per cent medium sand (mean grain size 389µm) and 25.4 per cent coarse sand, with only 0.6 per cent of very fine sand and 4.6 per cent of very coarse sand.

Ely's Harbour (Station **15)**

The sampled beach is located at the northern end of Ely's Harbour. The harbour, opened to the west, is protected by several little rocky islands, which nearly close the entrance. Therefore the beach could be considered as being sheltered. The sediment seemed to have a large amount of organic particles. A high percentage (55.1 per cent) of coarse sand was recorded, with 21.2 per cent very coarse sand and only 7.6 per cent medium sand. The fine sand fraction was 13.5 per cent of the total. The mean grain size here was 785µm.

Long **Bay Beach** (Station **16)**

This extended beach opens directly into the sea in north-western tlirection. It may be characterized as being a rather exposed beach. The light coloured sediment contained many small shell fragments. The grain size composition showed a high percentage (71.0 per cent) of the coarse fraction (>0.5mm). The fine sand and medium sand fractions **were** 13.2 and 14.8 per cent of the total.

Mangrove **Bay Beach** (Station **17)**

This steep sloping beach is protected by a spit of land, extending in north-eastern direction, and by some offshore islands. The background of the beach is formed by a stand of red mangroves. The content of detrital material, contributed by the mangroves, appeared to be moderate. The mean grain size here was 614µm. The proportions of fine, medium, coarse and very coarse sand were 17.7, 20.5, 30.9 and 16.5 per cent respectively.

SYSTEMATIC ACCOUNT

Class KINETOFRAGMINOPHORA
Subclass GYMNOSTOMATA
Order KARYORELICTIDA
Family TRACHELOCERCIDAE

TRACHELORAPHIS ***INCAUDATUS*** (Kahl, 1933)

Station 7.

Mesopsammal bio lopes.

Description: see Hartwig (1977).

Mesopsammal distribution. Baltic Sea, Coast of North Yorkshire (England), French Atlanti• Coast, **Gulf** of Naples, Caspian Sea, Russian and Rumanian Coast of the Black Sea, Hay of Bengal, Japan Sea.

Family LOXODIDAE

(?) *KENTROPHOROS GRACILE* (Raikov, 1963) (Fig. 3)

Station 8.

Purely mesopsammal species.

Our material resembles *Kentrophoros gracile,* described by Raikov (1963), in body shape, nuclear morphology and morphology of the bacteria covering the body. Body length, 640am (300-350µm reported by Raikov, 1963). Both body sides are flat; no longitudinal cytoplasmic thickening (as present in *Kentrophoros flavum* described by Raikov and Kovaleva, 1968). The anterior end shows a small rostrum; posteriorly rounded. The colour of the body is brownish.

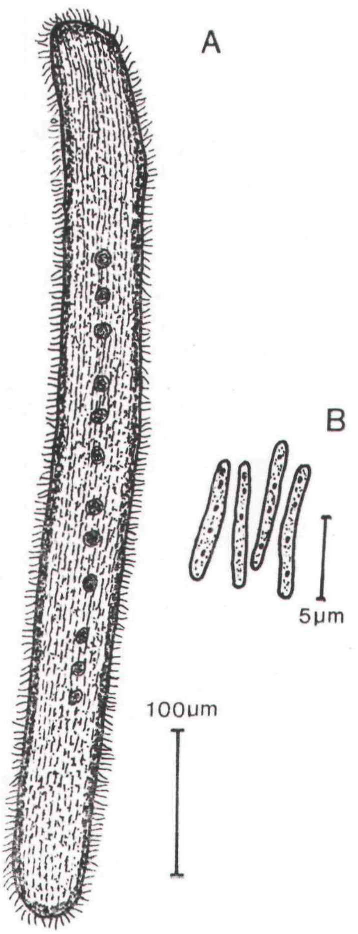

FIG. 3
Kentrophoros gracile.
(A) general aspect (ventral side) ;
(B) living isolated bacteria.

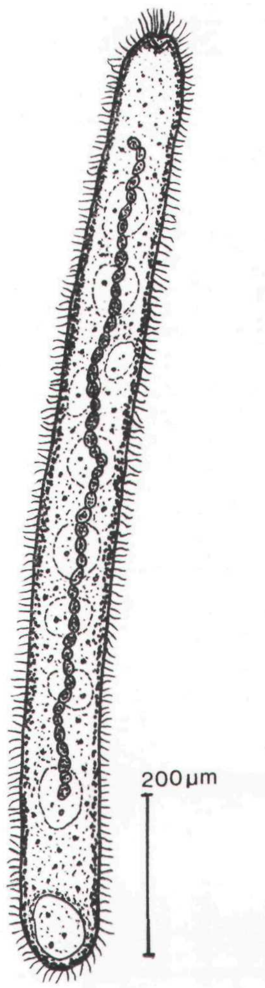

FIG. 4
Holophrya oblonga.
General aspect (without somatic ciliature).

The bacteria of the dorsal body cover are longer (8µm) than in *K. flavum* (4µm), the closest species. Nuclear apparatus composed of 12 oval MaN (forming groups of 3 fragments in each), which lie longitudinally in the cell; MiN not visible.

Mesopsammal distribution. Japan Sea (Posjet Gulf), Caspian Sea, Coast of Cameroun, Brazilian Coast.

REMANELLA RUGOSA Kahl, 1933

Stations 8, 13.

Purely mesopsammal species.

Body length, 180-240µm. Specimens conform to description given by various authors (Borror, 1963 a; Dragesco, 1960 and others).

Mesopsammal distribution. German North Sea Islands of Sylt and Helgoland, Westers Baltic Sea, French Mediterranean and Atlantic Coasts, Gulf of Naples, Barents Sea, White Sea, Rumanian and Russian Coasts of Black Sea, Caspian Sea, Sea of Japan, Atlantic Coast of United States, Coasts of Mauretania and Cameroun, Bay of Bengal, Brazilian Coast, Plymouth area (England).

Family GELEIIDAE

GELEIA NIGRICEPS Kahl, 1933

Stations 4 (also Hartwig, 1977), 8, 13.

Purely mesopsammal species.

Body length, 400-800µm. Specimens conform to detailed description as given by Hartwig (1977). The nuclear apparatus, generally consisting of 2 macronuclei with an intercalary micronucleus, differs in some specimens from Station 8 and 13: 3 MaN with one MiN form a group in centre of the cell. At this moment it is not to decide, if this variation represents a new species.

Mesopsammal distribution. Kiel Bay (Western Baltic Sea), Norwegian Coast. German North Sea Island of Sylt, French Atlantic Coast, Black Sea, Sea of Japan. White Sea, Barents Sea.

GELEIA ORBIS Fauré-Fremiet, 1950

Stations 4 (also Hartwig, 1977), 8, 13.

Purely mesopsammal species.

Body length, ca. 1300am. Specimens from the three stations correspond very well with the description given by Hartwig (1977).

Mesopsammal distribution. French Coast, Norwegian Coast, Black Sea, White Sea, Barents Sea, Sea of Japan, Atlantic Coast of United States, Gulf of Naples, Brazilian Coast.

(?) *GELEIA FOSSATA* Kahl, 1933

Station 8.

Purely mesopsammal species.

One specimen was examined and identified as *Geleia fossata.* Body length, 560µm as againsl 300-500µm reported by Dragesco (1960, 1965) and Fauré-Fremiet (1950). Anterior of worm-shaped body extended to a "beak". Frontal groove clearly visible. Body sides parallel tapering to rounded posterior end. Cytoplasm brown pigmented. Nuclear apparatus, situated at centre of body, is composed of 2 MaN and 1 MiN. According to Nouzarède (1976) G. *fossata* belongs to a group of 10 similar species (G. *nigriceps* Kahl, 1933; G. *decolor* Kahl, 1933; G. *simplex* Fauré-Fremiet, 1951; G. *swedmarki* Dragesco, 1954; G. *obliqua* Dragesco,, 1960; G. *hyalina* Dragesco, 1960; G. *tenuis* Dragesco, 1954; *G. heterotricha* Dragesco, 1960; G. *vacuolata* Dragesco, 1960).

