INDIAN AND ANTARCTIC BRYOZOANS - TAXONOMY AND OBSERVATIONS ON TOXICOLOGY

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To my

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CERTIFICATE

This is to certify that this thesis is an authentic record of the research work carried out by Smt. Geetha, P, under my scientific supervision and guidance in the School of Marine Sciences, Cochin University of Science and Technology, in partial fulfilment of the requirements for the degree of Doctor of Philosophy of the Cochin University of Science and Technology and no part there of has been presented before for the award of any other degree, diploma or associateship in any University.

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Prof. DR. N. RAVINDRANATHA MENON

DECLARATION

I, GEETHA, P., do hereby declare that this thesis entitled "INDIAN AND ANTARCTIC BRYOZOANS - TAXONOMY AND OBSERVATIONS ON TOXICOLOGY", is a genuine record of the research work done by me under the scientific supervision of Prof. Dr.N.RAVINDRANATHA MENON, Director, School of Marine Sciences, Cochin University of Science and Technology, and has not previously formed the basis of the award of any degree, diploma or associateship in any University.

Cochin - 16.

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GEETHA. P.

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PREFACE

This thesis embodies findings on a taxonomical investigation of a group of lower marine invertebrates belonging to the category coelomata. Bryozoans are well known both in fossil and recent taxonomical history. They comprise of about 5,000 living and 16000 fossil species. Bryozoans are well known for their taxonomic abundance and structural diversity, representing the various ecological niches ranging from the intertidal to the abyssal benthic. At a time when global marine biological diversity has become a concern of not only to the scientists but also to the policy makers, an understanding of species diversity and abundance are cardinal aspects of biological studies. Geological time scales which is known that by Pre-Cambrian, marine invertebrate diversity reach the maximum and this diversity has become more comprehensive as time advanced. Taxonomists a vanishing species of scientists have become more concerned in discerning patterns of species diversity. The basic tool for this is identification of animals. With this idea in mind a detailed study of taxonomy of bryozoan was undertaken. The major part of this thesis is devoted to describe various species of bryozoans with detailed description and ecotypical variations. The pattern of distribution and abundance which are important aspects of animal groups have also been documented. Possible effects of heavy metal contamination on the tolerance and growth of bryozoans, a few species of which have been eliminated from the chronically polluted areas of Cochin backwaters have also been documented. It is believed that this thesis would help in furthering our knowledge on the biological and ecological diversity of bryozoans.

SECTION I. TAXONOMY

INTRODUCTION

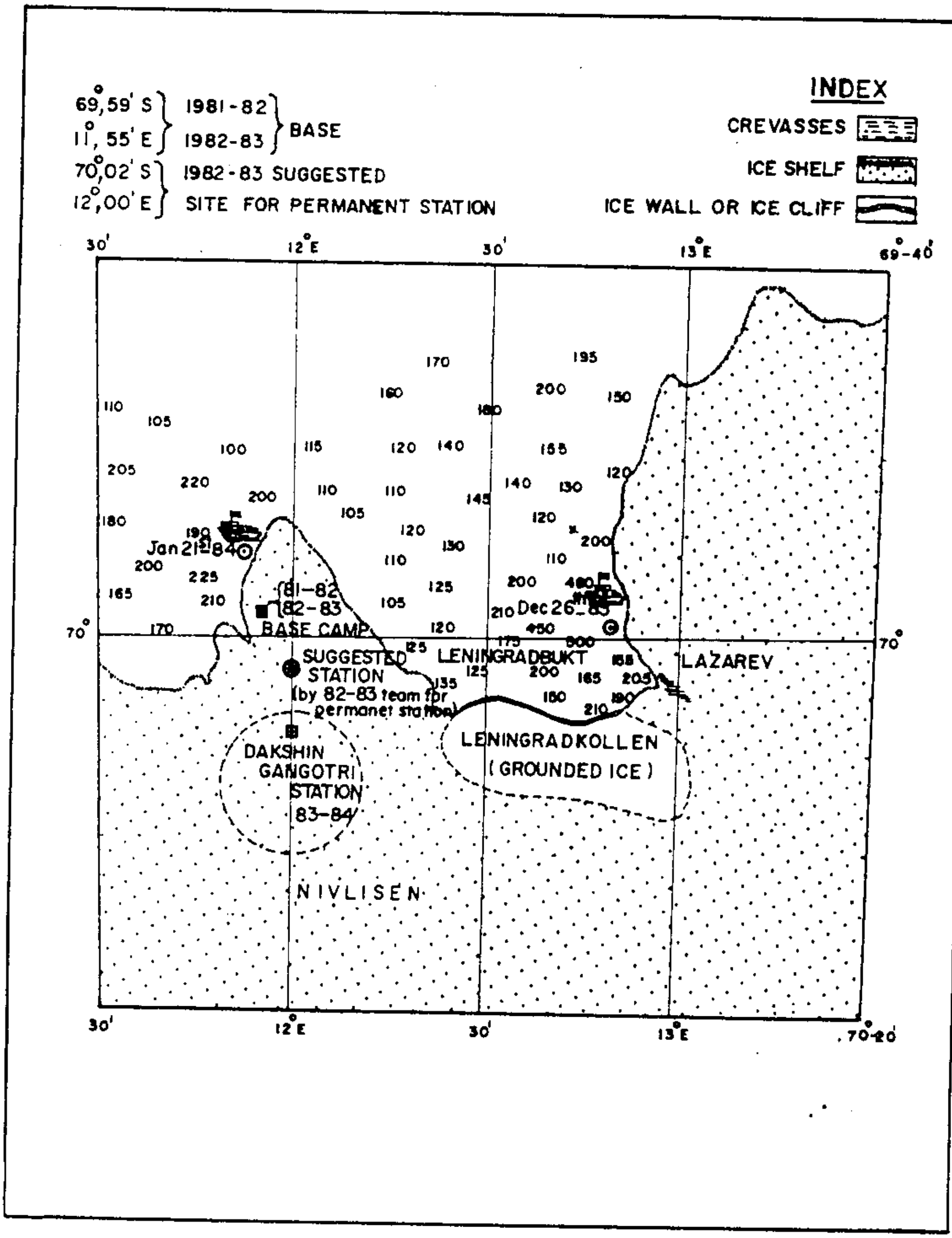
I. 1. INTRODUCTION

Bryozoans are a group of animals which inhabit both fresh water and marine ecosystems. Bryozoans comprise about 5,000 living species and about 16,000 fossil species. They normally occur prolifically below tide marks. Marine bryozoans exhibit a greater degree of abundance and diversity from the shore down to the oceanic regions going to a depth of about 8000 meters.

These animals are found to colonise free surfaces of submerged rocks and similar hard substrata. There are instances where 30 species were found on the surface of a single bivalve shell or as much as 90 species in one dredge haul. This shows the greatest abundance and diversity of this group. They are very prominent fouling organisms settling on the hulls of ships, submerged portions, directional buoys, harbour structures etc. Some of the known fouling bryozoans are highly copper resistant. Their quick growth results in rapid spreading of colonies on the hulls of ships, offer safe substratum for the settlement of other sedentary organisms.

The Antarctic Ocean presents unique features in several aspects of its environment. Life of the organisms inhabiting this region were influenced by many factors like the circum polar currents, the upwelling and the consequent enrichment of the surface waters, the cold climate, the ice cover etc. Above all, the continuous days and nights play, a major role in occurrence and abundance of green matter and animals in this ecosystem.

During the Third Indian Antarctic Research Expedition (December 1983 to March, 1984) bryozoans were accidentally caught in a plankton net

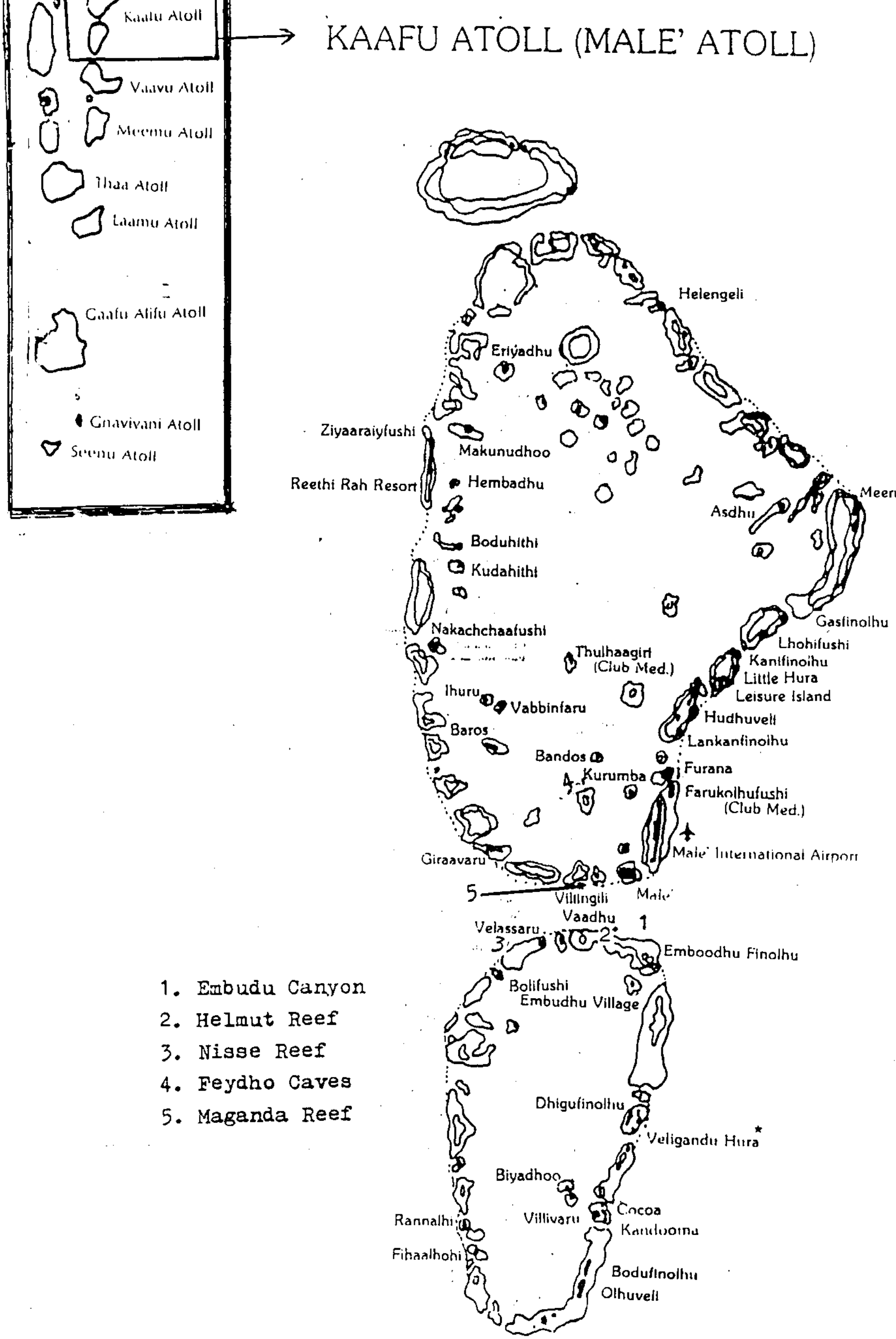


Map 1: Location map of Dakshin Gangotri at Antarctica showing the station (station - 200, 69°54'S and 12°49'E) from which the bryozoans were collected.

(Indian Ocean Standard Net) during a vertical haul from a depth of 200m on Ist January, 1984 at 1900 hrs. in the area 69°54'S and 12°49'E (See Map 1). It was later ascertained from a bathymetric survey that the area where the plankton net was lowered, was in a well like formation and the scraping by the rim of the net across the lateral wall of the well like depression while hauling has resulted in the accidental inclusion of a wide variety of sedentary organisms, growing luxuriantly along its vertical surface. The material collected had a total weight of 6.1Kg (wet weight) and was composed of mainly bits of shells, sponge spicule etc., harbouring a rich assemblage of both epi and infauna. Various groups of animals represented were sorted out and it was found from their numerical abundance that bryozoans enjoyed wide distribution along such vertical surfaces.

Most important studies on the Bryozoa of Antarctic waters are those of Rogick (1965) Moyano (1978) Winston (1983) Lopez Gappa (1986) Hayward and Thorpe (1988, 1990), Levinsen (1990), Hayward & Ryland (1991) etc.

Bryozoans are widely distributed in the Indian waters. To understand the fouling biology of bryozoans, it is essential to know about species composition, substrate preferences and relative growth of these animals. Since taxonomy is mainly based on the highly calcified zooecia, even dry material offer excellent specimens for taxonomic investigations. The historical introduction gives an idea of the extensive literature available on recent bryozoa. However, information on the taxonomy of bryozoans of Indian waters after the classical work of Menon (1967) is rather limited. The present account probably could help in adding to the already known information of this group in Indian waters.



Map: 2 Map of Maldives showing the spots (marked 1-5) from which the bryozoans were collected.

Specimens collected from different parts of India and those inhabited submerged materials obtained from various localities kept in the personal collections of Prof. Menon were also utilised for this study.

Only scanty information is available on the taxonomy of bryozoans from Maldives. The present collection was obtained from five spots namely Embudu Canyon, Helmut Reef, Nisse Reef, Feydhe caves and Maganda Reef in Maldives (See Map 2). The specimens were collected from the dead coral debris.

REVIEW OF LITERATURE

I. 2. REVIEW OF LITERATURE

Bryozoa (Polyzoa) is a distinct phylum of colonial aquatic sessile either free living or commensal invertebrates. J.V.Thompson (1830) gave the name Polyzoa and Ehrenberg (1831) the term Bryozoa. .Nitsche (1869) divided bryozoa into two groups Entoprocta and Ectoprocta. Ectoprocta is now generally recognised as equivalent to Polyzoa as an alternative name of the phylum, with Entoprocta as another phylum (Hyman 1959).

Works on the systematics of this group are numerous. For the convenience of presentation, the major studies carried out on bryozoan from different regions are arranged and listed below.

European waters

Busk's catalogues I, II and III of Marine Bryozoa in the collections of British museum, are pioneer works on Polyzoan taxonomy, these works appeared in the years 1852, 1854 and 1875. Yet another classical work is that of Hinck's History of British Marine Polyzoa (1880).

Sacchi (1961) and Carrada (1963) have studied the Polyzoans of Naples. These probably represent the important studies in that area on this subject, since the pioneering work of Waters (1879). Gerasi (1975) reported bryozoans of Genoa waters which includes 24 anascans, 29 ascophorans, nine cyclostomatous and four ctenostomatous bryozoans. Jebram (1976) described the ctenostomatous bryozoans in the lake near Naples, which include the species Victorella pavida and Bowerbankia sp. Nine species of bryozoans have been identified from the material collected during three surveys in the northern part of the lagoon of Venice by Ambrogi (1980). In the same year he also identified nine species of bryozoans from brackish water environments along the North Adriatic coasts. In a critical review of bryozoans of Italian lagoons, Ambrogi (1983) reported a smaller number of truly brakcish water species from a larger number of marine species which can be found only near the lagoon mouths and in the areas directly connected with sea, 64 species of epiphytic bryozoans were collected from the Scicily channel at a depth of 43m. by Chimenz and Scaletta (1985).

d'Hondt (1974) working on the 'Thalassa' Expedition collection from French-Spanish coast, Bay of Biscay has reported about 192 species of bryozoa. Hondt (1975) listed 103 species and forms of ctenostomatous, cheilostomatous (except Cribrimorpha and Escharellidae) bryozoa, dredged in 1971 by the Oceanographic mission of the 'Jean-Charcot'. Harmelin (1976) reported five genera and 16 species of cribrimorph from the Eastern Atlantic Ocean. Hayward and Ryland (1978) described 71 species of bryozoa from Bay of Biscay. Hondt and Hayward (1981) identified the abyssal and bathyal ctenostomatous bryozoans collected during some French and American Oceanographic cruises, they described seven new species. Hondt and Schopf (1984) studied the bathayal and abyssal bryozoans collected during 1961 - 1968 oceanographic cruises of the Woods Hole Oceanographic Institution. Hondt (1984) conducted a study on bryozoa of French - Austral territories. He (1985) also identified 34 species and forms of bryozoa, from North Atlantic during the Abyplaine programme (May - June 1982, July 1983). Hondt (1987) also made a systematic list of marine bryozoa from the French Atlantic Basque littoral coast. Harmelin and Hondt (1992) studied the faunal exchanges between Atlantic ocean and Mediterranean. He collected 103 species of bryozoan from the Gulf of Gibralter, which included two new genera, three new species and three new sub species.

Pulpeiro (1983) reported 11 species of bryozoans collected from different localities of Galician littoral, of which five are recorded for the first time. Villar et al. (1987) made a zoological list of 54 species of bryozoans collected at the inter tidal and infralittoral zones of the Ria de Pontevedra (Spain). Hondt (1988) identified 48 species in a collection of bryozoa from Spanish Basque coast. Alvarez (1988) conducted the biometric study of three species of bryozoa in the Basque coast. Systematic studies of three species of the genus Cellaria, by Alvarez (1989). He (1990) discovered one species of the cheilostome family Membraniporidae Busk, for the first time in the Bay of biscay. In the same year Alvarez (loc.cit.) conducted a faunistic study of 24 species of bryozoans from two places of the infralittoral zone of the Atlantic coast of Spain.

Mediterranean waters

The Mediterranean gymnolaemates have been described and studied by Hincks (1886); Waters (1918); Calvet (1900, 1902 a, b, 1927). Norman (1909) Canu and Bassler (1930a); and Gautier (1949, 1952, 1955, 1962).

Harmelin (1973) described the ecological needs and distribution of the species of the genus Crassimarginatella from the Western Mediterranean. Harmelin (1976) analysed the ecology and systematics of the Mediterranean cyclostomatous bryozoa belonging to the sub order Tubuliporina. Hondt and Ambrogi (1985) described a new species Tricellaria inopinata sp. from the lagoon of Venice. This is the first record of this genus from the Mediterranean sea. Harmelin et al. (1988) described a new species Puellina of the family Cribrilinidae from the upper bathyal of the Atlantico Mediterranean region. Harmelin and Aristegui (1988) described four new species of the family Cribrilinidae from the upper bathyal of the Atlanto-Mediterranean region. Zabala and Maluquer (1988) prepared a dichotomous key for the classification of the Western Mediterranean marine bryozoans, which include 379 species and forms. Morphological variability of Turbicellipora avicularis and T. magnicostata of the Atlantico - Mediterranean region was the topic of study for Alvarez (1990). Alvarez (1992) also described six species of the genus Disporella Gray from Atlantico - Mediterranean region.

Bryozoans from North and South American Waters

Canu and Bassler (1927) described 45 species from Hawaiian Islands. They also described 37 species and varieties from Panamic region (1930). Osburn (1950, 52, 53) in his contribution to bryozoa of the Pacific coast of America has described about 565 species and varieties of ectoprocts. This report is based chiefly on the bryozoa collected by the Allan Hancock Pacific expedition from off the coast of Mexico, Central America, South America and Galapagos Islands during 1933-1944. In this report Osburn has given a list of important contributions for the Pacific Coast of America. Of these the following are especially noteworthy. Hincks (1882-84) gives 95 species and varieties from the British Columbian waters, in his report "Polyzoa of the Queen Charlottle Islands'. Robertson (1900) described 36 species in her report on the bryozoa of the Harriman Alaska Expedition. In her subsequent publications (1905, 1908 and 1910) she described 98 species for the west coast of North America. C.H. and E.Donoghue (1923) listed 170 sepcies and 22 varieties in their paper entitled. "A priliminary list of Bryozoa from the Vancouver Island region". Same authors in a second list reveal 20 more species. Hastings (1930) worked on the collection made by Dr. C.Crossland from the vicinity of Panama Canal and described 62 species.

Long and Rucker (1970) identified 23 species of cheilostomatous bryozoa collected upon the marine fouling test panels exposed off shore of Fort-Lauderdale, Florida, USA. Powell (1971) found out that the diversity of bryozoa at the Pacific entrance of the Panama canal is three fold more than that of the Atlantic due to some difference in ecological components. Anderson (1973) listed 26 species of bryozoa from Northern Greenland waters out of which five species are first record for Greenland. Cameron and Campbell (1974) cited 29 species of bryozoans from Virgin Islands. This is about 11% of the tropical west Atlantic cheilostome fauna. 23 cheilostomatous and one cyclostomatous broyozoa from two localitites on the Atlantic and Pacific sides of Costa Rica were described and illustrated by Banta and Carson (1977). Hondt (1981) conducted a taxonomical study of 57 bathyal and abyssal species and forms of ctenostomatous bryozoa collected by American Oceanographic cruises of Atlantis II. Distribution and ecology of marine bryozoa of Indian river area on the East coast of Florida was studied by Winston (1982). Jebram and Everitt (1982) reported three species of the Victorellidae (Bryozoa, Ctenostomata) from North American waters, of which two are new species. One species of the ctenostome family Mimocellidae was recorded for the first time from Caribbean sea by Winston (1984). Hondt (1987) reported four new species and one new family of bryozoans from the deep waters of Pacific and North Atlantic. 49 species of erect bryozoa from a broad range of cyclostome, ctenostome and cheilostome families were described by Ryland and Hayward (1991).

Moyano (1973) described ten species of bryozoan from a collection obtained from the intertidal regions of Easter Island. He (1974) also described 15 species of bryozoa by several Chilean expeditions to Magellanic region during the years 1962, 69 and 72. Five species of cheilostomatous bryozoa were described from Tierradel fugeo, Argentina by Lopez Gappa (1975). Viviami (1977) described seven littoral species of the genus Hippothoa from Chilean waters. Lopez Gappa (1978) described and illustrated Smittina ehrlichi sp. nov. from samples collected at Burdwood Bank and Beagle Channel (Tierradel fugeo, Argentina) and he also described its affinities with, other Antarctic, sub-Antarctic and southern Smittinidae. Hondt and Moyano (1979) described three species of Alcyonidium collected near the Chilean coast. Moyano's (1982) studies summarises observations made on more than 140 species obtained in Southern Chile and many other species collected from Juan Fernandez Island to Antarctic Peninsula from 1962-1980. Eight Hippothoan species were recorded and described from the material collected from Ria Desado (Santha Cruz, Argentina) by Lopez Gappa (1985). He recorded the occurrence of new species belonging to the genus Hemismittoidea from the South Western Atlantic ocean. Barros Cortes Souza (1986) made a final survey of cheilostomatous bryozoans from the continental shelves of Columbia and Brazil. Banta and Redden (1990) had recorded 184 bryozoan species from the Galapagos Archipelago. Munoz et al. (1991) studied the membrainiporine bryozoans of Chile.

Australian Waters

Harmer (1915, 1926, 1934, 1957) working on the collections made by the Siboga Expeditions from the Indo-Australian Archipelago described not less than 527 species of bryozoans. These represent an out standing contribution to the knowledge of bryozoans taxonomy. Livingstone's papers which appeared in 1926, 1927, 1928 and 1929 dealt mainly with the bryozoans of the Great Barrier Reef, Queensland and New Zealand, Silen (1954) studied the materials collected by Prof. T. Gislen's expeditions to Australia during 1951-1952 and described 51 species. Cameron and Campbell (1974) reported 200 bryozoa species from barrier reefs in the central region of the Queensland coast. Wass and Yoo (1983) identified 495 species of cheilostomes from the bottom samples of Southern Australian continental shelf. Cook and Chimonides (1984) reported a new genus Helixotinella of the family Lunulitidae (Cheilostome bryozoa) from Australian waters. On a systematic study on bryozoans collected from Newcaledonia (1977-84) and Chesterfield shelf Hondt (1986) described 226 species including seven new species and six new sub-species. Ryland and Hayward (1992) studied the materials collected from shallow reef habitats around Heron Island and described 81 species.

New Zealand waters

11 genera of the bryozoan family Chaperidae collected from New Zealand were described by Gordon (1982). Cook and Chimonides (1984) recorded the genus Otinella fron New Zealand waters. Gordon (1985) has described 227 species of gymnolaematous Bryozoa from Kermedec ridge part of North East trending ridge system from Newzealand to Tonga. Gordon and Hondt (1985)

reported a new genus Talivittaticella of the family Catenicellidae from deeper waters of New Zealand. Gordon (1989) studied the major cryptofaunal species from reef-flat-rubble at Sa-aga Upolu Island which yielded ten bryozoan species. Six new cheilostome bryozoan genera were recorded from Newzealand region by Gordon (1989).

African Waters

Hondt (1975) identified new genera of bryozoans present in the Dakar region. Brood (1976) observed a living fauna of 34 cyclostomatous bryozoan species from the East African coast. Redier and Hondt (1976) made an annotated list of 14 bryozoan species collected by M.I. Marche Marchad off the coast of Senegal and Mauritiana. 51 bryozoans species were described by Hayward and Cook (1979) from the deeper shelf waters of Eastern South African coast. Bryozoans present in the African Sahelian zone was reported by Weiback (1980). A new species of cheilostome epizooite bryozoa Hippothoa mauritiana was reported from South Africa by Hayward and Fordy (1982). Hayward (1983) studied the materials collected by South African Museum's Mering Naude cruises between 1977 and 1979 and described 130 species bryozoa.

Japanese Waters

Mawatari (1952) after reviewing his previous works in detail presented a list of 152 species and varieties from Kei peninsula. In a check list of cyclostomatous bryozoa from the Japanese waters, Mawatari (1955) has listed 78 species of bryozoa. Mawatari and Mawatari (1974) reported 21 species of cyclostomatous bryozoans from Hokkaido. The same authors studied the anascan bryozoa of Japan and reported 12 species of Flustridae (1979), 50 other species (1980) with one new to science and 25 species of Hincksidae. They also made a check list of 130 species of cheilostomatous bryozoans collected along the coast of Hokkaido (1981), Mawatari (1987) described 22 species of cheilostomatous bryozoans from Sesoka, Okinawa. Hondt and Mawatari (1987) described two new abyssal species of ctenostomatous bryozoans collected during the French-Japanese Kaiko I Oceanographic cruise in Nakai Rift (Japan). Two new cheilostomatous bryozoan species were recorded for the first time from Hokkaido by Mawatari (1988).

Chinese waters

Futsing and Yuhnan (1976) discovered new species of bryozoa from the Chinese sea. Liu (1984) identified a species of bryozoa of the family Bicellariellidae from the Chinese sea. He also reported about the bryozoans belonging to the family Scrupocellaridae (1984). Six new species of bryozoans were reported by Liu and Li (1987) from the waters of Hong Kong and Zhu Jiang estuary. Descriptions of three new species of chielostomatous bryozoans collected from the coasts of Shandong and Zhu Jiang provinces (China) are presented by Liu (1990). Li Chuanyan (1992) reported 88 species of bryozoans from the coastal waters of Northern and Southern China sea.

Russian waters

Kluge (1975) studied the bryozoans of the seas of USSR and reported 340 species. Gontar (1978) reported 33 species and four sub species of bryozoans from the coastal waters of Iturup. Gontar (1991) described 18 species and one sub species of Bryozoa from the Fish Tail Bay. Six cyclostomatous bryzoans were identified and described by Ostrovskij (1991).

Antarctican waters

Extensive collections have been made from the Antarctic region during various expeditions and a detailed list is available in Rogick's paper (1965) entitled "Bryozoa of the Antarctica". Busk (1881 and 1886) studied material obtained from the "Challenger" collections. Hastings worked on the specimens collected during different expeditions, such as the Discovery 1925-1933. In the Discovery report Hastings (1943) has given a detailed account of the distribution of Cellularine bryozoa, describing 120 species belonging to this group. In an earlier paper (1939) the same author described 15 species. Rogick studied bryozoans collected by U.S. Navy's Antarctic expedition of 1947 to 1949. Her papers appeared as a series from 1955 to 1952. As far as can be assertained nearly 321 species of bryozoans have been recorded from this region, of which 199 species are confined to the Antarctic region (Rogick 1965). Moyano (1978) studied the bryozoans collected from several Antarctic bays and reported 128 species. Morphological peculiarities of Antarctic bryozoans were described by Androsova (1981). Patterns of growth, reproduction and mortality of two bryozoan species Melicerita obliqua species belonging to the genera Cellarinella from the Ross sea, Antarctica were studied by Winston (1983).

Lopez Gappa (1986) reported a new bryozoan genus Brettiopsis from the Weddell sea of Antarctica. Hayward and thorpe (1988) introduced eight new genera for certain endemic Antarctic cheilostomatous bryozoa. The same authors (1988) reported 18 species of the cheilostomatous bryozoan genus Arachnopusia Jullien, from Antarctic, sub Antarctic localities. Hayward and Thorpe (1990) described 26 species of bryozoans of the ascophoran family Smittinidae Levinsen (1909), from Antarctic and sub Antarctic localities. 16 species of cheilostomotous bryozoans of the family Celleporidae Busk (1852) were reported from Antarctic, sub Antarctic and South West Atlantic by Hayward (1990). Hayward and Ryland (1991) reported eight species of cheilostomatous bryozoans from Antarctic and Megellanic South West Atlantic. Liu and Yuemel (1991) studied the materials collected by China's first Southren Ocean Expedition during 1984-85 to the waters off the North West coast of Antarctican peninsula and reported 500 species.

Indian waters

Most important studies on the bryozons of Indian waters are those of Thornely (1905, 1907), Annandale (1906, 1907 a, b, c, 1908a, 1911a, b and 1912). Menon and Nair (1967) reported 70 species from the South West and South East Coasts of India, of which three species, one sub-species, one variety and three forms assigned to three genera are found to be new to science. Menon and Nair (1970) described a new species Schizoporella cochinensis sp. nov. from the Cochin backwaters. Three species of the genus Tremogasterina were also described by Menon and Nair in the same year from Indian waters. Menon and Nair (1972) described six species of Bugula Oken collected from the intertidal zone of the south west coast of India. In the same year Menon described 12 species of ctenostomatons bryozoans from Indian waters. Nine species of the genus Scrupocellaria Van Beneden were described by Menon (1972) from south west and south east coasts of India. Of these six species were described for the first time. Nine bryozoan species belonging to the genera Parasmittina were also described by Menon (1972). Unnikrishnan Nair (1973) observed the fouling characters of four bryozoan species of Cochin Harbour area. Twenty species of polyzoans belonging to the division Malacostega occurring in the Indian waters are described and illustrated by Menon and Nair (1975). Of these two species Electra crustulenta sub species borgii are described as new. Six intertidal bryozoan species of Godavari Estuary was reported by Rao and Ganapati (1975). Seven encrusting cheilostomaous bryozoan species were reported from the highly polluted coastal waters of Bombay by Swami and Karande (1987). Ravindran et al. (1990) reported eight fouling bryozoan species in the offshore waters of Bombay high. Nair (1991) reported 15 species of bryozoans from the Vellar estuary, Tamil Nadu and six species in the mangroves of Pichavaram.

MATERIALS AND METHODS

I. 3. MATERIALS AND METHODS

The material for the taxonomic studies was mainly obtained from collections made from the inter-tidal and sub-tidal regions of South west coast of India. Bryozoans from Antarctica was obtained during the Third Indian Antarctic Research Expedition (December, 1983 to March, 1984). These specimens were accidently caught in a plankton net (Indian Ocean Standard Net) during a vertical haul from a depth of 200m on Ist January 1984 at 1900 hrs. in the area 69°54' and 12°49' E. Some enrusting species of bryozoans on dead corals were also collected from Maldives.

The measurements of zooecium given are averages of the length and breadth of about six fully grown and normal zooecia measured with the help of an eye piece micrometer. Temporary slides for the examination of the chitinous parts (opercula, avicularian mandibles etc.) were prepared by by gently crushing few zooecia and adding glycerine before placing coverslips over the material. This procedure yeilded fairly good mounts of the chitinous parts for study. 'Skeletal' parts of the cheilostome bryzoans were cleaned by sodium hypochlorite, which removes all the organic materials from the animal colony. Drawings for the species were made by using a camera lucida.

Photographs of the specimens were taken using Scanning Electron Microscope. Specimens for scanning electron microscopy were cleaned with sodium hypochlorite solution (5%) rinced in tap water and dried. The dried specimens were sputted with gold for 20 minutes and fixed them on the stub using tape adhesive. They were observed and photographed in varying magnifications in JSM 35C (Jeol, Japan) operated at an accelerating voltage of 12 KV.

LIST OF SPECIES DESCRIBED

I. 4. LIST OF SPECIES DESCRIBED

1.4.1 SPECIES FROM INDIAN WATERS

ORDER CHEILOSTOMATA BUSK

SUB-ORDER ANASCA LEVINSEN

DIVISION INOVICELLATA JULLIEN

FAMILY AETEIDAE SMITT

GENUS AETEA Lamx

1. Aetea anguina (Linnaeus)
2. Aetea ligulata Busk

DIVISION MALACOSTEGA Levinsen

FAMILY HINKSINIDAE (Canu and Bassler)

GENUS ANTROPORA Norman

3. Antropora erecta Silen

FAMILY ALDERINIDAE Canu and Bassler

GENUS ALDERINA Norman

4. Alderina arabianensis Menon and Nair

DIVISION CELLULARINA Smitt

FAMILY EPISTOMIDAE Gregory

GENUS SYNNOTUM Pieper

5. Synnotum aegyptiacum (Aud.)

FAMILY CHLIDONIIDAE (Busk)

GENUS CREPIS Jullien

6. Crepis verticellata Harmer

DIVISION CRIBRIMORPHA Harmer

FAMILY CRIBRILINIDAE Hincks

GENUS REGINELLA Jullien

7. Reginella mattoidea Osburn

SUBORDER ASCOPHORA Levinsen

FAMILY ARACHNOPODIIDAE Harmer

GENUS TREMOGASTERINA Canu

8. Tremogasterina granulata Canu and Bassler

9. Tremogasterina ventricosa Canu and Bassler

10. Tremogasterina lanceolata canu and Bassler

FAMILY CELLEPORARIDAE Harmer

GENUS CELLEPORARIA Lamouroux

11. Celleporaria pilaefera Canu and Bassler

12. Celleporaria granulosa Haswell

FAMILY PETRALIELLIDAE Harmer

GENUS MUCROPETRALIELLA Stach

13. Mucropetraliella philippinensis (Canu and Bassler)

FAMILY SAVIGNYELLIDAE Levinsen

GENUS SAVIGNYELLA Levinsen

14. Savignyella lafontii (Aud.)

FAMILY ADEONIDAE (BUSK)

GENUS ADEONA Lamouroux

15. Adeona foliacea Lamx

FAMILY PHYLACTELLIDAE Jullien

GENUS LAGENICELLA Cheetham and Sandberg

16. Lagenicella punctulata (Gabb and Horn)

FAMILY CELLEPORIDAE Busk

GENUS TURBICELLEPORA Ryland

17. Turbicellepora redoutei (Audouin)

FAMILY SMITTINIDAE Levinsen

GENUS PARASMITTINA Osburn

18. *Parasmittina aviculata* (Mawatari)

19. *Parasmittina californica* (Robertson)

FAMILY MICROPORELLIDAE Hincks

GENUS MICROPORELLA Hincks

20. *Microporella orientalis* Harmer

21. *Microporella ciliata* (Pallas)

GENUS FENESTRULINA Jullien

22. *Fenestrulina malusii* (Aud.)

FAMILY HIPPOPODINIDAE Levinsen

GENUS HIPPOPODINA Levinsen

23. *Hippopodina feegeensis* Busk

24. *Hippopodina californica* Osburn

FAMILY SCHIZOPORELLIDAE Jullien

GENUS SCHIZOPORELLA Hincks

25. *Schizoporella unicornis* Johnston

GENUS CLEIDOCHASMA Harmer

26. *Cleidochasma biavicularium* (Canu and Bassler)

27. *Cleidochasma fallax* (Canu and Bassler)

GENUS SCHIZOMAVELLA Canu and Bassler

28. *Schizomavella inclusa* (Thornely)

29. *Schizomavella linearis* var. *inarmata* (Hincks)

GNENUS CALYPTOTHECA Harmer

30. *Calyptotheca tenuata* Harmer

GENUS CODONELLINA Bassler

31. Codonellina montferrandii (Aud.)

FAMILY RETEPORIDAE Smitt

GENUS RHYNCHOZOON Hincks

32. Rhynchozoon compatum (Thornely)

33. Rhynchozoon tubulosum (Hincks)

34. Rhynchozoon larreyi (Aud.)

35. Rhynchozoon globosum Harmer

1.4.2 SPECIES FROM WATERS OF MALDIVES

ORDER CHEILOSTOMATA BUSK

SUB-ORDER ANASCA Levinsen

DIVISION COELOSTEGA Levinsen

FAMILY STEGANOPORELLIDAE Smitt

GENUS STEGANOPORELLA Smitt

1. Steganoporella sp.

DIVISION CELLULARINA Smitt.

FAMILY FARCIMINARIDAE Busk

GENUS NELLIA Busk

2. Nellia oculata Busk

FAMILY SCRUPOCELLARIIDAE Levinsen

GENUS CABEREA Lamoroux

3. Caberea ellesi Fleming

GENUS SCRUPOCELLARIA Van Beneden

4. Scrupocellaria bertholetti (Aud.)

SUB-ORDER ASCOPHORA Levinsen

FAMILY SMITTINIDAE Levinsen

GENUS PARASMITTINA Osburn

5. Parasmittina tropica (Waters)

ORDER CYCLOSTOMATA Busk

DIVISION ARTICULATA Busk
=
CAMPTOSTEGA Borg

FAMILY CRISIIDAE Johnston

GENUS CRISIA Lamouroux

6. Crisia elongata Milne Edwards

1.4.3 SPECIES FROM ANTARCTICAN WATERS

ORDER CHEILOSTOMATA Busk

SUB-ORDER ANASCA Levinsen

DIVISION MALACOSTEGA Canu and Bassler

FAMILY HINCKSINIDAE Canu and Bassler

GENUS ELLISINA Norman

1. Ellisina levata (Hincks)

FAMILY ALDERINIDAE Canu and Bassler

GENUS COPIDOZOUM Harmer

2. Copidozoum spinatum Osburn

FAMILY ONYCHOCELLIDAE Jullien

GENUS ONYCHOCELLA Jullien

3. Onychocella sp.

DIVISION COELOSTEGA Levinsen

FAMILY STEGANOPORELLIDAE Smitt

GENUS STEGANOPORELLA Smitt

4. Steganoporella mandibulata Harmer

DIVISION CELLULARINA Smitt

FAMILY CELLARIIDAE Ellis and Solander

5. *Cellaria punctata* Busk

6. *Cellaria praelonga* Harmer

7. *Cellaria* sp. a.

8. *Cellaria* sp. b.

9. *Melicerita obliqua* Thornely

FAMILY BICELLARIELLIDAE Levinsen

GENUS BUGULA Oken

10. *Bugula* sp.

GENUS BEANIA Johnston

11. *Beania magellanica* Busk

DIVISION CRIBRIMORPHA Harmer

FAMILY CRIBRILINIDAE Hincks

GENUS COLLETOSIA Jullien

12. *Colletosia radiata* Moll

13. *Figularia* sp.

SUB-ORDER ASCOPHORA Levinsen

FAMILY HIPPOTHOIDAE Levinsen

GENUS HINCKSIPORA Osburn

14. *Hincksipora* sp.

FAMILY SCHIZOPORELLIDAE Jullien

GENUS HIPPODIPLOSIA Canu

15. *Hippodiplosia pertusa* Esper

GENUS ARTHROPOMA Levinsen

16. *Arthropoma cecili* (Audouin)

FAMILY ADEONIDAE Busk

GENUS REPTADEONELLA Busk

17. Reptadeonella plagipora Busk

FAMILY CELLARINELLIDAE Rogick

GENUS CELLARINELLA Rogick

18. Cellarinella laytoni Rogick

19. Cellarinella sp.

FAMILY MICROPORELLIDAE Hincks

GENUS FENESTRULINA Jullien

20. Fenestrulina malusii (Aud.)

FAMILY SMITTINIDAE Levinsen

GENUS SMITTINA Norman

21. Smittina arctica Norman

22. Smittina sp.

GENUS PARASMITTINA Osburn

23. Parasmittina sp.

GENUS MUCRONELLA Hincks

24. Mucronella labiata Levinsen

FAMILY RETEPORIDAE Smitt

GENUS RHYNCHOZOON Hincks

25. Rhynchozoon tubulosum

GENUS PHIDOLOPORA Osburn

26. Phidolopora aviculatum sp.

ORDER CYCLOSTOMATA Busk

DIVISION ARTICULATA Busk

=

CAMPTOSTEGA Borg

FAMILY TUBULIPORIDAE Johnston

GENUS TUBULIPORA Lamarck

27. Tubulipora flexuosa Pourtales

FAMILY HORNERIDAE Smitt.

GENUS HORNERA Lamouroux

28. Hornera pinnata Busk

FAMILY DIASTOPORIDAE Gregory

GENUS PLAGIOECIA Canu

29. Plagioecia patina (Lamarck)

DESCRIPTION OF SPECIES

I. 5. DESCRIPTION OF SPECIES

I.5.1 SPECIES FROM INDIAN WATERS

POLYZOA THOMPSON, 1830.

BRYOZOA EHRENBERG, 1831

PHYLUM ECTOPROCTA NITSCHE, 1856

CLASS GYMNOLAEMATA ALLMAN, 1856

ORDER CHEILOSTOMATA BUSK, 1852

SUB-ORDER ANASCA LEVINSEN, 1909

Cheilostomata without a compensation sac possessing an external frontal membrane.

DIVISION INOVICELLATA Jullien, 1888

Creeping zoarium adnate. No avicularia, spines or permanent ovicells.

FAMILY AETEIDAE Smitt, 1867

"zooecia tubular with a subterminal membraneous area, partly erect and free partly decumbent and adherent, uniserial" (Busk, 1884). Avicularia, vibracula and ovicells of the ordinary Cheilostome type wanting.

GENUS AETEA Lamx, 1812

1812 Aetea Lamouroux, Nouv. Bull. Sci. Philomat., 3, p.184.

1926 Aetea Harmer, Siboga Exped., 28b, p.194.

1953 Aetea Osburn, Rep. Allan Hancock Pacific Exped., 14, 3, p.11.

Zoecia tubular with a sub-terminal membraneous area. Partly erect, free partly, decumbent and adherent. No avicularia, vibracula, spines or permanent ovicell.

1. Aetea anguina (L), 1758

(Fig. 1)

1758 Sertularia anguina Linnaeus, System Naturae, p.816.

1905 Aetea anguina Thornely, Rep. Pearl Fish. Gulf of Mannar, p.108.

1912 Aetea anguina Osburn, Bull. Bur. Fish., 30, p.220. pl.21 fig. 14, 14a.

1926 Aetea anguina Harmer, Siboga, Exped., 28b, pp.194, 195, pl.13, figs. 1,2.

1956 Aetea anguina Mawatari, Pacific Science, 10, 2, p.115.

1963 Aetea anguina Mawatari, Ann. Rep. Nato Mar, Lab. Faculty of Science, 3, p.6.

Occurrence

One colony epizoic on Aeverrillia setigera (Hincks) was collected from the propeller of a boat dredged out off Cochin.

Measurements

Zooecium

Length	-	380 µ
Breadth	-	75 µ

Salient features

Attached to the substratum by the long, delicate and transparent portion of the zooecium. The tubular annulated peristome gradually expands to a non-annulated region with the frontal membrane and distally placed operculum. The terminal part of the peristome slightly bent. The rim of the operculum slightly thickened.

Remarks

These specimens closely agree with the descriptions and figures of Aetea anguina given by Waters (1913), Harmer (1926) and Mawatari (1956) and with the description given by Busk (1884).

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Cosmopolitan except polar waters.

2. Aetea ligulata Busk, 1852

(Fig. 2)

1884 Aetea liqulata Hincks, Ann. Mag. nat. Hist., 5, 13, p.202.

1937 Aetea ligulata Marcus, Bol. Fac. Phil., Sei. Letr., 1, p.30.

1950 Aetea ligulata Obsurn, Allan Hancock Pacific Exped., 14, 1, p.13, pl.1, fig.4.

1967 Aetea ligulata Menon and Nair, J. mar. biol. Ass. India, 9 (2) pp.430-433.

Occurrence

Two colonies epizoic on Conopeum reticulum collected from the materials dredged from a depth of 50m. off Quilon.

Measurements

Zooecium

Length	- 650 µ
Breadth	- 65 µ (stalk)

Salient features

Zoarium spread over the substratum by means of stolons. Erect zooecia arise from the expanded bases. The stalk of the zooecium corrugated, very different from the anulations found in Aetea anguina. The head portion smooth.

The basal expansion from which the zooecia arise shows vague punctuations. Branching at right angles from the expanded base. Stolons also show indistinct corrugations. Frontal membrane thin and translucent.

Remarks

Despite the variations shown by the present material, it resembles the description of Aetea ligulata Busk, given by Osburn (1950). The corrugations seem to be of specific value since they have been noticed in all portions of the colony. The nature of branching at right angles shows certain differences from the figure given by Osburn (1950).

Previous records from Indian waters

Menon & Nair (1967)

Distribution

"Widely distributed species" (Osburn, 1950).

FAMILY HINCKSINIDAE Canu and Bassler, 1927

"This family includes membranipores of simple structure, similar to the Membraniporidae except for the presence of an endozooecial ovicell. The ovicell is usually a narrow, transverse shallow structure opening widely into the zooecial cavity and closed by the operculum, but some times it is merely a rounded expansion of the zooecial cavity into the base of the succeeding zooecium. Spines, avicularia and dietellae may be present "Osburn 1950".

GENUS ANTROPORA Norman, 1903

1903 Antropora Norman, Ann. Mag. Nat. Hist 7, 12, p.87

1926 Antropora Harmer, Siboga Exped., 28b, p.232.

1950 Antropora Osburn Rep. Allan Hancock Pacific Exped., 14,1, p.51.

Frontal membrane occupies almost the entire front, gymnocyst reduced or vestigeal; A well developed cryptocyst present proximally and extends around the entire opesia. Opesia depressed because of the steep descent of the cryptocyst. Adventitious avicularia paired sometimes arranged so as to face one another on the distal border of the preceding zooecium. Vicarious avicularia with rounded mandibles occasionally present. Vestigeal ovicells present which are endozooecial.

3. Antropora erecta Silen 1941

1941 Antropora erecta Silen, Ask. Zool., 33A 12, pp. 43-45, figs.56, 57.

1967 Antropora erecta Menon and Nair, J. mar. biol. Ass. India, 9(2) pp.430-433.

Occurrence

Several colonies were collected from the mussel beds at Vizhinjam.

Measurements

Zooecium

Length	-	360 μ
Breadth	-	120 μ

Salient features

All colonies collected were encrusting on molluscan shells. Zooecia were broaded in the middle and slightly tapering bothways. Gymnocyst not discernible. Cryptocyst extensive proximally, extending about a third of the distance towards the distal end and less developed laterally, cryptocyst steep, and hence the opesia very much depressed and occupied the anterior half. Opesia more or less triangular or egg shaped. Vicarious, paired, slightly raised avicularia present, with thin pointed portions directing distally and occupying the lateral position of zooecia. Large vicarious avicularia present with a very enlarged rostrum and an extensive cryptocyst proximally.

Remarks

This material agrees remarkably well with silen's (1941) and Menon's (1967) description and figures of A. erecta. Majority of the zooids posses two, rarely one anteriorly directed vicarious avicularia, which are invaribaly placed at the junction of adjacent zooecia. A large vicarious avicularium with a well developed proximal cryptocyst and a nearly rounded rostrum seen in the present specimens is neither shown in silen's figures nor mentioned in the description.All the colonies collected were encrusting and not erect as noted by silen (1941).

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Bonin Is, Pacific (Silen, 1941) India (Menon and Nair, 1967).

FAMILY ALDERINIDAE Canu and Bassler, 1927

"The gymnocyst in the Alderinidae is usually small, but may cover half or more of the frontal length (Doryporella). The cryptocyst, in most cases, is confined to the descending portion, but it may expand to form a considerable proximal lamina. Spines are extremely varied both in number and form; occasionally they are wanting, usually they are simple in form, but they are sometimes branching and cervicorn. Avicularia are often present on the proximal gymnocyst less frequently they occur on the lateral walls; in several genera they are interzooecial or they may be wanting entirely" Osburn (1950).

GENUS ALDERINA Norman, 1903

1903 Alderina Norman, Ann. Mag. nat. Hist., 7, 11, p.596.

1950 Alderina Osburn, Rep. Allan Hancock Pacific Exped. 14, 1, p.59.

Membraneous frontal wall, crenulated side walls. Spines absent, nodular process may be present. Dietellae present. Usually ovicells single ribbed or with a depressed area.

4. Alderina arabianensis Menon 1967

(Figs. 4a & b)

1975 Alderina arabianensis Menon and Nair, J. mar. biol. Ass. India, 17(3), pp.553-579.

1989 Alderina arabianensis Nair, Ph.D. Thesis, p.58.

Occurrence

Several colonies were collected from the mussel beds of Vizhinjam.

Measurements

Zooecium

Length	-	420 µ
Breadth	-	240 µ

Salient features.

Colony encrusting. Zooecia elongated, quadrangular, the distal portion of the preceding zooecium slightly overarch the proximal portion of the succeeding one. Aperture occupying the three-fourth of the front.

Gymnocyst present, cryptocyst with spinules, the size of the spinules decrease at the distal portion of the cryptocyst. Two branched spines at the disto-lateral corners of the zooid. Ovicells hyperstomial and ribbed.

Remarks

Specimens agree with the descriptions given by Menon and Nair(1967) and Nair (1989).

Previous records from Indian waters

Menon and Nair, 1967, and Nair (1989).

Distribution

Menon and Nair (1967) and Nair (1989) India

FAMILY EPISTOMIIDAE Gregory, 1903

GENUS SYNNOTUM Pieper, 1881

1881 Mononota and Synnota Pieper, 9, Jahresb. Westfal. Provinzeal-Ver.Wiss.u.Kunst Pro 1880, p.43.

1926 Synnoyum Harmer, Siboga Exped., 28b, p.394-395.

1950 Synnotum Osburn, Rep. Allan Hancock Pacific Exped., 14, 1, p.150.

Internodes separated by joints. Zooecia arranged back to back in pairs. Each pair connected by tubular prolongations. Sessile lateral avicularia at the distal end, a stalked avicularium occasionally present. Slightly enlarged gonozooecia.

5. Synnotum aegyptiacum (Aud.), 1826

(Figs. 5a & b)

1826 Loricaria aegyptiaca Audouin, Description de l' Egypte, Hist. Nat., 1, 4, p.243.

1886 Synnotum aviculare Hincks, Ann. Mag. nat. Hist., 5, 17, p.257.

1921 Synnotum aviculare Robertson, Rec. Indian Mus., 22 p.35.

1926 Synnotum aegyptiacum Harmer, Siboga Exped., 28b, pp. 398-400, pl.27, figs.3, 4.

1950 Synnotum aegyptiacum Osburn, Rep. Allan Hancock Pacific Exped., 14, 1, p.151, pl.13, fig.5.

Occurrence

Several colonies growing on sponges were collected from the subtidal levels at Krusadi Is. and Minicoy Is,

Measurements

Zooecium

Length	- 470 μ
Breadth	- 145 μ

Salient features

Erect zoarium with prostrate branches at the older parts of the colony, attached by rootlets. Maximum height noticed - 20mm. Rootlets absent in most of the internodes. Zooecia paired with obliquely facing front. A frontal and a basal avicularia present at each internode. Occasionally a pedunculate avicularium takes the place of the frontal one. Enlarged gonozooecium present. Spines absent.

Remarks

Referable to Synnotum aegyptiacum (Aud.). A comparison of this witht the figures and descriptions of Synnotum contortum Waters, shows that these two species show resemblance. The rootlets emerging from almost all internodes characteristic of Synnotum contotrum, are, however not present in S. aegyptiacum. Other important distinguishing characters are the presence of sessile avicularia on "one or both the sides" (Waters, 1913) near the distal end of the zooecia and the arrangement of the internodes. Striking difference is seen in the shape of the pedunculate avicularia of these two species. Synnotum aegyptiacum is with very delicate zooecia, and with single basal avicularium at each internode. The production of gonozoecia takes place in S. aegyptiacum on normal internodes.

The pedunculate avicularium is with strongly hooked rostrum and deeply excavated palatal surface similar to what Harmer noticed in his what materials. Gonozooecium is formed out of only one of the pair of zooecia. This character is also in confirmity with what is noticed in his specimens.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

It can be made out from the literature that S. aegyptiacum enjoys a world wide distribution.

FAMILY CHLIDONIIDAE (BUSK) 1884

Repent or erect and jointed zoarium. Pyriform zooecia with elongate narrow tubular portion and expanded distal part. Front flat, strongly or feebly developed cryptocyst, vicarious avicularia rarely present. Spines and ovicells absent.

GENUS *Crepis* Jullien, 1883

1883 *Crepis* Jullien, *Bull. Soc. Zool. France*, 7, p.522.

1926 *Crepis* Harmer, *Sibogoa Exped.*, 28b, p. 318.

Zoaria with uniserial and creeping, erect and jointed or repent and unjointed zooecia. Proximal tubular potion of the zooecia arise from the preceding one. Cryptocyst extensive or less developed not reaching the operculum. Vicarious avicularia sometimes present.

6. *Crepis verticillata* Harmer, 1926

(Figs. 6a & b)

1926 *Crepis verticillata* Harmer, *Siboga Exped.*, 28b, pp.319-320, pl.15, figs. 13-18.

1967 *Crepis verticillata* Menon and Nair, *J. mar. biol. Ass. India*, 9(2) pp.430-433.

Occurrence

One colony from a hydroid stem, was collected from the dry dock, Bombay harbour.

Measurements

Zooecium

Length	-	510 μ
Breadth	-	105 μ

Salient features

Small zoarium whitish in hue when dry. Zooecium creeping with long tubular proximal portion and oval distal expansion, usually associated with another single zooecium where the tubular part may be shortened or suppressed. Margin of the oval part, occupied by the frontal membrane, elevated. Operculum membraniporine. Depressed and extensive cryptocyst. Avicularia absent.

Remarks

Available literature shows that the genus Crepis contains three species. C. longipes, C. verticillata and C. decussata. In 1883 Jullien created this genus to include a new spices C. longipes. Harmer added two more species to this genus in his Siboga Report. All the three species are represented in the Indo-Australian Archipelago even though, C. longipes was not present in the siboga collections.

Previous records from Indian waters

Menon and Nair, 1967

Distribution

Harmer (1926) records this species in the Haddon collections from strait, kept in the B.M. (N.H.)

DIVISION CRIBRIMORPHA Harmer, 1926

"This division was established by Harmer to include all of the genera in which the frontal sheld, or pericyst, is formed by the union of hollow spines or costae, more or less fused, with pores (Lacunae) between the costae, the "Cribrimorphs" of Lang"(Osburn, 1950).

FAMILY CRIBRILINIDAE HINCKS, 1880

"This family is generally taken to include all recent and fossil forms in which a frontal shield is produced by the union of modified spines (costae) over the original frontal membrane". (Harmer, 1926).

GENUS REGINELLA Jullien, 1886

1886 Reginella Jullien, Bull. Soc. Zool. France, II, pp.601-620.

1920 Reginella Canu and Bassler, Bull. U.S. nat. Mus., 106, p.283.

1950 Reginella Osburn, Rep. Allan Hancock Pacific Exped., 14, 1, pp.178-179.

The front formed by voluminous ribs. The pores placed in the centre of calcareous polygonal cells. These cells diminish in size from the talon to the extremity of the rib. A furrow, often broad, present in between each pair of ribs. Each pair of transverse ribs is separated by the inter-costal furrows extending the zooecium entirely. The inferior lip of the arched orifice mucronated. Avicularia wanting.

7. Reginella mattoidea Osburn, 1950

(Figs. 7a & b)

1950 Reginella mattoidea Osburn, Rep., Allan Hancock pacific Exped., 14, 1, p.182, pl.28, fig.2.

1967 Reginella mattoidea Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

A single colony encrusting on a colony of Codonellina montferrandii was present in the dredged material collected at a depth of 50m. off Quilon.

Measurements

Zooecium

Length	-	356 μ
Breadth	-	205 μ

Salient features

Encrusting. Zoarium dull white in colour. Zooecia alternate, radiating from a median point and separated by broad shallow grooves. Front convex with six to seven pairs of costae joining in the median line. Lacuna present, placed in the centre of distinct polygonal calcareous cells. Usually ten in number. The size of the polygonal thickenings increase laterally. Orifice small, rounded with slightly drawn out lateral sides. Ovicells present with a median thickening, non-porous.

Remarks

In the non-porpous nature of the ovicell, this form differs from Reginella mattoidea Osburn, with which it shows resemblance. The nature of the pericyst and the increased number of the lacunae distinguishes this species from the other species of the genus Reginella Jullien. In all other features the resemblance shown by this form to R. mattoidea prompted me to include it under that species.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Santa Barbara Island, California, Raza Island, California, Clarion Island, Revillagiged Islands, West of Mexico (Osburn, 1950).

SUB-ORDER ASCOPHORA Levinsen, 1909

The frontal area is completely calcified, leaving the aperture. Compensation sac present which opens into the proximal side of the aperture or into the ascopore situated proximal to the aperture. Operculum compound in the case of forms where the compensation sac opens into the aperture, simple in the case of those where an ascopore is present.

FAMILY ARACHNOPODIIDAE Harmer, 1957

GENUS TREMOGASTERINA Canu, 1911

1911 Tremogasterina Canu, An. Mus. Nac. Buenos Aires, 21, p.256.

1928 Tremogasterina Canu and Bassler, Proc. U.S. Nat. Mus., 72, 14, p.43.

1957 Tremogasterina Harmer, Siboga Exped., 28d, p.659.

"The ovicell is hyperstomial and closed by the operculum. The aperture bears two small cardelles, the operculum, often chitinised, is attached to the ectocyst, the peristome bears three to five hollow spines. The frontal is placed above the ectocyst; it is formed of an olocyst surmounted by a rugose or granulated pleurocyst more or less developed; a central by interjunctural pores. Large adventitious avicularia appear between the apertures". (Canu and Bassler, 1928).

8. Tremogasterina granulata Canu and Bassler, 1928

(Figs. 8a & b)

1928 Tremogasterina granulata Canu and Bassler, Proc. U.S. nat. Mus., 72, 14, pp.45-47, pl.13, figs.3, 4, pl.33, fig.2, text figs.6b-f.

1967 Tremogasterina granulata Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Three colonies encursting on corals were collected from a depth of 15m. off Rameswaram.

Measurements

Zooecium

Length - 500 μ

Breadth - 540 μ

Salient features

Encrusting, Distinct, elongate, clavate zooecia separated by small pores, which may be inconspicuous. Highly calcified and granulated front with a pore in the middle. Elongate and sub-orbicular orifice with a concave border. Two cardelles present. Operculum chitinuous with a continuous sclerite. Large avicularia placed on calcareous thickenings on either side of the orifice, directed distally. Mandibles long with slightly pointed ends. Three small oral spines present in juvenile zooecia.

Remarks

This form resembles in all essential characters Tremogasterina granulata Canu and Bassler. The only difference noticed is in the nature of the avicularian mandible which is distincly triangular in the figure given by Canu and Bassler, whereas it is elongated and slightly pointed in the present material, in which case it resembles T. lanceolata Canu and Bassler. No ovicell is noticed in the present instance.

Previous records from Indian waters

Menon and Nair 1967.

Distribution

Straits of Florida (Canu and Bassler, 1928).

9. Tremogasterina ventricosa Canu and Bassler, 1928

(Figs. 9a & b)

1928 Tremogasterina ventricosa Canu and Bassler, Proc. U.S. nat. Mus., 72, 14, pp.47-48, pl.13, figs.1, 2.

1967 Tremogasterina ventricosa Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

A single colony encrusting on a gastropod shell was collected from a depth of 330m. off Ponnani.

Measurements

Zooecium

Length	-	500 μ
Breadth	-	420 μ

Salient features

Zoarium encrusting. Young zooecia distinct, separated by interjunctural pores, which get obscrued as a result of calcification. Convex front tuberculated with small reniform pores. Aperture elongate oval. Thin peristome with three spines. Avicularia large with rounded tips. Mandidble with a sub-marginal sclerite. Ovicells not noticed.

Remarks

This form resembles the description and figures of Tremogasterina ventricosa Canu and Bassler. However, certain differences are discernible as follows:-

Only a few zooecia in the present instance have mucros, which are rather inconspicuous. The number of peristomial spines here is three where as Canu and Bassler found them to be five in their specimens. Frontal pores vary in number 4 to 6. The avicularia are all with rounded tips and are arranged on either side of the orifice. In the whole colony a single large avicularium is noticed.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Atlantic Coast of Georgia (Canu and Bassler, 1928).

10. Tremogasterina lanceolata Canu and Bassler, 1928

(Figs. 10)

1928 Tremogasterina lanceolata Canu and Bassler, Proc. U.S. nat. Mus., 72, 14, p.48, pl.13, fig.9, text fig.6a.

1967 Tremogasterina lanceolata Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Three colonies encrusting on corals dredged out from a depth of 10m. off Mandapam.

Measurements

Zooecium

Length	-	750 μ
Breadth	-	625 μ

Salient features

Zoarium encrusting, multilaminar. Distinct zooecia separated by a line of interjunctural pores. Convex front porvided with very small granulations. A median pore present. Cardelles small. Large anter and rather small poster. Chitinished elongated oval operculum with a thin marginal sclerite. Avicularia large, often paired usually pointed distally or rarely disto-medianly. Immersed ovicells tuberculated, often with few large tubercles. Ovicells closed by the operculum.

Remarks

The present form closely resembles both the figures and description of *T. lanceolata* given by Canu and Bassler. The calcification of the frontal area makes a detailed study of the species difficult. Though this form apparently shows some general resemblance to *T. granulata* it can easily be distinguished by the nature of the operculum and the presence of distinct interjunctural pores.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

North Cuba (Canu and Bassler, 1928)

FAMILY CELLEPORARIIDAE Harmer, 1957

Pleurilaminar zoarium, often forms massive encrustations. Tubular zooecia mainly imperforate with few inconspicuous marginal or submarginal pores. Non-sinuate orifice. Raised peristome. Unilateral sub-oral avicularium, often produced into an ascending rostrum which may be slight or a long spike. Frontal avicularia of various sizes, sometimes gigantic. Hyperstomial and imperforate ovicells.

GENUS CELLEPORARIA Lamouroux, 1821

1821 *Celleporaria* Lamouroux, *Exposition Mithodigue des genres ...... des Polypiers*, p.43.

11. Celleporaria pilaefera (Canu and Bassler), 1929

(Fig.11)

1919 Holoporella pilaefera Canu and Bassler, Bull. U.S. nat Mus., 9, p.422, pl.60, figs.2-6, text fig.165.

1967 Celleporaria pilaefera Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

A single colony encrusting on a shell was collected from a depth of 5m. off Mandapam, Gulf of Mannar.

Measurements

Zooecium

Length	-	420 μ
Breadth	-	290 μ

Salient features

Encrusting. Zooecia small. Front with small marginal pores. Semicircular orifice. No oral spines. Condyles wanting. Median sub-oral rostrum present often long, arises from an expanded base. Sub-oral avicularium not noticed. Large spatulate vicarious avicularium present with a free raised distal end. Ovicell imperforate and tuberculated with complete frontal wall, pyriform openings facing proximally.

Remarks

Waters (1909) created tge genus Holoporella to include species of Cellepora without sinus. Waters did not select a genotype for the genus.

Canu and Bassler (1917) selected a genotype for Waters' Holoporella, Cellepora discostilsii Waters (nec. Aud.). Unfortunately this species was synonymised by Harmer under Celleporaria labelligera Harmer. By this step adopted by Harmer, the genotype became non-available for Holoporella. Harmer (1957) synonymised Holoporella under Celleporaria. Harmer's step is followed here.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Philippines (Canu and Bassler, 1929); Banda Sea and Timur Id. (Harmer, 1957). In addition to these records specimens of this species kept in the B.M. (N.H.), collected from Saya de Malha, Indian Ocean (Thornely, 1935) and Ghardaqa, Red Sea (Crossland Collection) are recorded by Harmer (1957).

12. Celleporaria granulosa (Haswell), 1880

(Figs. 12a & b)

1880 Cellepora granulosa Haswell, Proc. Linn. Soc. Nis. W., 5, P.40.

1912 Holoporella simplex Thornely, Trans. Linn. Soc. (Zool.)., 15, p.155.

1957 Celleporaria granulosa Harmer, Siboga Exped., 28d, pp.688-690, Pl.43, figs.14-19.

1967 Celleporaria granulosa Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Two colonies encrusting on a coral were collected from a depth of 10m. off Mandapam south-east coast of India.

Measurements

Zooecium

Length	-	425 µ
Breadth	-	280 µ

Salient features

Encrusting, zoarium multilaminar. Distinct calcareous lines present in between young zooecia. Marginal pores present. Orifice orbicular, surrounded by a calcareous border, which sub-orally bears a rounded avicularium placed on a large rounded thickening. The spike-like projection absent. Large vicarious avicularium expanded distally with a columella rare. Operculum large and with slightly curved proximal border. No ovicells noticed.

Remarks

The form under consideration resembles the figures and description of Celleporaria granulosa given by Harmer. Certain differences are, however, noticed. The zoarium here is encrusting. Harmer states that it can be erect. Haswell's materials from Queensland, kept at the B.M. (N.H.) and the Cambridge Museum contain with erect sub-cylindrical branches. Harmer found that the Torres Strait specimens kept in the B.M. (N.H)., possessed numerous vicarious avicularia. But in the present instance the number of vicarious avicularia is much less. The vicarious avicularia here are expanded distally and the distal portions are raised from the zooecial surface. This is in agreement with Harmer's observation.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Queensland (Haswell, 1880); Mauritius (Thornely, 1912). This species was not represented in the Siboga collections (Harmer 1957).

FAMILY PETRALIELLIDAE Harmer, 1957

Colonies encrusting or hemescharan. Usually zooecia large and reticulopunctate. Large orifice, variable in form and in the presence or absence of lateral denticles or articular condycles. Sub-oral mucro often present. Different kinds of avicularia, like lateral oral, sub-oral and frontal. Rounded or acute mandible. Large mandibles sometimes with a median sclerite and frequently with a distal semi-circular, denticulate vertical flange. Globose and porous ovicells. Smooth basal sclerite usually with one or more pore-chambers capable of giving rise to membraneous root-lets. Rarely reticulo-punctate, uniformly porous.

GENUS MUCROPETRALIELLA Stach, 1936

1936 Mucropetraliella Stach, Rec. Aust. Mus., 19, 6, pp.363-372.

1957 Mucropetraliella Harmer, Siboga Exped., 28d, pp.709-710.

"Lyrula and lateral denticles usually present. A sub-oral avicularium, generally associated with a mucro is the most important feature of the genus". Harmer (1957).

13. Mucropetraliella philippinensis (Canu and Bassler), 1929
(Figs. 13a & b)

1929 Petraliella philippinensis Canu and Bassler, Bull.U.S. nat. Mus., 9, p.261, pl.25, figs.3-11.

1957 Mucropetraliella philippinensis Harmer, Siboga Exped., 28d, pp.710 - 711, Pl.45, figs.19-21.

1967 Mucropetraliella philippinensis Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

A part of a hemescharan colony was collected from the dredgings conducted in the Gulf of Mannar at a depth of 10m.

Measurements

Zooecium

Length - 510 μ

Breadth - 380 μ

Salient features

Colony hamescharan. Large and flat zooecia with unconspicuous septal lines. Front with small pores. Distal walls of the peristome thin. Orifices wider than long. Lyrula short and wide with pointed lateral corners. Denticles present, pointed. Sinuses not closed. Majority of avicularia small and rounded. Large lateral avicularia usually present placed slightly away from the lateral sides of the orifice. Sub-oral and lateral frontal avicularia large. Mandibles of small avicularia with denticles. A well developed mucro present, often branched and overarch the secondary orifice. No ovicells noticed.

Remarks

This material closely approaches Mucropetraliella philippinensis described by Harmer (1957). However, some differences have also been noticed. Such as the nature of the lateral avicularia occupying one side of the front, the position of the lateral oral avicularia and the nature of the mucro. The lateral frontal avicularia are not spatulate but rounded and the sides of the rostrum considerably raised so as to form a low calcareous wall springing from the front. The mucro is found to be rather large and in certain zooecia assume large size. Hence the sub-oral avicularium could be noticed only by removing the mucro. The nature of the lyrule and the lateral denticles are vey similar to that given by Harmer in his text.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Philippines (Canu and Bassler, 1929); Paternostu Is. and Tgalaut Is. (Harmer, 1957).

FAMILY SAVINGNYELLIDAE Levinsen, 1909

"The narrow, elongated, rather slightly calcified zooecia have a frontal surface, provided with scattered pores, which is separated from the basal surface by a more or less sharp boundary line. The distal wall has a number of uniporous or multiporous, rosette - plates in its periphery. Spines may appear around the aperture, proximally to which there may be a freely projecting avicularium. We may find free ooecia, two-layered from the proximal part, the ectooecium of which has a membraneous frontal side. The colonies are richly branched, jointed, and each internode consists of a single zooecium" (Levinsen, 1909, p.273).

GENUS SAVIGNYELLA Levinsen, 1909

1909 *Savignyella* Levinsen, *Morphological and Systematic studies on cheilostomatous Bryozoa*, pp.88, 274.

1952 *Savignyella* Osburn, *Rep. Allan Hancock Pacific Exped.*, 14, 2, pp.287.

1957 *Savignyella* Harmer, *Siboga Exped.*, 28d, pp.760-761.

Characters same as that of the family.

14. *Savignyella lafontii* (Audouin), 1826

(Figs. 14a & b)

1907 *Catenaria lafontii* Thornely, *Rec. Indian Mus.*, 1, p.180.

1921 *Catenaria lafontii* Robertson, *Rec. Indian Mus.*, 22, p.36.

1952 *Savignyella lafonti* Osburn, *Rep. Allan Hancock pacific Exped.*, 14, 2, p.288, pl.31. fig.3.

1957 *Savignyella lafontii* Harmer, *Siboga Exped.*, 28d, pp.761-763, pl.51, figs.11, 12.

1967 Savignyella lafontii Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

A single colony attached on to a glass panel was collected from the dry dock Cochin.

Measurements

Zooecium

Length	-	980 μ
Breadth	-	170 μ

Salient features

Zoarium erect, uniserial, light brown. Zooecia with chitinous joints, cylindrical proximal portion and expanded distal half, porous frontal and non-porous basal regions. Unsinuate orifice sub-terminal with six spines, placed distolaterally. Large sub-oral avicularium face distally. Ovicells not found.

Remarks

The form under consideration agrees in almost all respects with the figures and description of Savignyella lafontii (Aud.), given by Harmer. It is evident that the nature of the avicularium of the present form is different from that given by Osburn. Osburn's figure represents this structure as a small sessile one. How far this difference can be given some systematic importance is not clear.

Previous records from Indian waters

Madras (Robertson, 1921) and Menon and Nair (1967)

Distribution

"It is in the main circumtropical, extending, however, beyond these limits to about 45° N. on both sides of the Atlantic, but not reaching the British Is. Many records are from the Indian Ocean. It occurs commonly in the Mediterranean, and is found, in the Western pacific, in the Siboga Area, the great Barrier Reef and the Gilbert Is." (Harmer, 1957).

FAMILY ADEONIDAE (Busk), 1884

Foliaceous and bilaminar zooecia, less often encrusing. Zooecia with thick frontal walls traversed by long pore tubes. Usually one or more avicularia present on the front.

GENUS ADEONA Lamouroux, 1812

1812 Adeona Lamouroux, Nouv. Bull. Sci. Soc. Philomat., 63, p.188.

1957 Adeona Harmer, Siboga Exped., 28d, p.789.

"Zooaria erect, often large, proximally consisting of a branched root-let system, formed of linear series of stout, short, cylindrical, calcareous segments, connected by bundles of parallel chitinous tubes. Fronds bilaminar, foliaceous, in most species with numerous small fenestrae; or not fenestrate rarely composed of segments united by chitinous tubes. Median pore an ascopore. Operculum not sinuate, having the form of segment of a circle, the proximal margin straight or slightly curved, often wider than long". (Harmer, 1957).

15. Adeona foliacea Lamx, 1816

1816 Adeona foliacea (Fig. 14) Lamouroux, Nouv, Bull. Sci. Soc. Philomat., 63, p.188.

1957 Adeona foliacea Harmer, Siboga Exped., 28d, pp.790-793, pl.52, figs.1-14, 16-18.

1967 Adeona foliacea Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Fragment of a colony measuring 15mm. in length obtained from a dredge collection taken from a depth of 30m. off Cochin.

Measurements

Zooecium	
Length	- 385 µ
Breadth	- 230 µ

Salient features

The branch flattened with a median hollow space. Zooecia arranged in regular and more or less transverse rows. Marginal zooecia slightly larger than the central ones. Marginal pores present. Avicularia single, pointed, raised from the zooecial plane, and directed distally or proximally. A median ascopore. Raised peristome with a slightly bent distal portion. Vicarious avicularia present.

Remarks

The paucity of material (only a fragment of a colony) makes a correct understanding of the zoarial nature difficult. A comparison of this form with the description and figures of Adeona foliacea given by Harmer shows that the present form can be assigned to it. Harmer in his report has discussed in detail the nature of the zoarium and the zooecia, and has given an elaborate account of the variations noticed in this species.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Australia (Lamouroux, 1816; 1821); Jedan, Aru Is. (Harmer, 1957).

FAMILY PHYLACTELLIDAE Canu and Bassler, 1917

"The ovicell is recumbent, its orifice is very large and closed by a special operculum". Canu and Bassler (1920).

GENUS LAGENICELLA Cheetham and Sandberg, 1964

1964 Lagenicella Cheetham and Sandberg, J. Palaeont., 38, p.1041.

Zoarium encrusting. Vase shaped zooecia. Inflated front a tremocyst. Sub-orbicular orifice may be unmodified or with a broad shallow poorly defined sinus. Secondary orifice sub-orbicular to elliptical, unmodified or having irregular, spiniform projections. Small avicularia adventitious and paired, placed on the lateral margins of the secondary orifice. Ovicell small, globular, peristomial, placed about half way down the distal side of the peristome. Surface of the ovicell finely perforated.

16. Lagenicella punctulata (Gabb and Horn)., 1862

(Fig.16)

1862 Entalophora punctulata Gabb and Horn, Jour. Acad. Nat. Sci. Philadelphia, 5, 2, p.171.

1884 Lagenipora spinulosa Hincks, Ann. Mag. nat. Hist., 13, p.57, pl.3, fig.4.

1908 Lagenipora spinulosa Robertson. Univ. Calif. Publs. Zool., 4, pp.283-284, pl.18, fig.37.

1952 Lagenipora punctulata Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, pp.485-486, pl.60, figs.1-2.

1967 Lagenicella punctulata Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

A fragment of a colony obtained from the dredgings conducted off Alleppey.

Measurements

Zooecium

Length	-	750 μ
Breadth	-	306 μ

Salient features

Zoarium with a small encrusting base erect and with irregular branches. Zooecia lageniform slightly bent peristome. Front a tremocyst with large tremopores. A pair of minute avicularia occupy the rim of the peristome, latero-medianly. Position of the avicularia demarcated by two pointed calcareous prolongations, placed on the external phase of the avicularia. No ovicell noticed.

Remarks

In a paper Cheetham and Sandberg (1964) have created a new genus Lagenicella, with Lagenipora marginata Canu and Bassler as the genotype. In this paper the authors have considered Entalophora punctualata Gabb and Horn under the newly proposed genus.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

British Columbia to Monsterey Bay, California (Hincks, 1884; Robertson, 1908); Northern California to Lower California, Gulf of California, Galapagos Is. (Osburn, 1952).

FAMILY CELLEPORIDAE Busk, 1852

Characterised by the absence of oral spines and sinuate primary orifices. Operculum sinuate. Ovicells hyperstomial. Ectooecium wholly or partially calcified. Avicularia almost always asymmetrically placed, strongly projecting, placed proximal to the aperture.

GENUS TURBICELLEPORA Ryland, 1963

1963 Turbicellepora Ryland, Sarsia, 14, p.34.

"Zoarium encrusting, or rounded and more or less massive, sometimes branched zooecia heaped and jumbled together. Frontal walls an olocyst. Orifice with a proximal sinus and prominent unilateral, non-columnar sub-oral avicularium. Vicarious spatulate avicularia present. Ovicells recumbent, with scattered pores which do not form a crescentic series". (Ryland, 1963)

17. Turbicellepora redoutei (Audouin), 1826

(Fig. 17)

1826 Cellepora redoutei Audouin, Description de l'Egypte, Hist. Nat., 1, 4, p.238.

1905 Cellepora megasoma Thornely, Rep. Pearl Oyster Fish. Gulf of manaar, 4, Suppl. Rep. p.126.

1957 Schimsmopora redoutei Harmer, Siboga Exped., 28d, pp.909-911, pl.62, figs.20, 23, 24; text fig.98.

Occurrence

Two colonies encrusting on a polychaete tube from a dredge sample, taken from a depth of 65m. off Cochin.

Measurements

Zooecium (Fertile)

Length	- 650 μ
Breadth	- 290 μ

Salient features

Multi-laminar zoarium encrusts on the polychaete tubes. The zooecial front smooth, with sparsely distributed marginal pores. Primary orifice with a distinct sinus. Peristome slightly everted. Sub-oral avicularium single or rarely double, laterally placed at the proximal side of the orifice, often fuse with the peristome. Spatulate, large avicularia present. Ovicell globose and perforated.

Remarks

Turbicellepora is the new genus created by Ryland to include species of Schismopora. The history of the genus Schismopora is confusing. Even regarding the genotype, authors differ. Thus, Harmer (1957) has stated that the genotype is Cellepora costata which, however, he has rejected and selected a new species Schismopora redoutei (Aud.).

Harmer (1957) considered the selection of Cellepora costata as unfortunate since the genus won't be available at all. Hence he introduced Schimsmopora redoutei as the genotype. Ryland (1963) comments on this step of Harmer as follows: "Harmer, however, has adopted Canu and Bassler's (1917) conception of Schismopora and had deliberately chosen to ignore the rules of nomenclature, for the type species of Schismopora selected by Gregory (1893) is Cellepora costata Mac Gillivray which rightly belongs to the genus Celleporina. It is inescapable, therefore that Schismopra is another synonym of Celleporina". The species under consideration is, therefore, renamed as Turbicellepora redoutei (Aud.) Pouyet (1965), however, wishes to conserve the name Schismopora as Harmer (1957) has done.

Previous records from Indian waters

South-east coast and West coast of Ceylon and Gulf of Manaar (Thornely, 1905). Indian ocean (Thornely, 1912). Andaman Is. (Thornely, 1907). Menon and Nair (1967)

Distribution

Red Sea (Audouin, 1826); Victoria (MacGillivray, 1869) Cape of Good Hope (Busk, 1881); Ceylon (Thornely, 1907); Indian Ocean (Thornely, 1912). Borneo Bank, Strait of Makassar, Sumbawa, West Flores, North Celebes, West of North end of New Guinea, Aru Is. (Harmer, 1957).

In addition to the above records, Harmer has reported the specimens kept at the Cambridge Museum, sent by various donors. Mediterranean or Red Sea, Hincks coll, 1899; Singapore; Hanitsch collection, 1900. Torres Straits, Haddon collection, 1900. Torres Straits, Hincks collection, 1899.

FAMILY SMITTINIDAE Levinsen, 1909

Front an olocyst, pleurocyst or tremocyst. Semicircular primary orifice usually wtih cardelles and a lyrula. Oral spines common. Suboral or frontal avicularia present. Ovicells hyperstomial.

GENUS PARASMITTINA Osburn 1952

1952 Parasmittina Osburn, Rep. Allan Hancock Pacific Exped. 14,2, p.411.

1963 Parasmittina Lagaaij, Publ. Institute of Marine Science 9, p.197.

"Avicularia variously distributed on the frontal, but never median suboral and bilaterally symmetrically developed around the proximal border of the aperture; they take their origin from areolar pores on one side". (Osburn 1952). Pleurocyst with a row of areolar pores, Lyrula and Cardelles usually well developed. Variously developed ovicells present.

18. Parasmittina aviculata (Mawatari), 1952

(Figs. 18a & b)

1952 Smittina aviculata Mawatari, Publ. Seto Mar. Biol. Lab., 2,2, pp.280-281, fig.15.

1967 Parasmittina aviculata Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Few colonies encrusting on molluscan shells were collected from Vizhinjam.

Measurements

Zooecium (Fertile)

Length	- 360 μ
Breadth	- 120 μ

Salient features

Zoarium encrusting, distinctly whitish in hue. Zooecia arranged in longitudinal rows separated by calcareous lines. Front a highly tuberculated pleurocyst with comparitively small and rounded areolar pores. Peristome with raised proximal and lateral regions. Broad lyrula, condyles slightly pointed. Large spatulate avicularia arranged lateral to the peristome directing proximally. Small lateral avicularia of two types, pointed and circular occupy the lateral sides of the peristome, usually directed distally. Two inconspicuous spine bases noticed in young zooecia, porus ovicells, elevated with an ectooecium occupying the rim.

Remarks

Mawatari (1952) treated this species to include forms of smittina which possessed three types of avicularia. One of the conspicuous features of this species is the presence of the large spatulate avicularia and the nature of ovicell ectooecium, in the form of a rim. Present specimen agrees the descriptions given by Menon and Nair (1967)

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Kei Peninsula Japan (Mawatari, 1952).

19. Parasmittina californica (Robertson 1908)

(Figs. 19a & b)

1908 Mucronella californica Robertson, Univ. Calif. Publ. Zool. pp.308-309 Pl.23 fig.80.

1952 Parasmittina californica Osburn, Rep. Allan Mancock Pacific Exped. 14,2, pp.415-416 pl.51 figs.8-11.

1964 Parasmittina californica Soule and Soule, Amer. Mus. Novitates, 2199, pp.27-28 fig.8.

1967 Parasmittina californica Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Colonies encrusting on molluscan shells were collected from Vizhinjam.

Measurements

Zooecium

Length	-	480 μ
Breadth	-	180 μ

Salient features

Encrusting, quadrangular zooecia seperated by grooves. Calcified pleurocystal front, but irregularly arranged pores often present. Thin and low peristome. Primary orifice rounded with a moderaly developed and two small condlyles. Laterally directed oval, pointed, spatulate avicularia placed on various parts of the front. A large spatulate proximolaterally directed avicularium occasionally present. Heavily calcified ovicells perforated. Their proximal region usually invaded by the peristome.

Remarks

Robertson (1908) who described this species for the first time from California, included it under the genus Mucronella. In her description importance has been given for the nature of the spatulate avicularium. Osburn (1952) adopted M. californica Robertson as the type species, owing to the fact that, what Robertson thought to be the mucro, was in reality the lyrula. A scrutiny of the other specific character shows that the nature of the front, shape of the avicularia and nature of the ovicells are also important characters. The material in hand agrees well with descriptions given by Menon (1967).

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Southern California (Robertson, 1908), Southern and Lower California, Galapagos Is. (osburn 1952); Gulf of California, (Soule and Soule 1964)

FAMILY MICROPORELLIDAE Hincks, 1879

Characterised by the presence of a median ascopore, which varies inform and position placed proximal to the aperture. Proximal border of the aperture nearly straight, operculum without extensions proximal to the cardelles. In the genus Microporella avicularia present. Peristome with spines.

GENUS MICROPORELLA Hincks, 1877

Semicircular aperture straight proximally. No tremoposes between the semilunar or rounded ascopore which occupy a position close to the aperture.

20. Microporella orientalis Harmer, 1957

(Figs. 20a & b)

1957 Microporella orientalis Harmer, Siboga Exped., 28d, pp.962-963.

1967 *Microporella orientalis* Menon and Nair, *J. mar. biol. Ass. India*, 9(2), pp.430-433.

Occurrence

Five colonies encrusting on the shells of *Mytilus viridis* were collected from the sub-tidal region at Cochin.

Measurements

Zooecium

Length	-	380 µ
Breadth	-	280 µ

Salient features

Encrusting. Colonies glistening white, spreading over substratum in unilaminar fashion. Zooecia arranged in longitudal rows, uniformity in growth being lost at places of overcrowding owing to lack of space. Tremocyst with very minute tremopores. Zooecia separated by grooves. Orifice semicircular with straight proximal border. Spines present over peristome, stumpy, the number varying from four to six. The places from where spines are dislodged, marked by rounded spots. Ovicells hyperstomial. In fertile zooecia peristome personate. Operculum not chitinised, its main sclerite marginal, proximal border with few denticles. Ascopore reniform with minute teeth. Avicularia single, always placed proximo-laterally to an ascopore. Triangular avicularian mandible long with tip slightly elongated, forming a setiform process. Mandibles with a pair of hooks. Rostrum with a complete bar.

Remarks

Resembles closely Microporella orientalis Harmer. Harmer (1957) has stated that in some cases the lower lip of the fertile zooecium is incomplete, in the present form such a feature has not been noticed. Further the observation of Harmer that the "oral spines are usually inconspicuous or wanting, but may be as many as 5", does not agree in this case since six oral spines are noticed in the present form.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

W. Flores, Sulu Archipelago, Halmaheira, Aru Is. (Harmer, 1957).

21. Microporella ciliata (Pallas), 1766

(Figs.21a & b)

1766 Eschara ciliata Pallas, Elenchus zoophytorum, p. 38.

1923 Microporella ciliata Canu and Bassler, Bull. U.S. nat Mus., 125, pp.119-120, pl.20, figs.1-6, pl.36, figs.4-5.

1952 Microporella ciliata Osburn, Rep. Allan Hancock pacific Exped., 14, 2, p.377, pl.44, fig.1.

1967 Microporella ciliata Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Five colonies, encrusting on shells, were obtained from the dredge samples collected off Chavara, South-west coast.

Measurements

Zooecium

Length	-	500 μ
Breadth	-	300 μ

Salient features

Encrusting. Shape of zooecia varies from oval to elongate hexagonal. Zooecia arranged in longitudinal rows, separated by grooves. Front a tremocyst with numerous tremopores intermingled with small granulations. Umbo not noticed. Semicircular aperture with a straight proximal border, distal and lateral sides being provided with small teeth. Peristome slightly developed. Reniform ascopore. Ovicells hyperstomial, surface not smooth, a rib present at the base. Avicularia single, not placed in the median line, placed disto-laterally. Rostrum pointed, calcareous bar complete. Oral spines absent.

Remarks

These specimens resemble closely with the description of Microporella ciliata (Pallas) given by Osburn (1952) and Menon and Nair (1967). Minor differences noted are as follows. In no zooecium a pair of avicularia have been noticed. An umbo is apparently absent in the present material.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

"A cosmopolitan species, listed on the American Pacific coast by Hincks and O'Donoghue from British Columbia waters and by Hastings from Panama, Columbia and Galapagos Islands". Osburn (1952).

Mediterranean (Pallas, 1766)

GENUS FENESTRULINA Jullien, 1888

1923 Fenestrulina Canu and Bassler, Bull. U.S. nat. Mus., 125, p.113.

1952 Fenestrulina Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, p.387.

1957 Fenestrulina Harmer, Siboga Exped., 28d, p.966.

Very similar to Microporella Hincks, but distinguished by the absence of avicularia, stellate nature of tremopores one to two rows of which usually occupy the space between the aperture and the ascopore and by the presence of marginal areolae on the ovicells.

22. Fenestrulina malusii (Audouin), 1826

(Figs. 22a & b)

1923 Fenestrulina malusii Canu and Bassler, Bull. U.S. nat. Mus., 125 pp.115-117, fig.19a & j, pl.36, figs.2,3.

1952 Fenestrulina malusi Osburn, Rep. Allan Hancock Pacific Exped., 12, 2, pp;.387-388, pl.45, fig.3.

1957 Fenestrulina malusii Harmer, Siboga Exped., 28d, pp. 966-969, pl.62, figs.32,33.

1963 Fenestrulina malusii Mawatari, Annual Rep. Noto Marine Lab., 3, p.9.

1967 Fenestrulina malusii Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

A single colony, encrusting on a shell fragment, was collected from the dredged material, taken from a depth of 50m. off Quilon.

Measurements

Zooecium (Fertile)

Length	-	515 μ
Breadth	-	310 μ

Salient features

Encrusting. Zoarium forms white and flat encrustation over the shell. Zooecia separated by deep grooves, arranged alternately in longitudinal rows. Raised front a tremocyst with stellate tremopores which are large and distributed in a uniform manner. Aperture semicircular with a straight proximal border. peristome slightly raised. Reniform ascopore with small teeth placed proximal to the aperture and always surrounded by raised walls. Usually two rows of tremopores occupy the space between the ascopore and the aperture. Ovicells hyperstomial with moderately sized marginal pores separated by calcareous ridges. Ectooecium represented in the form of a calcareous bar placed at the base of the ovicell. Avicularia and spines wanting.