Mesopsammal distribution. Kiel Bay (Western Baltic Sea), Plymouth area (England), French Atlantic Coast, Atlantic Coast of United States, White Sea, Coast of Mauretania, Black Sea, Barents Sea, Sea of Japan, Brazilian Coast, Bay of Bengal, Gulf of Naples.

Order PROSTOMATIDA
Family PRORODONTIDAE

HELICOPRORODON GIGAS (Kahl, 1933)

Station 4.

Mcsopsammal and other biotopes.

Body length of the worm-shaped, contractile specimens 800µm: Dragesco (1960) reported lengths of 220-2000µm. My material conforms to descriptions given by Dragesco (1960) and Hartwig (1973 a).

***Mesopsammal** distribution.* **German** North Sea Islands **of** Sylt and Helgoland, Norwegian Coast, French Atlantic Coast, Gulf of Naples, Black Sea, Caspian Sea, White Sea, Barents Sea, Sea of Japan, Western Baltic Sea (Kiel Bay), Coast of Mauretania, East Coast of United States, Brazilian Coast.

HELICOPRORODON BARBATUS Dragesco, 1954

Station 13.

Purely psammobiotic species.

Body length, contracted 600am; Dragesco (1960) reported 400-2000µm. *Helicoprorodon barbatus* resembles very much the preceding species, but differs in several points. The anterior end, with the spirally running ciliary rows, has 10 distinct ectoplasmic ”horns” (like tentacles) as described by Dragesco (1960). The cytoplasm contains bundled trichites irregularly distributed. Ectoplasm filled with small trichocysts in bundles. The nuclear apparatus consists of about 30 spherical MaN elements arranged in a chain. Vacuole present in rounded posterior end.

Mesopsammal distribution. French **Coast** (Roscoff, Banyuls-sur-Mer), Coast of Mauretania, Gulf of Naples, Brazilian Coast.

HELICOPRORODON MULTINUCLEATUM Dragesco, 1960

Stations 4 (Hartwig, 1977), 14.

Purely mesopsammal species.

Body length, extended, ca. 1500µm; contracted, ca. 680µm. Conforms to description given by Hartwig (1977).

***Mesopsammal** distribution.* White Sea, French Atlantic Coast, Coast of Brazil.

(?) *HELICOPRORODON MINUTUS* Bock, 1952

Station 7.

Purely mesopsammal species.

Body length, 320µm; various authors (Bock, 1952; Dragesco, 1960; Hartwig, 1973 a) reported lengths of 150-300µm. One specimen was examined and identified. Body shape cylindrical with parallel sides, tapering to the rounded posterior end. Ciliature **of** anterior end resembles *Helicoprorodon gigas.* Anterior end with long, fine trichites and dark-pigmented due to endoplasmic inclusions. Trichocysts in cytoplasm and elongated, terminal cilia, described by Dragesco (1960), not visible. Contractile vacuole terminal. Nuclear apparatus consists of 10 oval MaN located in middle of cell; MiN not observed.

Mesopsammal distribution. Western Baltic Sea (Kiel Bay), German North Sea Island of Sylt, French Atlantic Coast, Black Sea, Caspian Sea, White Sea, Sea of Japan, Coast of Mauretania, Coast of **Brazil,**

PSEUDOPRORODON ARENICOLA Kahl, 1933

Stations 1, 13.

Only found in marine mesopsammal.

Body length of specimens, ca. 700am. Our material was identical to the descriptions given by various authors (Dragesco, 1960; Fauré-Fremiet, 1950; Hartwig, 1973 a; Hartwig and Parker, 1977; Kahl, 1933; and others), except for a pattern on the pellicula described by Bock (1952), which we did not observe.

Mesopsammal distribution. Kiel Bay, German North Sea Island of Sylt, North Yorkshire Coast (England), **Norwegian** Coast, Barents Sea, White Sea, French Mediterranean and Atlantic Coasts, Caspian Sea.

Family HOLOPHRYIDAE

HOLOPHRYA *OBLONGA* **Maupas,** 1883 (Fig. 4)

Stations 7.

Mesopsammal and other biotopes.

Body length, 1100µm; **300-1600**µm reported by Kahl (1935) and Dragesco (1960, 1963). Vermicular shape with parallel sides and rounded posterior. Unarmed, slitlike cytostome anteriorly, as described by Dragesco (1960). Endoplasm brown pigmented due to numerous inclusions. Body with vacuolated cytoplasm. Contractile vacuole terminal. Somatic ciliature complete and uniform, consisting of more than hundred kineties. Monoliform MaN comprised of about 45 oval elements.

Mesopsammal distribution. French Atlantic Coast, Norwegian Coast.

Family COLEPIDAE

COLEPS PULCHER Spiegel, 1926

Stations 1, 4, 8, 14, 17.

Mesopsammal and other biotopes.

Body length, 64-88µm; Spiegel (1926) reported lengths of up to 100µm. The pattern of the pellicular plates ascertains the identification. They are of Kahl's type 3 (Kahl, 1930: p. 132): without exposed frame structures; longitudinally with an undulating low ridge in the middle of plate. The cilia are arising from identations on pellicular plates, between two spine-like teeth. Macronucleus central with adjacent, spherical micronucleus. Long, caudal cilia present. At anterior-lateral margins of body plates with 2-4 rounded projections, each with **a** spine-like tooth. Number of caudal thorns up to 9 (the number varies with body size; Borror, 1963 a).

Mesopsammal distribution. Plymouth area (England), German North Sea Islands Helgoland and Sylt, Western Baltic Sea (Kiel Bay), French Atlantic and Mediterranean Coasts, Gulf of Naples, Coast of Mauretania, Caspian Sea, White Sea, Barents Sea, Sea of Japan, East Coast of **DSA.**

COLEPS TESSELATUS Kahl, 1930

Stations 1, 4 (also Hartwig, 1977), 16.

Mesopsammal biotopes.

Body length of specimens varies between 40-88µm (Hartwig, 1977, reported a specimen of 128µm). The pellicular plates are of Kahl's type 3 (Kahl, 1930), but with some modifications: a reticulate pattern is visible caused by longitudinal ridge of middle of plate and stiffening **of** teeth; "windows" are absent, but longitudinal the ridge has arched stiffenings, visible from underneath (this feature serves as a distinguishing **help** from ***Coleps*** *pulcher).* Anterior 3 lateral **spines at** each side. Number of caudal spines **up** to **7** (Hartwig, 1973 **a: 3-4** spines). Long cilia terminal. Spherical **MaN** with adjacent **MiN.** Food vacuole contains **unicellar** algae.

Mesopsammal distribution. North American E;ist Coast (Cape Cod), German North Sea Island of Svlt, Baltic **Sea,** Atlantic Coast of France, French Mediterranean Coast, Gulf of Naples, Barents Sea, White Sea. Caspian Sea, Sea of Japan, Black Sea, Bay of **Bengal.**

Order **HAPTORIDA**
Family **ENCHELYIDAE**

LACRYMARIA CORONATA Clap, **et** Lachm., 1858

Stations 4, 5, 6.
Eurytopic species.

Body length, ca. 250µm; very flexible. Conform to **description** given by Hartwig and Parker (1977).

Mesopsammal distribution. **German** Coast of Baltic Sea, Coast of North Yorkshire **(England),** Rumanian Coast of Black Sea, West Coast of Africa (Ivory Coast, Cameroun). French Atlantic and Mediterranean Coasts, Caspian Sea, White Sea, Sea of Japan, Adriatic Sea.

LACRYMARIA MARINA Kahl, 1933

Stations 11.

Mesopsammal and other biotopes.

Body length, ca. 400µm. In body shape, dilatability and flexibility of neck, and single elongated, oval MaN, specimens corresponded with descriptions given by Dragesco (1963).

Mesopsammal distribution. Baltic Sea. German North Sea Island of Sylt, French Atlantic Coast, Gulf of Naples, Caspian Sea, Barents Sea, White **Sea,** Coast of Brazil.

Family DIDINIIDAE

MESODINIUM PUPULA Kahl, 1933

Stations 2, 3, 6, 7, 9, 11, 12, 14, 16, 17.

Mesopsammal biotopes.

Body length, 20-30µm. Identical with the species described and illustrated by Dragesco (1963). Black inclusions in anterior body half very conspicuous.

Mesopsammal distribution. Baltic Sea, German North Sea Island of Sylt, White Sea, French Atlantic and Mediterranean Coasts, Gulf of Naples, Caspian Sea, Sea of Japan, American East Coast (Cape Cod), West Coast of Africa (Ivory Coast).

Order PLEUROSTOMATIDA
Family AMPHILEPTIDAE

LOXOPHYLLUM ***SETIGERUM*** var. *FIBRILLATUM* Dragesco. 1960

Station 10.

Mesopsammal species.

Body length of specimens only ca. 90µm as against 124-280µm reported by various authors (Hartwig, 1973 a; Dragesco, 1960; Hartwig and Parker, 1977). This species is very closely related to the **species** group of *setigerum*-type *(L.* ***setigerum, L. pseudosetigerum, L.*** *variabilis* and *L.* ***kahli)*** : common feature is presence of peribuccal papillae within the region of the cytostome. Lancet-like shape of body. Two contractile vacuoles along dorsal border. *L. setigerum* var. ***fibrillation*** is characterized by nuclear **apparatus** of four MaN in a row and lack of marginal spines.

Mesopsammal *distribution.* French Atlantic Coast. German North Sea Island of Sylt, Coast of Yorkshire (England).

LOXOPHYLLUM UNDULATUM Sauerbrey, 1928

Station 13.

Mesopsammal species.

Body length, **40**µm**:** Kahl (1931) reported lengths up to 860µm (Dragesco, 1960, gives mean lengths of 600uµm). General body shape, arrangements of ciliary rows on right side, distinct undulating body margins, and arrangements of marginal trichocysts conform with description given by Kahl (1931). Unciliated, but striated left side of body shows distinct pigmented hump. Nuclear apparatus forms chain of 20 oval MaN elements.

Mesopsammal distribution. Western Baltic Sea (Kiel Bay), Barents Sea, Sea of Japan, French Atlantic Coast.

Subclass VESTIBULIFERA
Order TRICHOSTOMATIDA
Family COELOSOMIDIDAE

COELOSOMIDES MARINA Anigstein, 1912

Stations 4 (Hartwig, 1977), 13, 16.

Found in mesopsammal biotopes.

Body lengths, 180-280µm. Body shape cylindrical, ovoid elongated; very flexible. Ectoplasm has reticular pattern. Anterior half of body pigmented due to dark endoplasmic inclusions. Vacuolated cytoplasm as described and illustrated by Dragesco (1960), Fauré-Fremiet (1950) and others. Cytostome apical. Several contractile vacuoles situated marginally. Nuclear apparatus of single oval MaN with a micronucleus, located at centre of cell. Food vacuole, anterior, filled with algae.

Mesopsammal distribution. **French** Atlantic Coast, Caspian Sea, Black Sea, Adriatic Sea, Brazilian Coast, Bay of Bengal.

PARASPATHIDIUM *FUSCUM* (Kahl, 1928)

Stations 4, 13.

Mesopsammal and other biotopes.

Body length, 380am. Specimens conform to descriptions given by various authors (Agamaliev, 1968; Dragesco, 1960; Hartwig, 1973 a; Kahl, 1930; Petzold, 1955).

Mesopsammal *distribution.* Baltic Sea, German North Sea Island of Sylt, **Norwegian** Coast, White Sea, Coast **of** Yorkshire **(England),** French Atlantic and Mediterranean Coasts, **Rumanian** and Russian Coast of Black Sea, Caspian Sea, Sea of Japan, Coasts of Cameroun and Mauretania, Brazilian Coast.

Subclass HYPOSTOMATA
Order CYRTOPHORIDA
Family CHLAMYDODONTIDAE

CHLAMYDODON MNEMOSYNE Ehrenberg, 1837

Station 6.

Mesopsammal and other biotopes.

Body length, ca. 92µm (Dragesco, 1960, reported **130-150**µm as against 90µm by Kattar, 1970). Reniform body shape, pharyngeal basket with 9-10 trichites, posteriorly closed ringband and lack of distinct beak (as reported in *Chlamydodon triquetrus)* ascertain my identification. Our specimens differ from descriptions given by Jones (1974), Kahl (1931) and Kiesselbach (1936) by presence of pigment-spot (described by Lepsi, 1962) in left anterior-dorsal ectoplasm (consisting of red-brown granules). Anterior body end often turned up on dorsal side. Up to 8 contractile vacuoles in 2 rows at body margins. Nuclear apparatus of single oval MaN.

Mesopsammal distribution. Northern Adriatic Sea, French Atlantic Coast, Coast of Mauretania, Black Sea, Caspian Sea, Coast of Brazil, East Coast of United States.

Class OLIGOHYMENOPHORA
Subclass HYMENOSTOMATA
Order HYMENOSTOMATIDA
Family FRONTONIIDAE

FRONTONIA MARINA Fabre-Domergue, 1891

Stations 1, 4, 6, 9, 13, 14.

Eurytopic species.

Body length, 170-240µm. Specimens conform to descriptions given by various authors.

Mesopsammal distribution. Baltic Sea, Plymouth area (England), French Mediterranean and Atlantic Coasts, Gulf of Naples, Barents Sea, Black Sea, Caspian Sea, Sea of Japan, East Coast of United States, Coast of Cameroun, Brazilian Coast.

FRONTONIA FUSCA (Quennerstedt, 1869)

Station 9.

Mesopsammal and other hiotopes.

Body length, 140µm. This species resembles *Frontonia atra* Ehrenberg, 1833 and *Frontonia caneti* Dragesco, 1960, but differs in several features. Body oval, egg-shaped, and rounded at both ends (not pointed as in F. *atra).* Trichocysts 6µm long, ending at pellicle. Mouth typical of the genus. It differs from *F. atra* by lacking of pigmented ectoplasm. Our material has anterior distinct green pigmented spot, typical for *F. fusca,* different in *F. atra. Frontonia caneti* possesses a blue pigmented spot near posterior end. Single contractile vacuole. Single MaN with adjacent MiN in second body half.

Mesopsammal distribution. Kiel Bay.

(?) *FRONTONIA ABERR ANS* Dragesco, 1960

Stations 13, 14.

Purely **mesopsammal** species.

Body length, 320-480µm. In body shape, arrangement of ca. 100 ciliary rows, long caudal cilia, absence of marginal trichocysts (only interkinetal protrichocysts) and transparent, vacuolated endoplasm, our specimens corresponded with original description by Dragesco (1960). They differed from that description by presence of an elongate, oval, not dump-bell-shaped MaN with 2-3 MiN, and absence of interkinetal pellicular fields caused by traversal and longitudinal fibrils.

Mesopsammal distribution. French Atlantic Coast.

Order SCUTICOCILIATIDA
Family LOXOCEPHALIDAE

CARDIOSTOMATELLA VERMIFORME (Kahl, 1928)

Stations 2, 14.

Mesopsammal and other biotopes.

Body length, 120-320μm. Vermicular shape, tapering slightly posteriorly. Numerous ciliary meridians. Endoplasm with oval granules. Contractile vacuole terminal. Pellicular fields distinct, each with a single cilium in centre. Nuclear apparatus formed of 10-16 MaN elements, arranged in one row.

Mesopsammal distribution. German North Sea Island of Sylt, Baltic Sea, French Atlantic and Meditarranean Coasts, White Sea, Caspian Sea, Sea of Japan, Atlantic Coast of USA, Coast of Mauretania.

Family PLEURONEMATIDAE

PLEURONEMA CORONATUM Kent, 1881

Stations 1, 4, 6, 9, 13, 14, 15, 16, 17.

Eurytopic species.