Remarks

This material approaches closely to the description of Fenestrulina malusii (Audouin) given by Harmer (1957). The only difference noticed being the absence of oral spines. The most characteristic feature of having marginal pores on the ovicells is clearly noticeable in the ovicells. The calcified ectooecium which is represented in the form of a calcareous ridge at the base of the ovicells noticed in the present form is a common feature in the genus Microporella Hincks. This character together with the rest support Harmer's statement that "the two genera must be regarded as closely allied."

The stellate nature of the tremopores in the present form can be noticed only in those zooecia where the epitheca has been destroyed. In the rest, the tremopores are found as white dots.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

"Fenestrulina malusii has been recorded from nearly all parts of the world except from the Arctic waters" Harmer (1957).

FAMILY HIPPOPODINIDAE Levinsen, 1909

Front a thick olocyst or pleurocyst. Usually imperforate but for the marginal areolar pores. Hyperstomial ovicells. Marginally or at some distance within the margin a strong sclerite. Strong cardelles, avicularia usually present.

GENUS HIPPOPODINA Levinsen, 1909

1909 Hippopodina Levinsen, Morphological and Systematic Studies on the Cheilostomatous Bryozoa, p.353.

1957 Hippopodina Harmer, Siboga Exped., 28d, pp.973-974.

Encrusting zoarium, large, flat and quadrate zooecia arranged in longitudinal rows, bounded by shallow marginal grooves. Front porous. Large orifice, genearlly longer than wide, parallel sides or indented by the condyles, straight or slightly curved proximal margin limit a wide and shallow sinus. Avicularia acute directing transversely inwards, placed on the distal side of the orifice, tips meeting if paired, occasionally directed proximally or even wanting, spines absent. Ovicells hyperstomial, large with numerous small pores.

23. Hippopodina feegeensis (Busk), 1884

(Figs. 23a & b)

1884 Lepralia feegeensis Busk, Zool. Challeng, Rep., 10, 30, p.144, pl.22, figs.9-9b.

1913 Lepralia feegeensis (Sic) Waters, Proc. Zool. Soc. Lond., p.514, pl.70, figs.21,22.

1921 Lepralia feegeensis Robertson, Rec. Indian Mus., 22, p.56.

1957 Hippopodina feegeensis Harmer, Siboga Exped., 28d, pp.974-976, pl.67, figs.7-9.

1967 Hippopodina feegeensis Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Two colonies, encrusting on a coral were collected at Mandapam from the Gulf of Mannar.

Measurements

Zooecium

Length	-	515 μ
Breadth	-	480 μ

Salient features

Encrusting, Unilaminar or multilaminar. Zooecia arranged in regular longitudinal rows separated by thin calcareous lines. Zooecia of the superposed layers slightly inflated. Surface reticulopunctate. Orifice with a semicircular distal portion and slightly arched posterior region and indented with cardelles otherwise straight lateral sides. Avicularia typically present, occupy the disto-lateral region, directing inwards; their tips do not touch each other in the median line. Mandibles pointed. The shape of the operculum very similar to that of the orifice. Main sclerite marginal. Ovicell hyperstomial and porous, with minute pearly tubercles.

Remarks

The characters of this material agree well with the figures and descriptions of Lepralia feegeensis Busk (1884), and Hippopodina feegeensis (Busk) given by Harmer (1957) and Menon and Nair (1967) hence is assigned to this species.

Previous records from Indian waters

First record from Indian waters by Menon and Nair (1967)

Distribution

Distributed in the tropical and warm temporate waters.

24. Hippopodina californica Osburn, 1952

(Figs. 24a & b)

1952 Hippopodina californica Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, pp.293-294. pl.31. fig.9, pl.32, figs.1-3.

1967 Hippopodina californica Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

A single colony encrusting on a shell was collected off Quilon, from a depth of 50m.

Measurements

Zooecium		
Length	-	380 μ
Breadth	-	260 μ

Salient features

Zoarium encrusting. Distinct zooecia arranged in longitudinal rows. Arched front a tremocyst. The distal end of the preceding zooecium over arches the proximal end of the succeeding one. Rounded aperture with a shallow sinus. Distinct condyles present. Peristome prominent with flaring lateral borders. Operculum with a main marginal sclerite. Acute, small, avicularia present, occupy the interior of the peristome, lateral in position. No ovicells noticed.

Remarks

The presence of avicularia makes the assignment of the present form under Hippopodina californica tentative.

The important difference noticed in the present instance is the occurrence of avicularia. Avicularia are disposed inside the peristome. It is not clear whether the presence of avicularia will justify the creation of a new species. A study of the common species of Hippopodina viz. H. feegeensis which does possess avicularia, shows that this structure may be absent in a number of zooecia of the same colony. So it is possible that the presence or absence of avicularia is not of much importance in H. californica also.

Previous records from indian waters

Menon and Nair (1967)

Distribution

"The known distribution is from the northern channel Islands off Southern California to San Pedro, Nolasco Island in the Gulf of California" (Osburn, 1952).

FAMILY SCHIZOPORELLIDAE Jullien, 1903

Front a tremocyst. Proximal border of the primary aperture usually with a distinct and moderately deep sinus. Operculum well chitinised. Avicularia usually present. Ovicells hyperstomial.

GENUS SCHIZOPORELLA Hincks, 1887

1887 Schizoporella Hincks Ann. Mag. nat. Hist., 19, pp.150-164.

1952 Schizoporella Osburn, Rep. Allan Hancock Pacific Exped. 14, 12, p.317.

Front is a tremocyst, aperture semicirculr distally, slightly vestibular arch. The proximal border with a rounded sinus, chitinised operculum. Ovicells hyperstomial, avicularia present, placed at the aperture.

25. Schizoporella unicornis (Johnston)

(Fig. 25)

1952 Schizoporella unicornis Osburn, Rep. Allan Hacock Pacific Exped. pl.317-318, pl.37, figs.1-2.

Occurrence

Encrusted colonies of this species were collected from Vizhinjam.

Measurements

Zooecium

Length	-	540 µ
Breadth	-	360 µ

Salient features

Zoarium encrusting, irregular, frequently multilaminar, zooecia quadrangular or hexagonal, front a thick tremocyst with large tremopores. An umbo present behind the aperture. Aperture rounded distally with a rounded sinus on the proximal border. Frontal thickening often does not encroach the peristome. Avicularia not pointed, triangular mandible directed centrally. Avicularian size can vary. Ovicells not noticed.

Remarks

Present specimens compare well with those belonging to S. unicornis. The only difference noticed was in the shape of the avicularian mandible. Osburn (1952) has remarked that the avicularian position can vary, but has not commented on the variability of the avicularian mandibular shape. Notwithstanding this shape the present specimens are assigned under S. unicornis.

Previous record from Indian waters

This is the first record from Indian waters.

Distribution

It is a widely distributed species, (Osburn, 1952).

GENUS CLEIDOHASMA Harmer, 1957

1957 Cleidochasma Harmer, Siboga Exped., 28d, pp.1058-1059.

Key hole-shaped elongate orifice. Relatively large sinus, minute condyles generally present. Zooecia generally with marginal pores. Globular ovicells tuberculated and sometimes porous, not closed by the operculum. Avicularia often two in number, acute or of two kinds.

26. Cleidochasma biavicularium Canu and Bassler, 1929

(Figs. 26a & b)

1929 Gemellipora biavicularia Canu and Bassler, Bull. U.S. nat. Mus., 50, 9, p.310.

1957 Cleridochasma biavicularium Harmer, Siboga Exped., 28d, pp. 1047-1048, pl.71, figs.22-25.

1967 Cleidochasma biavicularium Menon and Nair, J. mar. biol. Ass. India. 9(2), pp.430-433.

Occurrence

Erect fragments of several colonies were collected from the dredged materials, from a depth of 60m. off Cochin.

Measurements

Zooecium

Length	-	530 µ
Breadth	-	475 µ

Salient features

Zoarium erect,branching and escharan. Zooecia with regularly tuberculated convex front, arranged in longitudinal rows alternately. Zooecia seperated by deep grooves. Marginal pores present. Key hole shaped orifice with slightly narrow sinus. Peristome very low and smooth. Operculum with strong marginal sclerite. Avicularia often paired, placed on swollen projections one of which occupies the lateral sub-oral position and the other one lateral distal or parallel to the orifice. Lateral avicularium with slightly rounded rostrum and with triangular mandible, the sub-oral one with slightly pointed rostrum and long setiform mandible projecting beyond the tip of the rostrum, perforated ovicells, with small tubercles, placed above the operculum.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Strait of Makkassar (Harmer, 1957); Philippines (Canu and Bassler, 1929).

27. *Cleidochasma fallax* (Canu and Bassler), 1929

(Figs. 27a & b)

1929 *Hippoporina fallax* Canu and Bassler, *Bull U.S.nat. Mus.*, 9, p.320, pl37, figs.4,5.

1957 *Cleidochasma fallax* Harmer, *Siboga Exped.*, 28d, p.1043, pl.71, figs.6-8.

1967 *Cleidochasma fallax* Menon and Nair, *J. mar. biol. Ass. India*, 9(2), pp.430-433.

Occurrence

A single colony encrusting on a bivalve shell was collected from a depth of 50m. off Quilon.

Measurements

Zooecium

Length	-	525 µ
Breadth	-	370 µ

Salient features

Encrusting. Colony unilaminar. Zooecia tubular distinctly outlined. Front slightly tuberculated with small widely separated marignal pores. Orifice more or less cleithirate with a distinct sinus. Peristome thin. Operculum strongly chitinized with a distinct marginal sclerite. Avicularia lateral oral, may be single or paired directing disto-laterally. Mandible rounded distally. Transversely directed spatulate avicularia placed proximally.

Remarks

The present form approaches closely Cleidochasma fallax described by Harmer (1957). The differences noticed are in the presence of a spatulate aviculiarium and in the nature of the avicularian mandible.

The avicularian mandibles are rounded in the present material whereas Harmer, found them to be acute in his specimens. The occurrence of spatulate avicularia is interesting. Spatulate avicularia are occasionally noticed in some species assigned to this genus. A study of the present species based on Harmer's description and figures reveals that characters such as the marginal pores and lateral avicularia with spatulate rostra are present with pointed mandibles. In the present instance the mandible is lacking and only one spatulate avicularium has been noticed in the colony. It is, however, not clear whether the presence of this solitary spatulate avicularium should be given some importance and the present material be consiered as a variety of C. fallax.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Philippine Is. (Canu and Bassler, 1929); W.Timor and W. of Nort. end of New Guinea (Harmer, 1957).

GENUS SCHIZOMAVELLA Canu and Bassler, 1917

1917 Schizomavella Canu and Bassler, Bull. U.S. nat. Mus., 96, p.40.

1920 Schizomavella Canu and Bassler, Bull.U.s. nat. Mus., 106, p.353.

1957 Schizomavella Harmer, Siboga Exped., 28d, p.1027.

Well chitinized variably sinuate small opercula. Proximally directed sub-median avicularium. Porous ovicells.

28. Schizomavella inclusa (Thornely), 1905

(Fig. 28)

1905 Schizoporella triangula Thornely, Rep. Pearl Oyster Fish. Gulf of Mannar, p.115.

1957 Schizomavella inclusa Harmer, Siboga Exped., 28d, pp.1028-1030, pl.66, figs.4,6,7.

1967 Schizomavella inclusa Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

A single colony was collected encrusting on a gastropod shell, dredged off Ponnani, at 55m.

Measurements

Zooecium

Length	- 365 μ
Breadth	- 260 μ

Salient features

Unilaminar zoarium, encrusting. Zooecia arranged in longitudinal rows separated by thin calcareous lines. Slightly inflated front provided with uniformly distributed pores. Orifice round with a distinct sinus limited by two condyles. Avicularium present placed over a calcareous thickening at a distance from the proximal border of the peristome. Avicularia rounded directed proximally. Small mandibles semi-circular. Ovicells large, slightly immersed, porous operculum with a sub-marginal sclerite.

Remarks

This form while agreeeing in essential features with the figures and descriptions of Schizoporella avicularia given by Thornely (1905) and Schizomavella inclusa given by Harmer (1957), does exhibit differences.

No vicarious avicularium was noticed in the present instance. This may perhaps be owing to the paucity of the material (only one colony). Harmer comments about this character "The most striking character of Schizomavella inclusa is the occurence (rare) of large vicarious avicularia of a peculiar type." It is evident that Harmer has noticed that the vicarious avicularia are rare structures in this species. He could notice this structure only in Thornely's specimens kept at the Cambridge Museum.

The adventitious avicularia are placed over calcareous thickenings which extend proximally from the lateral border of the peristome. The shape of the avicularium is very similar to that shown by Harmer. Thornely in her text on Schizoporella avicularia has stated about the umbo over which the avicularia are placed. Her figure shows the umbos but not small avicularia.

Previous records from Indian waters

Ceylon (Thornely, 1905) Menon and Nair (1967)

Distribution

Madagaskar (Thornely, 1912); Ceylon (Thornely, 1905) S. of Mindano, Amboya and New Guinea (Harmer, 1957).

Charadaqa (Crossland collections kept at B.M. (N.H.). recorded by Harmer, 1957.

29. Shizomavella linearis var. inarmata (Hincks), 1884

(Fig.29)

1884 Schizoporella linearis from inarmata Hincks, Ann. Mag. nat. Hist. 5, 11, pp.442-451.

1908 Schizoporella linearis sub-sp. inarmata Robertson, Univ. Calif. Publ. (Zool). 4, p.291, pl.20, fig.48.

1952 Schizoporella linearis var. inarmata Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, pp.319-320, pl.37, figs.4-5.

1967 Schizomavella linearis var. inarmata Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Several colonies were collected from wooden test blocks and glass panels used for the study of marine fouling organisms in the Ernakulam and Mattancherry channels.

Measurements

Zooecium (Fertile)

Length	-	360 μ
Breadth	-	210 μ

Salient features

Encrusting. Colonies thin with glistening zooecia. Tremocyst with numerous small pores. The presence of small prominences in between the pores give the tremocyst a granulated appearance. An umbo not present proximal to the aperture. The aperture typically rounded with an arcuate posture. Cardelles present. Thin operculum with two transparent regions at the proximal part. Ovicell hyperstomial and porous, slightly embeded in the proximal region of the succeeding zooecium. The pores restricted to the front, the sides thickly calcified. Avicularia absent.

Remarks

Marcus (1964) has treated Schizoporella linearis var. inarmata under Schizomavella. A comparative study of the figure and description of Schizomavella auriculata (Hassal) the genotype of Schizomavella given by Osburn (1952) and the form at hand shows that the present material resembles ths species but for the absence of avicularia in this form. So it seems that Marcus's step in placing S. linenaris var. inarmata under Schizomavella is correct. Hence the form before me is also, likewise, treated under Schizomavella

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Queen Charlotte Is. (HIncks, 1884); Santha Catalina Id. (Robertson, 1908); West Coast of Mexico, Gulf of California, Southern California (Osburn, 1952).

GENUS CALYPTOTHECA Harmer, 1957

1957 Calyptotheca Harmer, Siboga Exped., 28d, pp.1008-1010.

Zooecial and ooecial surfaces with uniformly distributed pores. Orifice and operculum with wide sinus and small condyles, often a moderate sub-oral umbo present. Large adventitious avicularia present in some species. Adventitious small and paired avicularia commonly occupy the sides of the orifice. Immersed ovicells.

30. Calyptotheca tenuata Harmer, 1957

(Fig. 30)

1957 Calyptotheca tenuata Harmer Siboga Exped., 28d, pp.1016-1017, pl.68, figs.16, 17.

1967 Calyptotheca tenuata, Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

A single colony was collected encrusting on a concrete slab dredged off Cochin.

Measurements

Zooecium

Length	-	490 μ
Breadth	-	210 μ

Salient features

Encrusting, zoarium unilaminar, light red in colour. Zooecia arranged in longitudinal rows separated by thin calcareous lines. Zooecia rectangular elongated, slightly convex front provided with uniformly distributed pores. Orifice rounded slightly wider than long. Sinus separated by small condyles. Orifice of the fertile zooecium slightly smaller in dimension (Same as non-fertile zooecium). Operculum with a rounded anter and a broad triangular poster the marginal sclerite shallows proximally for the articulation of the condyles. Avicularia paired, placed on thickenings proximal to the peristome directed obliquely inwards. Mandibles pointed. Globose ovicells porous.

Remarks

Referable to Calyptotheca tenuata Harmer.

The important differences noticed are concerned with the mode of arrangement of the avicularia. Invariably every zooecium of the colony, both fertile as well as non-fertile bears two avicularia lateral to the orifice directing obliquely inwards. The two avicuaria are placed on a continuous calcareous thickening bordering the proximal portion of the peristome. In this peculiar arrangement of the avicularia these specimens resemble the selenariiform species of the genus Calyptotheca circularis. This species, also has avicularia in the same position over two calcareous swellings.

Previous records from Indian waters

Ceylon (Thornely, 1905) Menon and Nair (1967)

Distribution

Philippine Is. (Canu and Bassler, 1929); West Flores, Saleyer, East Borneo, Amboya (Harmer, 1957); Ceylon (Thornely, 1905).

GENUS CODONELLINA Bassler, 1934.

1930 Codonellina Canu and Bassler, Proc. U.S. Nat. Mus., 76, 13, p.29.
(Preoccupied & changed)

1957 Codonellina Harmer, Siboga Exped., 28d, p.1048.

Marginate, porous and hyperstomial ovicells closed by the operculum. Frontal a tremocyst. A median avicularium placed proximal to the aperture.

Complete and salient peristome. Sub-orbicular aperture with a concave poster. Peristome with two false cardelles which limit the broad and rounded sinus.

31. Codonellina montferrandii (Audouin), 1826
(Fig.31)

1826 Flustra montferrandi Audouin, Description de l'Egypte, Hist. Nat., 1, 2, 4, p.140.

1905 Lepralia mortoni Thornely, Rep. Pearl oyster Fish. Gulf of Manaar, p.119.

1957 Codonellina montferrandi Harmer, Siboga Exped., 28d, p.1049, pl.69, figs.25-26, 30.

1963 Codonellina montferrandii Lagaaij, Publ. Institute of Marine Science, 09, pp.196-197, pl.6, fig.3.

1967 Codonellina montferrandii Menon and Nair, J. mar. biol. Ass. India, 9(2) pp.430-433.

Occurrence

A single colony with numerous ovicells was collected from the dredged materials taken from a depth of 70m. off Cochin.

Measurements

Zooecium

Length	-	460 μ
Breadth	-	340 μ

Salient features

Encrusting, forms a thin and white shining layer over the substratum. Zooecia alternating, separated by deep grooves. The frontal an arched tremocyst with evenly distributed small pores. Rounded aperture with a pair of small cardelles. A shallow and narrow poster present. Elevated peristome present around the aperture. Frontal avicularium represented in all zooecia, placed symmetrically, directed proximally. The rostrum with slightly pointed tip. Ovicell hyperstomial, porous, the border slightly raised and usually the distal region of the peristome fuses with the ovicell.

Remarks

The present form resembles the figures and descriptions of *Codonellina anatina* given by Osburn (1952), and *Codonellina montferrandii* given by Harmer (1957) and Lagaaij (1963). Lagaaij (1963) considers *Codonellina anatina* of Osburn as a synonum of *C. montferrandii*. Osburn (1952) has considered *Codonella anatina* Canu and Bassler (1927) and *C. granulata* Canu and Bassler (1930) as synonyms of *C. anatina*. Harmer (1957) considers the above forms described by Canu and Bassler as synonyms of *C. montferrandii*. Lagaaij has followed Harmer and has included *C. anatina* Osburn under *C. montferrandii*.

Previous records from Indian waters

Menon and Nair (1967)

Distribuion

"This species has its main distribution in the tropical Indo-Pacific, where it is widely distributed". Lagaaij (1963).

FAMILY RETEPORIDAE Smitt, 1867

"Zooecia heavily calcified with a few pores. Spines present or wanting; a well developed vestibular arch which is usually beaded; dependant avicularia of varying size and form (usually sub-oral or not in the midline); ovicell at first prominent but becoming immersed, often with a median fissure, above the orifice a labellum or prolongation, (almost wanting in Rhymchozoon and Lepraliella in which there is a triangular or semi circular area above the orifice consisting of the endozooecial layer only). In the erect forms the zooecia are all on the frontal side and the dorsal side is covered by a layer of kenozooecia which may or may not have pores and avicularia. Erect species are usually fenestrate, sometimes forming a close network (retepores), but a few are mere branching or have occasional fusions". (Thornely, 1905)

GENUS RHYNCHOZOON Hincks, 1895

1895 Rhynchozoon Hincks, Ann. Mag. nat. Hist., Index p.5.

1952 Rhynchozoon Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, p.454.

1957 Rhynchozoon Harmer, SIboga Exped., 28d, pp.1062-1063.

Usually encrusting. Marginal zooecia with marginal pores. Superposed zooecia do not resemble marginal ones. Primary orifice denticulate distally. A sinus may generally be present limited by two condyles.

Peristome variously developed but may even be simple. Secondary orifice rarely simple provided with prominent mucros or tooth like projection. Sub-oral avicularia present or absent. Frontal avicularia acute or rounded. Differentiated frontal plate ornament the ovicell. Opercula strong and with granular thickening.

32. Rhynchozoon compactum (Thornely), 1905

(Fig. 32)

1905 Cellepora compacta Thornely, Rep. Pearl Oyster Fish. Gulf of Manaar p.126, fig.17.

1957 Rhynchozoon compactum Harmer, Siboga Exped., 28d, pp.1076-1078, pl.70, figs.21-25.

1967 Rhynchozoon compactum Menon and Nair, J. mar. bio. Ass. India, 9(2), pp.430-433.

Occurrence

A single colony encrusting on a shell fragment obtained from material dredged at a depth of 45m off Chavara.

Measurements

Zooecium

Length	-	420 μ
Breadth	-	340 μ

Salient features

Colony encrusting. Zooecia at the center of the colony semi-recumbent. Primary orifice broadly sinuate with denticulations. Young encrusting zooecia with a single median mucro and marginal pores. Old zooecia with two to three mucros the lateral ones aviculiferous. The rostrum lying diagonally or distally. The secondary orifice with a median sinus when only two mucros present. The median micro may be blunt, longer than the lateral ones. Sub-oral avicularia not noticed. Frontal avicularia present, rostra with parellel lateral margins and rounded tips. The calcareous bar complete. Ovicells not noticed.

Remarks

These are referable to the description of Rhynchozoon compactum (Thornely) given by Harmer, 1957. The presence of aviculiferous lateral mucro seems to be a point of interest. No sub-oral avicularium was noticed in the present material.

Previous records from Indian waters

Gulf of Manaar (Thornely, 1905). Menon and Nair (1967)

Distribution

Ceylon (Thornely, 1905); Japan (Harmer 1957).

33. Rhynchozoon tubulosum (Hincks), 1880

(Fig. 33)

1880 Mucronella tubulosa Hincks, Ann. Mag. Nat. Hist., 5,6, p.383, pl.17, fig.7.

1905 Mucronella tubulosa Thornely, Rep. Pearl Oystter Fish. Gulf Manaar p.124.

1957 Rhynchozoon tubulosum Harmer, Siboga Exped., 28d, pp.1064-1067, pl.65, figs.16-19.

1967 Rhynchozoon tubulosum Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Several colonies encrusting on shells were collected off Chavara.

Measurements

Zooecium

Length	-	420 µ
Breadth	-	170 µ

Salient features

Encrusting with the distal ends of zooecia raised from surface in young condition. Zooecia arranged in quincunx, convex, separated by distinct grooves. Peristome conceal the primary orifice which is rounded with a slightly arched proximal border. Sinus wide and shallow, conspicuous mucros present, usually three in number but in some there may be only two. Mucros very conspicuous, usually long, the median one associated with two lateral ones when the number of mucros is three. The median mucro may be flat or knob-like, while the lateral ones comparatively shorter than the median one. Sub-oral avicularia rarely represented. Frontal avicularium large placed horizontally, the tip directed proximally, rostrum with a rounded tip. Ovicells hyperstomial, the ectooecium calcified and imperforate, represented as a narrow rim. The exposed frontal surface of the ovicell bear tubercles.

Remarks

These specimens though resembling Rhynchozoon tubulosum do show variations. Harmer (1957) noticed that the median mucro in his specimens was minutely denticulate and recurved, but in the present form the median mucro does not possess any denticulation. The recurving of the median murco was noticed in cases where the same has grown long. The number of the mucro was more or less constant. The nature of the zooecia placed at the centre of the colony and towards the periphery showed minor variations. Areolar pores are noticed in the zooecia placed at the rim of the colony whereas they are inconspicuous in the regions where high calcification has taken place. The sinuation of the secondary orifice was noticed in few cases where the number of mucros was only two. The number of frontal avicularia was much less, sometimes even absent in few colonies examined. Harmer reports the same feature in the colonies collected from Siboga Station 81D. The ovicells are similar to the description and figures given by Harmer.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Indian Ocean (Thornely, 1912); Sulu Archipelago and Kei Is. (Harmer, 1957); Australia (Hicks, 1880); Great Barrier Reef (Thornely, 1932); Victoria (MacGillivray, 1883; 1980); Bass Strait (Hincks, 1880; Hastings, 1930).

34. Rhynchozoon larreyi (Audouin), 1826

(Fig. 34)

1826 Cekkeoira larreyi Audouin, Description del' Egypte, Hist. Nat., 1,4, p.239.

1957 Rhynchozoon larreyi Harmer, SIboga Exped., 28d, pp.1074-1076, pl.70, figs.12, 16-20.

1967 Rhynchozoon larreyi Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Several colonies encrusting on stones were collected from the sub-tidal region at Mandapam from the Gulf of Mannaar.

Measurements

Zooecium

Length	-	390 µ
Breadth	-	195 µ

Salient features

Zoaria encrusting and multilaminar. Zooecia distinct at the margin of the colony and irregular at the centre. Marginal pores present. Front highly tuberculated, and the tubercles give the colony a very irregular appearance. Peristome bilabiate, one of the processes aviculiferous. In the older zooecia small tooth-like processes present at the proximal region of the peristome. Small sub-oral avicularia placed obliquely. Frontal avicularia present, placed near the distal region proximal to the peristome, triangular and acute. Primary orifice with a distinct sinus, distal portion denticulate. Operculum with a wide circular anter and a distinct poster. Ovicells non-porous and tuberculated.

Remarks

Referable to Rhynchozoon larreyi (Audouin) given by Thornely (1905) Harmer (1957), Menon (1967)

Previous records from Indain waters

Menon and Nair (1967)

Distribution

Ceylon (Thornely, 1905); Indo-Australian Archipelago (Harmer, 1957).

35. Rhynchozoon globsoum Harmer, 1957

(Fig.35)

1957 Rhynchozoon globosum Harmer, Siboga Exped., 28d, pp.1072-1073, pl.70, figs.1-5.

1967 Rhynchozoon globosum Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Three colonies encrusting on sponges were collected from a depth of 5m. from the Gulf of Mannaar.

Measurements

Zooecium

Length - 47.0 µ

Breadth - 370 µ

Salient features

Encrusting. Front finely tuberculated. Peristome with two to three mucros, one of which may be aviculiferous. Sub-oral avicularia present, placed on globular thickenings. Rostrum without uncinate process. Frontal avicularia placed on calcareous thickneings in young zooecia. Mandibles hooked at the tips. Orifice with small sinus. No ovicells noticed.

Remarks

This species was created by Harmer based on the differences he noticed in the nature of the sub-oral avicularia from the some of other species of this genus. Harmer did notice the paucity of this structure in his specimens. Sub-oral avicularia of the same type Harmer noticed in his specimens are present in the material before me. The marginal zooecia in the form now under consideration did possess thick circular oral ridge even though the three processes which Harmer found in his Torres Strait specimens are not represented conspicuously here.

Previous records from Indian waters

Menon and Nair (1967)

Distribution

Timor (Harmer, 1957). In addition to this record Harmer (1957) has also reported this species from the Cambridge Museum collection obtained from Torres Strait and Japan, donated by Haddon and Owston respectively.

PLATE I

EXPLANATION OF FIGURES

Fig.1 - *Aetea anguina* (L) Single zooecia.

Fig.2 - *A. ligulata* Busk. Portion of a colony showing the details zooecia.

Fig.3 - *Antropora erecta* Silen. Portion of a colony showing details of zooecia.

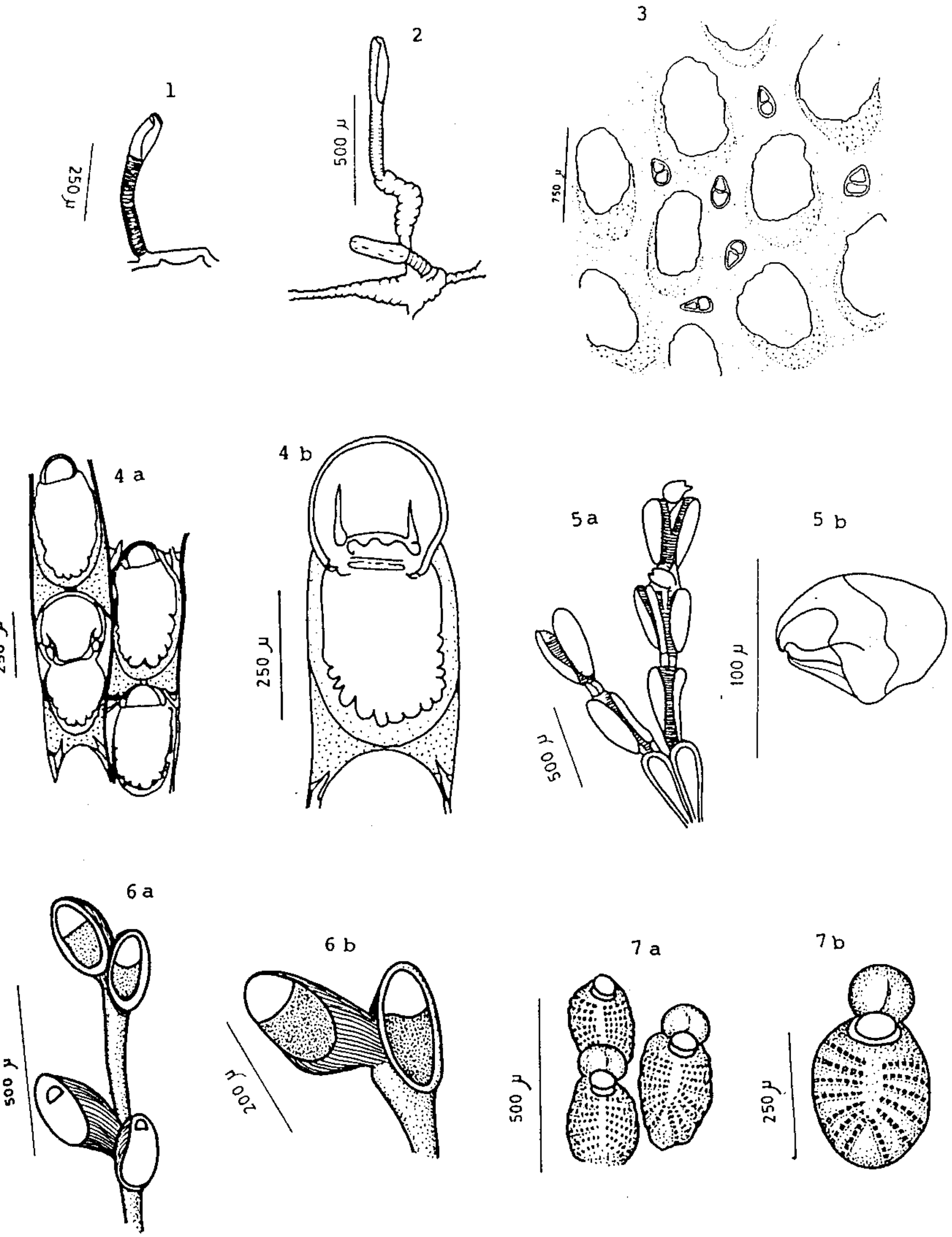
Figs.4a-4b *Alderina arabianensis* Menon and Nair. 4a. Portion of colony showing the details of zooecia. 4b. A fert zooecium.

Figs.5a-5b *Synnotum aegyptiacum* (Aud.) 5a. Portion of a colony show the arrangement of zooecia. 5b. Avicularium.

Figs.6a-6b *Crepis verticellata* Harmer. 6a. Portion of a colony show the details of zooecia. 6b. Two zooecia.

Figs.7a-7b *Reginella mattoidea* Osburn. 7a. Portion of a colony show the details of zooecia. 7b. A fertile zooecium.

PLATE I



1
250 μ
2
500 μ
3
4 a
4 b
250 μ
5a
500 μ
5 b
100 μ
6 a
500 μ
6 b
200 μ
7 a
500 μ
7 b
250 μ

PLATE II

EXPLANATION OF FIGURES

Figs.8a-8b. Tremogasterina granulata Canu and Bassler. 8a. A zooe with two avicularia. 8b. Operculum.

Figs.9a-9b. Tremogasterina ventricosa Canu and Bassler. 9a. Portion o colony, showing the details of zooecia. 9b.Operculum.

Fig. 10 Tremogasterina lanceolata Canu and Bassler. Portion of colony showing the details of zooecia.

Fig. 11 Celleporaria pilaefera Canu and Bassler. Portion of a col showing the details of the zooecia.

Figs.12a-12b - C. granulosa (Haswell) 12a. Two zooecia showing the detai 12b. Two marginal zooecia.

Figs.13a-13b - Mucropetraliella philippinensis (Canu and Bassler) 1 Portion of a colony showing the details of zooecia. 13 Primary orifice.

Fig.14a-14b - Savignyella lafontii (Aud.) 14a - 14b. Two zooecia.

Fig. 15 - Adeona foliacea Lamx. Portion of a colony showing t details of zooecia.

Fig. 16 - Lagenicella punctulata Gabb and Horn. Portion of a colo showing the details of zooecia.

PLATE II

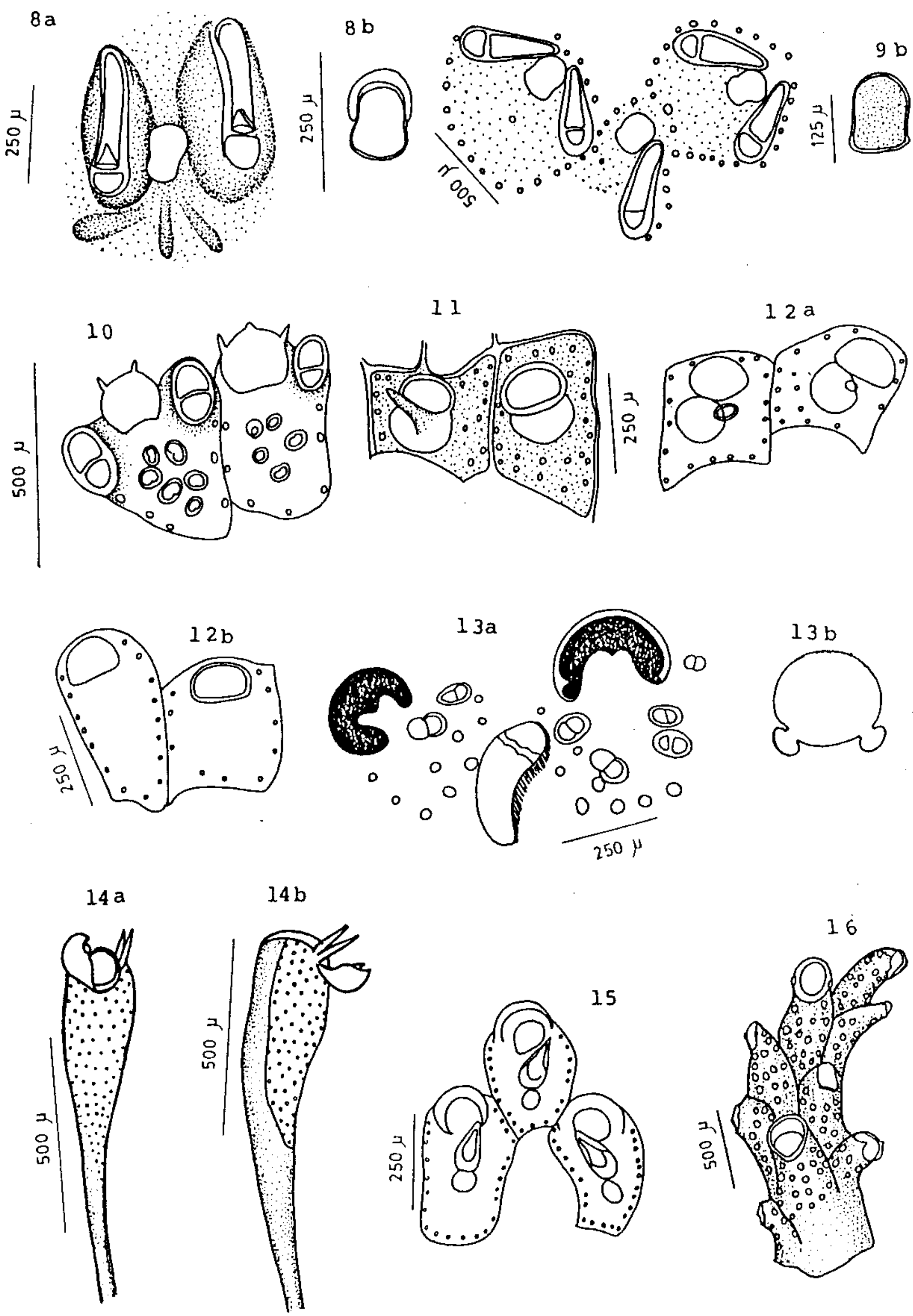

8a
8b
9a
9b
250 µ
250 µ
500 µ
125 µ
10
11
12a
500 µ
250 µ
12b
13a
13b
250 µ
250 µ
14a
14b
15
16
500 µ
500 µ
250 µ
500 µ

PLATE III

EXPLANATION OF FIGURES

Fig. 17 - *Turbicellepora redoutei* (Aud.) Portion of a colony sh the details of zooecia and avicularia.

Figs. 18a-18b. *Parasmittina aviculata* (Mawatari) 18a-18b. Portions colony showing the details of zooecia.

Figs.19a-19b- *P. california* (Robertson) 19a. Portion of a colony sh the details of zooecia. 19b. Two fertile zooecia.

Figs.20a-20b. *Microporella orientalis* Harmer. 20a. Portion of a c showing the details of zooecium. 20b. Operculum.

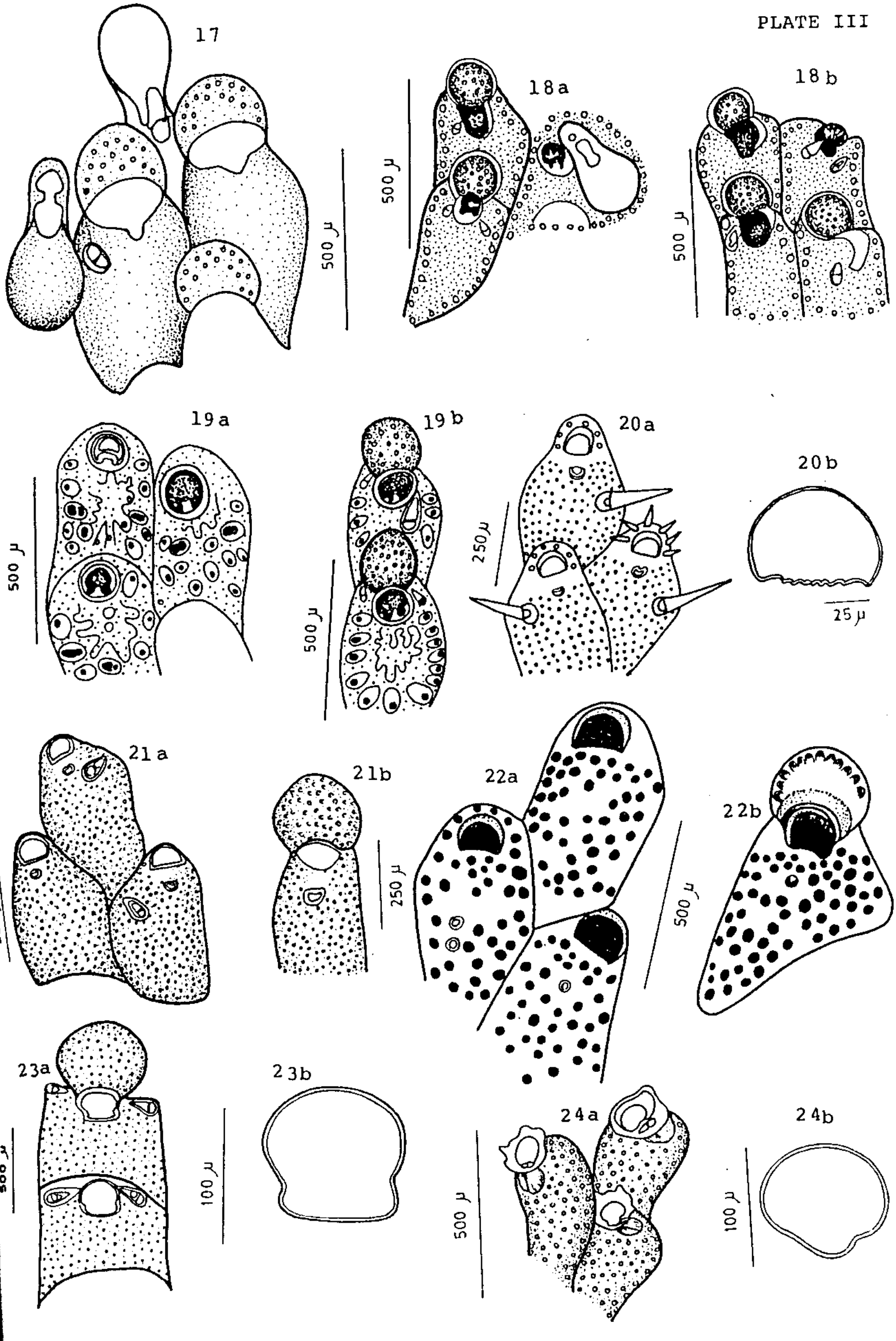
Figs.21a-21b - *M.ciliata* (Pallas) 21a. Portion of a colony showing details of a zooecium. 21b. A fertile zooecium.

Figs.22a-22b - *Fenestrulina malusii* (Aud.) 22a. Portions of a c showing the details of zooeia. 22b. A fertile zooecium.

Figs.23a-23b - *Hippopodina feegeens* (Busk) 23a. Portion of a colony sh the details of zooecia. 23b. Operculum.

Fig.24a-24b - *H. californica* Osburn. 24a. Portion of a colony showir details of zooecia. 24b. Operculum.

PLATE III



17
500 µ
18a
500 µ
18b
500 µ
19a
500 µ
19b
500 µ
20a
250µ
20b
25µ
21a
21b
250 µ
22a
500 µ
22b
23a
500 µ
23b
100µ
24a
500 µ
24b
100 µ

PLATE IV

EXPLANATION OF FIGURES

Fig. 25. - Schizoporella unicornis (Johnston) Portion of a colo showing the details of zooecia.

Figs.26a-26b. Cleidochasma biavicularicum (Canu and Bassler) 26a.Porti of a colony showing the details of zooecia 26b. Operculum.

Fig.27a-27b. - C. fallax (Canu and Bassler) 27a. Portion of a colo showing the details of zooecia. 27b. Operculum.

Fig. 28. - Schizomavella inclusa (Thornely) Portion of a colony showi the details of zooecia.

Fig. 29. - S. linearis var inarmata (Hincks) Two fertile zooecia.

Fig. 30. - Calyptotheca tenuata Harmer. Portion of a colony showing t details of zooecia.