Body length, 80-1 10μm. Specimens conform to descriptions given by various authors (Borror, 1963 a ; Dragesco, 1960, 1968; Kiesselbach, 1936; and others).

Mesopsammal distribution. Elbe Estuary (Germany), German North Sea Island of Sylt, White Sea, Mediterranean and Atlantic Coasts of France, Gulf of Naples, Rumanian and Bulgarian Coasts of Black Sea, Caspian Sea, Coast of Cameroun, Coast of Yorkshire (England), East Coast of United States, Bay of Bengal, Coast of Brazil.

(?) *PLEURONEMA GRASSEI* Dragesco, 1960

Station 13.

Purely mesopsammal species.

Body length, 80μm as against 140-210μm reported by Dragesco (1960). The nuclear apparatus represented by two MaN ascertains the identification of my specimens as *Pleuronema grassei.* It differs by the number of MiN (2 as against 5-7 indicated by Dragesco, 1960).

Mesopsammal distribution. This species has been reeorded from the Caspian Sea, and was originally described from Lac Léman (Suisse).

Class POLYHYMENOPHORA
Subclass SPIROTRICHA
Order HETEROTRICHIDA
Family SPIROSTOMATIDAE

BLEPHARISMA CLARISSIMUM Anigstein, 1912

Stations 8, 13.

Purely mesopsammal species.

Body length, 440μm; ratio length: width ca. 11:1 (as against 7-8:1 for *Blepharisma clarissimum* aff. *arenicola,* described by Kahl, 1932). Body flattened transversely, and without brown colour; displays thigmotaxis. Nuclear apparatus consists of chain of 31 oval MaN elements. Contractile vacuole terminal.

Mesopsammal distribution. East Coast of United States, Baltic Sea, Coast of Norway, White Sea, Sea of Japan, Lac Léman (Suisse), Barents Sea, Black Sea, Caspian Sea, Coast of Brazil.

PARABLEPHARISMA PELLITUM Kahl, 1932

Stations 4, 8.

Purely mesopsammal species.

Body length, 160am. Specimens possess hull of bacteria as in members of genus *Parablepharisma.* This species resembles *Parablepharisma bacteriophaga* Villeneuve-Brachon in body length, general body shape (tapering to narrowly rounded posterior end, and tapering more sharply to bluntly pointed anterior end), position of cytostome, and number of somatic ciliary rows (ca. 40), but differs distinct in the nuclear apparatus (comprised of 3 to 5 oval MaN; Kahl, 1932, reported 6-10 MaN). Contractile vacuole terminal.

Mesopsammal distribution. Western Baltic Sea, Caspian Sea, East Coast of United States.

Family CONDYLOSTOMATIDAE

CONDYLOSTOMA ARENARIUM Spiegel, 1926

Stations 2, 4, 7 (Hartwig, 1977), 12.

Eurytopic species.

Body length, 320-600µm. Morphological variations within this species have been reported by several authors (see Hartwig and Parker, 1977). Kiesselbach (1935) demonstrated the effect of temperature on total body length, body shape, and configuration of MaN in this species. Number of kineties, 28-40. Macronucleus moniliform with 8-16 oval elements. Food vacuoles contain diatoms.

Mesopsammal dislribution. **German** North Sea Islands of Helgoland and Sylt, Boreal Seas of USSR (White Sea, Barents Sea), French Atlantic and Mediterranean Coasts, Gulf of Naples, Black Sea, Caspian Sea, Sea of Japan, Coast of Yorkshire (England), Atlantic Coast of United States, Bay of Bengal, Coast of Mauretania, Brazilian Coast.

CONDYLOSTOMA ***REMANE!*** Spiegel, 1928

Stations 4 (Hartwig, 1977), 17.

Only mesopsammal biotopes.

Body length, ca. 500µm. Specimens corresponded with various descriptions in general body shape, arrangement of ciliary rows and chain of 15-22 MaN elements. *Condylostoma remanei* may be distinguished from *C. fjeldi* by its nuclear apparatus; in the latter, numerous oval MaN elements are scattered throughout the cytoplasm. Food vacuoles with diatoms.

Mesopsammal distribution. Baltic Sea, Norwegian Coast, North Sea Island of Sylt, Coast of Yorkshire, Boreal Seas of USSR, French Atlantic and Mediterranean Coasts, Gulf of Naples, Black Sea, Caspian Sea, Sea of Japan, Atlantic Coast of United States, Brazilian Coast.

Family PERITROMIDAE

PERITROMUS FAUREI Kahl, 1932

Stations 4 (also Hartwig, 1977), 14, 17.

Eurytopic species.

Body length, ca. 120µm. Identical with description given by Hartwig (1977); some specimens showed papillae on dorsal surface, shaped like a golf tee, as reported by Borror (1963 a) and Hartwig (1973 a).

Mesopsammal distribution. Coast of Yorkshire (England), German North Sea Island of Sylt, Baltic Sea, Norwegian Coast, White Sea, French Mediterranean and Atlantic Coasts, Caspian Sea, Sea of Japan, Atlantic Coast of United States, Black Sea.

Order HYPOTRICHIDA

Family STRONGYLIDIIDAE

UROSTRONGYLUM CAUDATUM Kahl, 1932

Stations 4 (also Hartwig, 1977), 13, 14.

Mesopsammal biotopes.

Body length, ca. 200µm. Conformed with original description by Kahl (1932).

Mesopsammal distribution. German North Sea Island of Sylt, Western Baltic Sea, French Atlantic Coast, Gulf of Naples, Caspian Sea, White Sea, Atlantic Coast of United States, Brazilian Coast, Plymouth area (England).

Family HOLOSTICHIDAE

HOLOSTICHA DISCOCEPHALUS Kahl, 1932

Station 4.

Mesopsammal and other biotopes.

Body length, 200µm. Our material was identified as *Holosticha discocephalus* by presence of head-like anterior part, 2 ventral rows of cirri, 2 distinct frontal cirri, 9 transverse cirri, not extending beyond posterior end, and nuclear apparatus of numerous oval MaN elements.

Mesopsammal distribution. Western Baltic Sea, Plymouth area (England), French Atlantic and Mediterranean Coasts, White Sea.

TRACHELOSTYLA PEDICULIFORMIS (Cohn, 1866)

Station 8.

Eurytopic species.

Body length, 200µm. Identical with species described and illustrated by Kahl (1932).

Mesopsammal distribution. German North Sea Island of Sylt, Baltic Sea, Norwegian Coast, Plymouth area and Coast of Yorkshire (England), French Mediterranean Coast and Gulf of Naples, White Sea, Caspian Sea, Atlantic Coast of United States, Coast of Brazil.

Family KERONIDAE

EPICLINTES AMBIGUUS (O.F. Müller, 1786)

Station 4 (see also Hartwig, 1977).
Eurytopic species.

Body length, 100-200µm; Kahl (1932) called attention to the variability in body length of this species.

Mesopsammal distribution. Baltic Sea, German North Sea Island of Sylt, Coast of Yorkshire and Plymouth area (England), White Sea, Gulf of Naples, French Atlantic and Mediterranean Coast, Black Sea, Caspian Sea, Sea of Japan, Bay of Bengal, Coast of United States, Coast of Mauretania, Adriatic Sea, Brazilian Coast.

Family OXYTRICHIDAE

OXYTRICHA DISCIFERA Kahl, 1932

Station 2.
Mostly mesopsammal biotopes.

Body length, 160µm: Kahl (1932) reported lengths of 180-240µm. Our material conforms to description given by Kahl (loc. cit.) in general body shape (head-like anterior part and rounded end), arrangements of 2 marginal cirri rows and 13 fronto-ventral cirri, presence of 5 transverse cirri and nuclear apparatus of 2 oval MaN. Similar "cephalization" occurs in *Oxytricha stenocephala* Borror, O. *longicirrata* Kahl, *Holosticha discocephalus* Kahl, *Amphisiella lithophora* Fauré-Fremiet and *A. faurei* Dragesco. These species are clearly distinct from *Oxytricha discifera* (see table 1).

Mesopsammal distribution. Western Baltic Sea, White Sea, Black Sea, Caspian Sea, Barents Sea, Sea of Japan. Adriatic Sea.

Family ASPIDISCIDAE

(?) *ASP1D1SCA LYNCASTER* (O.F. Müller) Stein, 1859

Station 3.
Mesopsammal and other biotopes.

Body length, 64am. Our material is identified as *Aspidisca lyncaster* by the presence of 5 transverse cirri, 7 fronto-ventral cirri, 4 marginal dents (3 on left side, 1 caudal) and a horseshoe-shaped MaN, and differs from the descriptions of various authors by the absence of a "satellite" cirrus between transverse and ventral cirri.

Table 2 summarizes the morphological features of these species of Aspidisca which have marginal dents.

Mesopsammal distribution. German Xorth Sea Island of Sylt, Western Baltic Sea, White Sea, French Atlantic Coast, Black Sea, Caspian Sea.

TABLE 1

Morphological characteristics of some selected species with head-like anterior body end ("cephalization")

Species	Body length (µm)	No. of marginal cirri	No. of caudal cirri	No. of frontal cirri	No. of ventral cirri	No. of transverse cirri	Nuclear apparatus	Shape of posterior end	Remarks
Oxytricha discifera Kahl, 1932	160-240	1 left and 1 right row	—	13 fronto-ventral cirri		5	2 MaN	rounded	—
Oxytricha stephanocephala Borror, 1963	160-220	1 left and 1 right row	2	15 fronto-ventral cirri		5	2 MaN	constricted	—
Oxytricha longicirrata Kahl, 1932	150-200	1 left and 1 right row	—	5 fronto-ventral cirri		5	2 MaN	constricted	—
Holosticha discocephalus Kahl, 1932	180-280	1 left and 1 right row	—	2	2 rows	8-10	numerous MaN elements	rounded	—
Amphisiella lithophora F-F, 1954	120-135	1 left and 1 right row	—	2	1 row and 3 single cirri near peristome	7-9	numerous MaN elements	rounded	—
Amphisiella faurei Dragesco, 1963	200-320	1 left and 1 right row	—	3	13	9-12	12-38 MaN	rounded	a group of 2-3 "satellite cirri" beside the 2 left transverse cirri

TABLE 2

Morphological characteristics of selected species of *Aspidisca* (i.e. those species which possess marginal dents)

Species	Body length (µm)	No. of transverse cirri	"Satellite cirrus" between peristome and 1. transverse cirrus	"Satellite cirrus" between transverse and ventral cirri	Fronto-ventral cirri	No. of lateral dents	No. of caudal dents (form of posterior body end)	Nuclear apparatus	Remarks
A. lyncaster Stein, 1859	60-96	5	—	+	7	3-4	1-2 (serrated)	horseshoe-shaped	—
A. fusca Kahl, 1928	40-78	5	—	—	7	1	none (even)	2 oval MaN	—
A. irinae Burkovsky, 1970	40-75	5	—	—	7	—	1	2 oval MaN	—
A. caspica Agamaliev, 1967	50-60	5	—	—	7	3	none (serrated)	horseshoe-shaped	—
A. fuscoides Agamaliev, 1975	50-60	5	—	—	7	1	none (serrated)	horseshoe-shaped	—
A. maxima Vacelet, 1961	150-220	5	—	—	7	1	none (even)	horseshoe-shaped	—
A. magna Kahl, 1935	135-157	5-6 (*)	—	—	7	1	none (even)	horseshoe-shaped	(*) Tuffrau, 1964
A. tridentata Dragesco, 1963	80-100	6	+	—	7	3	none (even)	horseshoe-shaped	—
A. sedigita Quenn., 1867	70-120	6	—	+	7	2-3	1, serrated else	horseshoe-shaped	—
A. fjeldi Dragesco, 1960	60-70	6	+	—	7	1	none (even)	horseshoe-shaped	—
A. pulcherrima Kahl, 1932	70-80	6	—	+	7	3	∿ 5	horseshoe-shaped	—
A. leptaspis Fresenius, 1865	80-100	6	—	+	7	1	none (even)	horseshoe-shaped	—
A. baltica Kahl, 1932	51-73	6	—	+	7	2-3	4-5	horseshoe-shaped	—
A. dentata Kahl, 1928	20-40	6	—	—	7	1	none (even)	horseshoe-shaped	one dent on dorsal ridge
A. hexeri Quenn., 1869	50-60	6	—	—	7	1	none (even)	horseshoe-shaped	—
A. crenata Fabre-Domergue, 1885	65-70	7	—	—	7	2	none (serrated)	horseshoe-shaped	—
A. robusta Kahl, 1932	75-80	7	—	+	7	1	none (even)	horseshoe-shaped	—

Family EUPLOTIDAE

DIOPHRYS SCUTUM Dujardin, 1842

Stations 15, 17.

Eurytopic species.

Body length, 120µm. Conformed to descriptions given by various authors.

Mesopsammal distribution. Baltic Sea, German North Sea Islands of Sylt and Helgoland, French Atlantic and Mediterranean Coasts, Gulf of Naples, Plymouth area and Coast of Yorkshire (England), Black Sea, Caspian Sea, Sea of Japan, Barents Sea, White Sea, Coast of Mauretania, East Coast of United States, Coast of Brazil, Adriatic Sea.

DIOPHRYS ***APPENDICULATA*** (Ehrenberg, 1838)

Stations 3, 12.

Eurytopic species.

Body length, 50-85µm. In body length and shape, number and arrangement of cirri (5 transverses, 5 frontals, 3 ventrals, 2 left marginals and 3 strong posterior dorsals) and nuclear apparatus of 2 MaN, specimens corresponded with description given by Kahl (1932).

Mesopsammal distribution. German North Sea Islands of Sylt and Helgoland, Baltic Sea, French Mediterranean Coast, Gulf of Naples, Caspian Sea, White Sea, East Coast of United States, Bay of Bengal, Coast of Brazil.

EUPLOTES DOGIELI Agamaliev, 1967

Station 15.

Purely mesopsammal species.

Body length, 88µm as against 60µm reported by Agamaliev (1967). Our specimens are identical with species described and illustrated by Agamaliev (loc. cit.), except for one pronounced ridge on ventral side (slightly transverse on entire body length) and short ones between transverse cirri, which I did observe.

Table 3 summarizes the morphological features of *E. dogieli* and some resembling species.

Mesopsammal distribution. Caspian Sea.

URONYCHIA TRANSFUGA (O.F. Müller, 1786)

Stations 7, 8, 12, 13, 14, 17.

Eurytopic species.

Body length, 80-100µm; 50-183µm reported by Borror (1963 b). Specimens were identical to descriptions given by various authors.

Mesopsammal distribution. German North Island of Sylt, Baltic Sea, White Sea, Barents Sea, French Atlantic and Mediterranean Coasts, Gulf of Naples, East Coast of England (Plymouth area and Whitstable), Rumanian and Russian Coasts of Black Sea, Caspian Sen, Sea of Japan, East Coast of United States, Brazilian Coast.