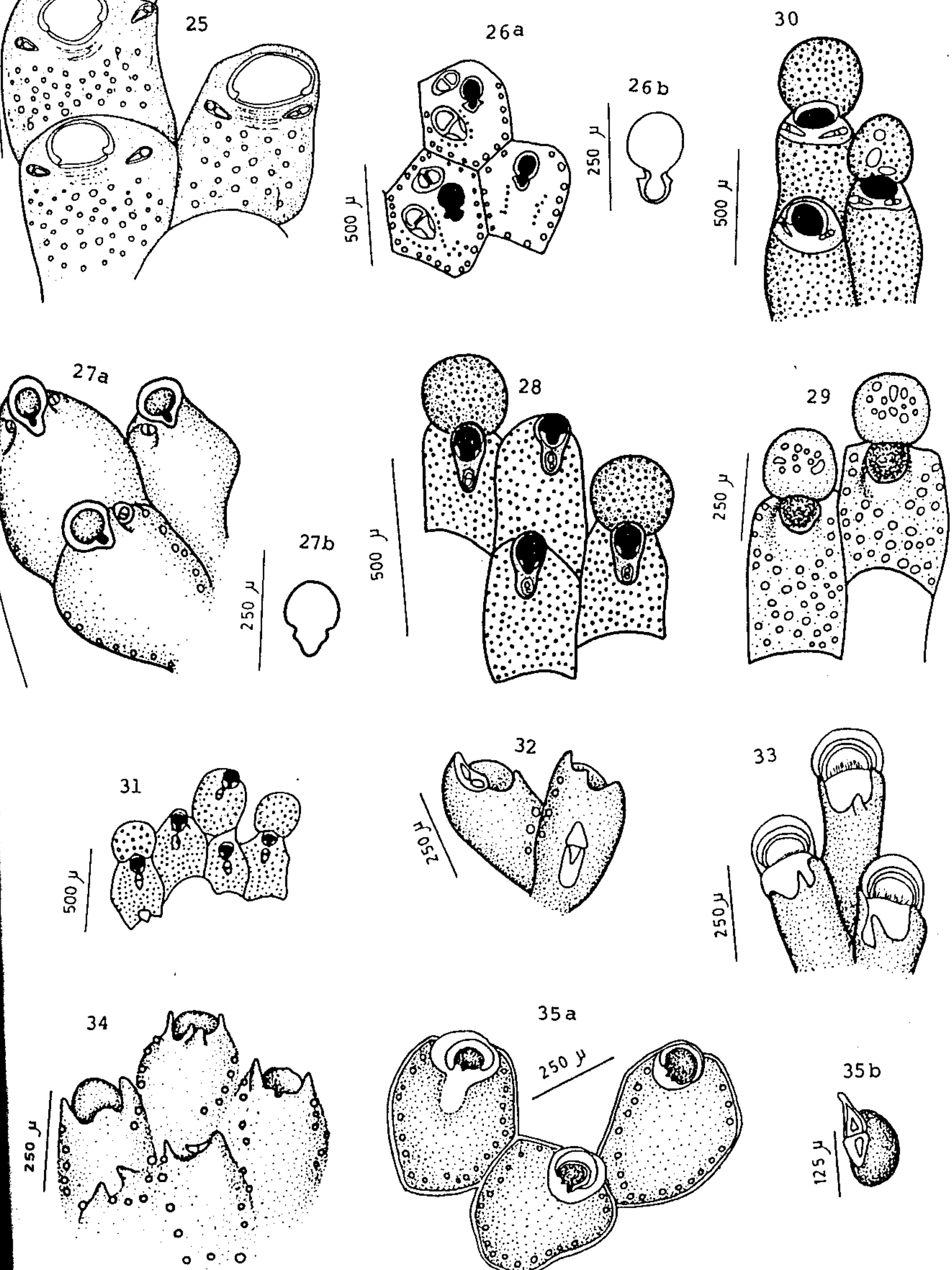
Fig. 32. - Rhynchozoon compactum (Thornely) portion of a colony showi the details of zooecia.

Fig. 33. - R. tubulosum (Hincks) Portion of a colony showing t details of zooecia.

Fig. 34. - R. larreyi (Aud.) Portion of a colony showing the details zooecia.

Fig. 35a-35b. R. globosum Harmer. 35a. Portion of a colony showing t details of zooecia. 35b. Frontal avicularium.

PLATE IV


25
26a
26b
250 µ
500 µ
30
500 µ
27a
27b
250 µ
28
500 µ
29
250 µ
31
500 µ
32
250 µ
33
250 µ
34
250 µ
35a
250 µ
35b
125 µ

I.5.2 SPECIES FROM MALDIVIAN WATERS

SUBORDER - ANASCA Levinsen, 1909

DIVISION - COELOSTEGA Harmer, 1926

Raised zooecial margins surround an aperture which is larger than the opesia owing to the development of a cryptocyst. Cryptocyst frequently with a descending portion which unites near its distal ends with the vertical or basal walls. The horizontal cryptocyst distally possesses in many zooecia a median process which forms the inner margin of the two lateral opesiules, through which the depressor muscles pass to their insertion in the frontal membrane. Marginal and oral spines wanting.

FAMILY STEGANOPORELLIDAE Smitt, 1873

Zooecia are dithalamic, two kinds of zooecia, one with a much enlarged operculum. Polypide tube is complete.

GENUS STEGANOPORELLA Smitt, 1873

1876 Steganoporella Harmer, Siboga Exped., 28b, p. 268.

1950 Steganoporella Osburn, Allan Hancock Pacific Exped., p.107.

Zooecium dithalamic, body cavity sub-divided, incomplete. Discending lamina of the crypotcyst which joins the basal or distal wall leaves a median fenestra. Gymnocyst wanting. The whole of the proximal region covered by the horizontal part of the porous cryptocyst by its thickened margin. Avicularia typically represented by enlarged zooecia, provided with a polypide which would be distinguished from the other zooecia by the difference in their distal portion by possessing a mandible structurally different from the operculum.

1. Steganoporella sp.

(Figs. 1a & 1b)

Occurrence

Two colonies of this species were collected from the seas of Maldivies.

Measurements

Zooecium

Length - 960 μ

Breadth - 600 μ

G5665

Salient features

Zooecia arranged quincuncially. Gymnocyst extensive, porous, cryptocyst narrow and evanescent. Operculum distinct, internal marginal sclerite highly chitinous. Opercular margin sheath like giving a distinct avicularian mandibular nature. The interior of the operculum with minute teeth on the extramarginal rim internally. A piece of a colony with numerous avicularia was obtained. The avicularian mandible is so similar to the operculum but for the modified placement of the internal marginal sclerite of the avicularian mandible. The mandible is rounded distally and with clear cut sclerite which look highly chitinous. Ovicells not noticed.

Remarks

Opercular nature itself warrents creation of a new species, to place the specimens described here. But lack of sufficient material makes it rather difficult to decide whether this species is new to science. The distal margin of the gymnocyst extends towards the opercular chamber giving two lateral sinus, very similar to those noticed in Thalamoporella. It looks as if this species is a link between Thalamoporella and Steganoporella. The interzooecial margin is covered with a distinct chitinuous material. The contrasting feature of the species is the avicularian mandible which is so similar to the normal operculum with modified placement of the internal sclerite. It is evident from the structure that the avicular mandible is the modified version of the normal operculum. It is quite likely that this is a species hither to unknown to science. For the time being I am not assigning a species name for this material. This is the Ist record of this species from Maldivies.

DIVISION CELLULARINA Smitt, 1867

"The zoarium is erect, flexible or jointed and attached by radicles (loosely encrusting in a few cases); zooecia not heavily calcified, as a rule, and all facing in the same direction (except in Farciminariidae where they form rounded stems) avicularia sessile or pedunculate (both in the Epistomiidae); sometimes modified into vibracula; spines occur in most of the species, sometimes modified into frontal scutes above the opesia. Ovicells usually hyperstomial" Osburn (1950).

FAMILY FARCIMINARIIDAE Busk, 1852

Erect dichotomously branched zoaria. Zooecia arranged longitudinally around an axis formed by the seperating walls of the zooecia. Uniporous septulae, frontal avicularia present, ovicells present, endozooecial.

GENUS NELLIA Busk, 1852

1852 Nellia Harmer, Siboga Exped., 28b, p.240.

1950 Nellia Osburn, Rep. Allan Hancock Pacific Exped., 14, 1, p.119.

Erect quadriserial branches, jointed at the bifurcation form the zoarium. Zoarium in alternate pairs. Internode consists of a four sided prism. Zooecia of each pair open on two opposite faces of the internode. The basal surface of the zooecia meet in a spindle shaped area about half the length of the zooecium. Cryptocyst most extensive proximally, spines absent. Gymnocyst short except at the base of the internode and bears a pair of avicularia which may be vestigal or with pointed mandibles, situated proximally to the opesia or at its sides. Ovicells small and endozooecial. Uniporous septule, one terminal and two lateral.

2. Nellia oculata Busk, 1852.

(Figs. 2a-c)

1852 Nellia oculata Busk, Cat. Mar. Poly. Brit. Mus., p.18, pl. 64, fig.6, p.65.

1920 Nellia oculata Canu and Bassler, Bull. U.S.nat. Mus., 106, p.198, pl.82.

1926 Nellia oculata Harmer, Siboga Exped. 28 pp.240-245 pl.14 fig.18 text figs.3b, d, 4a, b.

1950 Nellia oculata Osburn, Rel. Allan Hancock Pacific Exped, 14, 1, pp.119-120 pl.13, fig.4.

Occurrence

Colonies were collected from the waters of Maldivies.

Measurements

Zooecium

Length	-	570 µ
Breadth	-	120 µ

Salient features

Highly branched colonies reaching a length of nearly 20mm, attached to the substratum by tufts of rootlets. The length of the internode greater distally and lesser proximally. The distal region of the preceding zooecium slightly overarch the proximal portion of the succeeding one. The frontal membrane occupies the entire front. The mural rim thin and raised and this gives the zooecium the shape of a boat. Operculum large and occupies the distal region. Gymnocyst well developed proximally and bears two triangular avicularia. Non granulated cryptocyst present, slightly extensive proximally. Opesia smaller than the aperture, ovicells not noticed.

Remarks

These specimens agree well with the figure and description of Nellia oculata Busk given by Harmer (1926), Menon & Nair (1967). The material was found attached to hydroid stems.

Distribution

Indian Ocean (Thornely 1905); Andaman Is. (Thornely 1907); Lacadives (Robertson, 1921); Florida (Smitt 1873); Victoria (Mac Gillivray, 1880); Queensland (Haswell 1880); Singapore and Batavia (Marcus 1921).

FAMILY SCRUPOCELLARIIDAE (Levinsen, 1909)

Zoaria erect and unilaminar attached to the substratum by means of rootlets. Zooecia in most species being arranged biserially. Spines usually occur at the distal end of the zooecia, scutum which is a modified spine, present. Dorsal vibracula or avicularia present, but may be wanting in Tricellaria.

GENUS CABEREA Lamouroux, 1816

1950 Caberea Osburn, Rep. Allan Hancock Pacific Exped., 14, 1, p.129.

Coarse zoarium without joints, vibracula large covering a large part of the dorsal surface. They are exposed from the frontal view. Setae large and elongate, feathered at the tip.

3. Caberea ellesi (Fleming) 1828

(Fig. 3)

1950 Caberea ellesi Osburn, Rep. Allan Hancock Pacific Exped., 14, 1, pp.130, pl.16. figs. 1 and 2.

Occurrence

A single piece of a colony was collected from the seas of Maldives.

Measurements

Zooecium

Length	-	480 µ
Breadth	-	120 µ

Salient features

Zoarium coarse, fan shaped whitish in hue. Zooecia well calcified, elliptical opesia occupying three fourth of the front, scutum entirely absent. Spines not noticed. The frontal and lateral avicularia are present, vibracular chambers large, covering a large part of the dorsal surface. Groove is long and narrow.

Remarks

The material before me is tentatively assigned to C. ellesi. It shows variations in some characters from those described by Osburn (1950). The most important is the absence of vibracular setae. Apart from this difference the present material compare well with C. ellesi described by Osburn (1950)

Distribution

This species is common in the Atlantic ocean from the British Isles northward and North of Cape Cod. The present material is obtained from Maldivies.

GENUS SCRUPOCELLARIA van Beneden, 1855

1855 Scrupocellaria van Benedan, Nouv. Arch. Mus. Hist. Nat. 18 p.16.

1926 Scrupocellaria Harmer, Siboga Exped., 28b, pp. 364-367.

1950 Scrupocellaria Osburn, Rep. Allan Hancock Pacific. Exped., 14, 1, pp.130-132.

Biserial zoarium. Opesia more or less oval, sometimes reduced by the development of a crypotcyst of varying extent on its proximal side. Operculum seldom distinct. Scutum present or wanting. On the proximal or innerside of the opesia each zooecium typically provided with a frontal avicularium, a marginal avicularium at its distal end and a basal vibraculam at its proximal end. Avicularia of the pointed type, vibraculam projects beyond the edge of the branch. Rostrum with two shallow grooves. Seta without lateral branches. Rootlets commonly with barbing spines. Ovicells hyperstomial with or without pores.

4. Scrupocellaria bertholettiii (Audouin), 1826

(Figs. 4a & b)

1950 Scrupocellaria bertholetti Osburn, Rep. Allan. Hancock Pacific Exped., 14, 1, p.133, pl.15, figs. 7,8, pl. 21 fig.8.

1965 Scrupocellaria bertholetti Ryland, Catalogue of Main Marine Fouling Organisms Polyzoa, pp. 55-57 figs. 27a, b and c.

1972 Scrupocellaria bertholetti Menon, Int. Revue ges. Hydrobiol., 57, 5, pp.801-819.

Occurrence

Some colonies were collected from the waters of Maldivies.

Measurements

Zooecium

Length	-	400 µ
Breadth	-	210 µ

Salient features

Branching zoarium erect, whitish. Elongated zooecia, with opesia occupying more than half of the front. The number of spines varies greatly usually three external and two internal. Scutum present, may be a simple spine or a forked one. Frontal avicularia present, small or very large. In the large ones the rostrum hooked. Vibracular chamber not triangular, a proximolaterally placed rhizoidal chamber. Axial vibracula single. Joints traverse the opesia of the outer zooecia, cryptocyst present not tuberculated. Ovicells large with perforations placed at the tip of the tubercles.

Remarks

Despite certain differences, the form under consideration approaches closely the figure and description of S. bertholetti given by Osburn (1950). A study of this species from the available literature shows that characters like the number of spines and the nature of scuta show considerable variations. A detailed examination of the present material also reveals that both the number of spines as well as the nature of the scuta does exhibit variations. Thus the spine number in the present specimens ranges from two to five, however, has not been shown in Osburn's figures.

Distribution

Widely distributed species (Osburn 1950), India (Menon and Nair, 1972, Nair 1989).

Sub Order ASCOPHORA Levinsen

The frontal area is completely calcified, leaving the aperture. Compensation sac present, which opens into the proximal side of the aperture or into the ascopore situated proximal to the aperture. Operculum compound in the case of forms where the compensation sac opens into the aperture, simple in the case of those where an ascopore is present.

FAMILY SMITTINIDAE Levinsen, 1909

Front an olocyst, pleurocyst or tremocyst. Semicircular primary orifice, usually with cardelles and a lyrula. Oral spines common Sub-oral or frontal avicularia present. Ovicells hyperstomial.

GENUS PARASMITTINIA Osburn, 1952.

1952 Parasmittina Osburn, Rep. Allen. Hancock Pacific Exped., 14, 2, p.411.

1963 Parasimittina Lagaaij, Publ. Institute of Marine Sciences, 9, p.197.

1972 Parasmittina Menon, Marine Biology, Vol.14, No.1, pp.72-84.

"Avicularia variously distributed on the frontal, but never median, placed suborally or bilaterally, symmetrically around the proximal border of the aperture, they take their origin from areolar pores on one side". (Osburn, 1952). Pleurocyst, with a row of areolar pores. Lyrula and cardelles usually well developed. Variously developed ovicells present.

5. Parasmittina tropica (Waters), 1909

(Fig. 5)

1957 Smittina tropica Harmer, Siboga Exped. 28b, pp.934-937.

1972 Parasmittina tropica Menon, Marine Biology, Vol.14, No.1, pp.72-84.

Occurrence

A piece of a colony was obtained from the waters of Maldives.

Measurements

Zooecium

Length	-	420 μ
Breadth	-	240 μ

Salient features

Encrusting, whitish in hue, zooecia arranged in longitudinal rows, seperated by grooves. Marginal pores represented in every zooecium. Front convex and tuberculated. Oral spines present usually three in number. Distally rounded aperture with a distinct rounded or elongate oval sinus. The sinus limited by two lateral cusps which may be pointed or even bifurcated at the tip. Lateral oral avicularia represented in all zooecia, very long and acute directed proximally, placed over a swelling on the front. Rostrum everted distally with well developed distal spinules. Mandible long and pointed, primary orifice rounded, provided with a broad and truncate lyrule and two backwardly directed cardelles. Ovicells small, convex and perforated. Ectooecium do not cover the frontal surface.

Remarks

The presence of long acute sub oral lateral avicularia, with the distally everted rostra, represented in every zooecium is a characteristic feature of this material. The number of oral spines noticed by Waters (1909) was two and by Harmer (1957) three, but in the present case it ranges from three to four. The pointed and bifurcated nature of the cusps is yet another character of interest in the present form. Available literature indicates that this species shows a wide range of variations and the variations noticed here are probably only of an ecotypical nature and hence this form is placed under Smittina tropica (Waters 1909).

Distribution

Victoria (Hincks, 1884) Indian Ocean (Thornely, 1907); Sudanese Red Sea (Waters, 1909) India (Menon 1972).

ORDER CYCLOSTOMATA Busk, 1852

DIVISION ARTICULATA Busk, 1859

CAMPTOSTEGA Borg, 1926

"Primary zooid erect, seperated by chitinous joint from the pro ancestrula, zoarium jointed, rhizoids present. Body wall a gymnocyst, vestibular sphincter present, brood chamber a gonozooid, moderately dialated in its middle part, polypide of gonozoid degenerating before having been full grown." "Borg, 1944.

FAMILY CRISIIDAE Johnston, 1838.

Erect and jointed zoarium, with zooecia arranged in single series or alternating in two series. Ovicell a gonozooid, with a zooeciostome.

GENUS-CRISIA Lamouroux, 1812

1915 Crisia Harmer, Siboga Exped. 28a, p.96.

1953 Crisia Osburn, Rep. Allan. Hancock Pacific Exped., 14, 3, pp. 678-679

Long internodes. Zooecia arranged symmetrically into two alternating series. The projecting peristome giving the edges a serrated appearance. Gonozooids usually placed in the median line between the zooid rows.

6. Crisia elongata Milne Edwards, 1838

(Figs. 6a & b)

1838 Crisia elongata Milne Edwards, Ann. Sci. Nat. Zool., 2, 9, p.203, p.17.

1915 Crisia elongata Harmer, Siboga Exped., 28a, pp.96-102, pl.8, fig.1-8.

1957 Crisia elongata Osburn, Rep. Allan Hancock Pacific Exped. 14, 4, p.684, pl. 71, fig. 9.

1967 Crisia elongata Menon and Nair, J. mar. biol. Ass. India, 9(2), pp.430-433.

Occurrence

Some colonies were collected from the seas of Maldivies.

Measurements

Zooecium

Length	- 360 μ
Breadth	- 60 μ

Salient features

Zoarium with long, slender, sprawling branches, 8-12 zooids in each internode. Zooecia long and adnate, the peristome placed obliquely directing forwards. No ovicells noticed.

Remarks

The close similarity shown by the present form with the figures and descriptions of *Crisia elongata* given by Harmer (1915) Osburn (1953) Menon and Nair (1967) made it possible to assign the form under consideration to *C. elongata*.

Distribution

Red sea (Milne Edwards, 1838) Ceylon (Thornely, 1905) Gulf of California (Osburn, 1953) India (Menon and Nair, 1967, Satyanarayana Rao, 1975; Nair, 1989).

PLATE V

EXPLANATION OF FIGURES

Figs 1a-1b. - Steganoporella sp. Portions of colonies showing details o zooecia.

Figs. 2a-2c.- Nellia oculata Busk 2a. Habit sketch. 2b& 2c. Portions of colony showing the details of zooecia.

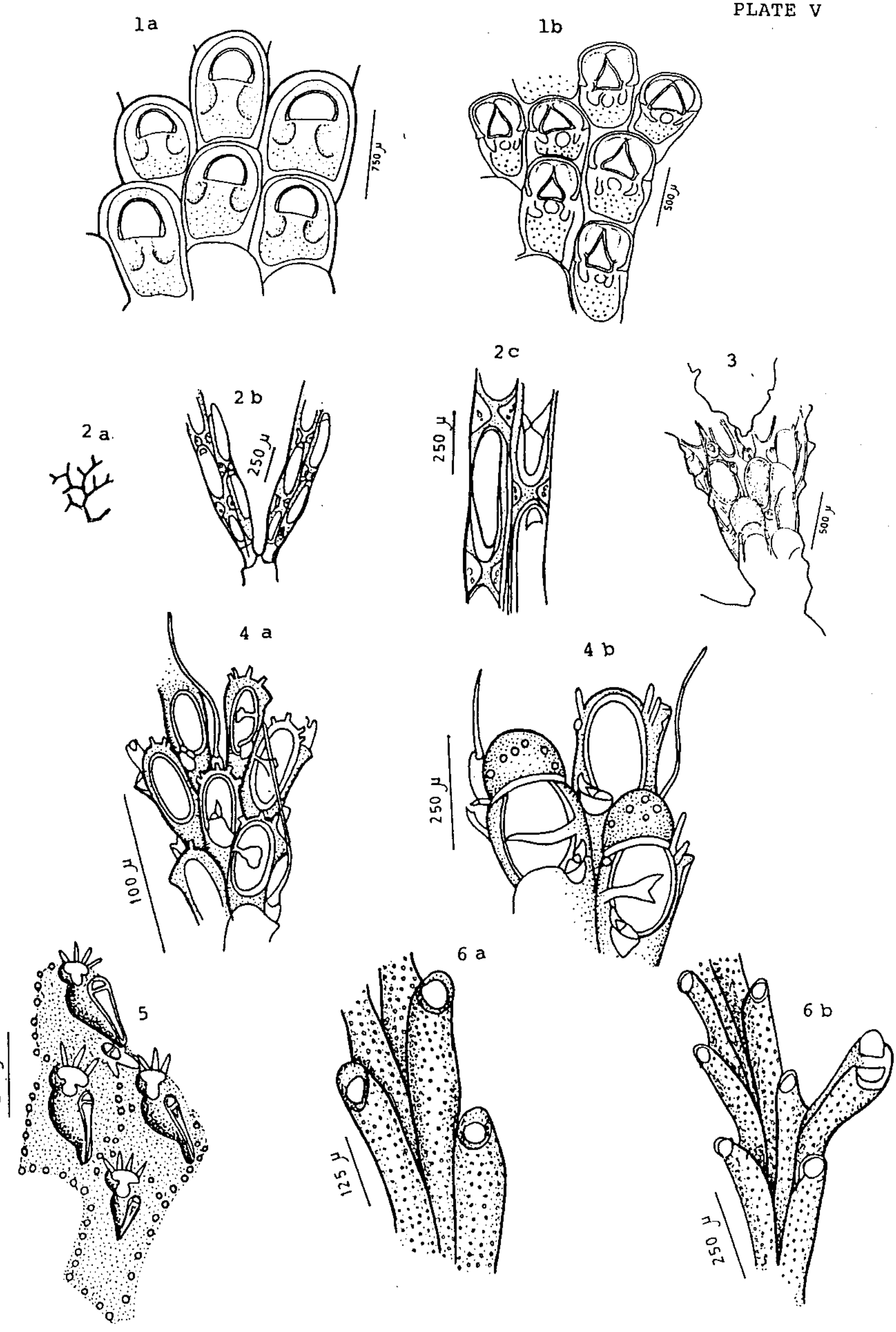
Fig. 3. - Caberea ellesi Fleming. Portion of a colony showing th details of zooecia.

Figs 4a-4b. - Scrupocellaria bertholetti (Audouin) 4a. Bifurcatio ventral view. 4b. Portion of a colony showing the details o zooecia.

Fig. 5. - Parasmittina tropica (Waters) Portion of a colony showin the details of zooecia.

Fig. 6a-6b. - Crisia elongata. Milne edwards 6a. A node. 6b. Portion of w colony with the details of zooecia.

PLATE V


1a
750 µ
1b
500 µ
2 a
2 b
250 µ
2 c
250 µ
3
500 µ
4 a
100 µ
4 b
250 µ
5
250 µ
6 a
125 µ
6 b
250 µ

1.5.3 SPECIES FROM ANTARCTICAN WATERS

ORDER - CHEILOSTOMATA Busk, 1852

SUB ORDER - ANASCA Levinsen, 1909

DIVISION - INOVICELLATA Jullien, 1888

FAMILY HINCKSINIDAE Canu and Bassler, 1927

This family includes genera which contains species of relatively simple structure similar to Membraniporidae, except for the presence of endozooecial ovicell. The ovicell is usually narrow transverse shallow structure opening widely into the zooecial cavity and closed by the operculum, but sometimes it is merely a rounded expansion of the zooecial cavity in the base of the succeeding zooecium. Spines, avicularia and diatellae may be present.

GENUS ELLISINA Norman, 1903

1903 Ellisina Norman, Ann. Mag. Nat. Hist., Ser. 71, 11, pp.596

1945 Ellisina Hastings, Ann. Mag. Nat. Hist., Ser.11, 12, pp.56

1950 Ellisina Osburn, Rep. Allan Hancock Pacific Exped., 14, pp. 49

Zooecia membraniporidine, ovicells endozooecial and closed by the operculum. Avicularia vicarious and pointed pore chambers present. It appears that ovicells may be immersed in a vicarious avicularium, a kenozooecium or an autozooecium.

1. Ellisina levata (Hincks), 1882

(Fig. 1)

1882 Membranipora levata, Hincks, Ann. Mag. Nat. Hist., Ser.5, 10, pp.249.

1945 Ellisina levata Hastings, Ann. Mag. Nat. Hist., Ser. 11, 12, pp.87.

1950 Ellisina levata Osburn, Rep. Allan Hancock Pacific Exped., 50, pp.50, pl4, fig.4.

Occurrence

Colonies of this bryozoan found encrusted on another bryozoans were obtained from the Antarctican waters at a depth of 200m.

Measurements

Zooecium

Length	-	960 μ
Breadth	-	660 μ

Salient features

Encrusting zooeicum, white and smooth, dimension of the zoarium relatively moderate. The shape of the zooecia vary. The ancestrula rather small. The zooecia are separated by distinct inter zooecial grooves, gymnocyst moderate distributed proximally and laterally in zooecia placed at junctions. Cryptocyst narrow, evanescent with munute tubercles. The rim of the cryptocyst provided with minute tubercles. Vicarius avicularia present placed distally as an extension of the distal marginal zooecium, seperated by grooves. Avicularia with horizontally directed mandible which is acute. The whole process placed on a calcareous tubercle of considerable size. Ovicells endzooecial. Avicularia absent in the case of those zooecia which have ovicells. Ovicells covered by the operculum.

Remarks

The material under examination possesses both endozooecial ovicells and avicularia. Hastings (1945) has created a species named E. antarcitca collected from Antarctican waters for the reason that vicarious aviularia was present in the place of endozooecial ovicells. Curiously enough the present specimens possess both the structures. An examination of the material clearly indicates that presence of avicularia suppresses the development of an ooecium. This evidently shows that a kenozooecium or an autozooecium or an avicularium are morphologically derived from the same zooid.

Distribution

Houston Stewart Channel, Cumshewa, British Columbia (Hastings 1945) Santa Barbara Islands, California (Osburn, 1950). The present record is from Antarctican waters.

FAMILY ALDERINIDAE Canu and Bassler, 1927

"The gymnocyst in the Alderinidae is usually small, but may cover half or more of the frontal length (Doryporella). The cryptocyst in most cases is confined to the descending portion but it may expand to form a considerable proximal lamina. Spines are extremely varied both in number and form, occasionally they are wanting; usually they are simple in form, but they are sometimes branching and cervicorn. Avicularia are often present on the proximal gymnocyst, less frequently they occur on the lateral walls, in several genera they are interzooecial, or they may be wanting entirely". Osburn (1950)

GENUS COPIDOZOUM Harmer, 1926

1926 Copidozoum, Harmer, Siboga Exped., 28b, p. 226,

1950 Copidozoum, Osburn, Rep. Allan Hancock Pacific Exped., 14,1, p.71.

Zooecia with greatly reduced gymnocyst. The frontal membrane covering almost the entire front. Proximally developed cryptocyst moderate or extensive. Spines present or absent Acicularia vicarious. Ovicells hyperstomial.

2. Copidozoum spinatum Osburn, 1950

(Fig.2)

1950 Copidozoum spinatum Osburn, Rep. Allan Hancock Pacific Exped., 14, 7, p.74. pl.7, fig.3.

Occurrence

Sample obtained from Antarctican waters from a depth of 200m.

Measurements

Zooecium

Length	-	660 μ
Breadth	-	480 μ

Salient features

Encrusting colony, zooecia of moderate size with oval to elliptical opecia. Gymnocyst very narrow. Cryptocyst narrow and not tuberculate usually more broad towards the proximal region or in the case of those zooecium from where new zooids are budding. Operculum semicircular with marginal sclerites. Ovicells hyperstomial and smooth. Spines present, characteristically five in number. Avicularia vicarious small with acute and subacute mandibles. On the whole the colony is highly calcified.

Remarks

Two colonies of this species were found growing on Hippodiplosia sp. Although it is mentioned that species of this genus have got vicarious avicularia alternated with normal zooids, but were invariably placed on proximal portion of the zooid, they were numerous in number. Avicularia has got subacute mandibles and are placed on calcareous thickening. The tip of the spines are brownish in hue indicating the less calcareous structure. Gymnocyst is so narrow in distal portion. Ovicells are hyperstomial tuberculated and has got elongated oval shape. Although these characters demands distinct specific position, the specimen is temporarily placed under C. spinatum

Distribution

Gulf of Dulce, Costa Rica (Osburn 1950), the pesent record is from Antarctican waters.

FAMILY ONYCHOCELLIDAE Jullien, 1882

1927 Onychocellidae Harmer, Siboga Exped., 28b, p.255.

The members of the family have well developed cryptocyst, small opesia, ovicells and vicarious avicularia. Since the avicularia are of peculiar shape they are termed as Onychocellers. This family contains four recent genera. This family has been studied in detailed by Jullien (1882) and Levinsen (1909).

GENUS ONYCHOCELLA Jullien, 1882

1927 Oncychocella Harmer, Siboga Exped., 28b, p.256.

1950 Onychocella Osburn, Rep. Allan Hancock Pacific Exped., 14, 1, p.100.

Zooecia more or less hexagonal, extensive cryptocyst, which could be depressed and hence not differentiated from the oral shelf, often extending round the distal border of the orifice. Opesia could be reduced with straight or curved sides or trifoliate. Opisules open, some times indistinct. Avicularia vicarious assymmetrical with a well developed rostrum. The avicularian cryptocyst with undivided opesia. Mandible with membraneous expansion. Ovicells endozooecial.

3. Onychocella sp.

(Fig. 3)

Occurrence

A single colony of this species was collected from Antarctic waters from 200m depth

Measurements

Zooecium

Length	-	780 μ
Breadth	-	480 μ

Salient features

Zoaria encrusting on sponges. Zooecia small, seperated by calcareous margin. Extensive cryptocyst present all around the opesia. Opesia distinctly trifoliated. Operculum semicircular with thin marginal sclerite. Vicarious avicularia with calcareous thickening proximally developed into a flare with diverting calcareous thickenings. The whole structure over hangs the preceeding zooarium. Vicarious avicularium have got finely distributed calcareous tubercles. Ovicells not noticed.

Remarks

Material in hand could be assigned to the genus Onychocella mainly because of special character and the presence of vicarious avicularia. However, the specimens in hand does not truely resemble the two species namely O. angulosa and O. alula described by Harmer (1926) and Osburn (1950). The presence of numerous vicarious avicularia gives the species a distinct character and hence it may become necessary to assign the specimen to a new genus. A character which would form a distinct feature of the new species would be the over hanging nature of the avicularium and the bulbous base of the avicularian chamber which emanates from the proximal part of the normal zooecium.

DIVISION - COELOSTEGA, Levinsen, 1909

Raised zooecial margins surround an aperture which is larger than the opesia, owing to the development of a crypotcyst. Crypotcyst frequently with a descending portion which unites near its distal ends with the vertical or basal walls. The horizontal cryptocyst distally possesses in many zooecia a median process which forms the inner margin of the two lateral opesiules, through which the derpessor muscles pass to their insertion in the frontal membrane. Marginal and oral spines wanting.

FAMILY - STEGANOPORELLIDAE, Smitt, 1873

The zooecia are dithalamic, two kinds of zooecia, one with a much enlarged operculam. Polypide tube is complete.

GENUS STEGANOPORELLA Smitt, 1873

1921 Steganoporella Harmer, Siboga Exped., 28b, p.268.

1950 Steganoporella Osburn, Rep. Allan Hancock Pacific Exped., 14, 1, p.107.

Zooecium dithalamic. Body cavity sub-divided, descending lamina of the cryptocyst which joins the basal or distal wall leaving a median fenestra, gymnocyst wanting. The whole of the proximal region covered by the horizontal part of the porous cryptocyst by its thickened margin. Avicularia typically represented by enlarged zooecia provided with a polypide which could be distinguished from the other zooecia by difference in their distal portion by possessing a mandible structurally different from the operculum.

4. Steganoporella mandibulata Harmer, 1926

(Fig. 4)

1926 Steganoporella mandibulata Harmer, Siboga Exped., 28b, p.279, pl.16, fig.20.

Occurrence

Numerous colonies of this species were collected from Antarctican waters from 200m depth.

Measurements

Zooecium

Length - 900 μ

Breadth - 480 μ

Salient features

The zooecia encrusting or laminating and erect. Dimorphism extremely pronounced by transformation of the zooecia into typically vicarious avicularia. Zooecia large and oral arch nearly half as long as the frontal surface. Oral shelf not pronounced, condyles prominent, cryptocyst forming broad granulated post oral shelf around the proximal and lateral sides of the zooecium. Its porous portion transversally descending limitted distally by a transverse thickened branch at right angle to join the basal wall. The median process small, could be variable to a nearly triangular structure, with a flat knob or with a frontal depression bounded laterally or distally by an outstanding edge. The oral arch narrow distally, wider proximally. Cryptocyst without pores or descending portion represented only by the post-oral shelf. Mandible not articulated with the calcareous part. The proximal part of the sclerite very strong. The avicularium contains no functional polypide. The avicularian opesia is nearly oval, remain concealed in frontal view by the two sides of the oral arch. The tip of the mandible typically mandibularian in structure.

Remarks

The material in hand temporarily assigned to S. mandibulata, shows distinct variation from one described by Harmer (1926). All the colonies examined in the present instance are bilaminate erect forms. A vicarious avicularia which is a modified 'B' zooid is very common and was present more or less like regular zooids in some portion of the colony. The opesial shape is elongated oval. The zooecial margin, especially the distal portion, is considerably raised giving a hooded structure. The cryptocyst is finely granulated. The character noticed here does not warrant the creation of a new species. Therefore, the material is, assigned to S. mandibulata.

Distribution

Halnaheira (Harmer 1926). The present record is from Antarctican waters.

DIVISION - PSEUDOSTEGA Levinsen, 1909

"The cryptocyst covers most of the frontal area. There are no spines or pores; the avicularia are vicarious (replacing zooecia in series) with usually a transverse pivot. The ooecia are embedded in the base of the succeeding zooecia and open by special pores distal to the aperture". Osburn (1950).

FAMILY CELLARIIDAE Hincks, 1880

1880 Cellariidae Hincks, A History of the British Marine Polyzoa, p.103.

1926 Cellariidae Harmer, Siboga Exped., 28b, p.334.

1950 Cellariidae Osburn, Rep. Allan Hancock Pacific Exped., p.116.

Zoaria jointed or unjointed. Opesia completely surrounded by cryptocyst, often at a considerable distance from the distal end of the area. These areas are outlined by ridges generally hexagonal or lozenge shape. Zooecia arranged in longitudinal rows, but commonly appearing to be alternate, longitudinal arrangement can be marked by the over growth of alternate zooecia. Cryptocyst without perforations, spines lacking. Avicularia vicarious. Inconspicuous ovicells with independant orifice.

GENUS CELLARIA Ellis and Solander, 1786

1926 Cellaria Harmer, Siboga Exped., 28b, p.334.

1950 Cellaria Osburn, Rep. Allan Hancock Pacific Exped., p.116.

Zoaria normally jointed, but there are species belonging to this genus having unjointed zoaria. The zooecia usually opening all around the cylindrical internodes which could be flattened. Body cavities pear shaped. Out-line of the zooecia hexagonal, pentagonal or lozenge shaped. Cryptocyst horizontal not demarkated precisely. The lateral walls are recumbent over lapping the adjoining zooecia. Opesia greatly reduced, hardly larger than the orifice. The distal margin semicircular. The convex proximal border formed by a small median process. The sides with a pair of condyles. Avicularia with undivided opesia or opesules.

5. Cellaria punctata (Busk, 1852)

(Fig. 5)

1926 Cellaria punctata Harmer, Siboga Exped., 28b, p.337-340, pl.21, fig.14-16, text fig.13a.

Occurrence

Colonies of this species were collected from Antarctican waters.

Measurements

Zooecium

Length - 780 μ

Breadth - 480 μ

Salient features

Sturdy zoarium composed of zooids arranged in four or six series. Zooecia typically hexagonal. The zooecial margins distinctly raised from the granulated cryptocyst. The zooecial margins maintains a typical hexagonal shape. Internodes could be as short as two to three mm or longer. The nodal region could be compressed or expanded. Opesia subcentral, transversally elongated. A pair of strong condyles and median pores present. Immersed ovicells possesses orifices located above the orifice giving the zooecia a characteristic double orificed look. Opening of the ovicells also have a distinctly raised proximal margin. Avicularia rare when present.

Remarks

Specimens examined in the present study resembles the description of the species given by Harmer (1926). Absence of numerous avicularia was a conspicuous feature in the present material. Occurrence of this species in the southern latitudes beyond 100m depth makes present finding note worthy.

Distribution

It is reported from Ceylon (Thornely 1906) and from most of the stations of Siboga expedition (Harmer 1926). The present recrod is from Antarcitcan waters.

6. *Cellaria praelonga* Harmer, 1926

(Fig. 6)

1926 *Cellaria praelonga* Harmer, *Siboga Exped.*, 28b, p.342-343, pl.21, fig.27-30.

Occurrence

A few colonies obtained from Antarctican waters from 200m depth.

Measurements

Zooecium

Length	-	1020 μ
Breadth	-	300 μ

Salient features

Delicate and well branched zoarium with nodular joints. Internodes cylindrical and could be rather long ranging from 10 to 15mm. The zooecia triserial. The front of zooecia in a longitudinal rows can be widely seperated or united by elongated median ridge. The front could be hexagonal with elongated lateral ridges. Proximal cryptocyst convex, slightly depressed medianly. Avicularium replaces the zooecium with hexagonal area. Rostrum narrow, elongated and triangulate. Mandible with a spike distally.

Remarks

This species was described by Harmer (1926) from station located out of Celebes. He created this species mainly to accomodate two colonies which were found to have triserial and elongated zooecia. The present material contain pieces mainly formed of internodes having length upto 15mm. The zooids tend to get elongated, virtually affecting the normal cellarial shape. Vicarious avicularia, when present. Proximal denticles when present assume the shape of tubercles making it difficult to assertain whether they are additional structures apart from the proximal denticles.

Distribution

Celebes (Harmer 1926). The present record is from Antarctican waters.

7. Cellaria sp. a.

(Fig. 7)

Occurrence

Colonies obtained from Antartican waters from 200m depth.

Measurements

Zooecium

Length - 900 μ

Breadth - 360 μ

Salient features

Zoarial structure of typical cellarian character. Branches not noticed. Presence of nodes suggests branching. Zooids arranged triserilally, always frontal portion occupied by four rows of zooids. Opesia having reduced to the size of secondary orifice because of the presence of a very well developed cryptocyst. The cryptocyst smooth. Operculum rounded distally with two lateral drawn out processes. The median portion of the orifical margin projects into the lumen giving the appearance of lyrules. Vicarious avicularia present, placed distally. Avicularian mandible triangular in shape with pointed tips. Ovicells not noticed.

Remarks

The specimen under observation basically differ from other species of the genus described in the presence of string like hold fasts used for rooting to the substratum. Further, the avicularia based on the position could be treated as vicarious. The avicularia occur at regular intervals and are placed at the proximal end of the zooecium. Absence of distinct zooecial margins give them vicarious appearence.

8. Cellaria sp.b.

(Figs. 8a & 8b)

Occurrence

Some colonies of this species were collected from Antarctican waters from a depth of 200m.

Measurements

Zooecium

Length	-	900 μ
Breadth	-	540 μ

Salient features

Colony erect, zooecia multiserial. At the base of the colony there could be as much as six to seven rows of zooecia. Avicularia interspersed with zooecia and as large as the zooecia. The gymnocyst elevated, forming distinct zooecial margins. Cryptocyst evanescent. Opesia oval, colony assumes massive structure. Avicularian mandible spatulate, sometimes with blunt tips. The rostral tip with minute tubercles. Ovicells not noticed.

Remarks

The present specimens are tentatively placed under Cellaria. Since the zooecial character resemble that belonging this genus. The nature of the zooecia simple and hence justify the present placement. The avicularia may be grouped as adventitious, since they are distinct in character.

GENUS MELICERITA Milne-Edwards, 1836

1983 Melicerita Wass and Yoo, Aust. J. Mar. Fresh W. Res., 34, p. 307.

1983 Melicerita Winston, Bull. Mar. Scinece, 33 (3), pp. 688-702.

"Zoarium compressed, bilaminar, rigid, lobate, ligulate or foliaceous, articulated or continuous. Zooecia usually dispersed in transverse rows, surface areolated, area rhomboid or hexagonal. Orifice sub-central, semicircular or oblong, boarder entire with two articular teeth below and sometimes also above" Busk (1884)

9. Melicerita obliqua Thornely, 1924

(Fig. 9a & 9b)

1983 Melicerita obliqua Winston, Bull Mar. Science, 33 (3), pp.688-702.

Occurrence

Two colonies of this species were obtained from Antarctican waters from 200m depth.

Measurements

Zooecium

Length	-	720 μ
Breadth	-	480 μ

Salient features

Colonies are flattened, straight or curved blade reaching around 10cm length and 1 to 1.5 cm in width. Colonies tend to be broader distally and rather pointed proximally getting attached by rootlets. Zooecia are hexagonal in shape. The frontal pores are numerous and those located centrally tend to get enlarged in size. Hexagonal zooids are arranged in longitudinal rows. The number of such rows could be as much as fifteen at the broadest part of the colony. The zooidal boundaries are distinct and the separation could be detected by the presence of thin calcareous margins. The presence of distinct rows of zooids and their longitudinal distribution give the colony a fascicled appearance. The ovicells are embedded. The ascopores are within the orifical margin and are not discernible externally. Orifice when dislodged by crushing gives a typical opercular appeerence.

Ecological notes and distribtuion

This species is found in abundant number in Antarctican waters. Silen (1980) while considering the mode of attachment of bryozoan

Scrupocellaria, where the attachemnt is ephimeral mainly attained by the ancestrular rhizoids noticed that subsequent attachment in effected by rhizoids developed from each zooid. Attachment in the case of erect colonies with highly calcified zooids is an important parameter since lack of it would result in breakage of colonies by water movements. It may be assumed that in the case of Antarctican benthic bryozoans, the presence of highly calcified colonies necessitates the development of rhizoids. In the case of Melicerita, which have large colony, the capacity for the formation of rhizoids is limited to the basal protion of the colony. This would help them to oscilate under water currents. However, dislodgement would result in the death of the colony, since regaining perpendicular posture will be difficult without the help of lateral rhizoids. The colonies examined in the present instance were found to have over growth of other bryozoans like Arthropoma sp., Colletosia sp. This might be an indication of partial mortality of the colony.

It has been opined that benthic bryozoans had a long history of isolation, evidenced by endemism in the Antarctic waters. There are 14 species of cellarids in the Antarctic. These species show wide spread distribution in the Ross Sea, the Antarctic Peninsula, Weddell sea and Adelie land and the homogeneity of the species belonging to this family implies that they are derived from a single stock. Even the presence of species with varied morphological characters indicate that family has undergone a long period of isolation in Antarctica. Melicerita obliqua is a member of the cosmopolitan family Cellariidae which may also have a long history in Antarctica. This species has been described from the Ross Sea and Adelie land (Rogick, 1956 Androsova 1972 and Winston 1983).

There is another species in this genus M. latilaminata, which has a broader brnaching bilaminate colony, zooecial orifice with longer condyles and a few vicarious avicularia.

FAMILY - BICELLARIELLIDAE Levinsen 1909

Typically cellularine, consisting of erect branched zoaria. Unilaminar and for most part biserial. Some species of the genus Beania coming under this family are encrusing in habit. The zooecia in most cases elongate and turbinate. The proximal ends frequently forked and equitant on the basal surface of the predessors, therefore a certain degree of overlapping a delicate texture of the zoaria. Opesia and the frontal membrane generally extensive and operculum is not always differentiated from the frontal membrane. Well developed gymnocyst and feeble cryptocyst. Marginal and oral spines commonly present. Avicularia pedunculate usually with an aquiline beak and invaribaly with acute rostra and mandibles. Majority of species have prominent free hyperstomial ovicell. It is quite likely that the genus Beania which has more or less encursting species retains a more primitive habit than their counterparts of the family.

GENUS BUGULA Oken, 1815

1926 Bugula Harmer, Siboga Erxped., 28b, pp.432-434.

1950 Bugula Osburn, Rep. Allan Hancock Pacific Exped., 14, I pp.153-154.

1960 Bugula Ryland, Proc. Zool. Soc. (Lond)., 134, I, p.66.

1972 Bugula Menon & Nair, Proc. Indian Nat. Sci. Acad., 38, pp.403-413.

Zoaria unilaminar, erect, branching. Alternate zooecia boat shaped with proximal forking. The front usually truncate, distally and slightly attenuate towards the base. Basal and lateral walls calcified. One or more spines present, if more than one usually occuring distolaterally. Avicularia present or absent positioned laterally or frontaly. Ovicells hyperstomial, shape ranginging from globular to elliptical.

Among the bicellariellids, Bugula is a common genus finding its distribution in lower as well as higher latitudes. Types of bifurcation are important which is a morphological feature that help a categorisation of different species of bugulids into distinct groups. Three such groups are recognised to occur, designated as type III, IV & V. Type V is known to comprise of more number of species, where as the type III includes only limited number of species.

10. Bugula sp.

(Figs.10a & b)

Occurrence

Colonies of this species were obtained from Antarctican waters.

Measurements

Zooecium

Length - 780 μ

Breadth - 240 μ

Salient features

Zoarium greyish brown when dried. Zooecia arranged multiserially. Avicularia absent. Ovicells not noticed. Bifurcation is of type IV. Spines are uniformly lacking. Outer distal margin of the zooids smooth giving the appearance of rounded boarders.

Remarks

The present specimen can logically be assigned only to Bugula neritina, since this species lacks avicularia. Multiserial nature of the zoarium at some place makes the present specimen distinctly different from B. neritina. Another feature is the area of occurrence. B. neritina is known to be a tropical and sub-tropical species, whereas the present specimen came from typically polar waters beyond the southern limits of the Indian Ocean. Lack of avicularia and spines, multiserial arrangemnet of the zooids and the geographical distribution probably support the creation of a new sepcies. However, temporarily the species is assigned to the genus without any specific ranking. Examination of more material is considered feasible and advisbale for the creation of new species. Until such time this species shall be known as Bugula sp. only.

GENUS BEANIA Johnston, 1840

1840 Beania, Johnston, Annals of Nat. Hist., V. p.272.

1926 Beania Harmer, Siboga Exped., 28b, pp.410-411.

1950 Beania Osburn, Rep. Allan Hancock Pacific Exped., 14, pp.169-170.

Zoarium with a narrow tubular proximal end expanded distally. Generally four to six connecting tubes attach neighbouring zooecia. Opesia occupies the entire front. Spines present or absent. Opercula differentiated from the frontal membrane. Pedunculate avicularia usually present. Ovicells present, vestigeal or wanting.

11. Beania magellanica (Busk) 1852

(Fig. 11)

1926 Beania magellanica Harmer, Siboga Exped., 28b, p.412.

1992 Beania magellanica Ryland and Hayward, Men. Queensland Museum., 32(1), p. 235-236.

Occurrence

A single colony of this species was obtained from Antarctican waters from a depth of 200m.

Measurements

Zooecium

Length	-	1080 µ
Breadth	-	480 µ

Avicularia

Length	-	240 µ
Breadth	-	120 µ

Salient features

Zooecia forms a network with large meshes adhering to substratum by wide rootlets, emenating from the basal side near the distal end. Spines absent. Large avicularia usually arranged disto-laterally. Rostrum more or less compressed. Distal portion reticulate. Ovicells not noticed.

Remarks

This species is supposed to enjoy a wide distribution in the southern hemisphere. Conspicuous feature of the specimen examined is the absence of oral spines. Harmer (1926) remarked the presence of two vestigeal spines. The operculum of the present specimen has distinct marginal sclerites. However, there is no mention of such distinct structure in the description of this species by Harmer and Osburn (1950). In this respect the present material distinctly differs from that examined by both Harmer and Osburn. Further the tip of the rostrum is bent more acutely than that shown by Harmer. The denticles present on the lateral sides of the rostrum of specimens described by Harmer are also wanting in the present material. The proximal marginal sclerite sited as an important character by Harmer are more pronounced in present material.

Distribution

Ryland (1922) reported that *Beania magellanica* was present in tropical, sub-tropical and temporate seas. Present material is collected from Antarctican waters which extends its distribution to polar regions. It is also present in Eastern Pacific (Osburn 1950) and throughout Indian Ocean (Ryland (1992).

DIVISION CRIBRIMORPHA Harmer, 1926

"This division was established by Harmer to include all the genera in which the frontal shield or pericyst is formed by the union of hollow spines or costae, more or less fused, with pores (lacunae) between the costae, the "Cribrimorphs" of "Lang" (Osburn, 1950).

FAMILY - CRIBRILINIDAE Hincks, 1880

"This family is generally taken to include all recent and fossil forms in which a frontal shield is produced by the union of modified spines (costae) over the original frontal membrane". Harmer (1926).

GENUS COLLETOSIA - Jullien, 1886

1926 *Colletosia* Harmer *SIboga Exped*., 28b, pp.474-475.

1950 *Colletosia* Osburn *Rep. Allan Hancock Pacific Exped*., 14, i, p.187.

The costae seperated by row of small lacunae. Orifice semicircular with oral spines. Avicularia vicarious or absent. Ovicells hyperstomial. Pore chambers present.

12. *Colletosia radiata* (Moll), 1803

(Fig. 12)

1926 *Colletosia radiata* Harmer, *Siboga Exped*., 28b, pp.475-478, pl.34, fig.15-18.

1950 *Colletosia radiata* Osburn, *Rep. Allan Hancock Pacific Exped*., 14, I,, pp.187-188, pl.29, fig.2 and 2a.

Occurrence

This species was collected from Antartican waters from 200m depth.

Measurements

Zooecium

Length	-	960 μ
Breadth	-	660 μ

Salient features

Zoarium encrusting, zooecia relatively small, distinguished by inter zooecial grooves giving the zooecia a more or less globular appearence. Front strongly convex. The costae bent in a horizontal angle. Orifice semicircular and small with chitinised operculum. Oral spines present varying in numbers, usually oral spines in the form of stumps. These spines are placed closely in a semicircle. The costae make the apertural bar oblique, which converge proximally and unite to form an elevated lower lip. This rises to form a pointed mucro. The beaded costae form distinct ridges with serially arranged pores usually increasing in size towards the periphery. The median front often provided with pores. The distal part of the zooecium with two costae often unites to form a continuous ridge. Avicularia vicarious, very variable in form with acute elongated mandible. Ovicells not noticed. Pore chambers present.

Remarks

This species according to Osburn (1950) shows great deal of variation in most of the characters such as size, the number of costae, amount of calcification, number and form of pre-apertural pores, the size and form of the avicularia, the size and distribution of spines and setae. This has resulted in the description of numerous forms of this species and some of them have been accepted as valid species. Osburn (1950) opined that consideration of sub-oral pores as a valid specific character would be erroneous since there are variation in the number of sub-oral pores. The vicarious avicularia can be of various forms, the mandible sometimes are elongated and spinous, uncommonly acute with sub-acute mandible. The sub-oral lip sometimes spinous. The fenestrae could be varying in shape. Certain portions of the colony could be occupied by zooecium with numerous vicarious avicularia.

Distribution

C. radiata is cosmoplitan species. It is repored from coast of Oregon, South to the Galapagos Islands and the coast of Peru (Osburn 1950). The present record is from Antarctican waters.

GENUS *FIGULARIA* Jullien, 1886

1950 *Figularia* Osburn, *Rep. Allan Hancock Pacific Exped.*, 5, 14, p.189.

The pericyst with well developed costae. Lacunae developed by the fusion of well defined costate. Orifice closed by a completely chitinised operculum, which articulates with the lateral condyles. Oral spines usually wanting. Ovicells large, hyperstomial. Ooecium generally with membraneous fenestrae. Avicularia when present vicarious.

13. *Figularia* sp.

(Fig. 13)

Occurrence

Some colonies of this species were collected from Antarctic waters from a depth of 200m.

Measurements

Zooecium

Length	-	960 μ
Breadth	-	480 μ

Salient features

Zoaria whitish in hue. Circular colonies having zooids arranged on both sides. Proximal portion of the secondary orifice raised to form a peristome with a distinct margin. The ascopore situated towards the proximal end of the peristome. The pore provided with minute denitcles, frontal area with characteristic calcareous architecture. Zooecial margin provided with sparingly distributed pores. Operculum semicircular with a straight proximal margin. Main sclerite marginal and opercular muscles well developed, the operculum covers the pore of the ovicell also. The front provided with lateral fenestrae. Thickening and merging of the costae gives the front an artificial tremocyst nature. Avicularia not noticed. Ovicells slightly immersed.

Remarks

The genus *Figularia* created by Jullien (1886) contains only a few species. The species which is described from the Indo pacific area is *F. hilli* (Osburn, 1950). However, the present species in no way resembles *F. hilli*. Even the generic assignment may be considered provisional. Well developed chitinous operculum, and a prominent peristome like structure formed by the fusion of costae are characteristic features of the specimens under consideration. Pending examination of more material, the presentform is not assigned to any species.

SUB-ORDER - ASCOPHORA Levinsen, 1909

The frontal area is completely calcified leaving the aperture. Compensation sac present which opens into the proximal side of the aperture or into the ascopore situated proximal to the aperture. Operculum compound in the case of forms where the compensation sac opens into the aperture, simple in the case of those where an ascopore is present.

FAMILY HIPPOTHOIDAE Levinsen, 1909

"Zooecia become calcified from behind in successive zones forwards leaving at the surface more or less salient lines of growth and are furnished with a variable number of diatellae." (Canu and Bassler, 1920). Ovicells may be hyperstomial or endozooecial. Avicularia present or wanting. Primitive ascophorans are noted for the simplicity in structure.

GENUS HINCKSIPORA Osburn, 1952

1952 Hincksipora Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, p.82.

Zoarium encrusting, front is a heavy sclerocyst with a single row of areolar pores and covered by thick ectocyst. Ovicell is endozooecial, opening below the closed position of the operculum and extending into the proximal end of the succeeding zooecium. The operculum is simple, heavily chitinised, attached with out cardelles and straight across its proximal border. The primary aperture is straight with out a sinus sub-oral spinules wanting. The oral rim is formed by thick frontal walls.

14. Hincksipora sp.

(Fig. 14)

Occurrence

A single colony collected from Antarctican waters from a depth of 200m..

Measurements

Zooecium

Length	-	1380 μ
Breadth	-	840 μ

Salient features

Zoarium encrusting, whitish in hue. Zooecial margins provided with thin calcareous ridges. Heavily calcified front raising distally to form a distinct peristome giving indication of a secondary orifice. Minute spinules present in the primary orifice. The primary orifice with a prominent lyrule which is broad, giving the proximal part of the orifice two lateral sinuses. Avicularia and spines wanting. Ovicells endozooecial.

Remarks

Relatively very simple structure of the zooecia, heavy secondary calcification, prominent peristome and conspicuous marginal pores resulted in placing this species in Hincksipora. However, the basic differences noticed where in the presence of more than one row of pores, distinct lyrule and conspicuous sinuses in the primary orifice. Total absence of common Kenozooid and relatively simple structure has resulted in the present placing.

FAMILY SCHIZOPORELLIDAE Jullien, 1903

Front a tremocyst, proximal border of the primary aperture usually with a distinct and moderately deep sinus. Operculum well chitinised. Avicularia usually present, ovicells hyperstomial.

GENUS HIPPODIPLOSIA Canu, 1916

1952 Hippodiplosia Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, p.338.

Zoaria generally encrusting, front a tremocyst, with numerous large pores which might become infundibulate. The tremocyst at the proximal border of the aperture is smooth. Aperture rounded with a broadly arcuate or somewhat sinuated proximal border. Perforate ovicells could be endozooecial. Avicularia sometimes present on the distal and lateral walls. Ovicells hyperstomial with incompletely calcified ectoecium. The calcareous wall of the endozooecium may not have pores.

15. Hippodiplosia pertusa (Esper), 1796

(Figs. a, b &c)

1952 Hippodiplosia pertusa, Osburn, Rep. Allan Hancock Pacific Expedition, 14.2, p.340, pl.40, fig.5-8.

1975 Hippodiplosia pertusa, Kluge, Bryozoa of the Northern seas of U.S.S.R., p.600, fig.340.

Occurrence

A collection was obtained from the Antarctican waters from 200m depth.

Measurements

Zooecium

Length	-	1260 μ
Breadth	-	540 μ

Salient features

Zoarium encrusting, distinctly whitish in hue when dried. Front tremocyst with numerous pores. Marginal pores comparatively larger. The pore walls merging at the margin. The interpore spaces of the tremocyst provided with minute calcareous tubercles. The proximal border of the orifice is slightly elevated and thickened. Operculum semicircular, thin proximal border nearly straight, latero proximally inundate. Lateral pore plates present. Avicularia absent. Colony immature, ovicells not noticed.

Remarks

The record of this species from the Antarctican water spreads its range of geographical distribution. The general characters of this species is in confirmity with the description of Canu and Bassler (1923) Osburn (1952) and Kluge (1975). Kluge in her descriptions of this species as referred to the presence of large number of alveoli. Prominent alveoli walls have also been noticed by Kluge. Kluge seems to have noticed condyles in her material.

The present material was collected from a depth of 200m which extends the bathymetric distribution of the species. The species has been recorded from the Arctic waters. Kluge described this species as a boreal species, Hippodiplosia reticulopunctat , a very close relative of this species resembles H. pertusa very much. The only major difference being the architecture of the pore plates. H. reticulopunctata has circumpolar distribution and could tolerate very low temperature.

Distribution

Mazatlan, Mexico, Hincks (1880) Gorgona, Columbia and from Galapagos Islands (Hastings 1930). Osburn (1952) reported this species from San Pedro, Santa Rosa Island, Santacruz Island and from Southern California. Present record is from Antarctican waters.

GENUS ARTHROPOMA Levinsen, 1909

1952 Arthropoma Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, p.333.

1957 Arthropoma Hamer, Siboga Exped., 28d, p.1000-1001.

Porous zooecia, spines wanting, pores sometimes extending to the distal margin of the orifice. Orifice provided with a narrow sinus occupied by the part of the operculum. The occlusor tendons inserted at some distance from the marginal aperture. Vicarious avicularia rarely present. Ovicells globose without perforations and closed by the operculum.

16. Arthropoma cecili (Audouin), 1826

(Fig. 16)

1952 Arthropoma çecili Osburn, Rep. Allan Hancock Pacific Exped. 14, 2, pp.333-334, pl.38, figs.1-3.

Occurrence

A collection was obtained from the Antarctican waters from 200m depth.

Measurements

Zooecium

Length	-	660 μ
Breadth	-	540 μ

Salient features

Zoarium encrusting, whitish in hue. Large zooecium convex. Marginal portion perforate. Median portion less perforate. Zooecial margins distinct provided with grooves. Whole zooecia gives a bulbous nature. Ovicells without perforations and with calcareous tubercles, however, that portion of the ovicell embedded on the succeeding zooecia with pores very similar to the tremocystal pores. Operculum brownish with marginal sclerite. A tongue like extension overhangs the proximal fissure of the orifice. Occlusor muscles attached lateromedially on the operculum. The marginal sclerite of the operculum complete proximally. Ovicells closed by the operculum. Ovicells hyperstomial.

Remarks

The material in hand resembles very much that described by Harmer (1957). The zooecial size and shape extremly variable. Presence of minute tubercles on the tremocyst gives it a glistening appearence. In some cases the central portion of the zooecium with calcareous thickening. Avicularia never noticed.

Distribution

San Pedro (Robertson 1908), and Eastern Pacific area (Osburn 1952). Ryland and Hayward (1992) reported that *A. cecili* is common and widespread in all shallow, tropical, subtropical and warm temporate seas. The present record is from Antarctican waters.

FAMILY *ADEONIDAE* (Busk), 1884

The zoaria are foliaceous and bilaminar or encrusting. *Adeona*, the most important genus coming under this family differs from the others in possessing an articulated basal calcareous axis prolonged into branching rootlets of the same kind. The only one genus included under this family has got representatives with encrusting zoarium. Genera like *Adeona*, *Adeonella* and *Adeonellopsis* are generally foliaceous. Zooecia has thick frontal wall traversed by long vertical pore tubes mostly near the margin. Opercula are situated at the base of the long peristomes which is often completely immersed and the isolation is difficult. Their form has not been satisfactorally assertained. Frontal pores around areoli conspicuous, extending around the distal side of the peristome, in more than one series. Gonoesia with wide, short secondary orifice; opercula not sinuate; the proximal border straight or slightly curved.

GENUS *REPTADEONELLA* Busk , 1884

1957 *Reptadeonella* Harmer, *Siboga Exped.*, 28d, pp.814.

Zooecium encrusting, unilaminar, the zooecia with a small circular ascopore. Peristome not much raised or cylindrical, an acute suboral avicularium on its proximal side, transverse or extending obliquely towards one side of the orifice. Conspicuous frontal pores and areolae extending round the distal side of the peristome, in more than one series. Gonoesia with wide, short secondary orifice; opercula not sinuate; the proximal border straight or slightly curved.

GENUS REPTADEONELLA Busk, 1884

1957 Reptadeonella Harmer, Siboga Exped., 28d, pp. 814.

Zooecium encrusting, unilaminar, the zooecia with a small circular ascopore. Peristome not much raised or cylindrical, an acute suboral avicularium on its proximal side, transverse or extending obliquely towards one side of the orifice. Conspicuous frontal pores and areolae extending round the distal side of the peristome, in more than one series. Opercula not sinuate, the proximal border straight or slightly curved.

17. Reptadeonella plagipora (Busk 1859)

1957 Reptadeonella plagipora Harmer, Siboga Exped., 28d, pp.815-816, text fig.85.

Occurrence

A collection of material was obtained from the Antarctican waters from 200m depth.

Measurements

Zooecium

Length - 1500 μ

Breadth - 840 μ

Salient features

Colony encrusting, zooids large and elongated. Peristomes thick, pores conspicuous covering the entire frontal, the median portion devoid of pores but with sclerite and occassionally an ascopore. Avicularia characteristically directed distally towards the median portion of the orifice. The avicularia is placed on mounted calcareous thickening. The proximal portion of the peristome therefore characteristically thickened. Ascopore seldom discernible. Ovicells not noticed.

Remarks

The specimens examined here characteristically differ from the one described by Harmer (1957) in the absence of ascopore uniformly. However, the thick walled peristomes, proximally placed avicularia and conspicuous areolae make this specimen assignable to the above species.

Distribution

Britain, Florida (Osburn 1914) Ceylon (Harmer 1957). The present record is from Antarctican waters.

FAMILY CELLARINELLIDAE Rogick, 1956

Cellarinellidae, is one of the most abundant bryozoan family belonging to ascophorans. The species of this family are known to be present abundantly in Ross Sea. The most striking feature of the species is the lack of operculum. Sexual reproduction is minimal and increase number is known to be effected by fragmentation and subsequent growth by a sexual reporduction. Some species have colonies formed of delicate tube like branches, assuming a height of a few centimeters. There are species with stout flattened branches. The zooids have a thick clacified front with large pores. They lack external boundaries, which are evidences of separation or demarkation individuals. Extensive calcification below the orifice creates bumpy protruberances on the surface of the colony. The Cellarinellids are totally different from other cheilostomes in that they lack operculum. Open orifice leads to a long curved passage with extensive calcification and internal avicularia. Embryos develop inside the ovicells and are embedded frontally.

GENUS CELLARINELLA Rogick, 1956

1983 Cellarinella Winston, Bull. Mar. Science, 33 (3), pp.688-702.

This genus is characterised by massive colonies which are erect. The zooids are arranged as fascicles. The highly umbonated orifice facing both the sides. Vicarious avicularia or avicularia embedded in the peristome may be present or absent. Highly porous tremocyst gives the colony coralline structure. Avicularia when present, placed on an umbo. This genus is exclusively distributed in the Antarctic.

18. Cellarinella laytoni

(Figs. 18a & b)

1983 Cellarinella laytoni Winston, Bull. Mar. Sciences, 33 (3), p.688-702.

Occurrence

Colonies of this species are obtained from the Antarctican waters from 200m depth.

Measurements

Zooecium

Length	-	1080 µ
Breadth	-	540 µ

Salient features

Few colonies of this species were obtained from Antartica. Erect colonies formed of zooids arranged multiserially in a circular fashion give the colony fascicled appearance. Zooid rows may vary from three to six at areas of bifurcation. A conspicuous feature of this species is the drawn out umbonal structure. The orifice deeply embedded and not visible on superficial examination. The tremocyst highly perforated. Vicarious avicularia placed frontally with their mandibles directed laterally. Normally single avicularia placed at the umbonal projection, therefore, hidden. Avicularian mandibles triangular in shape with pointed tip. Highly porous tremocyst has uniformly arranged tremopores. These tremopores give serial sequences at the points of bifurcation. No ovicells noticed.

Ecological notes and distribution

This genus represents an important member of the family Cellarinellidae. The species of this genus had a wide bathymatry and are known to reach physical diversity at great depths. The reasons for wide benthic distribution may be due to the lack of uniform hydrographical features of the benthic regions. It is known that broad depth zonations of the speices of Cellarinella occur covering several hundreds of meters in the Antarctic waters C. laytoni is having a restrcited spatial distribution. Moyano (1982) estimated that cyclostome bryozoans share about 50% of species with the Antarctican bryozoaons. However, among the cheilostomatous bryozoans Cellarinella occupies a very important position.

19. Cellarinella sp.

(Fig. 19a & b)

Occurence

Some bits of a colony of this species was collected from Antarctican waters from 200m depth.

Measurements

Zooecium

Length	-	720 µ
Breadth	-	320 µ

Salient features

A few bits of a colony obtained from the collections made in Antartica formed the material. Zoarium erect. Zooecium arranged circularly ranging four to six in number. Zooids are arranged one above the other in rows giving the zoarium a bicellarian nature. Peristome or secondary orifice slightly elevated from the tremocystal surface. The distinct proximal bulbous portion of the peristome is occupied by an avicularia. The avicularian mandible sometimes overhangs the secondary orifice. Primary orifice visible with two distinct lyrules. Tremopores present, uniformly distributed. The colony is whitish in hue. No ovicells detected.

Remarks

This species is very similar to the one described above. However, in the nature of secondary orifice with a characteristic inundation; a adventitious avicularia, this form differs from that early described one. Examination of more material is necessary for distinct specification of this species. Therefore, it is assigned as a species coming under the genus Cellarinella

FAMILY MICROPORELLIDAE Hincks, 1880

A median ascopore is present, which varies in form and position, placed proximal to the aperture. Proximal border of the aperture nearly straight, operculum simple without extensions proximal to the cardelles. Peristome with spines.

GENUS FENESTRULINA Jullien, 1888

1952 Fenestrulina Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, p.387.

1957 Fenestrulina Harmer, Siboga Exped., 28d, p.966.

Semicircular aperture straight on the proximal border. Ascopore is semicircular placed more centrally on the tremocyst, so as to provide space for tremopores in between the ascus and the proximal border of the aperture. Tremopores stellate. Avicularia absent.

20. *Fenestrulina malusii* (Audouin), 1826

(Fig.20)

1826 *Cellepora malusi* Audouin, *Description de l Egypte historic naturelle*, 1,4, p.239, pl.8, fig.8.

1952 *Fenestrulina malusii* Osburn, *Rep. Allan Hancock Pacific Exped.*, 12, 2, pp.387-388, pl.62, figs.32, 33.

Occurrence

The collection was obtained from Antarctican waters from 200m depth.

Measurements

Zooecium

Length	- 840 μ
Breadth	- 540 μ

Salient features

Zooecium forms whitish patch on substratum. Zooecia moderately large normally separated by thick grooves with calacareous thickening. Aperture distinctly semicircular with elevated proximal margin, operculum brownish in hue with conspicuous marginal sclerite. Oral spines can be as many as six in number, some of them branched. Tremopores stellate. Reniform ascopore with minute tubercles at the fenestral margin. Area around the ascopore slightly elevated with fine calcareous tubercles. Tremopores arranged in rows, more localised towards the margin of the zooecium. Ovicells hyperstomial with fine calcareous granulations.

Remarks

The material resembles in all its character of those examined by both Harmer (1957) and Osburn (1952). Osburn has described another variety of this species wherein an umbonate process is placed proximal to the ascopore. Osburn thought that this variety ought to be placed under malusii. This indicate that this species could depict variations. Menon (1967) recorded this species from Arabian Sea. However, this material did not contain zooecia with oral spines. Further the front is uniformly perforated. Harmer (1957) stated that the frontal pores can vary, where it could range from uniserial marginal and sub-oral rows to a uniformly perforated front. Microporella malusii described by Robertson (1908) have been noted under malusii by Harmer. Conspicuous feature of this species seems to be high degree of variability. The species described by Menon (1967) did not possess oral spines and Ryland remarked that he had never heard of a form without oral spines. Previous authors have not recorded branched oral spines which were very common in the present material.

Distribution

"Fenestrulina malusii apparently occurs around the world in tropical and temporate waters." Osburn (1952) and Harmer (1957) reported that it has been recorded from nearly all parts of the world except from the Arctic waters. Menon and Nair (1967) recorded this species from Arabian Sea. Present record is from Antarctican waters.

FAMILY SMITTINIDAE Levinsen, 1909

Front an olyocyst, pleurocyst or tremocyst, primary orifice is semicircular usually with cardelles and a lyrula. Oral spines common, sub-oral or frontal avicularium present, ovicells hyperstomial.

GENUS SMITTINIA Norman, 1903

1952 Smittina Osburn, Rep. Allan Hancock Pacific Exped., 2, 14, p.399.

1957 Smittina Harmer, Siboga Exped., 28d, pp.912-914.

Encrusting, tubular or hemischaran. Zoarium at first unilaminar, often with a lighter, upper position. Vicarious avicularia differ from the juvenile zooecia. Distinct marginal pores and areolae present. Sometimes scattered frontal pores are present. Occasionally well developed spines often represented merely by their bases, absent in few species. Primary orifice sunk, operculum delicate, lyrula and condyles present. Peristome more or less raised and thin or represented by a depression. Avicularia lateral or median or sub-oral. Hyperstomial ovicells, globose or immersed, ectooecium incomplete, sometimes a mere basal rim surrounding the porous endooecium.

21. Smittina arctica (Norman), 1894

(Fig. 21)

1952 Smittina arctica Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, p.402, p.47, figs.13-14.

Occurrence

Two colonies of this species were collected from Antarctic waters from 200m depth.

Measurements

Zooecium

Length	-	1380 µ
Breadth	-	540 µ

Salient features

Encrusting zoarium. Regularly arranged zooecia, seperated by calcerous thickening. Enflated tremocyst with uniformly distributed tremopores. Median suboral avicularia invading into the secondary orifice. Primary aperture as big as the secondary. Lyrula wide, peristome elevated on the sides. Old zooids with calcareous thickening. Avicularia small, with small and pointed mandibles. Avicularia placed on calcareous thickening, project over the suboral margin. Ovicells remain elevated when young, become immersed into the proximal end of the succeeding zooecium rendering it completely immersed.

Remarks

The specimens in hand resemble very close S. arctica described by Osburn (1952). Osburn has suggested circumpolar distribution of this species. The present record extends the distribution to Antarctica also.

Distribution

Alaska (Osburn, 1952).

22. Smittina sp.

(Fig. 22)

Occurrence

A few colonies of this species were collected from Antarctican waters from a depth of 200m.

Measurements

Zooecium

Length	-	1080 µ
Breadth	-	420 µ

Salient features

Colony hemischaran, elongated zooecium. Marginal pores present, scattered frontal pores. Zoaria seperated by distinct calcareous ridges. Peristome slightly elevated. Proximal region of the peristome merges in some cases to form a pore, when not merging the proximal portion represented by a well defined sinus. Avicularia median, placed nearer to the peristome, rounded distal portion directed proximally. Lyrules present, broad. Ovicells not noticed.

Remarks

Present specimen in their basic character come closer to S. longiscula, but for the distinct seperation noticed in the proximal peristomial margin. The elevated marginal peristomial walls when merged proximally produces a sinus, which brdiges the gap between the proximally directed avicularium and the peristomial opening. By the above nature the specimens closely resemble S. longiscula. The hemischaran nature of the colony also makes the present material distinct. Quite likely that the bulky nature of the colony is owing to the geographical position of the habitat, which is characterised by low temperature known to support massive build up of the bryozoan colonies.

GENUS Parasmittina Osburn, 1952

1952 Parasmittina Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, p.411.

1963 Parasmittina Lagaaiji, Publ. Institute of Marine Science, 9, p.197.

1972 Parasimittina Menon & Nair, Marine Biology, Vol.14, 1, pp.72-84.

"Avicularia variously distributed on the frontal, but never median, suboral and bilaterally symmetrically developed around the proximal border of the aperture, they have taken their origin from areolar pores. Lyrula and cardelles usually well developed. Variously developed ovicells present.

23. Parasmittina sp.

(Fig. 23)

Occurrence

Colonies collected from Antarctican waters from 200m depth.

Measurements

Zooecium

Length	-	1920 µ
Breadth	-	1260 µ

Salient features

Zooecium encrusting, in the zooecial margin, provided with fine calcareous ridges, peristome moderately elevated. Areolar pores present, evenly distributed. Tremocyst with tremopores peristomial elevation arising from the median portion of the zooecium. Secondary orifice with a proximal sinus. Two types of avicularia present, acute and rounded, positioned on the lateral sides of the peristome pointing sideways. Peristomial thickening conspicuous in the proximal area. Ooecium endozooecial.

Remarks

The presence of two types of avicularia and moderately elevated peristome makes this species different from those described in literature. Minute pores distributed on the median portion of the zooeica structurally different from the prominent areolar pores is a character different from the one described in the literature. Total absence of spines or tubercles also is a character distinguishing this species from the rest. Pending further scrutiny with more material, the present form is not assigned to any species.

GENUS MUCRONELLA Hincks, 1880

1952 Mucronella Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, pp. 435-436.

Zooecia with a subcircular or semi circular orifice. Peristome elevated in front into a more or less prominent mucro. The front is a pleurocyst with one row of areolar pores. Spines are present on the oral border. Avicularia absent. Lyrula of varying length and breadth, excavation at the tip and lateral points present. Diatellae present.

24. Mucronella labiata (Boeck MS) Levinsen, 1886

(Fig.24)

1952 Mucronella labiata Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, pp.437-438, pl.52, figs.1-2.

Occurrence

Material collected from Antarctican waters from a depth of 200m.

Measurements

Zooecium

Length	-	1080 μ
Breadth	-	540 μ

Salient features

Zoarium encrusting, zooecia assume a pyramidine shape because of elevated front and well defined proximal mucro. Front a distinct pleurocyst. Oral spines vary in number, and could be four to six. Calcification of the front gives the pleurocyst a striated appearance. Mucro distinct, semicircle and spatulated. The lyrule broad. Avicularia not noticed. Ovicells not noticed.

Remarks

The specimens under consideration resemble very much M. labiata (Osburn 1952). Distal elevation encompassing the secondary orificial area and the surrounding proximal portions give the zooecia a pyramidal appearence. The calcification of varying thickness gives this part of the front a striated appearence. However, in the major characters the specimens closely resemble *M. labiata*.

Distribution

Osburn (1962) suggested circumpolar distribution to this species. The present record is from Antarctica.

FAMILY *RETEPORIDAE* Smitt, 1867

"Zooecia heavily calcified, with a few pores, spines present or wanting; a well developed vestibular arch which is usually beaded, dependant avicularia of varying size and form (usually sub-oral or not in the mid line). Ovicell at first prominent but becoming immersed, often with a median fissure, above the orifice a labellum or prolongation (almost wanting in *Rhynchozoon* and *Lepraliella*, in which there is a triangular or semi circular area above the orifice consisting of endozooecial layer only). In the erect forms the zooecia are all on the frontal side and the dorsal side is covered by a layer of kenozooecia which may or may not have pores and avicularia. Erect species are usually fenestrate, sometimes forming a close net work (retepores), but a few are mere branching or have occasional fusion." (Osburn, 1952).

GENUS *RHYNCHOZOON* Hincks, 1895

1885 *Rhynchozoon* Hincks, *Ann. Mag. Nat. Hist. Index*, p.5.

1952 *Rhychoozon* Osburn, *Rep. Allan Hancock Pacific Exped.*, 14, 2, p.454.

1957 Rhynchozoon Harmer, Siboga Exped., 28d, pp.1062-1063.

Usually encrusting zoarium, marginal zooecia with marginal pores. Superposed zooecia do not resemble marginal ones. Primary orifice denticulate distally. A sinus may generally be present limited by two condyles. Peristome variously developed but may even be simple. Secondary orifice rarely simple provided with prominent mucros or tooth-like projection. Sub-oral avicularia present or absent. Frontal avicularia acute or rounded. Differentiated frontal acute or rounded. Differentiated frontal plate ornament the ovicell. Opercula strong and with granular thickening.

25. Rhynchozoon tubulosum (Hincks), 1880

(Figs. 25a & b)

1880 Mucronella tubulosa Hincks, Ann. Mag. Nat. Hist., 5, 6, p.383, pl.7, fig.7.

1957 Rhynchozoon tubulosum Harmer, Siboga Exped., 28d, pp.1064-1067, pl.65, fig.16-19.

Occurrence

Several colonies were collected from Antarctican waters from a depth of 200m.

Measurements

Zooecium

Length	-	1200 μ
Breadth	-	540 μ

Salient features

Zoarium erect, tubular, giving a coralline picture. Zooecia tubular, looking like vases in scanning electronmicrophotographs. Smooth with minute marginal pores. secondary orifice rounded often with variously produced peristome. Avicularia present, distinct, usually placed at the proximal or distal rim of the peristome. Independant avicularia, when present placed at the tip of tubular projections. Sub-oral avicularium is placed above the level of the primary orifice. Unsinuate process wanting. Large avicularia not noticed. Ovicells not noticed.

Remarks

Present species which enjoys distribution in Antarctic waters has been reported from the cold regions of Pacific and the Atlantic. This differs from R. tubulosum described by Harmer (1957) and Menon and Nair (1967) by the absence of large vicarious avicularium. Barring this feature the material resemble R. tubulosum.

Distribution

Indian ocean (Thornely 1912) Australia (Hincks, 1880) Bass strait (Hincks, 1880, Hastings, 1930) India (Menon & Nair 1967)

GENUS PHIDOLOPORA Gabb and Horn, 1862

1952 Phidolopora Osburn, Rep. Allan Hancock Pacific Exped., 14, 2, p.447.

Zooarium fenestrate, calcareous part either coloured or white. Dimorphic peristome, at first projecting orifices with more or less distinct marginal teeth and marginal denticles. Orifice without spines the descending lamina of ovicell produced into a projecting lip, (labellum), bearing a median keel, generally terminating distally into a minute pore. Small avicularia usually absent.

26. Phidolopora aviculatum sp. nov.

(Fig. 26a & b)

Occurrence

Several colonies of this species were collected from Antarctican waters from a depth of 200m.

Measurements

Zooecium

Length	-	840 μ
Breadth	-	300 μ

Salient features

Zoarium brown and purplish in hue, when kept dry, white, Fenestrate, fenestra being oval or rhomboidal. Fenestrae usually smooth, sometimes with very minute denticles. Septal ridges high, marginal valleys distinct with minute elongated pores. The front bulbous, ascending towards the peristome, the proximal peristomial margin invariably occupied by vicarious aviacularium with more or less tubular rostrum provided with distal internal tubercles. Two or more types of avicularia common, smaller rounded ones occupying the lateral frontal margin. Orifice spatulate, the distal margin being broader. Peristome elevated, proximal margin with calcareous thickening in the absence of avicularia. The avicularia can be numerous, in the form of large swellings with ascending rostrum, with an apex beak curved with a vertically outstanding beak. The suprafenestral avicularia can also have the same structure. Smaller avicularia when numerous would be rounded or elliptical. In the case of young zooids, the front is provided with spinous calcareous ridge. Ovicells not noticed but should be hyperstomial.

Remarks

Numerous colonies of this species were obtained from Antarctican waters. In many characters this species resemble Iodictyium willieye. But the presence of large peristomial avicularia, with characteristic tubular and ascending rostrum giving the colony a spiny appearence. This is a character, demanding special attention. Further the presence of numerous smaller avicularia is also a character in which the present form differ distinctly from I. willieyi. The fenestral shape and the relative smoothness also looks to be distinct character. Taking these into consideration I assign the material before me as a new species.

ORDER - CYCLOSTOMATA BUSK, 1852

DIVISION - ARTICULATA BUSK, 1859

= CAMPTOSTEGA BORG, 1926

"Primary zooid erect, seperated by chitinous joint from the pro ancestrula, zoarium jointed, rhizoids present. Body wall a gymnocyst, vestibular sphincter present, brood chamber gonozooid, moderately dialated in its middle part, polypide of the gonozooid degenerating before having been full grown". (Borg, 1944)

FAMILY TUBULIPORIDAE Johnston, 1838

Zoaria entirely adherent or erect, multiform often leniar, labellate or lobate, sometimes cylindrical. Zooecia tubular, disposed in contigous series or in single lines. Zooecium enlarged baloon like structure. This family contains large number of fossils.

GENUS TUBULIPORA Lamarck, 1816

1816 Tubulipora Lamarck, 'Hist. An. Sans. Vert., Ed.I, II, p.161.

1926 Tubulipora Harmer, Siboga Exped, 28a, pp. 122-123.

1953 Tubulipora Osburn, Rep. Allan Hancock Pacific Exped., 14, 3, pp.648-649.

Zoarium variable, encrusting and lobulate, repent and branching or erect or branching. Zooecia arranged on the frontal surface more or less in transverse series or in groups. The ovicell is an enlarged gonozooid between the tubules on the frontal surface. The ovicells could be simple and pyriform, broadly lobate with the lobes extending between clusters of tubules. Opening is usually located at the side of a zooecial tubule.

27. Tubulipora flexuosa (Pourtales, 1867)

(Fig. 27)

1867 Idmonea flexuosa Pourtales, Bul. Mus. Compar. Zool., Vol.1, p.111.

1953 Tubulipora flexuosa Osburn, Rep. Allan Hancock Pacific Exped., 14, 3, pp.653-655, pl.71, fig.11.

Occurrence

A few colonies of this species were collected from Antarctican waters from a depth of 200m.

Measurements

Zooecium

Length	- 1620 μ
Breadth	- 360 μ

Salient features

Zoaria erect and branching from a base, branches slender, flexed and sinuous, short fascicles, the tubules could be two or three rarely four. The tip of the tubules slightly narrow, short ooecium occupying one or two inter fascicular areas. Usually this is not lobated. Perforations of the ovicells are small and numerous. The ooeciostome short with rather thick boarder.

Remarks

The species was originally described by Pourtales (1867) from North of Cuba. Osburn (1953) found this species from the southern shore of Caribbea. Harmer (1915) referred about a species very similar to this from East Indies. The present specimen came from Antarctica. Assigning this specimens under flexuosa is temporary, since it seems that the character of the ooecium are different from that of flexuosa or atlantica. In one colony the ooecium was found to be rather small occupying only a single fascicular space. It is not clear whether Osburn's delegation of this Tubulipora as a seperate species was based mainly on ooecial characters. If this is so, the present specimen also may require further more clear scrutiny enabling assingment to another species. The present record had extended the distribution to Antarctica.

Distribution

Cuba (Pourtales 1867, Smitt, 1872) East Indies (Harmer 1915) Porto Rico and Southern shore of Caribbean Sea (Osburn, 1953). The present record is from Antarcitcan waters.

FAMILY HORNERIDAE, Smitt 1867

Erect zoarium with branches like a tree. Zooids opening on the frontal side only. Inflation of the ooecium on the dorsal side of the zoarium.

GENUS Hornera Lamouroux, 1821

1821 Hornera Lamourous, Exp. Meth., p.41.

1915 Hornera Harmer, Siboga Exped., 28a, p.147.

1953 Hornera Osburn, Rep. Allan Hancock Pacific Exped., 14, 3, p.688.

Zoarium with a moderate encrusting base. Erect round stem branching like a tree with the successive branches diminishing in diameter. The zooecia opening on one side is the important distinguishable character of this genus. Fresh material coloured red or purple.

28. Hornera pinnata Canu and Bassler, 1929

(Figs. 28a & b)

1929 Hornera pinnata Canu and Bassler, U.S. Natl. Mus. Bul., 100, Vol.9, p.550.

1953 Hornera pinnata Osburn. Rep. Allan Hancock Pacific Exped., 14, 3, p.689, pl.72, fig. 7, 8 and 9.

Occurrence

Colonies of this bryozoan were collected from Antarctican waters from a depth of 200m.

Measurements

Zooecium

Length	-	420 μ
Breadth	-	240 μ

Salient features

Zoarium widely branched. The zooids opening only on one side. Peristomes arranged serially varying from three to seven. Peristomes arranged in the periphery of the zoarium are characteristically bent. The opening smooth or with less pronounced internal projections. The peristome thickened with heavy calcium deposition. Inter peristomial space provided with minute pores which are discernible only at the tip of the zoarium bearing young zooids. Ovicells not noticed. The colony has got a pleasant reddish hue.

Remarks

The material in hand is assigned to the species *Hornera pinnata* which has a flabulate structure with one plane branching. The zooecia as in the present case are typically round and smooth. The rim is neither flared, seldom serrated. The marginal peristomes can be elongated upto 0.5mm. The pores are either round or slightly elongated. The sulci are not clear in the older portion of the colony. The material in hand is temporarily assigned to this species pending detail scrutiny with more material.

Distribution

Philippines, China Sea, Borneo and from coast of California (Osburn, 1953). The present record is from Antarctican waters.

FAMILY DIASTOPORIDAE Gregoy, 1899

Family consists of species belonging to the genera Diastopora,, Plagioecia, Diperoecia and Diplosolen. The character of these members of this family are nature of the peristome and character of the zooarium. The shape of the ovicell could range from oblong irregular or massive. The ovicells could be proliferated by ooeciopore, could be surrounded by peristomes or scattered with normal tubules. Dimorphism of the zooecial tubule is also a character of the family.

GENUS PLAGIOECIA Canu, 1918

1953 Plagioecia Osburn, Rep. Allan Hancock Pacific Exped., 14, 3, pp.629-631.

"Ovicell is a long transverse sac, obliterating a certain number of zooecial tubes and developed in the vicinity of the zooecial margins. The ooecistome is small, equal to or less than the zooecial diameter. The tubes are isolated from each other. No adventitious tubes "(Canu and Bassler, 1922, page 26). The shape of the ovicell may vary. This could be even symmetrical. It is also likely that the ovicell is inflated that it often surrounds several peristomes. There could be closure of the old peristome by a calcified membrane, which is either perforated by a number of small pores or provided with a small erect central tubular pore. The zoarium usually adnate, may be erect or semi erect.

29. Plagioecia patina (Lamarck), 1816

1953 Plagioecia patina Osburn, Rep. Allan Hancock Pacific Exped., 14, 3, pp.631-632, pl.73, fig.4.

Occurrence

Single colony was obtained from the Antarctican waters from a depth of 200m.

Measurements

Zooecium

Length	-	900 μ
Breadth	-	180 μ

Salient features

The zoarium has different forms. This could have rounded periphery, could be lobate, nature of adhesion could be entirely encrusting or partially free. The peristomes are very short, the major portion of the zooids embedded for most of their length. The peristomial aperture eliptical or rounded. The embedded portions of the zooids convex and provided with numerous minute pores. There is no serial arrangement of peristomes and they are not even connate at the base. At times the peristomial aperture could be covered by a calcareous layer provided with minute pores. The basal lamina often forms a distinct border, beyond the functional zooids. Ovicell distinct, slightly thickened, rounded in shape with a laterally placed pore. Zooecial peristomes may be found arranged as if they pierse the ovicell, indicating enlargement and merging. Usually the number of peristomes could vary from zero to seven. The ooeciostome is not erect or flexed.

Remarks

This species although well represented in the Atlantic has not been previously recorded from the Antarctic. The southern point of occurrence of this species has a very wide bathymatric distribution and have been found to occur from 35m to 200m. Present collection came from deeper waters. Only one colony was available in the present collection. A critical examination of the morphology is limited to othe examination of this colony only. It is not clear whether this species should be seperated from P. patina, since the ooecial character especially with reference to size is not in confirmity with the description in the literature for P. patina. However, for the time being this species is maintained as P. patina.

Distribution

Wemmen Island, Galapagos, Lower California. Santa Barabara (Osburn 1953). The present collection is from Antarctic waters.