TABLE 3

Morphological characteristics of *Euplotes dogieli* Agamaliev and sonic resembling species (BL = body length)

Species	Body length (μm)	No. of fronto-ventral cirri	No. of transverse cirri	No. of caudal cirri	No. of membranelles of adoral zone	No. of latero-dorsal rows of bristles	No. of bristles per middorsal row	Peristome length
Euplotes dogieli Agamaliev, 1967	60	9	5	3	35-38	7	13	2/3 BL
E. raikovi Agamaliev, 1966	50-60	7-8	5	3	30-35	7	11	2/3 BL
E. poljanskyi Agamaliev, 1966	55-70	8	5	3	36-40	7	10-12	2/3 BL
E. octocirratus Agamaliev, 1967	55-60	10	5	3	30-35	7	14	2/3 BL
E. strelkovi Agamaliev, 1967	45-60	8	6	3	33-38	6	10	3/4 BL
E. aberrans Dragesco, 1960	70-80	8	5	4	50	4	?	2/3 BL

TABLE 4

Morphological characteristics of known species of *Euplotidium*

Species	Body length (μm)	No. of transverse cirri	No. of fronto-ventral cirri	No. of marginal cirri	No. of caudal cirri	Dorsal ciliature	Nuclear apparatus
E. helgae n. sp.	168-200	4 (or 5 transverse cirri and 7 fronto-ventral cirri)	8	—	1	(not observed)	C-shaped MaN of 5-18 oval elements, 3MiN
E. agitatum Noland, 1937	65-95	5	9	—	—	~ 5 kineties	(not observed)
E. arenarium Magagnini et Nobili, 1964	71-121	5	10	1	—	2 marginal rows	C-shaped MaN of 5-10 fragments, 1MiN
E. psammophilus (Vacelet, 1961)	125	5	7 (3 frontal and 4 ventral)	—	2	?	horseshoe-shaped MaN, 1MiN

URONYCHIA SETIGERA Calkins, 1902

Station 3.

Mesopsammal and other biotopes.

Body length, 56µm; 40-50µm reported by Kahl (1932) and Kattar (1970). Body oval to barrel-shaped. The cirri pattern as described by Kahl (1932): 2 left marginal cirri, 5 transverse cirri, and 3 strong posterior dorsals. The macronucleus consists of one oval element.

Mesopsammal distribution. **Brazilian Coast, Plymouth** area (England).

Family GASTROCIRRHIDAE

EUPLOTIDIUM HELGAE n. sp. (Fig. 5)

Stations 7, 8, 13.

Body length, 168-200µm. Body of oval to cylindrical shape, ventrally flat and dorsally convex. The peristome is widely open anteriorly and appears nearly circular in front view. The cytostome

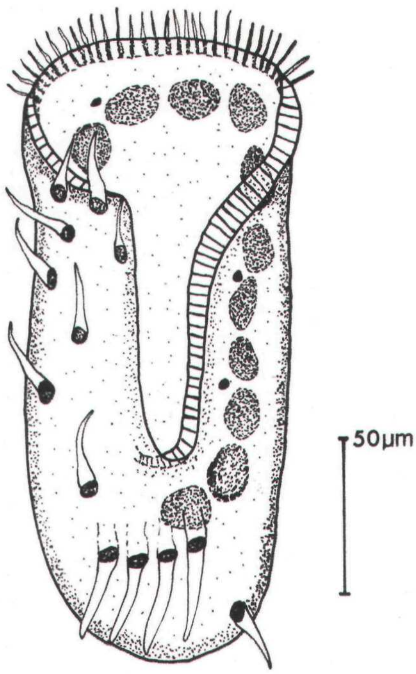

FIG. 5
Euplotidium helgae n. sp.
General aspect.

lies at end of narrow peristomial furrow in posterior half of body. Well developed adorai zone with about 70 membranelles. Ventral ciliature of 4 transverse cirri, 8 fronto-ventral cirri (one ventral cirrus very close to right side of transverse cirri, so that it might be regarded as part of this cirri complex. This would mean: 5 transverse cirri and 7 fronto-ventral cirri) and one left caudal cirri. Marginal cirri are lacking. Dorsal kineties not observed. Cytoplasm

TABLE 5

List of interstitial ciliate species recorded from Bermuda **(**+ indicate the presence **of** the species **;** — not observed)

Species	Sampling stations																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Aspidisca lyncaster	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Blepharisma clarissimum	—	—	—	—	—	—	—	+	—	—	—	—	+	—	—	—	—
Cardiostomatella vermiforme	—	+	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—
Chlamydodon mnemosyne	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—
Coelosomides marina	—	—	—	+	—	—	—	—	—	—	—	—	+	—	—	+	—
Coleps pulcher	+	—	—	+	—	—	—	+	—	—	—	—	—	+	—	—	+
Coleps tesselatus	+	—	—	+	—	—	—	—	—	—	—	—	—	—	—	+	—
Condylostoma arenarium	—	+	—	+	—	—	+	—	—	—	—	+	—	—	—	—	—
Condylostoma remanei	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	+
Diophrys appendiculata	—	—	+	—	—	—	—	—	—	—	—	+	—	—	—	—	—
Diophrys scutum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	+
Epiclintes ambiguus	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Euplotes dogieli	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—
Euplotidium helgae	—	—	—	—	—	—	+	+	—	—	—	—	+	—	—	—	—
Frontonia aberrans	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	—	—
Frontonia marina	+	—	—	+	—	+	—	—	+	—	—	—	+	+	—	—	—
Frontonia fusca	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—
Geleia fossata	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
Geleia nigriceps	—	—	—	+	—	—	—	+	—	—	—	—	+	—	—	—	—
Geleia orbis	—	—	—	+	—	—	—	+	—	—	—	—	+	—	—	—	—
Helicoprorodon barbatus	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Helicoprorodon gigas	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Helicoprorodon multinucleatum	—	—	—	+	—	—	—	—	—	—	—	—	—	+	—	—	—
Helicoprorodon minutus	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—
Holophrya oblonga	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—
Holosticha discocephalus	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Kentrophoros gracile	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
Lacrymaria coronata	—	—	—	+	+	+	—	—	—	—	—	—	—	—	—	—	—
Lacrymaria marina	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—
Loxophyllum setigerum var. *fibrillatum*	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—
Loxophyllum undulatum	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Mesodinium pupula	—	+	+	—	—	+	+	—	+	—	+	+	—	+	—	+	+
Oxytricha discifera	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Parablepharisma pellitum	—	—	—	+	—	—	—	+	—	—	—	—	—	—	—	—	—
Paraspathidium fuscum	—	—	—	+	—	—	—	—	—	—	—	—	+	—	—	—	—
Peritromus faurei	—	—	—	+	—	—	—	—	—	—	—	—	—	+	—	—	+
Pleuronema coronatum	+	—	—	+	—	+	—	—	+	—	—	—	+	+	+	+	+
Pleuronema grassei	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Pseudoprorodon arenicola	+	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—
Remanella rugosa	—	—	—	—	—	—	—	+	—	—	—	—	+	—	—	—	—
Tracheloraphis incaudatus	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—
Trachelostyla pediculiformis	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
Uronychia setigera	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Uronychia transfuga	—	—	—	—	—	—	+	+	—	—	—	+	+	+	—	—	+
Urostrongylum caudatum	—	—	—	+	—	—	—	—	—	—	—	—	+	+	—	—	—
Numbers of species at **each** location	5	4	4	18	1	5	7	11	4	1	2	4	16	10	3	4	7

darkened by granules. MaN C-shaped, consisting of 5-18 oval elements, with, about 3 MiN. Food vacuoles with algae.

The general shape of body, size and peristome places this gastrocirrhid in the genus *Euplotidium. E. helgae* differs distinctly from the other known species (table 4).

Etymology : I wish to dedicate this species to my wife Helga.

DISCUSSION

In addition to the reports by Hartwig (1977), the present paper increases the amount of species of interstitial ciliates now known from marine sands of the Bermuda Islands to 45; these are listed in table 5. *Euplotidium helgae* is considered as new and hitherto undescribed. This paper gives the second record of the species ***Euplotes** dogieli, Frontonia aberrans,* and *Frontonia fusca* from the sand lacunar system. The vast majority of the reported species shows a cosmopolitan distribution. This is presented in Fig. 6 for some obligatorily interstitial species (e.g. *Geleia fossata, Geleia nigriceps, Remanella rugosa, Tracheloraphis incaudatus)* and for some adapted species to a life in the lacunar system (e.g. *Condylostoma arenarium* and *Condylostoma remanei)* (for a more recent reviewsee Corliss and Hartwig, 1977).

In comparison with the microfauna of the German Bight and the English coast that of the Bermuda Islands shows the cosmopolitan character of the ciliatc fauna by the approximate correspondence of the quotients (table 6) on the basis of similarity quotients QS (after Juario, 1975), in spite of environmertal differences between the biotopes.

TABLE 6

Comparison of fauna of Bermuda (B), English Coast (EC) and German Bight (GB) areas (j = number of species common to both areas; a,b = number of species restricted to each area)

	B	EC	GB
Total number of species	45	96	99
	B and EC	B and GB	EC and GB
Number common to both areas (j)	22	25	38
Quotient of similarity (QS) = 2j/(a+b)	0.31	0.35	0.38

A high conformity with the interstitial ciliate fauna of the east coast of the American continent has also been confirmed. 30 of the 45 Bermuda species are reported from this coast (for records sec Borror, 1963 a, b; Fauré-Fremiet, 1951; Jones, 1974; Kattar, 1970, 1976; Lackey, 1936). They are distributed as follows: 8 species are common to the coast of Brazil *(Coelosomides marina, Helicoprorodon barbatus, Helicoprorodon minutus, Helicoprorodon multinucleatum,* *Kentrophoros gracile, Lacrymaria marina, Paraspathidium fuscum, Uronychia transfuga),* 6 species are common to the east coast of the USA, including the Gulf of Mexico *(Cardiostomatella vermiforme, Coleps pulcher, Coleps tesselatus, Mesodinium pupula, Parablepharisma pellitum, Peritromus faurei)* and 16 species are common to both regions.

TABLE 7

Distribution of species, recorded from the East Coast of the American Continent and common to the Bermuda Islands, in relation to the latitude (32°N) of Bermuda

Species	North of Bermuda latitude (32°N)	South of Bermuda latitude (32°N)
Blepharisma clarissimum	+	+
Cardiostomatella vermiforme	—	+
Chlamydodon mnemosyne	+	+
Coelosomides marina	—	+
Coleps pulcher	—	+
Coleps tesselatus	+	—
Condylostoma arenarium	—	+
Condylostoma remanei	+	+
Diophrys appendiculata	—	+
Diophrys scutum	+	+
Epiclintes ambiguus	+	+
Frontonia marina	—	+
Geleia fossata	+	+
Geleia orbis	+	+
Helicoprorodon barbatus	—	+
Helicoprorodon gigas	+	+
Helicoprorodon minutus	—	+
Helicoprorodon multinucleatum	—	+
Kentrophoros gracile	—	+
Lacrymaria marina	—	+
Mesodinium pupula	+	—
Parablepharisma pellitum	+	—
Paraspathidium fuscum	—	+
Peritromus faurei	—	+
Pleuronema coronatum	—	+
Remanella rugosa	—	+
Trachelostyla pediculiformis	—	+
Uronychia setigera	—	+
Uronychia transfuga	+	+
Urostrongylum caudatum	+	+
Numbers of species	13	27

When studying the relation of the distribution of the 30 species reported from the American east coast and also common to the microfauna of Bermuda to the latitude 32° N (table 7) on which the Bermudas are situated, we find 13 species to be reported from sediments north of this latitude (Cape Cod; Woods Hole; Fauré-Fremiet, 1951; Lackey, 1936), and 27 from localities located south of the above mentioned latitude (Alligator Harbor, Florida; Gulf of Mexico; Coast of Brazil; Borror, 1963 a, b; Jones, 1974; Kattar, 1970, 1976). The Bermuda islands are formed by sand and coral limestone layers

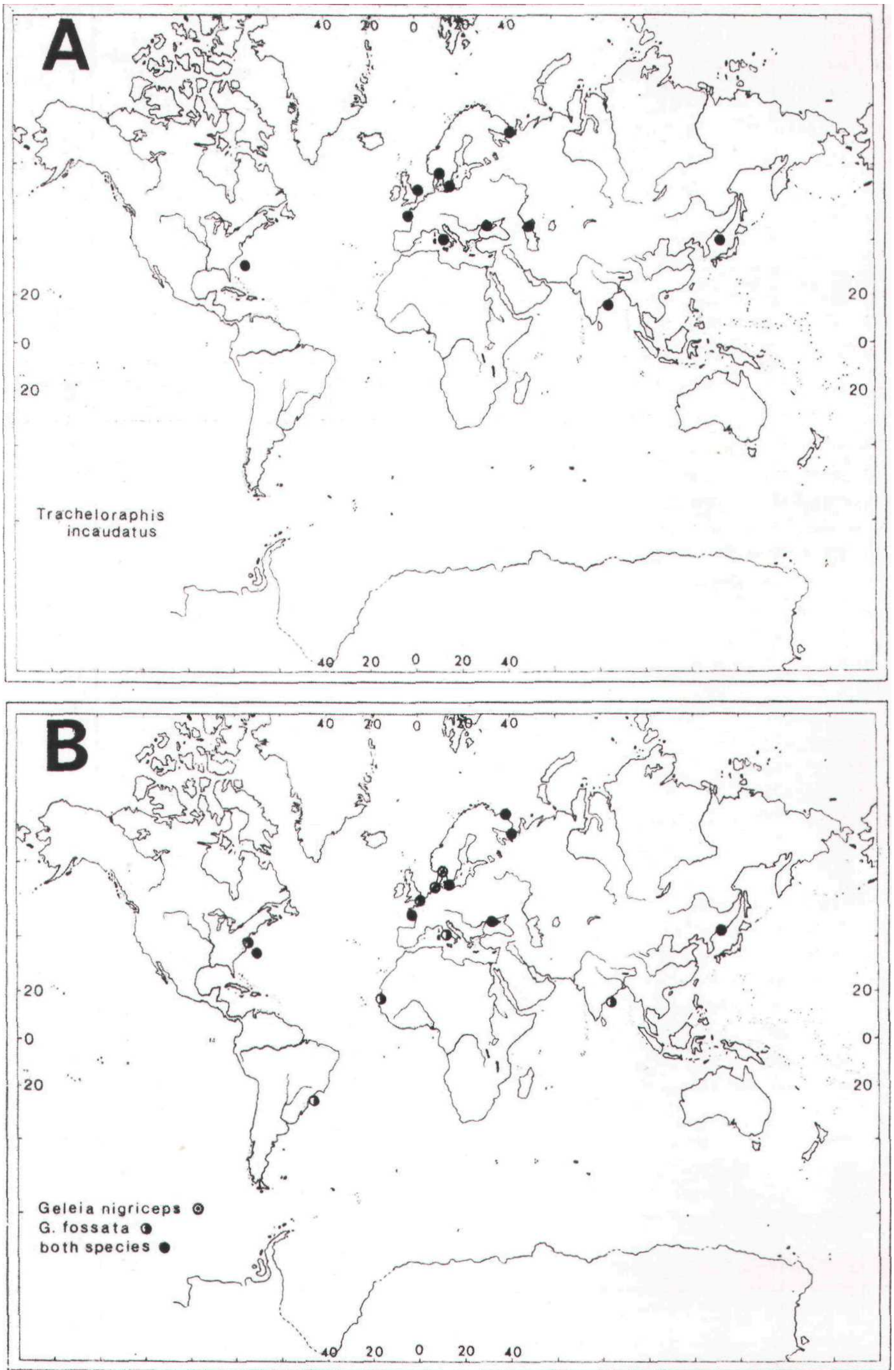

FIG. 6 A, B
The known geographical distribution of some obligatorily interstitial species (A, B, D) and facultatively interstitial (adapted) species (C).

deposited on top of volcanic rocks which originate from volcanic eruptions about 100 millions years ago. They are in the reach of ocean currents having their origins in the equatorial currents (Morris