PLATE VI

EXPLANATION OF FIGURES

Fig. 1. - *Ellisina levata* (Hincks) Portion of a colony showing the details of zooecia.

Fig. 2. - *Copidozoum spinatum* Osburn. Portion of a colony showing the details of zooecia.

Fig. 3. - *Onychocella* sp. Portion of a colony showing the details of zooecia.

Fig. 4. - *Steganoporella mandibulata* Harmer. Portion of a colony showing the details of zooecia.

Fig. 5. - *Cellaria punctuata* Busk. Portion of a colony showing the details of zooecia.

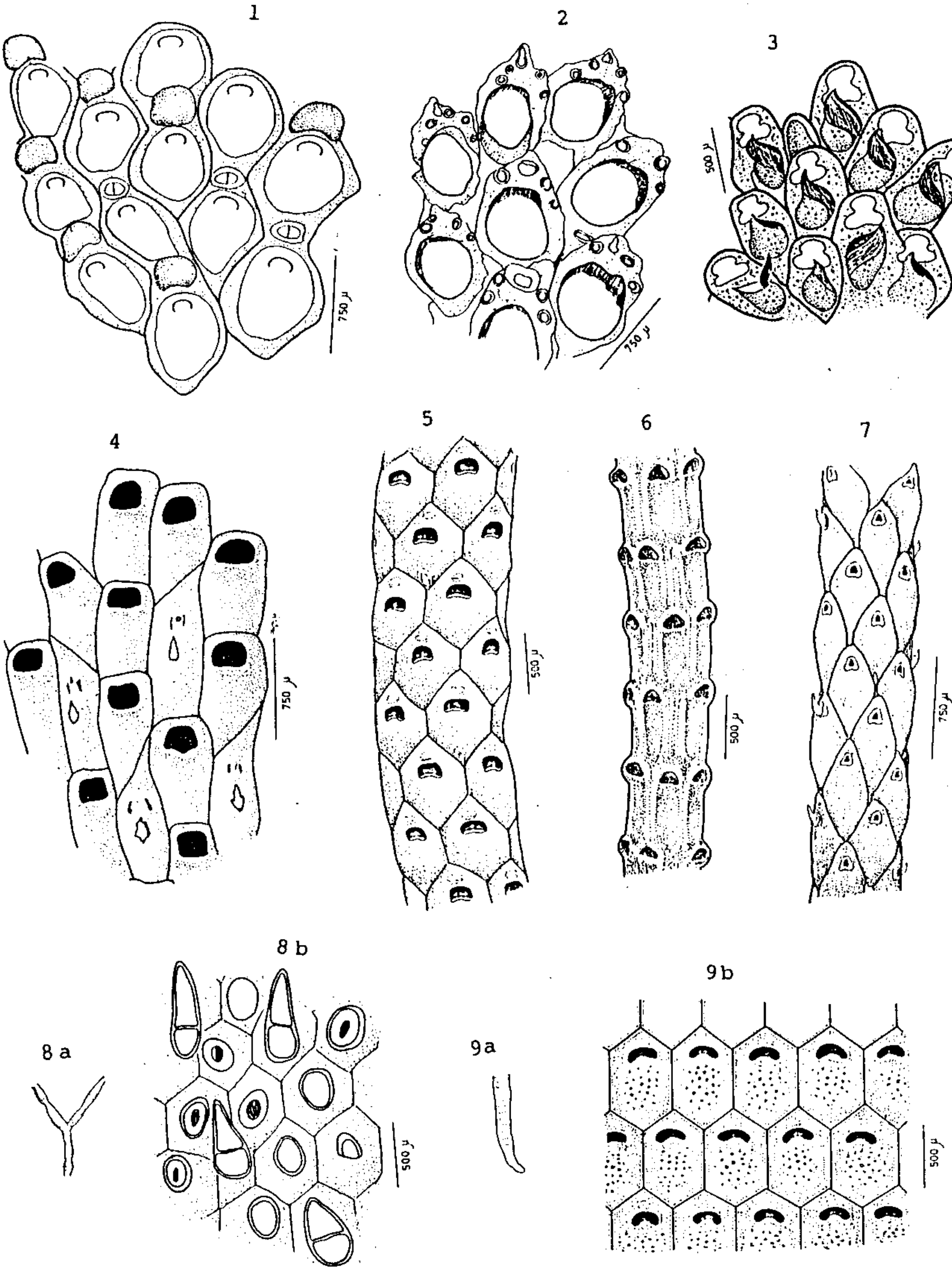
Fig. 6. - *Cellaria praelonga* Harmer. Portion of a colony showing the details of zooecia.

Fig. 7. - *Cellaria* sp. a. Portion of a colony showing the details of zooecia.

Fig. 8a-8b. - *Cellaria* sp. b. 8a. Habit sketch. 8b. Portion of a colony showing the details of zooecia.

Fig. 9a-9b- *Melicerita obliqua.* Thornely. 9a. Habit sketch. 9b. Portion of a colony showing the details of zooecia.

PLATE VI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7
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8 a
8 b
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9a
9b
500 µ

PLATE VII

EXPLANATION OF FIGURES

Figs.10a-10b.- *Bugula* sp. 10a. Portion of a colony showing the details o zooecia. 10b. Figure showing bifurcation.

Fig. 11. - *Beania magellanica* Busk. Portion of a colony showing th details of zooecia.

Fig. 12. - *Colletosia radiata* Moll. Portion of a colony showing th details of zooecia.

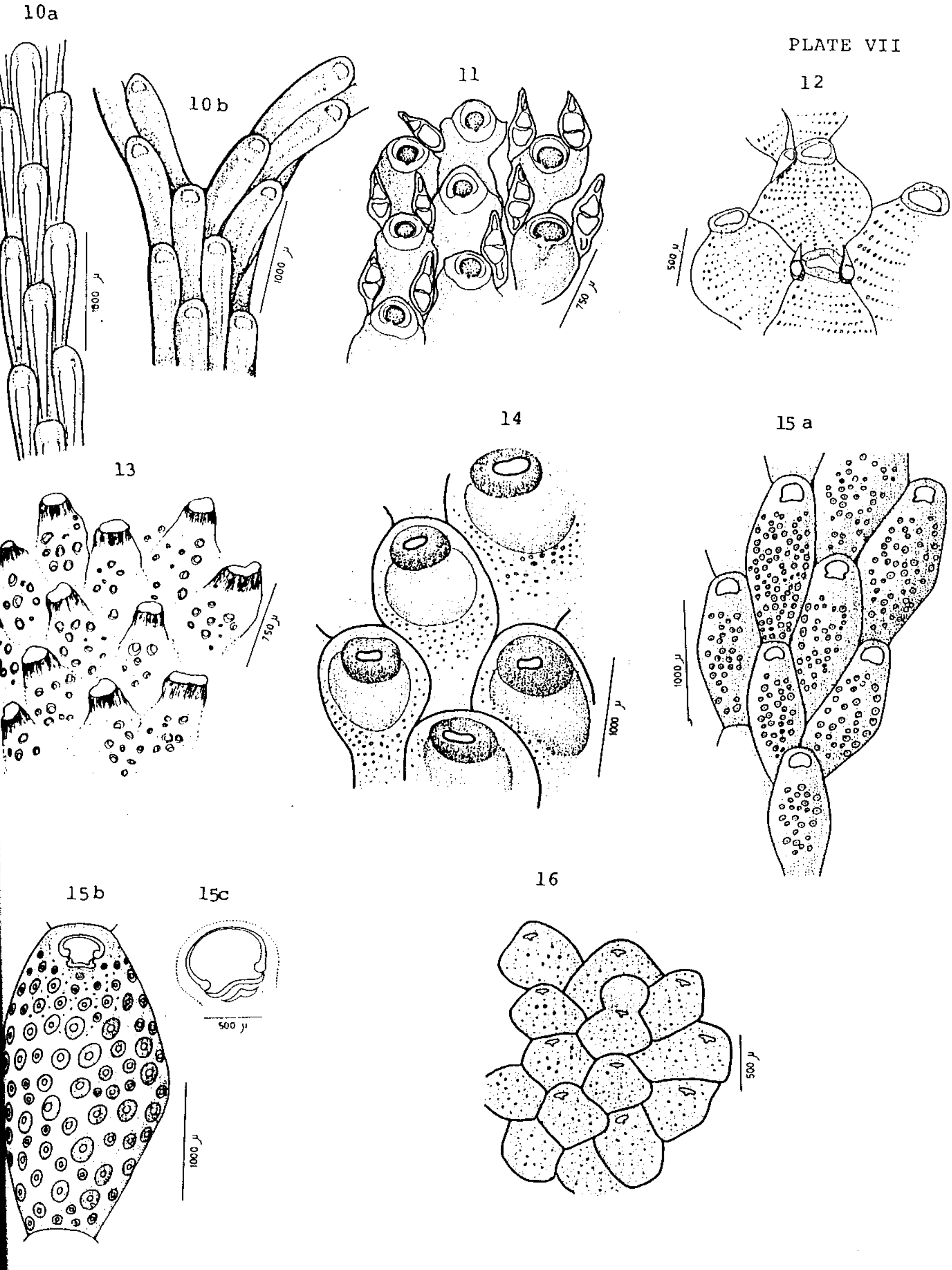
Fig. 13. - *Figularia* sp. Portion of a colony showing the details of zooecia.

Fig. 14. - *Hincksipora* sp. Portion of a colony showing the details of zooecia.

Figs.15a-15c.- *Hippodiplosia pertusa* Esper 15a. Portion of a colony showin the details of zooecia. 15b. Single zooecium. 15c. Operculum.

Fig. 16. - *Arthropoma cecili* (Audouin) Portion of a colony showing the details of zooecia.

PLATE VII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14
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15 a
1000 μ
15 b
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15c
500 μ
16
500 μ

PLATE VIII

EXPLANATION OF FIGURES

Figs.17a-17b - Reptadeonella plagipora (Busk). 17a. Portion of a colo showing the details of zooecia. 17b. Figure showing po oral avicularia.

Figs.18a-18b - Cellarinella laytoni Rogick. 18a. Habit sketch. 18b. Porti of a colony showing the details of zooecia.

Figs.19a-19b - Cellarinella sp. 19a. Habit sketch. 19b. Portion of a colo showing the details of zooecia.

Fig. 20 - Fenestrulina malusii (Audouin). Portion of a colony showi the details of zooecia.

Fig. 21 - Smittina arctica Norman. Portion of a colony showing th details of zooecia.

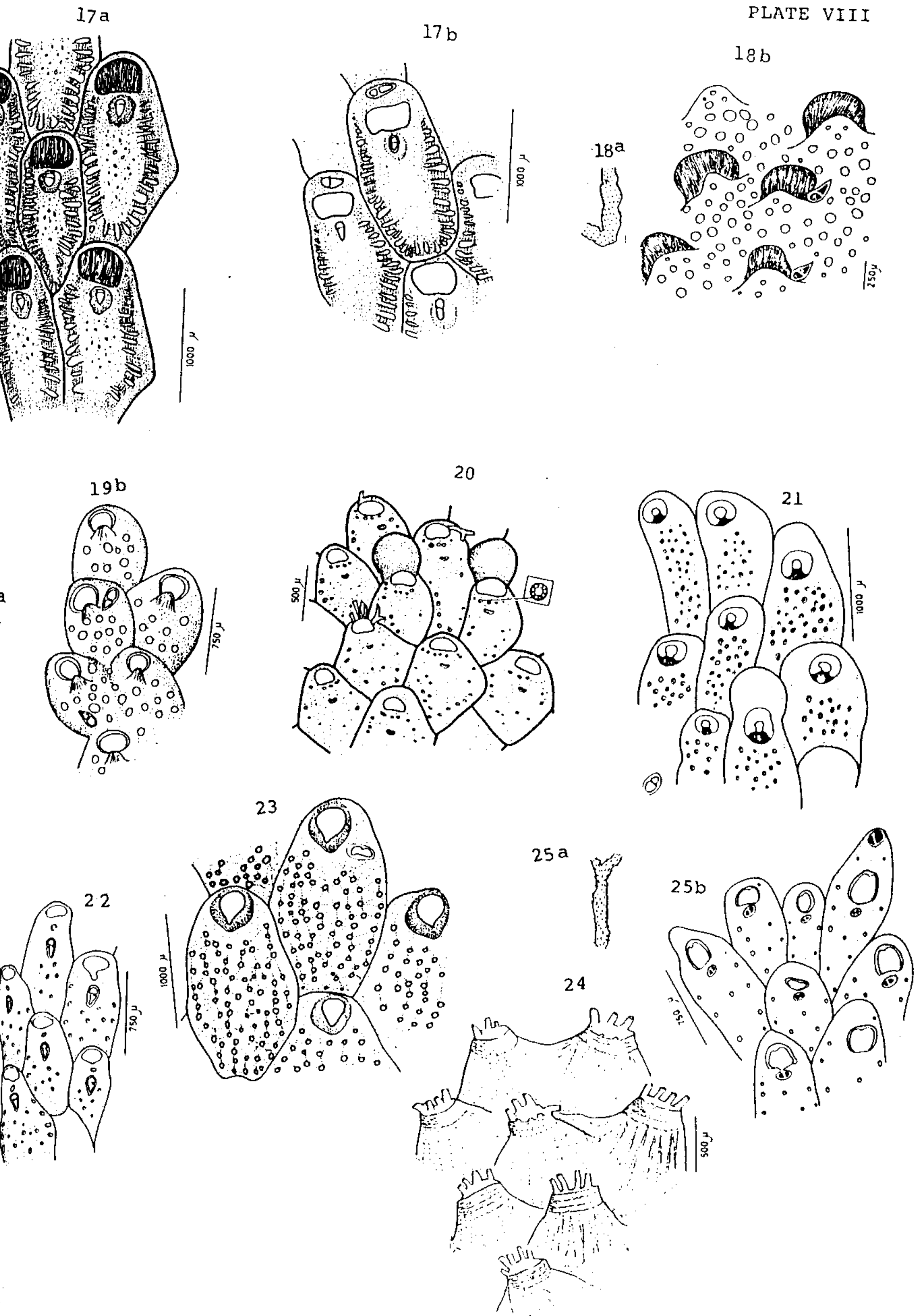
Fig. 22 - Smittina sp. Portion of a colony showing the details o zooecia.

Fig.23 - Parasmittina sp. Portion of a colony showing the details o zooecia.

Fig. 24 - Mucronella labiata Levinsen. Portion of a colony showing th details of zooecia.

Fig. 25a-25b - Rhynchozoon tubulosum (Hincks). 25a. Habit sketch. 25 Portion of a colony showing the details of zooecia.

PLATE VIII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19b
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21
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22
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23
1000 μ
25a
25b
750 μ
24
500 μ

PLATE IX

EXPLANATION OF FIGURES

Figs. 26a-26b- Phidolopora aviculatum sp. nov. 26a. Habit sketch. 26b Portion of a colony showing the details of zooecia.

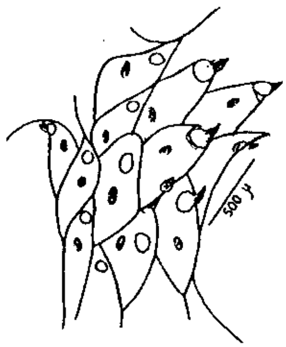
Fig. 27 - Tubulipora flexuosa (Pourtales) Portion of a colony showin the details of zooecia.

Figs.28a-28b. Hornera pinnata canu and Bassler. 28a. Habit sketch. 28b Portion of a colony showing the details of zooecia.

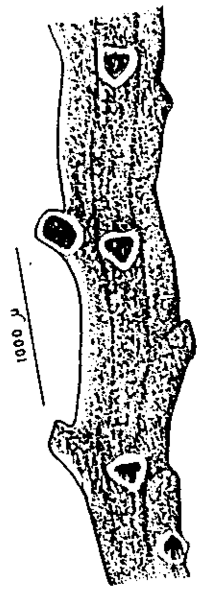
Figs.29a-29c - Plagioecia patina (Lamarck) 29a & b. Portions of a colon showing the details of zooecia. 29c. Ovicell.

26a

26b

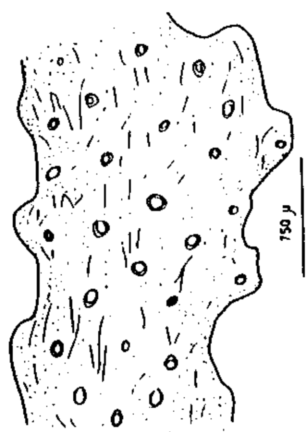


27

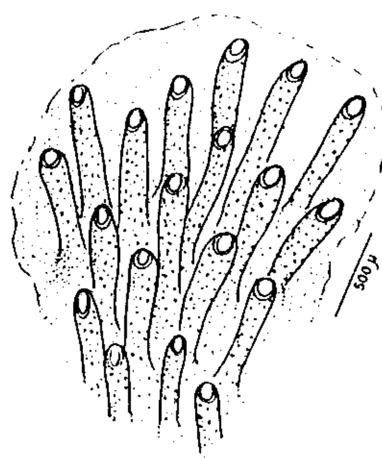


28a

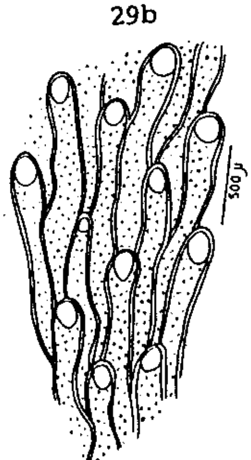
28b



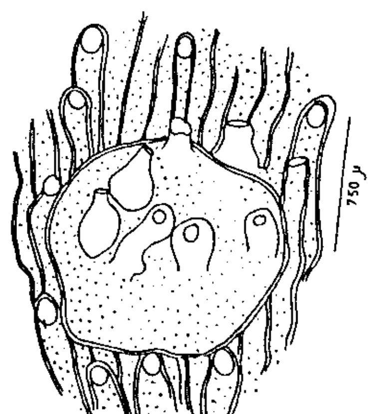
29 a



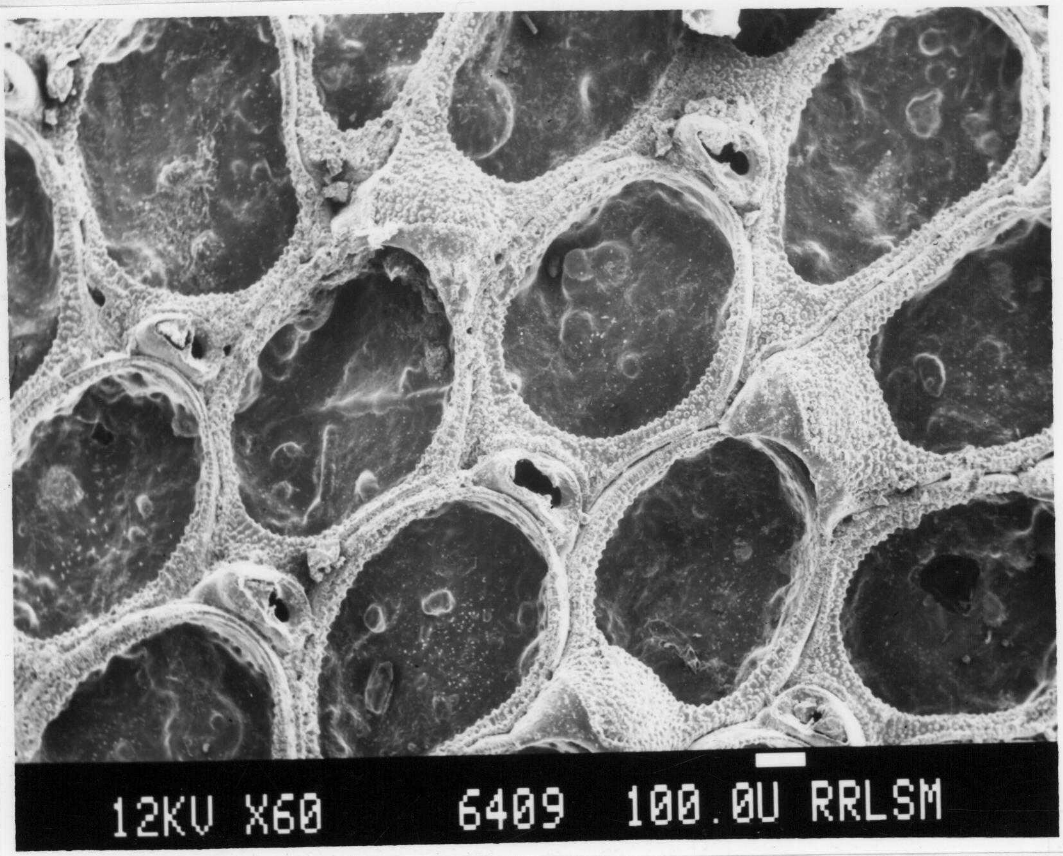
29b



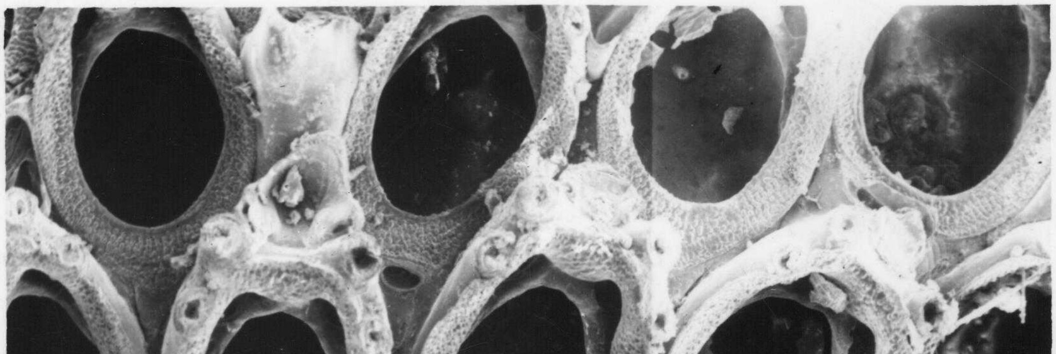
29 c



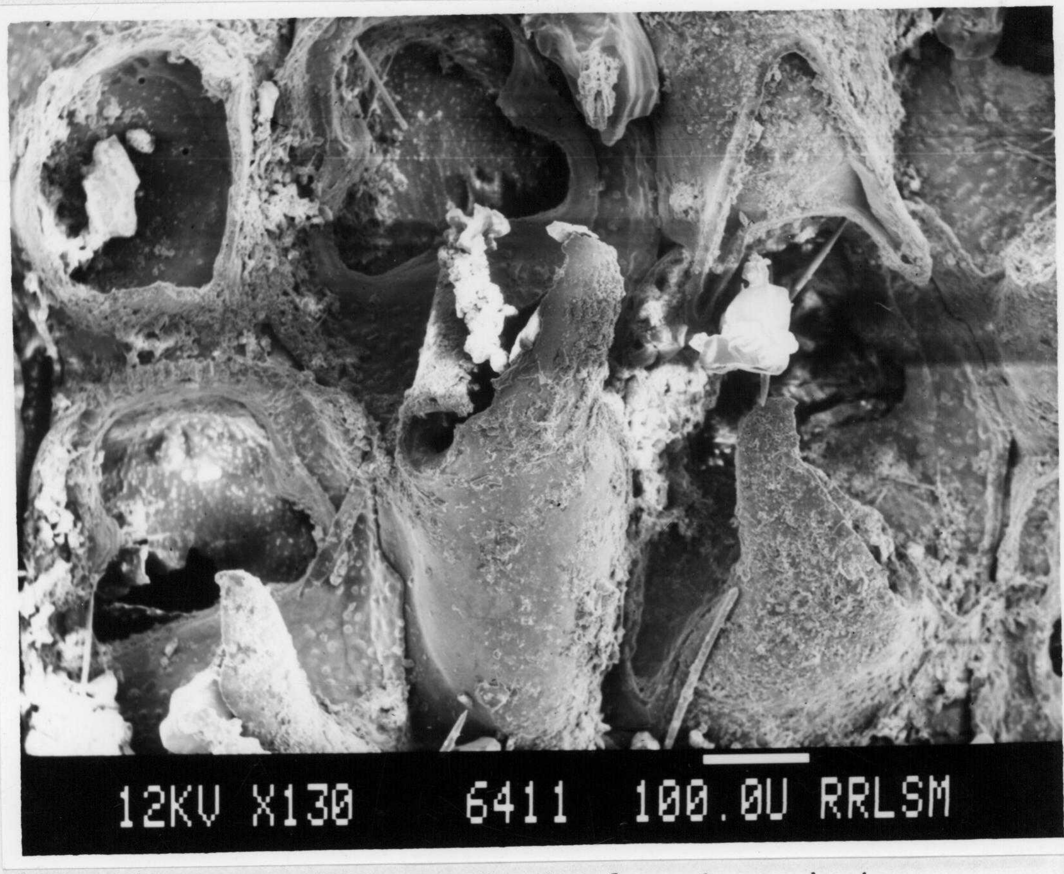
SCANNING ELECTRONMICROPHOTOGRAPHS



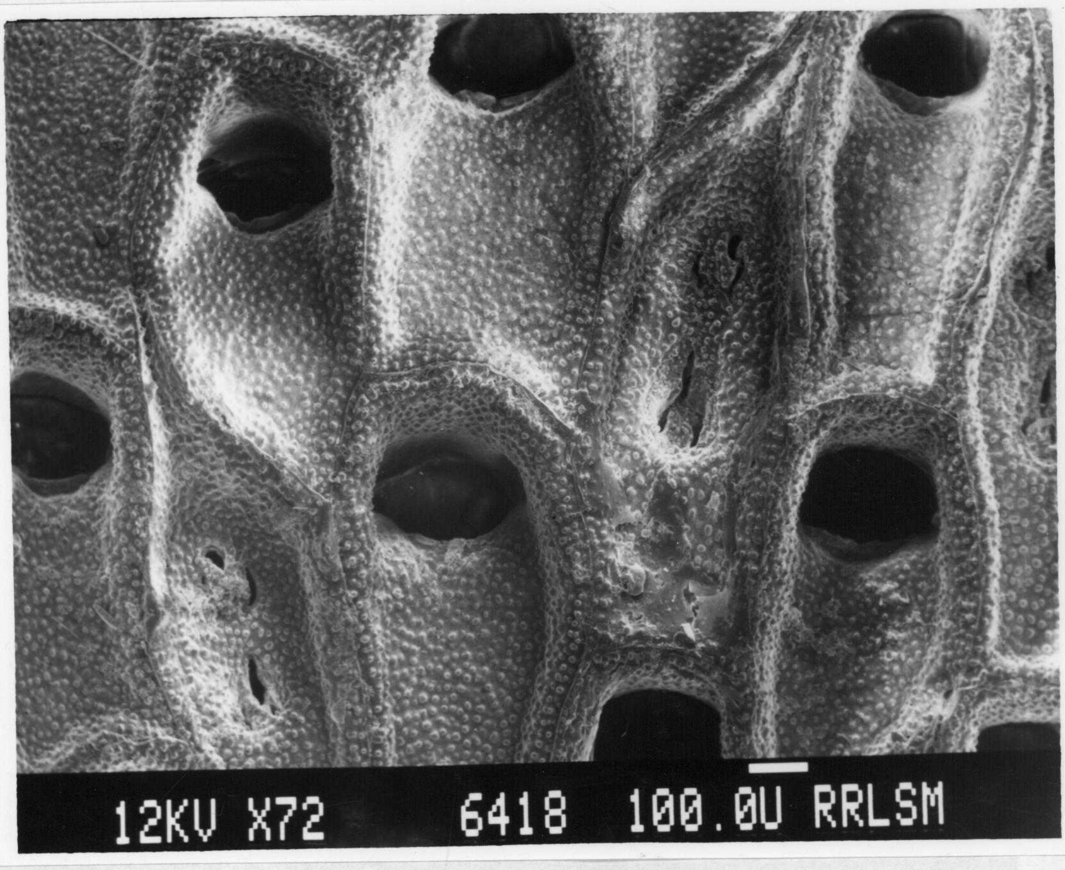
Photograph 1. Ellisina levata (Hincks). Portion of a colony showing the details of zooecium.



Photograph 2. Copodozoum spinatum Osburn. Portion of a colony showing the details of zooecium.

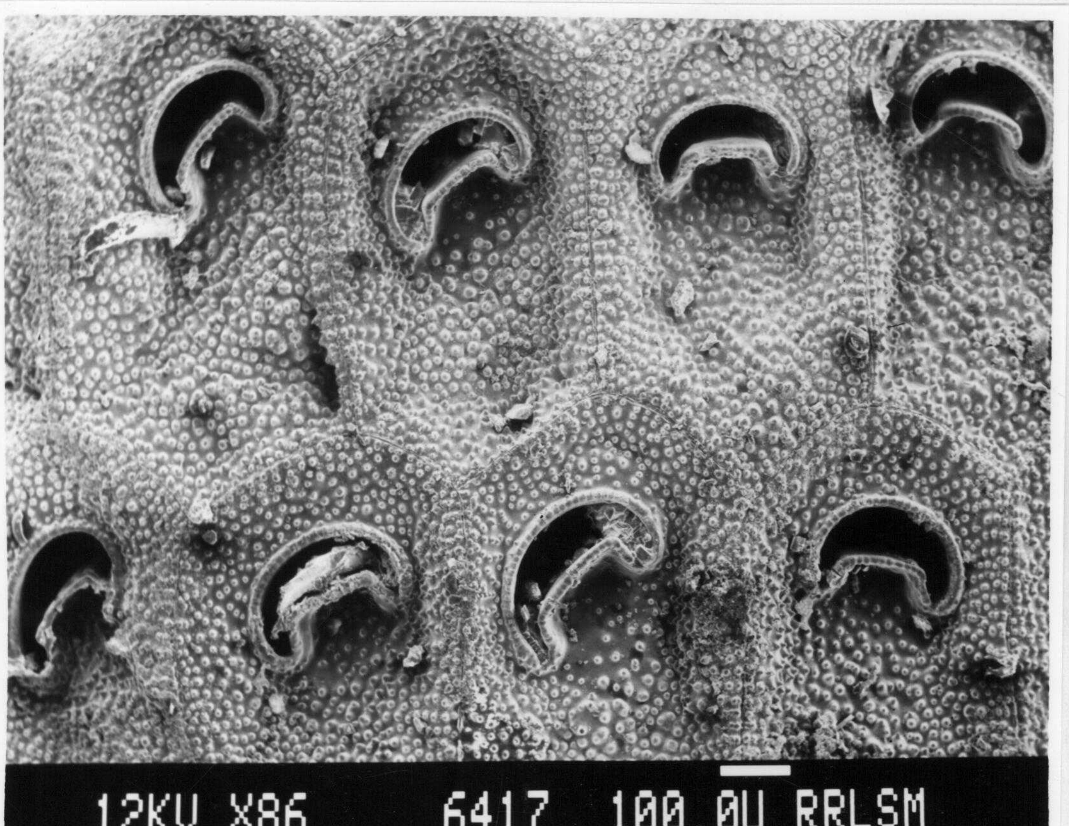


Photograph 3. Onychocella sp. Portionof a colony showing the details of the zooecium.

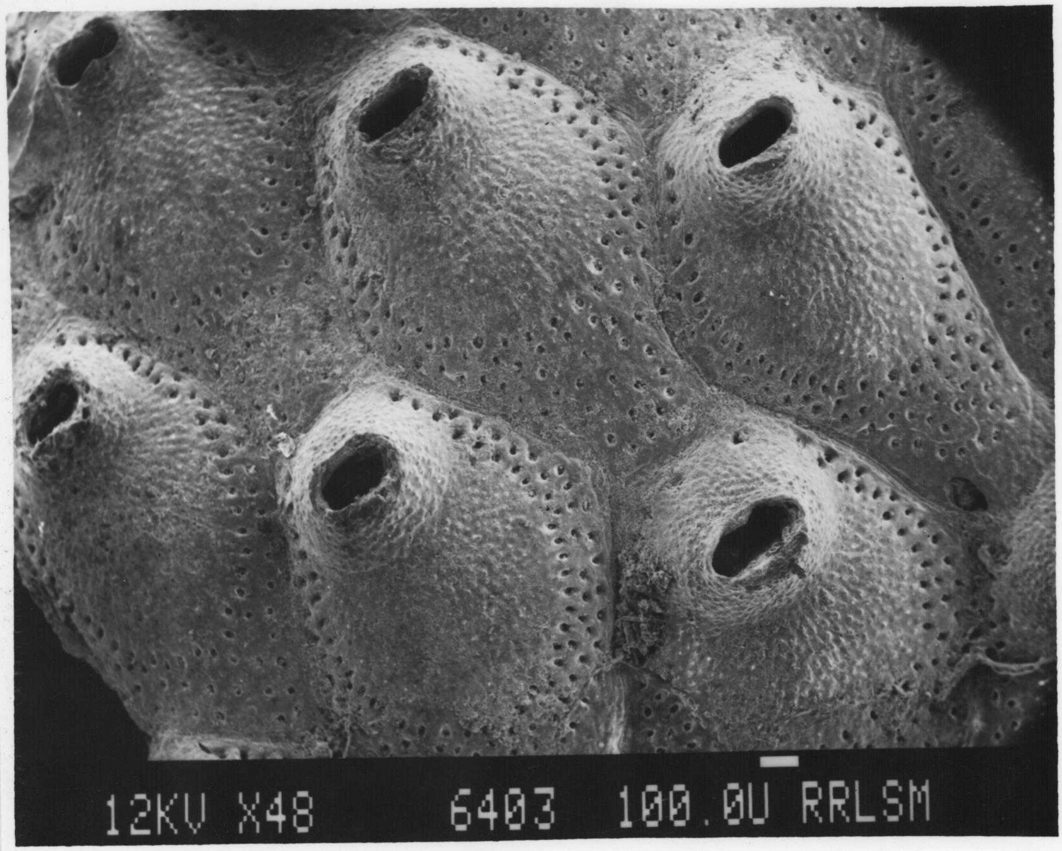


Photograph 4. Steganoporella mandibulata Harmer. Portion of a colony showing the details of zooecium.

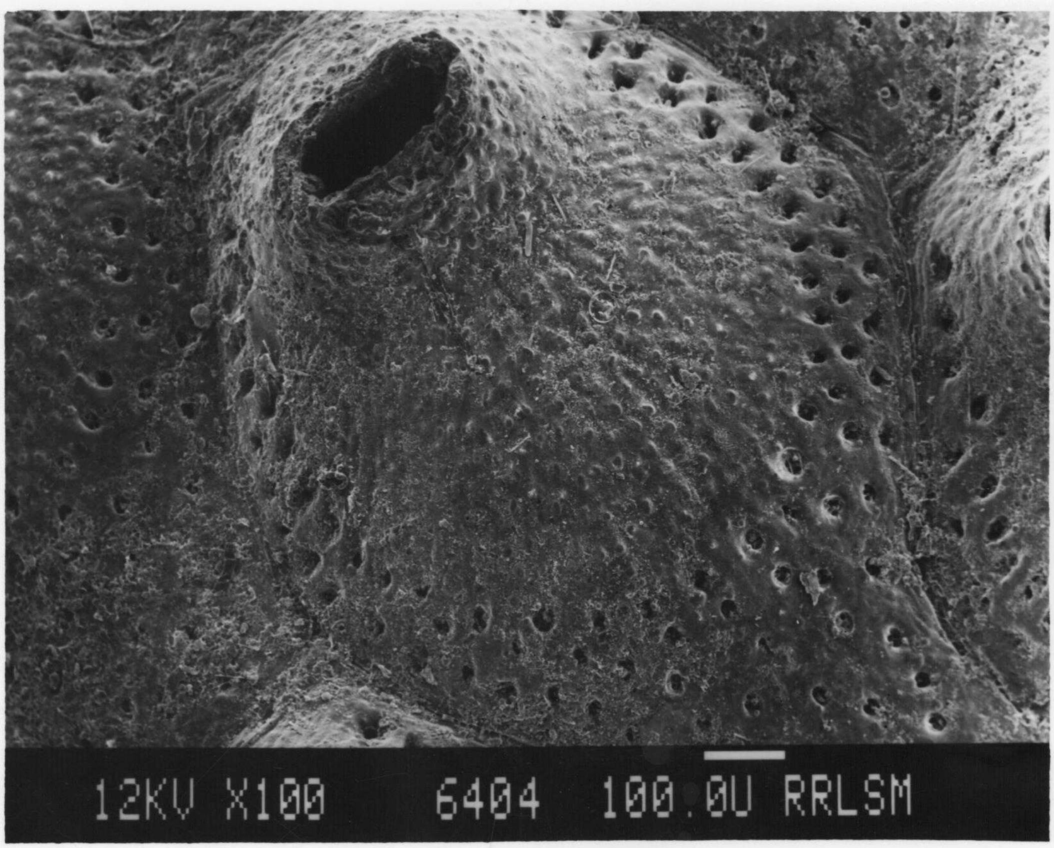
Photograph 5. Cellarinella praelonga Harmer. Portion of a colony showing the details of zooecium.



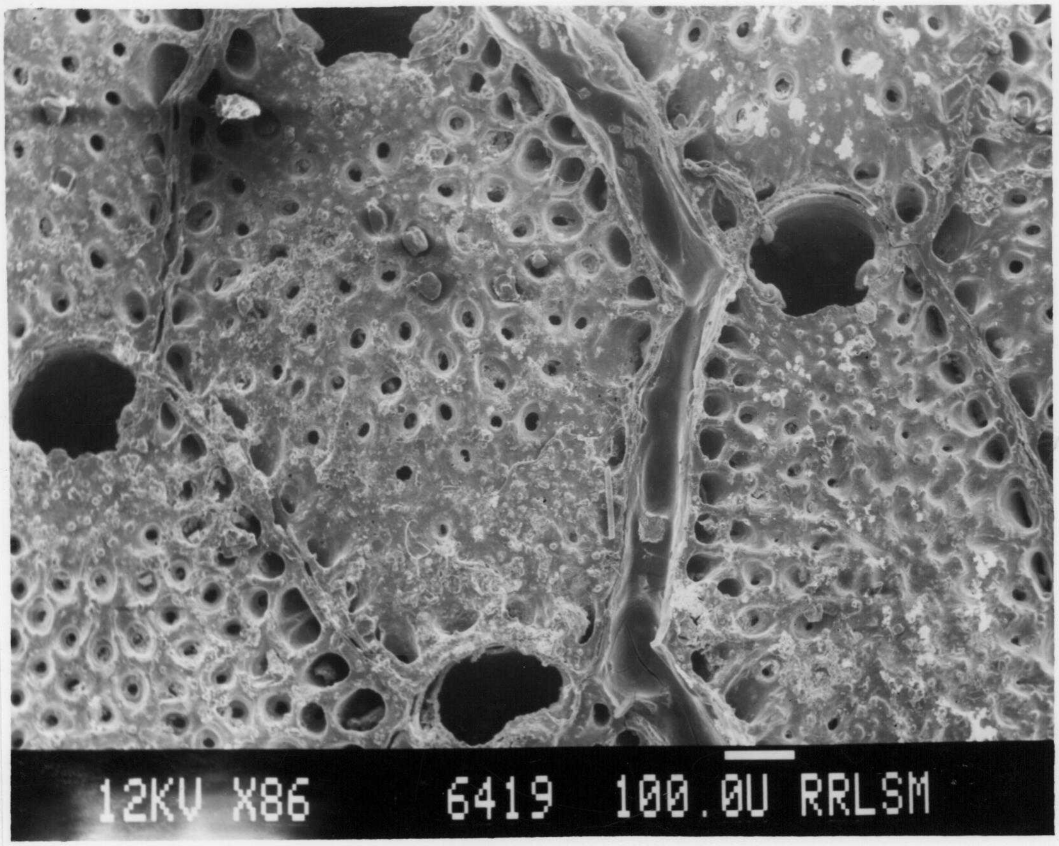
Photograph 6. Melicerita obliqua Thornely. portion of a colony showing the details of zooecium.



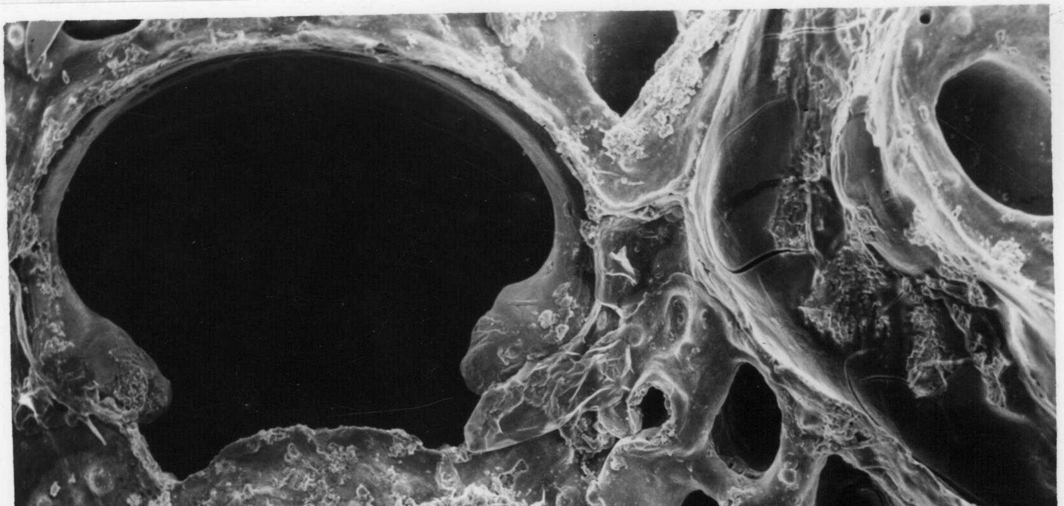
Photograph 7.1 <u>Hincksipora</u> sp. Portion of a colony showing the details of zooecium.



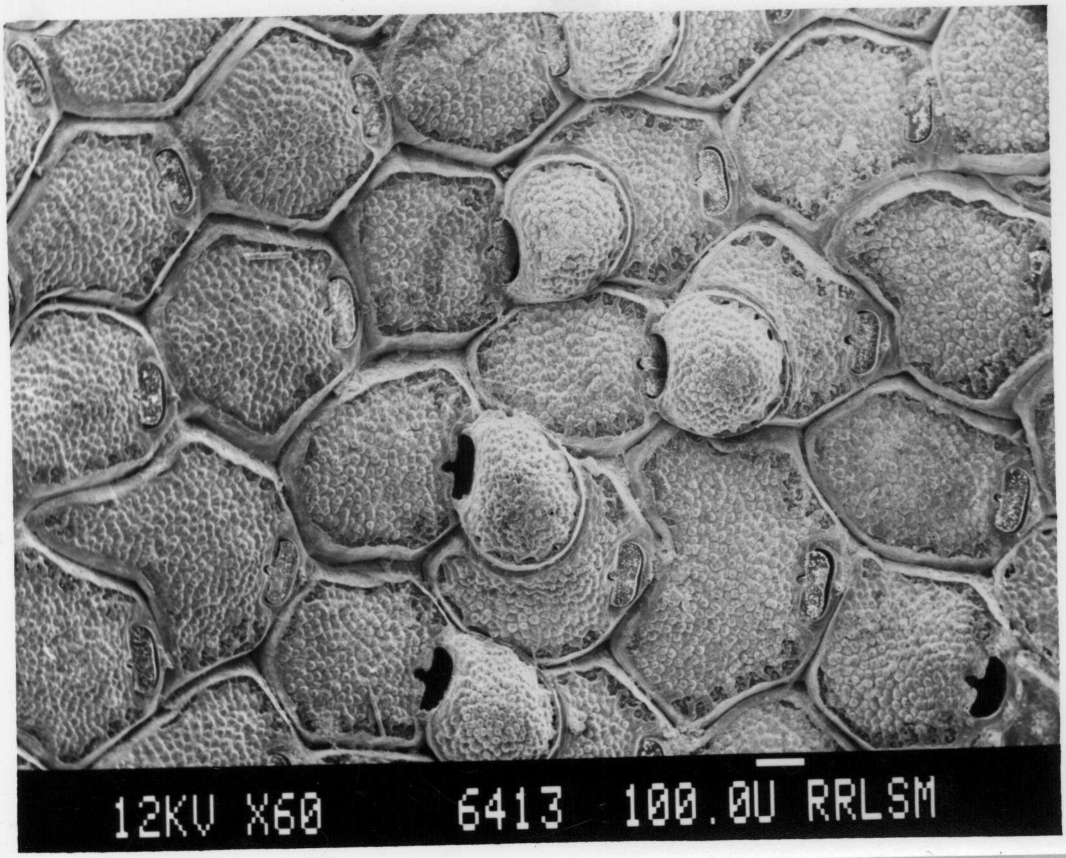
Photograph 7.2 <u>Hincksipora</u> sp. Single zooecium enlarged.



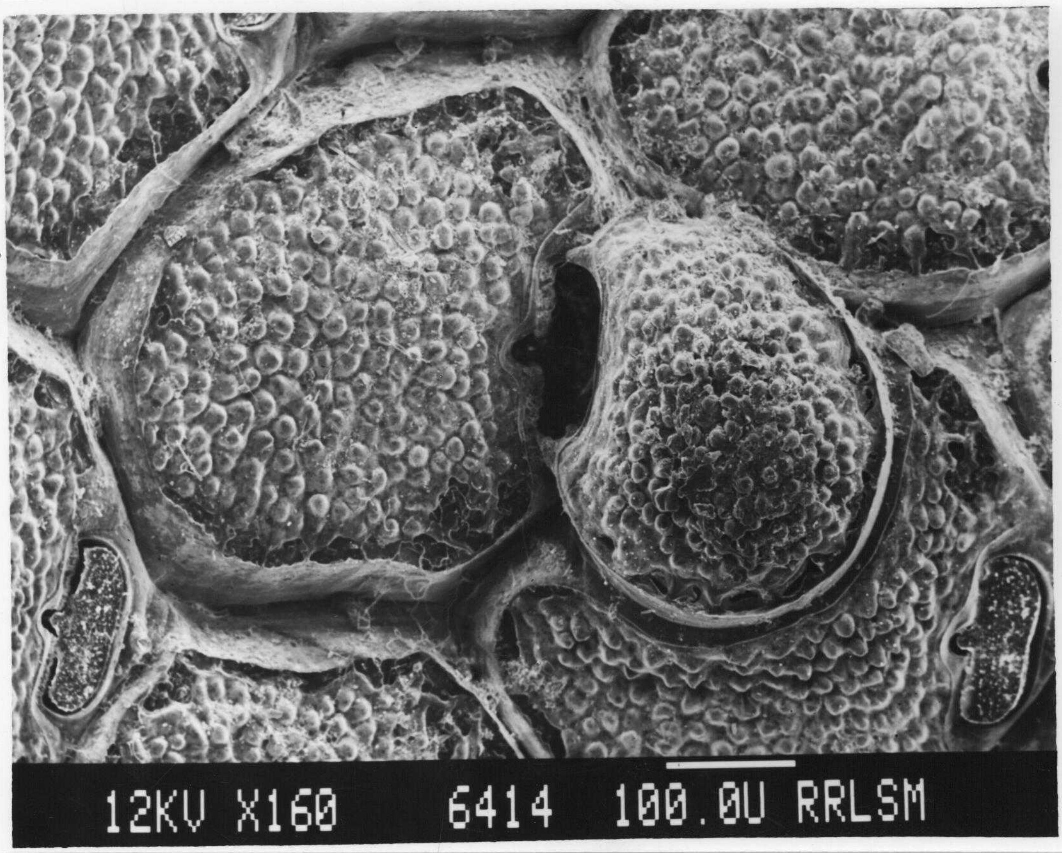
Photograph 8.1 Hippodiplosia pertusa (Esper). Portion of a colony showing the details of zooecium.



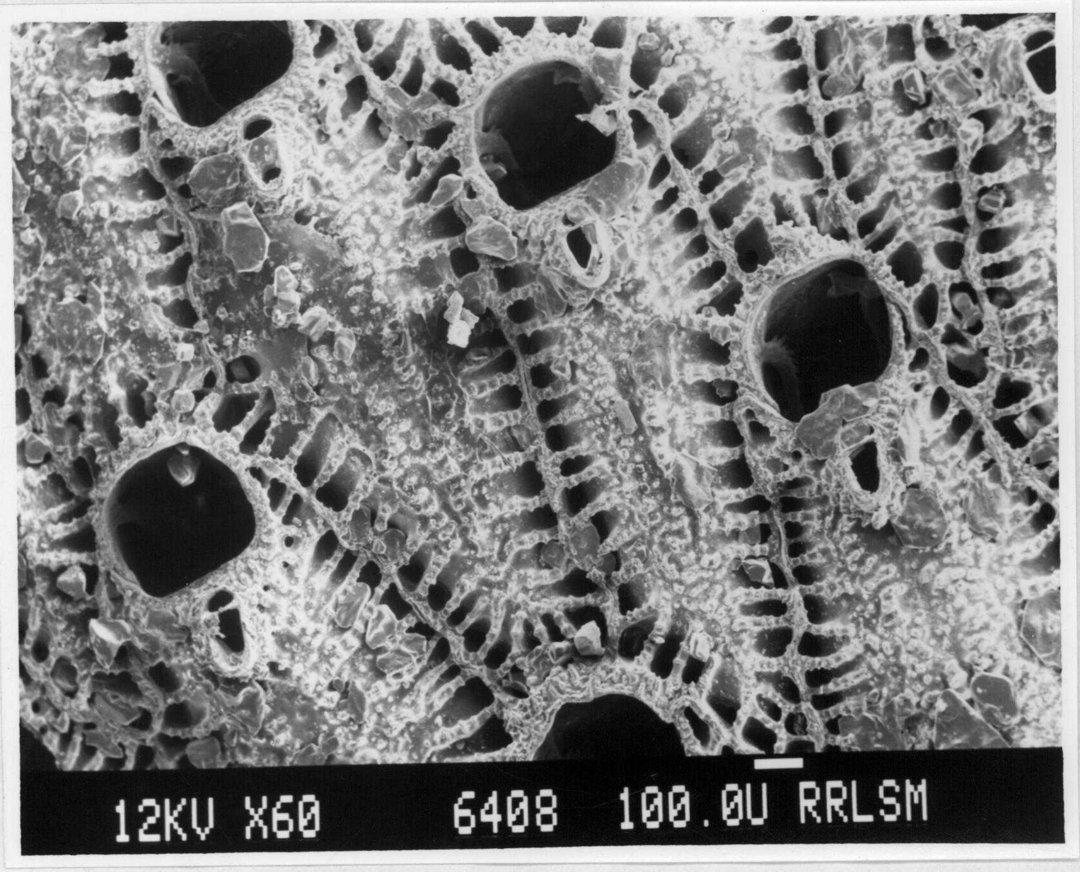
Photograph 8.2 Hippodiplosia pertusa (Esper). Orifice enlarged.



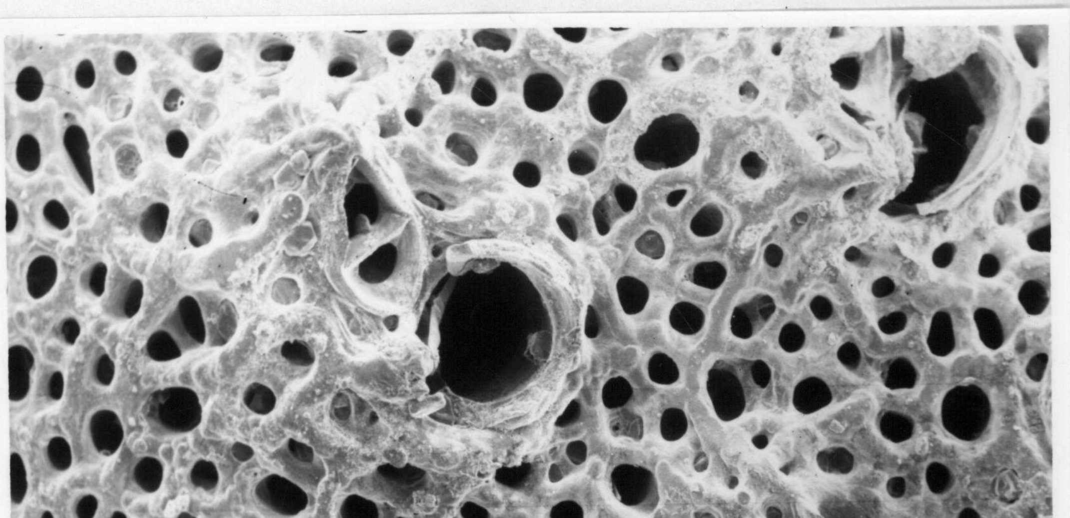
Photograph 9.1 Arthropoma cecili (Audouin). Portion of a colony showing the details of zooecium.



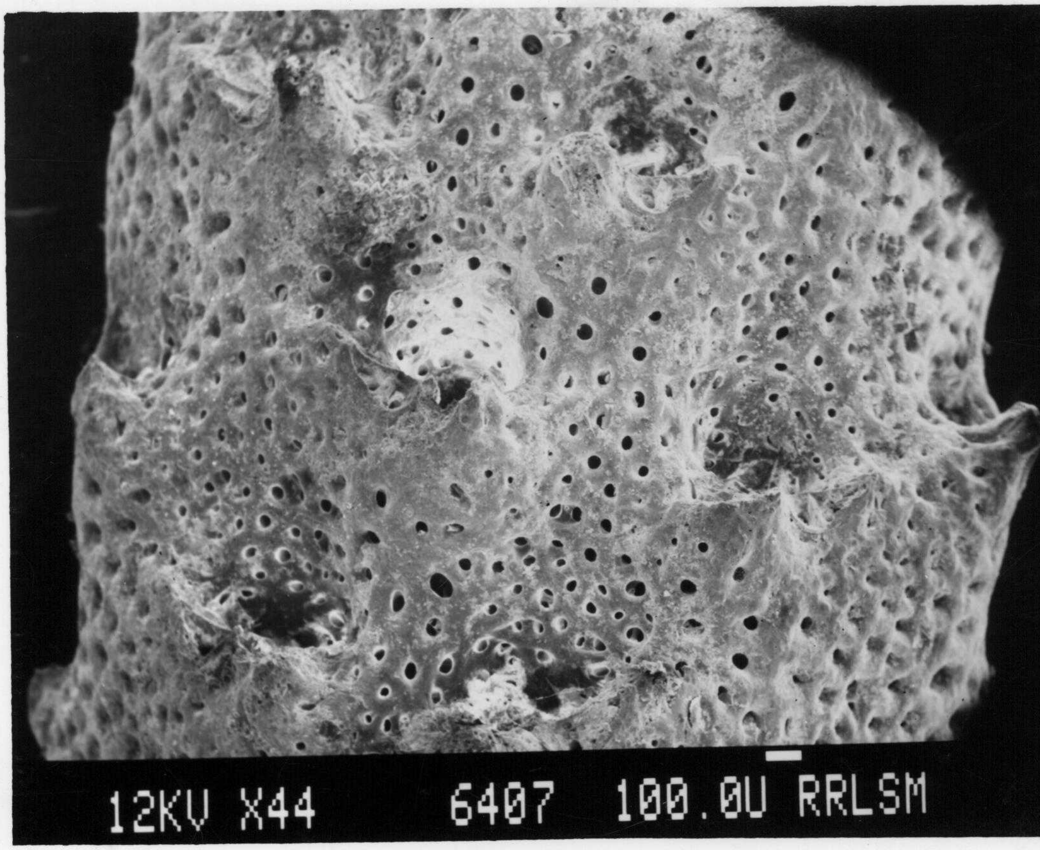
Photograph 9.2 Arthropoma cecili (Audouin). Zooecium with an ovicell enlarged.



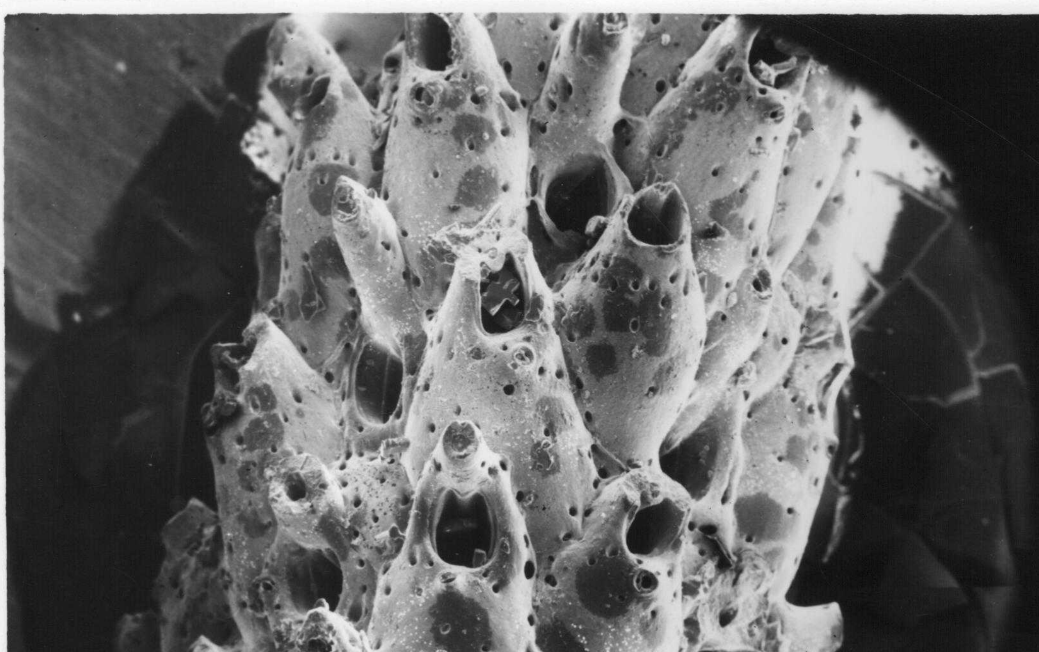
Phtograph 10. Reptadeonella plagipora Busk. Portion of a colony showing the details of zooecia.



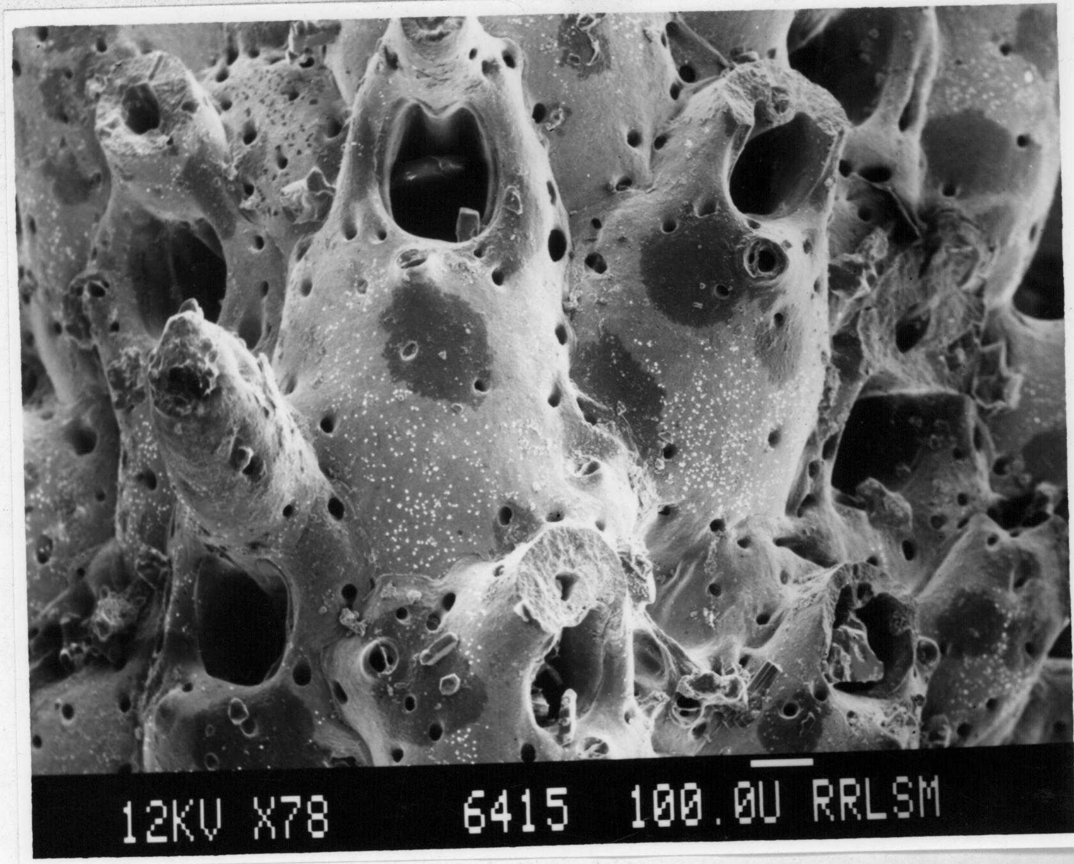
Photograph 11. Cellarinella laytoni Rogick. Portion of a colony showing the details of zooecia.



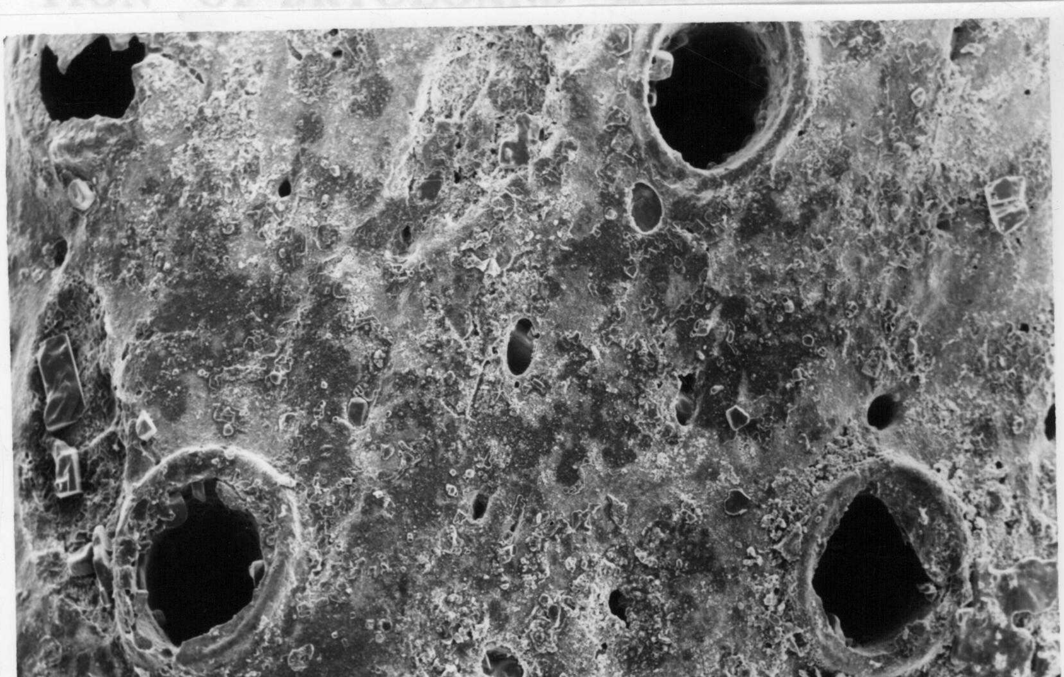
Photograph 12. Cellarinella sp. Portion of a colony showing the details of zooecia.



Photograph 13.1 Rhynchozoon tubulosum Hincks. Portion of a colony showing the details of zooecia.



Phtograph 13.2 Rhynchoozoon tubulosum (Hincks). zooecium enlarged.



Photograph 14. Hornera pinnata Canu and Bassler. Portion of a colony showing the details of zooecium.

REMARKS ON THE GEOGRAPHICAL DISTRIBUTION OF BRYOZOANS RECORDED FROM INDIAN COASTS, MALDIVES AND ANTARCTIC WATERS

I. 6. REMARKS ON THE GEOGRAPHICAL DISTRIBUTION OF BRYOZOANS RECORDED FROM INDIAN COASTS, MALDIVES AND ANTARCTIC WATERS

Zoogeographical distribution is an important aspect of taxonomy, which gives an idea about the success that the group of animals have achieved in distribution. Cosmopolitanism of a group indicates the ability of certain species to exist in varying ecological conditions. This inturn reflects the animal's capability of tolerance to varying environmental conditions. It is known that tolerance leads to adaptations, which could be genetic or non-genetic. Genetic irreversible adaptations result in restricted distribution of animals. On the other hand, those benthic species which are capable of genetic reversible adaptation could enjoy wider distribution, since the environmental characters of benthic realm seldom depicts drastic seasonal or regional variations. Bryozoans are a category of animals which have succeeded in colonising areas from the intertidal realm to greater depths. As in the case of many benthic animals this group of animals also show cosmopolitanism, endemism and bipolarity. However, from a bathymetric stand point, species which are erect are more common along the continental shelves. Beyond the continental shelves especially in the continental slopes the bryozoan species are predominantly encrusting.

The present work describes the taxonomy of 70 species of bryozoans. Table I gives the details of the distribution of species recorded here, in the world oceans. Essentially the species distribution is Indo-Pacific in nature. There are representatives from such diverse geographical localities like the Arctic; the Antarctic, Red Sea, Gulf of Mexico and the European Atlantic. This indicates the capabiltities of this group of animals to get distributed in vast regions of the world oceans. Various theoreies have been put forward to explain the reasons for the present distribution pattern of bryozoans.

The information gathered by the Challenger Expedition in the Southern seas suggested zoogeographical connections among the southern tip of Antarctica. Subsequent studies made by d'Hondt, (1969), Lopez-Gappa (1978); M oyano (1982) completed our knowledge of sub Antarctic bryozoa. The work of Thornely (1907), Robertson (1921), Harmer (1926 and 1957), Menon (1967), Sathya Narayana Rao (1975), and Nair (1989) have given us information on the bryozoans of Indian ocean. From all these studies it has become evident that the Indian ocean bryozoans have a distinct Pacific connection.

Early studies have indicated that less similarities exist between the fauna of the Red sea and Indian waters. It is normally understood that ascophorans are capable of wide distribution because of their capacity for greater adaptability. The present study clearly supports this view made by Soule and Soule (1964). Among the 35 species from the Indian waters examined and studied in the present instance 80% are ascophorans, collected from localities rangiing from intertidal belt to 200m depth. From a geographical stand point among the 70 species recorded from Indian and Antarctic waters 31% are Indo-Australian character. Among the 29 species of Antarctican bryozoans only two were found in Indian waters. Around 7% of the species were found in the Red Sea. The Atlantic components from this group of species is only 14% of which 10% was recorded from the North-West Atlantic. Occurrence of 85% of species in areas outside the Atlantic is a significant information collected during the present study. This clearly supports the view that the Indian Ocean bryozoans are distinctly distributed mainly in the Indian waters and only those species enjoying wide distribution are found in the Indian and Pacific oceans. Seven species were found to be cosmopolitan and they were Aetea anguina, Synnotum aegyptiacum, Microporella ciliata. Fenestrulina malusii, Hippopodina feegeensis, Scrupocellaria bertholetti and Colletosia radiata. Savignyella lafonti, Codonellina montferrandi, Arthropoma ceceli were found to be circumtropical in distribution.

Discussing on the distribution of bryozoans of the Magellanic area which includes the whole of antarctican waters, Moyano suggested that the Magellanic area is a sight of active evolution of Cyclostomata. According to Borg (1944) and Androsova (1968) the family Calvetiidae and Pseudidmoneidae are endemic for Antarctic. In her scholastic remarks on the biogeography of Antarctic bryozoans, Winston (1983) felt that the bryozoans appear to have had a long history of isolation in the Antarctic. This is quite true as evidenced in the present study, which showed that out of the 29 species, only 2 were found in Indian ocean. This reflects the endemic nature of distribution of bryozoans in the Antarctica. Rogick (1965) listed 321 species from Antarctic and sub-Antarctic waters of which 179 limitted to Antarctica. It is interesting in this connection that Dell (1972) speculated that many species living in the Antarctic are derived from deep sea forms and this enables them to move into shallow waters due to cold and physically stable condition in many ways resembling those of deep sea. Connections have been shown between Antarctic fauna and Magellanic fauna. Possibility of connection between Australian region and the Antarctic region was ruled out because of the presence of band of deep waters seperating the two continents as well as the presence of strong circum Antarctic current systems. The fossil records of bryozoans very clearly indicate the connection between Antarctica and Australia during the Cretaceous period. Since the bryozoan evolution starts well in advance, it is quite likely that during the Cretaceous, the presence of shallow seas that existed between Antarctica and Australia would have helped in bryozoan faunal contiguity (Frakes, 1979, Zinsmeister, 1982). The teritiary deposits ranging from Palaeocene to Pliocene in age were rich in bryozoans. It was noticed that some of the paleobiological sediments were entirely made from bryozoan skeletons (Douglas and Ferguson, 1976; Brown, 1958; Cockbain, 1971). Zinsmeister (1982) concluded that a highly endemic paleoaustral fauna existed in Cretaceous times from South Australia through Antarctic sea ways to South America with subsequent opening of circum Antarctic circulations and the movement of Australia and Newzealand into the middle latitudes. This lead to the loss of many species because of physico-chemical changes of the environment or the impact of Indo-Pacific immigrants, thereby depleting the Antarctic components in southern Indian ocean and Australian waters. However, reconsideration of Australian Pacific origin of Antarctic bryozoans would be necessary in the context of very meaningful information collected on thefauna of Antarctica.

Geographical Areas

SPECIES	Cosmo-politan	Circum-tropical	Arctic	Antarctica	European Atlantic	Mediterranean	Red Sea	East coast of Africa & Persian Gulf	India	Ceylon	Maldives	Indo Australian Archipelago	Australian waters	North west Pacific (Japan & Hawaii)	North East Pacific (Pacific coast of N. America)	South West Pacific (Pacific coast of S. America & Galapagos)	N.W. Atlantic (Atlantic coast of N. America)	Gulf of Mexico & Carribean	S.W. Atlantic (Atlantic coast of S America)	Atlantic coast of Africa & Madeira
1. Aetea anguina	+								+@											
2. Aetea ligulata							+		+@			+			+			+		
3. Antropora erecta									+@			+			+.					
4. Alderina arabianensis									+@											
5. Synnotum aegyptiacum									+@											
6. Crepis verticillata									+@			+								
7. Reginella mattoidea									+@						+.					
8. Tremogasterina ventricosa									+@											
9. T. lanceolata									+@								+			
10. T. granulata																				
11. Celleporaria pilaefera								+	+@			+								

SPECIES	Cosmopolitan	Circumtropical	Arctic	Antarctica	European Atlantic	Mediterranean	Red Sea	East coast of Africa & Persian Gulf	India	Ceylon	Maldives	Indo Australian Archipelago	Australian waters	North west Pacific (Japan & Hawaii)	North East Pacific (Pacific coast of N. America)	South West Pacific (Pacific coast of S. America & Galapagos)	N.W. Atlantic (Atlantic coast of N. America)	Gulf of Mexico & Carribean	S.W. Atlantic (Atlantic coast of S America)	Atlantic coast of Africa & Maderia
12. <u>Celleporaria granulosa</u>									+@			+								
13. <u>Mucropetraliella philippinensis</u>									+@			+								
14. <u>Savignyella lafontii</u>	+								+@											
15. <u>Adeona foliacea</u>									+@			+								
16. <u>Lagenicella punctulata</u>									+@			+			+					
17. <u>Turbicellopora redoutei</u>							+	+	+@	+		+	+							
18. <u>Parasmittina aviculata</u>									+@					+						
19. <u>Parasmittina californica</u>									+@						+					
20. <u>Microporella orientalis</u>									+@			+								
21. <u>Microporella ciliata</u>									+@											
22. <u>Fenestrulina malusii</u>	+			+					+@											

SPECIES	Cosmo-poli-tan	Circum-tropi-cal	Arctic	Antar-ctica	Euro-pean Atla-ntic	Medite-rranean	Red Sea	East coast of Africa & Per-sian Gulf	India	Ceylon	Mald-ives	Indo Aust-rali-an Archi-pelago	Austra-lian waters	North west Paci-fic (Japan & Hawaii)	North East Paci-fic (Paci-fic coast of N. America)	South West Paci-fic (Paci-fic coast of S. America & Gala-pagos)	N.W. Atla-ntic (Atla-ntic coast of N. Ameri-ca)	Gulf of Mexi-co & Carr-ibean	S.W. Atl-ant-ic (Atla-ntic coast of S Amer-ica)	Atlan-tic coast of Africa & Mad-eria
23. Hippopodina fegeensis																				
24. Hippopodina calfornica									+@						+					
25. Schizoporella unicornis									+@						+		+			
26. Cleidochasma biavicularium									+@			+								
27. Cleidochasma fallax									+@			+								
28. Schizomavella inclusa									+@			+								
29. Schizomavella linearis var. inarmata									+@						+	+				
30. Calyptotheca tenuata									+@			+								
31. Codonellina montferrandii		+							+@											
32. Rhynchozoon compactum									+@	+		+	+	+						
33. R. tubulosum				+					+@	+										
34. R. larreyi						+			+@	+		+								
35. R. globosum									+@			+		+						

Geographical Areas

SPECIES	Cosmopolitan	Circumtropical	Arctic	Antarctica	European Atlantic	Mediterranean	Red Sea	East coast of Africa & Persian Gulf	India	Ceylon	Maldives	Indo Australian Archipelago	Australian waters	North west Pacific (Japan & Hawaii)	North East Pacific (Pacific coast of N. America)	South West Pacific (Pacific coast of S. America & Galapagos)	N.W. Atlantic (Atlantic coast of N. America)	Gulf of Mexico & Carribean	S.W. Atlantic (Atlantic coast of S America)	Atlantic coast of Africa & Maderia
1. Steganoporella sp.											+@									
2. Nellia oculata									+	+	+@	+	+	+					+	
3. Caberea ellesi											+@						+			
4. Scrupocellaria bertholetti	+								+		+@					+				
5. Parasmittina tropica								+	+	+	+@	+		+						
6. Crisia elongata						+	+		+	+	+@	+	+		+					

Geographical Areas

SPECIES	Cosmopolitan	Circumtropical	Arctic	Antarctica	European Atlantic	Mediterranean	Red Sea	East coast of Africa & Persian Gulf	India	Ceylon	Maldives	Indo Australian Archipelago	Australian waters	North west Pacific (Japan & Hawaii)	North East Pacific (Pacific coast of N. America)	South West Pacific (Pacific coast of S. America & Galapagos)	N.W. Atlantic (Atlantic coast of N. America)	Gulf of Mexico & Carribean	S.W. Atlantic (Atlantic coast of S America)	Atlantic coast of Africa & Maderia
1. <u>Ellisina lervata</u>				+@											+					
2. <u>Copidozoum spinatum</u>				+@										+						
3. <u>Onychocella</u> sp.				+@																
4. <u>Steganoporella mandibulata</u>				+@								+								
5. <u>Cellaria puntata</u>				+@						+			+	+						
6. <u>Cellaria praelonga</u>				+@								+								
7. <u>Cellaria</u> sp.a				+@																
8. <u>Cellaria</u> sp.b				+@																
9. <u>Melicerita obliqua</u>				+@																
10. <u>Bugula</u> sp.				+@																
11. <u>Beania magellanica</u>				+@			+							+						

SPECIES	Cosmo-politan	Circum-tropical	Arctic	Antar-ctica	Euro-pean Atla-ntic	Medite-rranean	Red Sea	East coast of Africa & Per-sian Gulf	India	Ceylon	Mald-ives	Indo Aust-rali-an Archi-pelago	Austra-lian waters	North west Paci-fic (Japan & Hawaii)	North East Paci-fic (Paci-fic coast of N. America)	South West Paci-fic (Paci-fic coast of S. America & Gala-pagos)	N.W. Atla-ntic (Atla-ntic coast of N. Ameri-ca)	Gulf of Mexi-co & Carr-ibean	S.W. Atl-ant-ic (Atla-ntic coast of S Amer-ica)	Atlan-tic coast of Africa & Mad-eria
12. Colletosia radiata	+			+@												+				
13. Figularia sp.				+@																
14. Hincksipora sp.				+@																
15. Hippodiplosia pertusa				+@											+	+	+			
16. Arthropoma cecili		+	+	+@									+				+			
17. Reptadeonella plagipora				+@	+												+			
18. Cellarinella laytoni				+@																
19. Cellarinella sp.				+@																
20. Fenestrulina malusii	+			+@					+											
21. Smittina arctica			+	+@																
22. Smittina sp.				+@																
23. Parasmittina sp.				+@																

Geographical Areas

SPECIES	Cosmopolitan	Circumtropical	Arctic	Antarctica	European Atlantic	Mediterranean	Red Sea	East coast of Africa & Persian Gulf	India	Ceylon	Maldives	Indo Australian Archipelago	Australian waters	North west Pacific (Japan & Hawaii)	North East Pacific (Pacific coast of N. America)	South West Pacific (Pacific coast of S. America & Galapagos)	N.W. Atlantic (Atlantic coast of N. America)	Gulf of Mexico & Carribean	S.W. Atlantic (Atlantic coast of S America)	Atlantic coast of Africa & Maderia
24. Mucronella labiata			+	+@																
25. Rhynchozoon tubulosum				+@	+				+	+										
26. Phidolopora aviculatum sp.novo.				+@																
27. Tubulipora flexuosa				+@											+	+		+		
28. Hornera pinnata				+@											+					
29. Plagioecia patina				+@											+					

+@ Present record.

SECTION II. TOXICOLOGY

INFLUENCE OF HEAVY METALS ON TOLERANCE AND GROWTH

INTRODUCTION

INFLUENCE OF HEAVY METALS ON TOLERANCE AND GROWTH

II. 1. INTRODUCTION

Heavy metals are normal constituents of the marine environment and marine organisms contain traces of these metals. Only those heavy metals which are used in vast quantities usually give pollutional stress. Metals from anthropogenic sources reach the sea through rivers and out falls, fallout from atmosphere, direct dumping through ore tailings, marine mining, drilling and also from ships. Heavy metals when present above the threshold concentrations in the marine ecosystem act as pollutants to organisms. Marine animals tend to accumulate heavy metals from the environment although they are adapted to handle changes in the concentration brought about by natural fluctuations.

Industrial effluents and agricultural runoff into aquatic systems burden the ecosystem with mixtures of toxic or potentially toxic metals. Heavy metals in their pure state pose little hazard except those having a high vapour pressure such as mercury and those which may be present in particulate form in the atmosphere. It is the soluble fractions, which cause biological alterations (Waldichuck, 1974). Some of the metallo organic compounds like methyl mercury and tetraethyl lead are the most toxic compounds known.

Bryan (1976) suggested that the process of heavy metal uptake from water is a passive one. It has been demonstrated that pinocytosis is the key process involved in the uptake and transfer of metals in molluscs. In marine invertebrates several factors are believed to be involved in the detoxification process. Among these, those that bind to non-specific high molecular weight metallothionein like proteins seem to be the most important ones.

Winner and Farrel (1976) suggested that although survival is considered as the best index of metal stress, an analysis of sub-lethal toxic stress is quite useful as the sensitivity of this index is relatively higher than that of lethal toxicity indices. Organisms generally can tolerate large doses for short periods of time and progressively lower doses for increasingly longer period of time. Thus, there seem to exist a time-dose interaction in nature.

The use of sessile marine invertebrates in the environment quality assessment has received considerable thrust from the scientific world since they are unable to escape from environmental deterioration and must either adjust to the change or succumb. Among these, marine mussels, clams, oysters, hydroids and bryozoans have been shown to exhibit the capacity of concentrating a variety of pollutants within their tissues and they therefore represent good indicators of pollutant bioaccumulation, thereby proving as an convenient indicators of environmental pollution.

Bryozoans which are distributed along the intertidal, subtidal and the littoral areas of the west and east coasts of India form an important group among the marine fouling organisms causing serious problem to all man made structures and devices submerged in the sea and coastal industrial installations. The main reason for using bryozoans for toxicological studies was their size, sessile habitat, tolerance and mode of a sexual reproduction. Since they generally reproduce by budding, they provide a genetically homogeneous source of experimental material.

The present scientific investigation is the effects of copper, mercury and cadmium on three fouling bryozoans such as Victorella pavida, Electra crustulenta, and E.bengalensis, conspicuous representatives of the tropical intertidal areas. The investigation centered around delineating the cause and effects of heavy metal stress on the growth and tolerance of these species under laboratory conditions, employing selected concentrations of heavy metals. Studies of this sort help to understand and delineate the detrimental effects of heavy metal pollution on the flora and fauna of the coastal waters.

REVIEW OF LITERATURE

II. 2. REVIEW OF LITERATURE

Bryan (1984) made an attempt to review the literature available on the various aspects of heavy metal pollution with reference to marine animals. Several factors like the lack of proper concepts on the factors contributing to pollution, diversity in the reporting of literature and the adoption of non-conventional methodologies, etc., make a proper understanding of this subject rather difficult.

Heavy metals have been defined as those with specific gravity greater than 4 or 5, located from atomic numbers 22 - 34 and 40 - 52 in the periodic table (as well as the lanthanide and actinide series) and having specific biological response (Murphy and Spiegel, 1983).

The Oslo and Paris conventions have classified the contaminants in the marine environment to black and grey lists. The black list compounds which include heavy metals such as mercury and cadmium and their compounds are very toxic and their release into the marine environment is completely banned. Heavy metals pose little hazard to the life and activity of the marine organisms in their pure state. Heavy metals when above the optimal values produce serious damage to the ecosystem in general and marine organisms in particular, although many of the metals are highly essential for the normal physiology of marine organisms (Bryan, 1976). Many of the metals do enter into the composition of enzymes, respiratory pigments or structural components.

Heavy metal pollution studies of marine animals include lethal and sublethal toxicity, accumulation, depuration, histopathology etc. It is believed that the soluble compounds of metals pose the most serious toxicological problem. Toxicity of the same metal varies according to salt form of the metal, environmental factors, condition of the animal, acclimation and acclimatization to the metal (Bryan, 1976).

Vallee and Wacker (1970) studied the enzyme inhibitory actions of heavy metals namely copper, mercury, cadmium, lead and silver. Copper is one of the essential metals and its average natural concentration in coastal waters is around 2 - 5 ppb. (Deven port and Redpath, 1984). Copper is known to enter into the composition of cytochrome oxidase, lysine oxidase and tyrosinase and is believed to be associated with the enzyme systems involved in removing the toxic side products of aerobic metabolosm (Simkiss et at, 1982).

There is extensive literature on the chemistry of copper in sea water (Zirino and Yamamoto, 1972; Ahrland, 1975; Lewis and Cave 1982). Factors, such as the solubility, capacity to form complexes, colloids, adsorption and pH, have been found to influence the chemistry of copper in sea water. Copper is found to enter the marine ecosystem through terrestrial run off, aeolian import and geothermal addition.

Prabhudeva and Menon (1988) observed that the sulphate forms of copper (individually as well as in combination) were more toxic to Perna indica than the nitrate form, the additive index being more than additive (synergistic) in both the cases. Studies by Lakshmanan and Nambisan (1977) showed that copper was the most toxic metal ion to Perna viridis, Meretrix casta and Villorita cyprinoides var. cochinensis. It was found that variable salinity influenced bioaccumulation of copper by Sunetta scripta

(Latha et al; 1982). There is a linear relation-ship between the uptake of copper and its concentration in water (Nambisan et al; 1977).

Mercury enter the marine environment as divalent inorganic form or as phenyl mercury acetate. It is first incorporated to the bottom sediments and thence mobilized by the formation of soluble complexes such as mercuric chloride or by biological methylation to dimethyl mercury (Jernelov, 1972). The toxicity of mercury is influenced by salinity and temperature of the medium. Portman (1970) reporting on the lethal toxicity of mercury on Cardium edule suggested that this species is relatively hardy and compares well with Crangon crangon in its sensitivity to mercury. Studies on the mortality rates of juveniles of Argopectan irrandians revealed that this animal is relatively less sensitive to mercury (Nelson et al; 1976)

Flatau and Aubert (1979) studied the acute toxicity of cadmium in the marine environment and reported that the acute toxicity of cadmium is rather slow, the concentration phenomenon appears rapidly, the concentration factor of a decreasing order from phytoplankton to fish. Mohan et al. (1984) studied the acute toxicity of cadmium to four species of intertidal molluscs following static bioassay technique. The studies revealed that Perna viridis was much more sensitive to cadmium than two species of Modiolus. Studies by Krishnakumar et al. (1987) revealed that in Perna viridis, smaller size groups (15 - 20mm) are more sensitive than the larger size groups (30 - 40 mm); the order of toxicities of metals tested being copper, mercury and zinc. Philip (1990) studied the sub-lethal effects of three heavy metals namely copper, mercury and cadmium and found copper was most toxic than the other two.

Stebbing has done a lot of work in hydroid toxicology. Stebbing (1976) studied the sublethal effects of three heavy metals on the colonial growth rate of Campanularia flexuosa, and found out the thresholds of sensitivity to 3 metals in 11 day experiments. Stebbing and Pomroy (1978) desribed a technique for estimating the biological effects of low levels of heavy metals on the rate of asexual reproduction of Hydra littoralis. The results of preliminary experiments show that the rate of reproducition becomes significantly inhibited by levels 2 to 12 μg of copper. They also noticed that a control mechanism appears to regulate the rate of asexual reproduction within the range of 0.5 to 2.5 μg copper, which enables the organism to counter act the inhibitory effect of copper.

There is no information available on the effects of heavy metals on the growth of bryozoans. Milton (1946) studied the specific role of copper in the prevention of fouling and the mechanism of action of copper paint surfaces using copper solutions and paints and found that it inhibits the growth and metamorphosis of attached larvae of Bugula neritina. Many authors have studied the growth of bryozoans in relation of factors like temperature, salinity etc. (Gordon 1971, Menon 1972, Hayward and Ryland, 1973; Menon 1975, Jeremy and Winston, 1981).

The present investigation was planned with a view to understanding the effect of three heavy metals namely copper, mercury and cadmium, on certain common representative bryozoans occurring in this region. The species studied were Victorella pavida, Electra crustulenta and Electra bengalensis.

MATERIALS AND METHODS

II. 3. MATERIALS AND METHODS

This part of the investigation has centered mainly around delineating the toxic effects of copper, mercury and cadmium on three species of bryozoans namely Victorella pavida, Electra crustulenta and Electra bengalensis.

Specimens for the present study were collected at Marine Sciences boatjetty in the Ernakulam channel with the aid of inert glass panels (7.5 x 2.5 cm.) arranged on a grooved wooden rack. These test coupons were put out and replaced every 10 days. Panels with settled bryozoan colonies were taken to the laboratory, cleared off all the unwanted organisms and detritus and later transferred to glass beakers containing well aerated, unfiltered sea water having the same habitat salinity. After a period of 48 hrs, the panels containing bryozoan colonies were transferred to unfiltered sea water containing selected concentration of the three heavy metals namely copper, mercury and cadmium. The culture media was renewed every 24 hours and continuously aerated right through the period of experimentation. The increment in number of zooids in each colony was enumerated every four days.

II.3.1. TOXICANTS

II.3.1.a Copper

Analar grade of copper sulphate (M.W.249.68) was the source of copper. The salt was dissolved in distilled water and added to achieve the required concentration

II.3.1.b. Mercury

Standard solutions of mercury were prepared using analar grade mercuric chloride (M.W.271.50) in glass distilled water and stored in amber coloured bottles. Since mercury solutions are not stable for long periods they were prepared afresh for each set of experiments and added to make up the required concentration.

II.3.1.c. Cadmium

Analar grade of cadmium chloride (M.W.201.32) was the source of cadmium. It was dissolved in glass distilled water and added to achieve the desired concentration. Cadmium solutions are relatively stable and hence was prepared fresh only every 15 days.

Growth of the colonies was assessed by counting zooecia which had functional zooids. The increase in the number of zooecia in the controls was typically linear, when the natural logarithms of individuals were plotted against the time. Effect of low levels of metals in depressing the slope of the line or in relative rate of growth (rate of asexual reproduction - K) is calculated from the formula

$$K = \frac{\log_e (ny) - \log_e (nx)}{ty - tx}$$

Where nx is the number of zooids in the first day (tx) and ny- the number after Y - x days (ty) K may be calculated as a mean value for the entire experiment, or for period with in it, limited only by the frequency of the counts, which in present case was once in four days.

RESULTS

II. 4. RESULTS

Three species of bryozoans allowed to settle on experimental coupons were maintained in the laboratory to analyse growth rate under heavy metal stress. These three species inclduded Victorella pavida Kent, which is a very highly tolerant ctenostomatous bryozoan abounding oligohaline and mesohaline stretches of Cochin backwaters. Electra custulenta (Pallas) is another brackish water bryozoan which is also highly tolerant to salinity fluctuations. Electra bengalensis (stoliczka) is a typical marine bryozoan which, however, colonises the brackishwater situations during hot summer months when Physico chemical characterisitics of the waters reach near marine codnditions.

II.4.1. Victorella pavida kent

Tables 1 to 3 present data gathered on the growth rate of colonies assessed by way of increment in the number of zooids for a period of 20 days. It is clear from the table that in the case of copper exposed animals, the maximum growth occured during the early phase of the experiments in all the concentrations. The trend in growth was comparable when the culture medium contained 5 to 10 ppb of copper. Increase in the copper concentrations in the medium brought about retardations in growth after 12 days. None of the colonies kept in 30 ppb recorded growth.