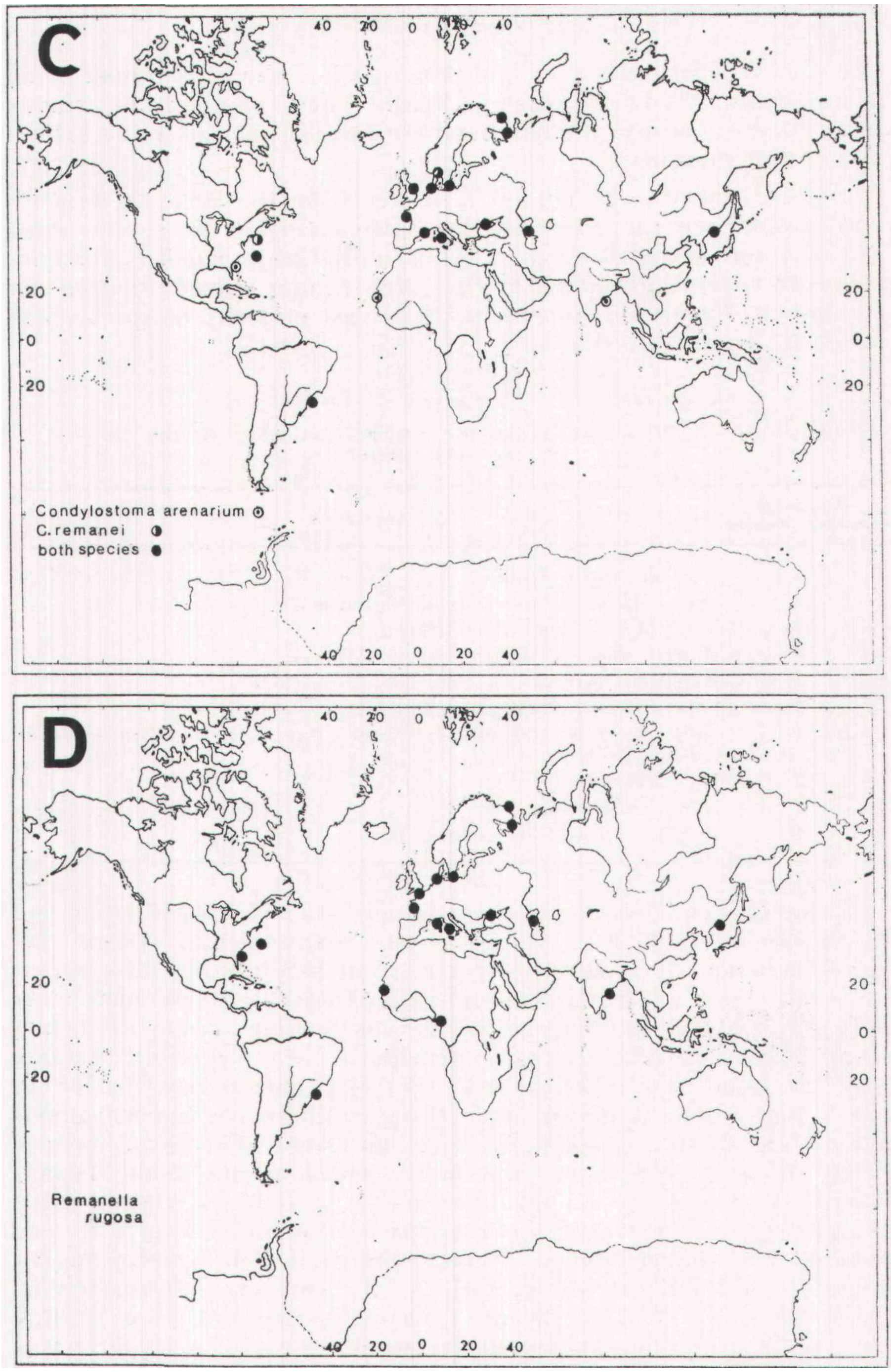

FIG. 6 C, D

et al., 1977; Tait, 1968). Therefore the distribution of species from the east coast of the American continent common to species from Bermuda in relation to the geographical position of Bermuda is of importance in answering the question, by what means the fauna living in the sediments of the present beaches has colonized the islands from outside, because the beaches were formed only after the extinction of the volcano.

The distribution of ciliates identified from the Bermuda beaches and subtidal areas is summarized in table 5. Only a few species show a widely spread distribution on the islands *(Coleps pulcher, Condylostoma arenarium, Frontonia marina, Mesodinium pupula, Pleuronema coronatum, Uronychia transfuga).* The vast majority of species was found at 3 and less stations.

TABLE 8

Rankorder of the sampling stations (ordered according to the number of recorded species)

Number of recorded species	Locations
18	Tuckers Town Beach
16	Trunk Island/Rabbit Island (Sublittoral)
11	Three Hills Shoals (Sublittoral)
10	Hungry Bay
7	Mangrove Bay; North Rock Reef (Sublittoral)
5	Tobacco Bay; Shelly Bay Beach
4	Mullet Bay; Whalebone Bay; Stovell Bay; Long Bay Beach; Trunk Island Beach
3	Ely's Harbour
2	John Smith's Bay
1	Windsor Beach; Devonshire Bay

The species diversity at the stations studied ranges from one to 18 species (table 8). As the abiotic environmental system was determined mainly qualitatively, a relation between the distribution of ciliates and the environmental regime of the single biotope is difficult to establish. The grain size composition of the sediments seems to have no influence on the distribution of the species. Stations with the same number of reported species (Tobacco Bay, Station 1; Shelly Bay Beach, Station 6; table 8) show different sediment compositions (Fig. 2); likewise stations with less divergent sediment composition (Trunk Island Beach, Station 12; Trunk Island/Rabbit Island, Station 13) have large faunal differences. An obvious relation (with exceptions) can be slated between species composition of different biotopes and the instability of the sediment, which is according to Remane (1952) an extreme factor. At the very exposed beaches of the south shore (Windsor Beach, Devonshire Bay and John Smith's Bay) actually only one to two species were recorded *(Lacrymaria marina, Lacrymaria coronata, Loxophyllum setigerum* var. *fibrillatum, Mesodinium pupula).* These are not species typical for these beaches with morphological adaptations. The species diversity increases from very exposed to sheltered and protected biotopes (table 8). It is noticeable that the species diversity is higher at sublittoral (Trunk Island/Rabbit Island, Three Hills Shoals and North Rock Reef) and eulittoral stations (Tuckers Town Beach, Hungry Bay, Mangrove Bay) with a significant input of detrital materials from plants *(e.g.* mangroves al eulittoral stations) and animal remains than at the other stations. Reduced water turbulence and low sediment mixing at these stations leads to a sedimentation of organic matter. This material is an important energy source within a decomposer food chain (Fenchel, 1972, 1973; Fenchel and Harrison, 1976; Nagel et al., 1973 and others). Bacteria, as primary converter of organic material, while decomposing the detritus, assimilate inorganic nutrients from the sea-water and in this way enrich the detritus with essential nitrogen and phosphorus. Thus the material can be utilized by organisms higher placed in the food chain (protozoa and metazoa). Fenchel (1968) found that protozoa associated with detritus feed exclusively on bacteria or on other protists. If one looks under this at the composition of the ciliate fauna of the Bermudas, it can be shown that bacteriophagous and carnivorous species are dominant at eulittoral and sublittoral stations with a significant input of particulate organic matter. The following species belong to this group: *Blepharisma clarissimum, Cardiostomatella vermiforme, Coelosomides marina, Condylostoma arenarium,* C. *remanei, Geleia fossata, G. orbis, Helicoprorodon gigas, H. mimitus, Holosticha discocephalus, Lacrymaria marina, Loxophyllum undulatum, Parablepharisma peilituni, Paraspathidium fuscum, Peritromus faurei, Pleuronema coronatum, P. grassei, Tracheloraphis incaudatus, Trachelostyla pediculiformis, Uronychia transfuga.* Abiotic and biotic ecological factors act together in the distribution and composition of the microfaunal community (Fenchel, 1978; Picken, 1937).

Summary

In a survey of 17 eulittoral and sublittoral sampling stations from the marine sands of the bermuda Islands, 45 interstitial ciliate species were identified. Descriptions of their morphologies are presented together with their mesopsammal distributions. One new species, *Euplofidium helgae,* is described. A high conformity with the interstitial ciliate fauna of the east coast of the American continent is found and discussed in relation to the geographical position of Bermuda. An ecological characterization of the eulittoral and sublittoral sampling stations is attempted with particular reference to the instability of the sediment and the input of detrita) materials from plants and animal remains (an energy source within a decomposer food chain).

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