Presence of mercury was found to influence the rate of growth of Victorella pavida after four days of exposure. Here also presence of heavy metals above 15 ppb retarded the growth rate of V. pavida. Those colonies maintained in a medium which contain 25 ppb of mercury, the growth was stopped after eight days.

TABLE 1

EFFECT OF COPPER ON THE SPECIFIC GROWTH RATE (K) OF VICTORELLA PAVIDA KENT ALONG WITH THE RESPECTIVE PERCENTAGE OF THE CONTROL VALUES

Conc. of copper (ppb)	Time 4	8	(Days) 12	16	20
5	0.6412 (82.9%)	0.1013 (100.0%)	0.0813 (108.8%)	0.0263 (72.0%)	0.0275 (167.6%)
10	0.7426 (96.0%)	0.0670 (66.1%)	0.0567 (75.9%)	0.0328 (89.8%)	0.0101 (61.5%)
15	0.5493 (71.08%)	0.0821 (81.04%)	0.0694 (92.9%)	0.00746 (20.4%)	0.0044 (26.8%)
20	0.3760 (48.6%)	0.0834 (82.3%)	0.0602 (80.5%)	0.0063 (17.2%)	0.0028 (17.0%)
25	0.2746 (35.5%)	0.0590 (58.2%)	0.0068 (9.1%)	0.004917 (13.47%)	No growth
30	No growth	No growth	No growth	No growth	No growth
Control	0.7727	0.1013	0.0747	0.0365	0.0164

TABLE 2

EFFECT OF MERCURY ON THE SPECIFIC GROWTH RATE (K) OF *VICTORELLA PAVIDA* KENT ALONG WITH THE RESPECTIVE PERCENTAGE OF THE CONTROL VALUES

Conc. of mercury (ppb)	4	Time 8	(Days) 12	16	20
5	0.3131 (62.1%)	0.1547 (73.0%)	0.0670 (79.66%)	0.0755 (113.3%)	0.04 (58.9%)
10	0.3760 (74.6%)	0.1438 (67.8%)	0.0706 (94.6%)	0.0511 (76.7%)	0.05016 (75.9%)
15	0.2746 (54.50%)	0.1932 (91.2%)	0.0948 (112.7%)	0.0477 (71.6%)	0.02084 (30.6%)
20	0.3465 (68.7%)	0.0796 (37.5%)	0.0231 (27.4%)	0.0321 (48.19%)	0.0283 (41.6%)
25	0.03131 (62.1%)	0.0333 (15.7%)	No growth	No growth	No growth
30	No growth	No growth	No growth	No growth	No growth
Control	0.5037	0.2118	0.0841	0.0666	0.0679

TABLE 3

EFFECT OF CADMIUM ON THE SPECIFIC GROWTH RATE (K) OF VICTORELLA PAVIDA KENT ALONG WITH THE RESPECTIVE PERCENTAGE OF THE CONTROL VALUES

Conc. of cadmium (ppb)	4	Time 8	(Days) 12	16	20
50	0.5198 (94.6%)	0.1308 (86.3%)	0.0854 (86.4%)	0.0735 (110.0%)	0.0719 (122.2%)
250	0.3760 (68.4%)	0.1438 (94.9%)	0.1013 (102.5%)	0.0473 (70.9%)	0.0540 (91.8%)
500	0.3131 (56.9%)	0.1129 (74.5%)	No growth	No growth	No growth
750	0.3465 (63.8%)	0.1013 (66.8%)	No growth	No growth	No growth
Control	0.5493	0.1515	0.0988	0.0667	0.0588

Fig.1

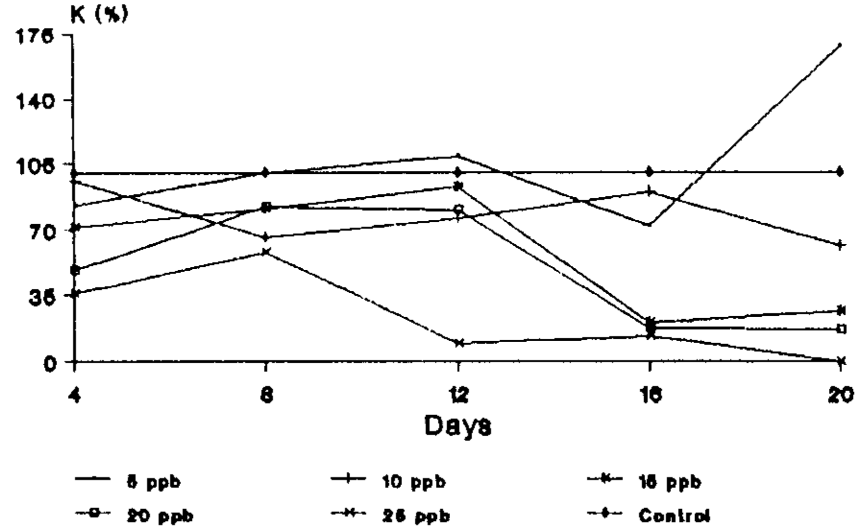


Fig.2

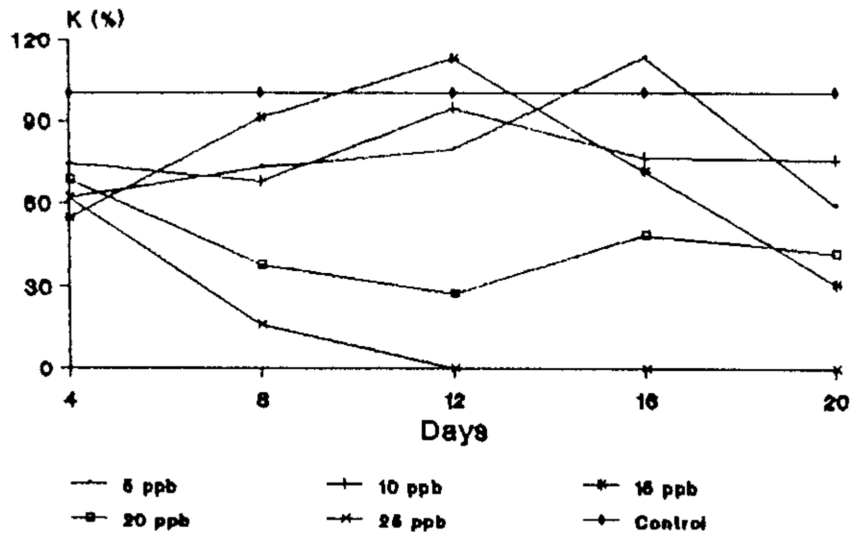
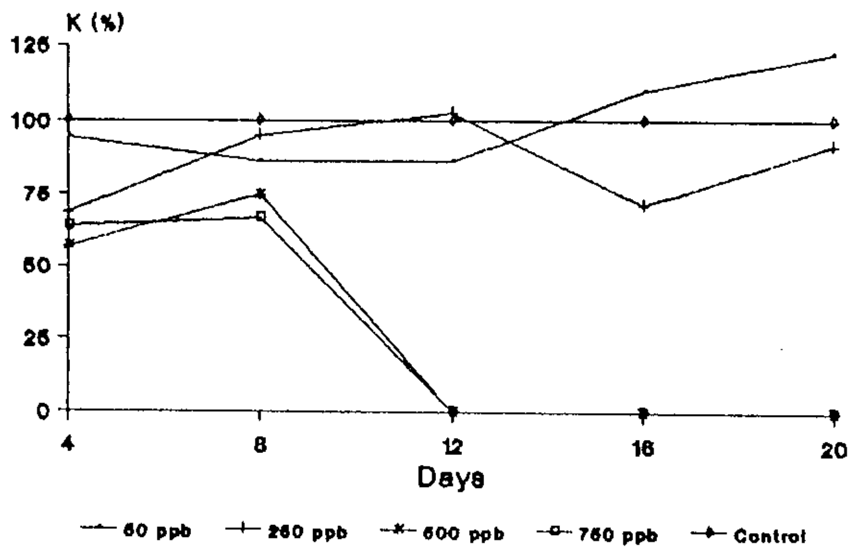


Fig.3



Effect of copper (Fig.1), mercury (Fig.2) and cadmium (Fig.3) on the specific growth rate (k) of <u>Victorella pavida</u> kent

Cadmium was the least toxic heavy metal with reference to growth *V. pavida.* Animals maintained in 50 and 250 ppb of cadmium registered growth even after 20 days of exposure. However, higher concentrations of cadmium was found to result in cessation of growth after eight days. The animals continued to survive but did not grow (See table 1 to 3 and fig. 1 to 3)

II.4.2. *Electra crustulenta* (Pallas)

Colonies of this species were also allowed to grow in culture media containing various concentrations of copper, mercury and cadmium. The results obtained are presented in tables 4 to 6 and figures 4 to 6. This euryhaline species was found not to tolerate copper. The rate of growth was normally low when the environment contained 10 to 20 ppb of copper. Only in those culture media contained 5 ppb of copper there was perseviable growth during the duration of the experiment. Growth was very slow and retarded in the case of those colonies which encountered 20 ppb of copper in the culture medium.

Low levels of mercury (5 ppb) did not reduce the growth of *E. crustulenta* for 8 days. Normal growth was recorded in all colonies maintained in culture media containing mercury from 5 to 20 ppb during the initial phase of the experiments. Retardation of growth happened in the colonies which were kept in media containing 10 and 15 ppb of mercury after the fourth day. None of the colonies exposed to 20 and 25 ppb of mercury grew after four days (See table 5 and figure 5).

TABLE 4

EFFECT OF COPPER ON THE SPECIFIC GROWTH RATE (K) OF *ELECTRA CRUSTULENTA* (PALLAS) ALONG WITH THE RESPECTIVE PERCENTAGE OF THE CONTROL VALUES

Conc. of copper (ppb)	Time (Days) 4	8	12	16	20
5	0.4023 (81.7%)	0.1971 (59.0%)	0.0852 (87.9%)	0.0768 (188.9%)	0.0528 (163.4%)
10	0.3864 (78.4%)	0.1905 (57.0%)	0.0560 (57.8%)	0.0483 (55.9%)	0.0477 (57.3%)
15	0.2479 (50.3%)	0.1732 (51.9%)	0.0515 (53.0%)	0.0452 (52.3%)	0.0309 (37.1%)
20	0.1023 (20.7%)	No growth	0.0455 (49.9%)	No growth	No growth
Control	0.4923	0.3337	0.0969	0.0863	0.0832

TABLE 5

EFFECT OF MERCURY ON THE SPECIFIC GROWTH RATE (K) OF ELECTRA CRUSTULENTA (PALLAS) ALONG WITH THE RESPECTIVE PERCENTAGE OF THE CONTROL VALUES

Conc. of mercury (ppb)	4	Time 8	(Days) 12	16	20
5	0.4023 (100%)	0.1971 (100%)	0.0936 (76.0%)	0.0557 (30.2%)	0.04558 (92.6%)
10	0.3465 (86.0%)	0.1027 (52.1%)	0.0919 (74.6%)	0.0813 (44.1%)	0.0385 (78.2%)
15	0.4023 (100%)	0.0732 (37.1%)	0.0655 (53.0%)	0.0670 (36.3%)	0.0206 (41.9%)
20	0.4023 (100%)	No growth	No growth	No growth	No growth
25	0.1732 (43.0%)	No growth	No growth	No growth	No growth
Control	0.4023	0.1971	0.1231	0.1843	0.04917

TABLE 6

EFFECT OF CADMIUM ON THE SPECIFIC GROWTH RATE (K) OF <u>ELECTRA CRUSTULENTA</u> (PALLAS) ALONG WITH THE RESPECTIVE PERCENTAGE OF THE CONTROL VALUES

Conc. of cadmium (ppb)	4	Time 8	(Days) 12	16	20
50	0.6770 (168.2%)	0.0841 (27.5%)	0.1648 (191.1%)	0.0609 (84.7%)	0.0375 (29.5%)
250	0.6412 (159.3%)	0.1426 (46.6%)	0.0746 (86.5%)	0.0442 (61.4%)	0.0375 (29.3%)
500	0.3465 (86.1%)	0.2027 (66.2%)	0.0919 (106.6%)	0.067 (93.0%)	No growth
750	0.1732 (43.0%)	No growth	No growth	No growth	No growth
Control	0.4023	0.3059	0.0862	0.0719	0.1277

Fig.4

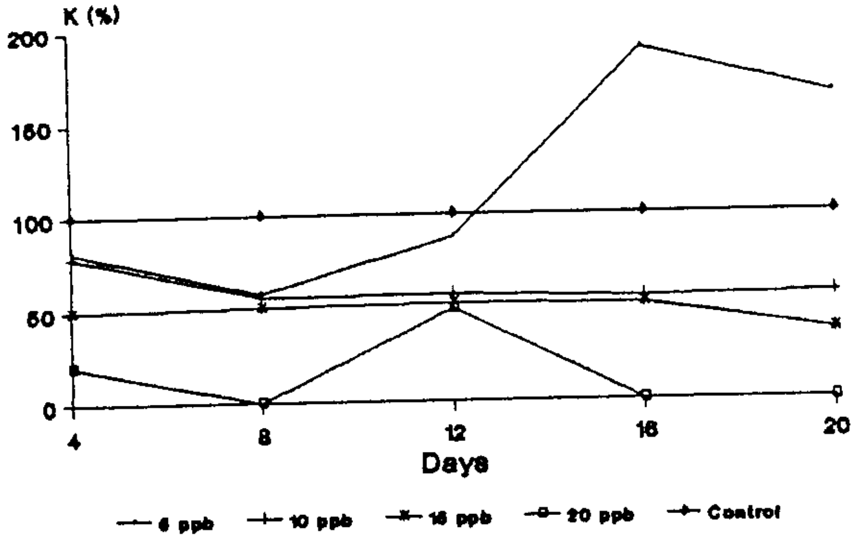


Fig.5

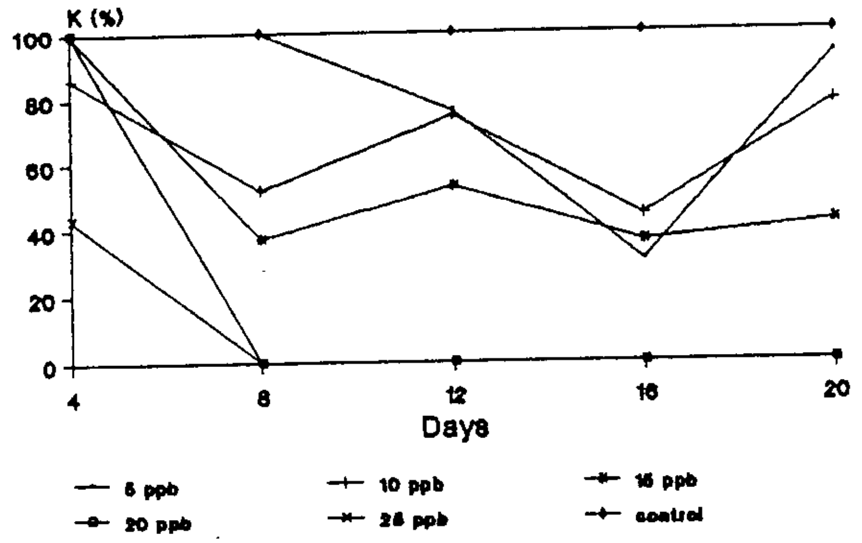
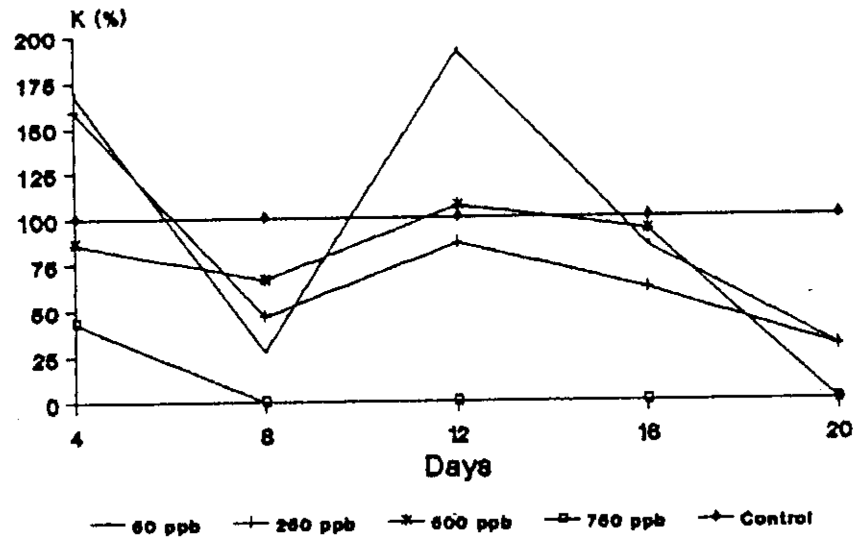


Fig.6



Effect of copper (Fig.4), mercury (Fig.5) and cadmium (Fig.6) on the specific growth rate (k) of <u>Electra crustulenta</u> (Pallas)

The presence of cadmium in the culture medium was found to resuslt in sporadic growth of E. crustulenta. Thus those maintained at 50 and 250 ppb of cadmium, very high growth rate was recorded in the first four days. Presence of 500 ppb of cadmium also did not result in drastic reduction of the growth in colonies, however, no growth was evinced during the final phase of the experiment (16 to 20 days). Presence of 750 ppb of cadmium retarded the growth rate. Colonies maintained in the above medium stopped growing after four days. (See tables 4 to 6 and figures 4 to 6).

II.4.3 Electra bengalensis (Stoliczka)

This is a highly sensitive coastal bryozoan. Presence of copper in the culture medium was found to affect the rate of growth of this animal. Only the presence of 5 ppb of copper did not result in a conspicuous reduction in growth rate of E. bengalensis. Concentrations of copper such as 10, 15 and 20 ppb resulted in retarded growth. None of the colonies which lived in media containing 15 and 20 ppb of copper grew after 12 and 8 days of exposure respectively.

Presence of mercury at 5 and 10 ppb levels did not result in reduced growth of this species. Presence of 20 and 25 ppb of mercury caused cessation of growth of E. bengalensis. The presence of mercury in concentrations ranging from 5 to 25 ppb, curiosly enough did not affect the total cessation of growth during the early phase of the experiment. Upto 12 days all the colonies showed growth activity.

The results obtained or the specific growth of E. bengalensis exposed to cadmium containing media were inconclusive (7 to 9 table and figure).

TABLE 7

EFFECT OF COPPER ON THE SPECIFIC GROWTH RATE (K) OF ELECTRA BENGALENSIS STOLICZKA ALONG WITH THE RESPECTIVE PERCENTAGE OF THE CONTROL VALUES

Conc. of copper (ppb)	4	Time 8	(Days) 12	16	20
5	0.5756 (118%)	0.1013 (58.4%)	0.07192 (94.2%)	0.0455 (124.3%)	0.020 (33.17%)
10	0.4864 (100%)	0.1547 (89.3%)	0.01852 (24.2%)	0.01724 (47.1%)	0.01613 (26.7%)
15	0.4023 (82.7%)	No growth	0.0455 (59.6%)	No growth	No growth
20	0.1732 (35.6%)	0.1732 (100%)	No growth	No growth	No growth
Control	0.4864	0.1732	0.0763	0.0366	0.0629

TABLE 8

EFFECT OF MERCURY ON THE SPECIFIC GROWTH RATE (K) OF <u>ELECTRA BENGALENSIS</u> (STOLICZKA) ALONG WITH THE RESPECTIVE PERCENTAGE OF THE CONTROL VALUES

Conc. of mercury (ppb)	Time (Days) 4	8	12	16	20
5	0.5198 (90.3%)	0.1213 (91.4%)	0.0948 (89.26%)	0.0584 (97.9%)	0.05578 (132.5%)
10	0.4023 (69.8%)	0.1971 (148.6%)	0.0775 (72.9%)	0.03129 (52.5%)	0.0278 (66.5%)
15	0.2746 (47.7%)	0.1732 (130.6%)	0.1277 (120.2%)	0.0238 (39.3%)	No growth
20	0.1732 (30%)	0.0131 (98.7%)	0.0513 (48.3%)	0.0501 (84.0%)	No growth
25	0.2746 (47.7%)	0.0719 (54.2%)	0.0557 (52.4%)	No growth	No growth
Control	0.5756	0.1326	0.1062	0.0596	0.04176

TABLE 9

EFFECT OF CADMIUM ON THE SPECIFIC GROWTH RATE (K) OF _ELECTRA BENGALENSIS_ (STOLICZKA) ALONG WITH THE RESPECTIVE PERCENTAGE OF THE CONTROL VALuES

Conc. of cadmium (ppb)	4	Time 8	(Days) 12	16	20
50	0.4479 (86.1%)	0.2118 (112.4%)	0.0763 (88.5%)	0.03665 (46.0%)	0.03195 (66.4%)
250	0.1732 (33.0%)	No growth	No growth	No growth	No growth
500	No growth	No growth	No growth	No growth	No growth
Control	0.5198	0.1884	0.0862	0.0796	0.04809

Fig.7

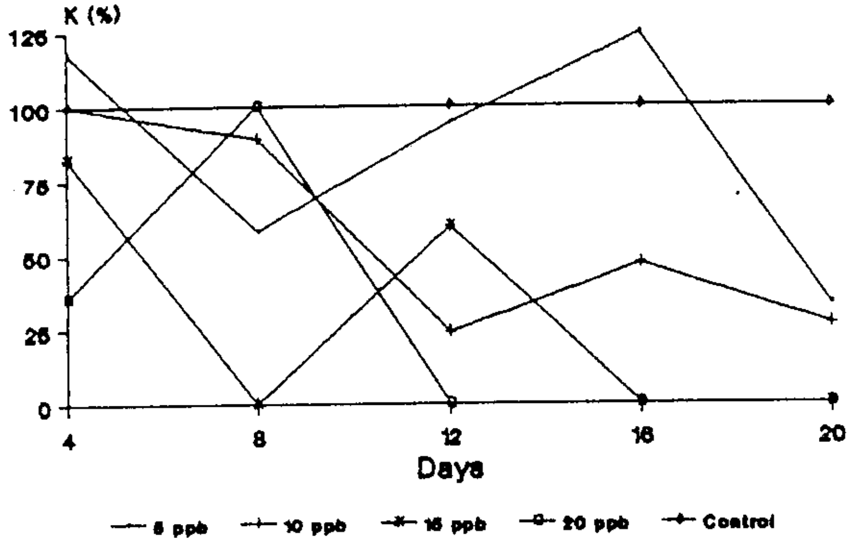


Fig.8

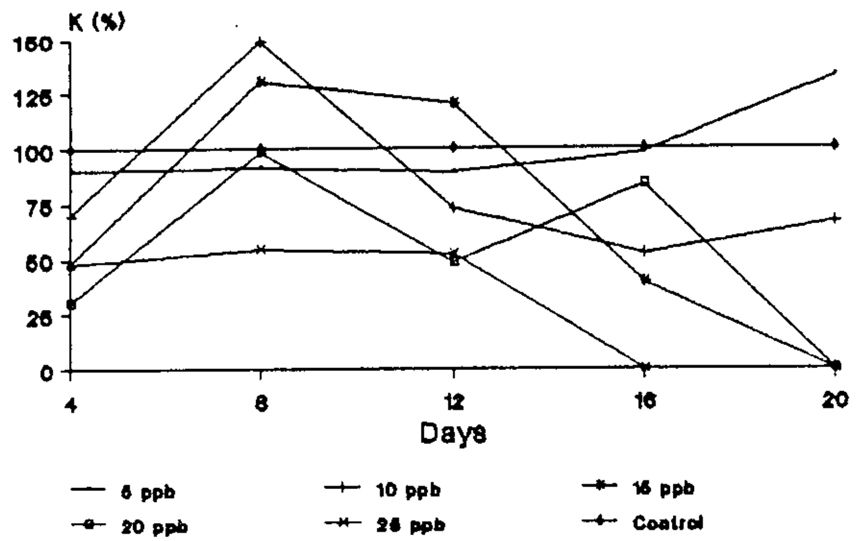
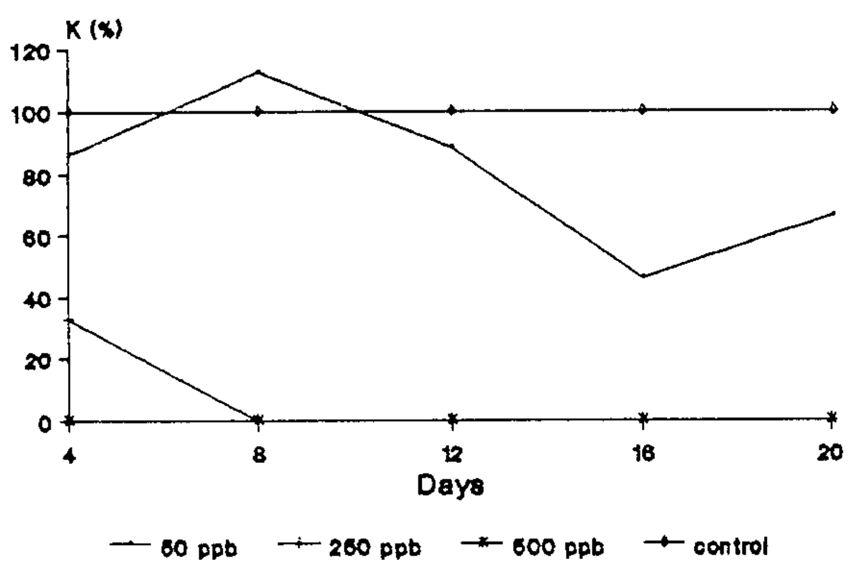


Fig.9



Effect of copper (Fig.7), mercury (Fig.8) and cadmium (Fig.9) on the specific growth rate (k) of Electra bengalensis (stoliczka)

DISCUSSION

II. 5. DISCUSSION

Utilisation of lower marine invertebrates to investigate chronic effects of low level heavy metal pollution has gained momentum in recent years. This is mainly owing to the fact that, culture, maintenance and prolonged observation are possible without the help of extensive water circulatory system and the associated facilities. Since it is understood that the effects of heavy metals will mainly be manifested initially at centers of high physiological activities, examination of tissues associated with basic physiological functions like respiration, excreation and digestion has become the mainstay of investigations on heavy metal pollution. However, it is evident from the available literature that the animals employed for such investigations are mainly hydroids, bivalve molluscs, gastropod molluscs and polychaets. Bryozoans are seldom being used to study the toxic effects. Menon (1974) studied the effects of elevated temperature on growth and food passage time in two bryozoans distributed abundantly in the North Atlantic. He has found that this group of animals offer excellent material to study the growth effect under stress conditions.

It is clear that the animals occuring in estuaries can be grouped under the mesohaline and marine tolerant categories was found that copper and mercury could influence the size and growth of Mytilus edulis, (Boyden, 1977) Ostrea edulis (Boyden 1977). Cerastoderma edule (Boyden, 1974; Bryan & Hummerstone, 1977; Seeligar and Edwards, 1977; Bryan and Uysal 1978).

It was noticed that there could be acceleration, deceleration or cessation in growth rates in the above animals in the presence of mercury or cadmium in the environment or in the culture media. (Bryan and Hummerstone 1977; Seeliger and Edwards, 1977; Boyden, 1974; Boyden 1977; Bryan and Uysal 1978). Changes in growth rates result in animals under pollutional stress owing to various reasons. It is known that the toxic effects of a pollutant starts from subcellular levels affecting basic physiological functions culminating in influencing variations in the energy budgets. Excess energy will be spend for maintenance which result in reduced availability of energy for growth. Structural modifications especially at sub-cellular and cellular levels have been assigned pollutional influences in marine invertebrates (Viarengo *et. al*, 1980, Viarengo, 1985, Mali *et. al*., 1984, Moore 1985, Mary and Menon 1994).

Bryozoans react to environmental stress rather quickly. The rate of asexual reproduction which controls the growth rates of these animals, is highly sensitive to environmental stress. It has been noticed that the common esturine bryozoans living in brackish water conditions stop growing when subjected to minor changes in the different physical environmental parameters (Menon & Nair, 1972).

Victorella pavida which is a typical mesohaline species recorded accelerated growth in the presence of low levels of copper. Total cessation occurred only beyond 16th day in 25 ppb of copper. No structural deformity or variation in the size of the zooids was noticed, in the case of any of the colonies maintained in copper contaminated culture media. Variation in specific growth as a function of time was also interesting in the sense that the continuity in growth could be affected in the case of this ctenostome growing in a copper contaminated environment. Of the three metals employed cadmium seems to be the least toxic to V. pavida and mercury the most toxic. In the case of Bugula neritina, a cosmopolitan bryozoan, the rate of growth was found to decrease, when the culture medium contained more than 100 ppb of copper. Further, the development of polypides was found to be very slow resulting in deformed polypides (Miller, 1946). In the case of Mytilus edulis copper, mercury and cadmium was found to result in reduced growth at concentrations above 5 ppb of copper, 10 ppb of cadmium and 5 ppb of mercury. The concentrations which were found to influence the growth rate of animals in the open sea were between 0.01 to 0.1 ppb of cadmium (Stromgren ,1982), whereas the present resuslt show that the bryozoans are capable to tolerating higher concentrations and still continue to grow. Another important factor which was noticed in the present instance was the clear cut inter specific in growth rate. The influence of three metals on the growth of three species inhabiting the same habitat varied according to species.

Of the three species Electra bengalensis is relatively more sensitive to the presence of heavy metals. Information on the pollutional effects or bryozoans is limited. Gordon (personal communication) has reported that many bryozoan species are susceptable to heavy siltation,. variations in temperature, availability of food, petroleum hydrocarbons and heavy metals. Bryozoans were completely distroyed and removed when hydrocarbon pollution occurred due to the foundering of Amoco Cadiz in the North Atlantic (d'Hondt, 1980). Many sensitive bryozoans that flourished in the Cochin Harbour area before 1970 disappeared from this region. (Menon, personal communication). Survey conducted during 1991-92 showed that of the 14 species of bryozoans occurring in this area, atleast five have totally disappeared from the Cochin backwaters. The Cochin backwaters experience considerable pollution by the presence of petroleum hydrocarbons and heavy metals.

Information available on the growth of bryozoans show that, growth of these animals could be influenced by various factors. Many physical and chemical parameters affect growth of bryozoan (Gordon 1971; Menon 1972; Hayward and Ryland 1973, Stebbings, 1975, Menon 1975, Jebram and Winston, 1981). Stebbing (1976) working on the effect of heavy metals on the growth of hydroids found that 1.6 ppb of mercury, 10 to 13 ppb of copper and 110 - 280 ppb of cadmium can affect the colonial growth rate of this species. However, he found that after an initial increase in sensitivity, there could be a transistory stimulatory effect of heavy metals on growth rates. This is known as Arndt Schulz Effect. (Schulz 1888). In this connection, it is interesting to note that such effects have been noticed in the case of V. pavida and E. crustulenta. This is very evident in the case of copper and cadmium exposed colonies. The stimulatory effects of low concentrations of copper and cadmium on the growth rate has been assigned to various reasons. Their effect is well illustrated in man by the temporarily stimulatory effect on metabolism of subinhibitory levels of toxicants such as caffeine in coffee and Nicotine in tobacco. Arsenic has been used as a growth stimulant in the diet of poultry, pigs and cattles. In marine organisms number of examples of stimulatory effects of metals have been described. Increased respiratory rates in Gammarus pulex (Jones, 1941) when exposed to mercury, elevated oxygen consumption on chronic exposure to silver by Perna virids (Mathew and Menon, 1984) are examples of stimulatory effects of heavy metals. Bertrand (1962) established that the relation between the concentration of essential trace elements and their physiological function is diphasic and this has been found to apply generally in biological system. However, the Arndt Schulz Effect proposes that an organism is stimulated by a toxic substance, and this stimulation is not the effect of satisfying a deficiency, and the agents which cause these stimulation are not micronutrients and also such stimulatory responses are transistory. These aspects have been well demonstrated in the case of two esturine bryozoans namely V. pavida and E. crustulenta when exposed to copper and cadmium. Although copper is an essential metal to majority of marine animals, cadmium is a non-essential metal to marine organisms. Davies (1974) assumes that temporary stimulatory effect is one aspect of animal's normal homeostatic responses.

The concept of scope for growth proposed by Warren and Davis (1967) based on the assumption that the most important physiological changes associated with contaminant exposure are those that, may adversely affect the organism's growth and survival. There are various physiologiclal indices which are linked to the survial and growth potential of a marine animal and those indices are bio-energetic variables, feeding, digestion and respiration. In the case of bryozoans, none of these indices could be assessed in the present case. However, the reduced growth rate indicate that, all the above indices have been affected. The effect of contaminants on the growth and development of marine organisms have been done mainly in the case of those animals, where delineation and assessment of growth indices are possible (Manley et al. 1984). In majority of such studies the reason for reduced growth have been assigned to inhibition of various rate functions of the animal. In the case of bivalves reduction in filtration rates have been reported as a reason for reduced uptake of food and there by growth, when the animals are exposed to copper (Widdows et al., 1990). In the case of bryozoans reduced growth could also be owing to the direct effect of toxicants on the cells involved in asexual reproduction. Majority of bryozoans have a capacity to stop growth, repair damages etc. On encountering delterious environmental conditions, these animals are capable of even total atrophy of polypides leading to the formation of brown bodies, Which are capable of regeneration. This has been proved in the case of those species when exposed to elevated water temperature (Menon 1974). Since they have very high capacity for regeneration, these animal can always tide over unfavourable environmental conditions. It is possible that prolonged exposure to heavy metals or chronic exposure to a contaminant culture medium would result in total cessation of growth and formation of brown bodies in this animal.

SUMMARY

SUMMARY

This thesis is laid out in two section. The section I dealing with taxonomy and section II toxicology of bryozoans.

The Chapter on Intoduction coming under section I gives information on the nature of material used for the study.

The literature on bryozoans of the world in general and that of Indian and Antarctican waters in particular has been reviewed and presented in the literature survey. The methods employed to study the morphology of bryozoans are detailed out.

The taxonomic section of the thesis presents the list of species, description of species collected from Indian, Maldives and Antarctican Waters. A total number of 70 species have been described, of which 35 are from Indian waters, belonging to the genera Aetea, Antropora, Alderina, Synnotum, Crepis, Reginella, Tremogasterina, Celleporaria, Mucropetraliella, Savignyella, Adeona, Lagenicella, Turbicellepora, Parasmittina, Microporella, Fenestrulina, Schizoporella, Cleidochasma, Schizomavella, Calyptotheca, Codonellina and Rhynchozoon. Six species belonging to the genera Steganoporella, Nellia, Caberea, Scrupocellaria, Parasmittina and Crisia were recorded from Maldives. 29 Antarctic species belonging to the genera Ellisina, Copidozoum Onychocella, Steganoporella, Cellaria, Melicerita, Bugula, Beania, Colletosia, Figularia, Hincksipora, Hippodiplosia, Arthropoma, Reptadeonella, Cellarinella, Fenestrulina, Smittina, Parasmittina, Mucronella, Rhynchozoon, Phidolopora, Tubulipora, Hornera, Plagioecia were described. Remarks on the geographical

distribution of bryozoans recorded from Indian coasts, Maldives and Antarctic waters were also described.

The chapter introduc/tion coming under Section II explains the relevance of toxicological studies of benthic invertebrates especially a species belonging to sedentary communities. Scanty literature avaialable on similar studies are reviewed.

The materials and methods employed for the investigation of toxicology are given in detail. The results of the study are presented along with the discussion. The results obtained have been explained with reference to the information available on the toxicology and the growth of bryozoans or related groups of animals based on laboratory investigations. Literature cited are listed out at the end of the thesis.

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APPENDIX

BIOGEOGRAPHICAL DISTRIBUTION OF BRYOZOANS FROM INDIAN WATERS AND ANTARCTICA

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INTRODUCTION

Bryozoans are aquatic, colonial, sessile invertebrates which comprises about 5,000 living species and about 16,000 fossil species. They are distributed both in marine and freshwater habitats, almost invariably as incrustations or as growth on any substratum.

The study of biogeography of an animal group is extremely important in order to understand their succession and subsistence in a geographical realm where their distribution is substantially influenced by the prevailing environmental conditions. The inherent capacity to tolerate a wide range of abiotic variables has been used in tracing the limits of faunistic distribution in aquatic environs. The tolerance may either be genetic or nongenetic. Genetic irreversible adaptations result in scanty distribution of a population whereas genetic reversible adaptations as in benthic forms, pave way to a wider distribution. Marine bryozoans exhibit a greater degree of abundance and diversity from the shore down to the oceanic regions. However, they are plenty in the shallow waters of the continental shelf. Bryozoan colonies may be encrusting straggling or foliaceous type. Bathymatrically erect bryozoans are more common along the continental shelves whereas in the continental slopes, the encrusting forms dominate.

Hincks (1887) collected seven species of bryozoans from the Mergui Archipelago, which might be first report on their systematics from the Indian subcontinent. Thornely (1907) analysed a collection of bryozoans kept in the Indian Museum, Calcutta and described 81 species including 4 new species, Though Robertson (1921) succeeded in identifying 95 species of bryozoans including three new Membraniporid species from the Bay of Bengal, she could not describe about 80 species in detail. The other works on Indian bryozoa include : Kurian (1950); Daniel (1954); Antony Raja (1959); Menon (1967) Satyanarayana Rao (1975) and Nair (1989). Menon has conducted extensive studies on the taxonomy and ecology of Indian bryozoans (Menon and Nair, 1967b, 1969a, b, c, & 1971, 1972a & c, 1975).

This paper deals with the biogeographical distribution of 108 species which were collected from Indian waters and Antarctican waters.

MATERIALS AND METHODS

The materials for the present study were obtained from the collections made from the shore, inter-tidal, sub-tidal regions of southwest and southeast coasts of India. Specimens were also collected by trawl-net from the neritic areas; by scrapings from rocks and boulders, from littoral algae, underwater structures, stilt roots of mangrove trees and dredged from the sea floor. Glass and wooden test panels employed also provided material for the present study. Corals, shells and sponges dredged from the Gulf of Manaar, oyster beds in Tuticorin, Parangipettai and the Gulf of Kutch were also examined for the collection of materials. A few epizoic forms were collected from crustaceans like crabs and giant prawns. Some species were obtained from the anchors of mechanised fishing trawlers.

RESULTS AND DISCUSSION

The tables (1, 2 & 3) give the details of the biogeographical distribution of 108 species collected from Indian waters. The pattern of distribution, as inferred from the present study in the light of available global literature enables one to draw certain interesting inferences. Three species of bryozoans namely, Electra indica, Alderina arabianesis and Shizoporella cochinensis are now known new to Science. Sixty nine species are recorded for the first time from Indian waters, There are 19 cosmopolitan species represented in the present study which have been previously collected by various workers usually from the hulls of ships or such other floating objects and sea weeds. Thus in the artificial and man influenced agency of dispersal of the bryozoa is further aided by a favourable milieu of sea water and nature of oceanic currents. Eurythermal species would exhibit a greater ability to tolerate over a wide range of sea water temperature enabling them to spread far and wide in the areas of seas and ocean.

The composition in a biogeographical sense, of 108 species is as follows:

12 species represented Ctenostomata, among which the distribution of 4 species is cosmopolitan; 2 species, Indo-pacific; 11 species, Arabian sea and 8 species, Bay of Bengal.

Of the 55 species represented in Cheilostomous anascan bryozoans, the distribution of 10 species is cosmopolitan; 20 species, Indo-pacific; 32 species, Arabian Sea and 36 species, Bay of Bengal.

40 species represented the Cheilostomous ascophoran bryozoans in which the distribution of 5 species is cosmopolitan; 23 species, Indo-pacific; 2 species, Antarctic; 28 species, Arabian sea and 17 species, Bay of Bengal.

Of the 29 species from Antarctica (Table 4) 7% of species represented the Red Sea, 14%, the Atlantic. The occurrence of 85% of species in regions outside the Atlantic is a significant information which clearly supports that the Indian Ocean bryozoans are distinctly distributed mainly in the Indian waters.

Only a single species Crisia elongata represented Cyclostomata which has a distribution in Indo-pacific and in the Bay of Bengal.

Generally, the distribution of bryozoans is achieved either through larval dispersal or by transport by their attachment to the hulls of ships or through other drift objects. Transportation is also possible through epizoic forms such as algae, shells and other floating materials as on "flotsam and jetsam". As the larvae of Membraniporid and Electrid bryozoans are planktonic, surface water currents would play a major role in the dispersal of the species so as to distribute them far and wide to different regions.

Earlier studies indicated that no remarkable similarity exist between the fauna of the Red sea and Indian waters. It is noteworthy that the Gymnolaemates are capable of widespread distribution owing to their greater adaptability. Of the 108 species collected, 90% are Gymnolaemates. Among the whole collection, the distribution of only two ascophoran species, Rhynchozoon tubulosum and Fenestrulina malusi are represented in the Antarctica.

The similarity in species composition between the Indo-Australian Archipelago, the Pacific Ocean and the Red sea on the one hand and the main Indian region on the other hand is worth mentioning. It has been also earlier commented upon for Bryozoa (Menon, 1972). The reason for this similarity can be explained owing to the greater diversity of tropical species and mixing of waters between the Pacific and the Indian Ocean through the Malay region and the straits of Malacca (Swell, 1948), and through the Arabian sea with the Red sea of the sub surface waters and due to the seasonal upwelling. A degree of bryozoan faunal resemblance between these regions (inclusive of the Indian forms) can naturally be expected. This leads to greater changes of dispersal and spread of planktonic larvae as well as the adult bryozoan colonies through the water currents besides their transport through hulls of ships, sea weeds, drift material or as epizoic forms on gastropods, etc. Despite these successful means of 'migration' of species, their very survival in the new environs would primarly depend upon encountering favourable temperature and salinity regime of sea water.

The bryozoan species recorded from Cochin and Parangipettai area showed their peaks of settlement during the summer and premonsoonal seasons. The prevailing circulation pattern during the premonsoon (July-August) in Parangipettai together the southwest drift current associated with the easterly flowing monsoon current (from Africa) washing this coast line and the seasonal upwelling cumulatively play an important role for the recruitment and seasonal transportation of Plankton including bryozoan larvae for their effective settlement during these seasons (Naidu & Krishnamurthy, 1985, Lafond, 1957, 1961).

The meeting of the warm current flowing westwardly, the Mozambique and the cold Atlantic current of the westwind drift, current off the south-west coast of Africa, bring about abrupt changes in, particularly in the sea water temperature (Sewell, 1984), which could affect the distribution of bryozoan larvae in the Arabian sea of India.

Among 29 species of Antarctic bryozoans only 2 were found in Indian Ocean. This clearly supports the view of Winston (1983). She remarked that the bryozoans appear to have had a long history of isolation in the Antarctica. Rogick (1965) recorded 321 species from the Antarctic and sub Antarctic of which 179 are confined to Antarctic waters.

The separation of Australian region and Antarctica by the deep water band and the existence of strong Circum Antarctic current systems hindered the possibility of faunistic resemblance between these regions. Evaluating the fossil record of bryozoa, it is found that there existed a linkage between Australia and Antarctica during the Cretaceous period. Since the bryozoan evolution starts well in advance, it is quite likely that during Cretaceous, the presence of shallow seas existed between Australia and Antarctica would have helped in bryozoan faunal contiguity (Frakes, 1979). The Teritiary deposits ranging from Palaeocene to pliocene in age were rich in bryozoans. The shifting of Australia and New Zealand into the middle latitudes and opening of Circum Antarctic circulation culminated in the elimination of many bryozoans owing to the impact of Indo-Pacific immigrants and physicochemical variations in the environment. This process ultimately affected the bryozoan population in Southern Indian Ocean and Australian region.

Table 1. Geographical distribution of Indian bryozoans: Ctenostomata and Cyclostomata

No.	Species	ENDEMIC A.S	B.B	C.P.	I.P.	ANT
CTENOSTOMATA						
1.	*Alcyonidium erectum*	+				
2.	*Alcyonidium polyoum*	+	+	+		
3.	*Victorella pavida*	+	+	+		
4.	*Nolella papuensis*	+			+	
5.	*Vesicularia papuensis*	+	+		+	
6.	*Amathia distans*	+	+			
7.	*Amathia convoluta*	+	+	+		
8.	*Zoobotryon verticillatum*		+			
9.	*Bowerbankia gracilis*	+	+	+		
10.	*Triticella korenii*	+				
11.	*Triticella pedicellate*	+				
12.	*Aeverrillia setigera*	+	+			
CYCLOSTOMATA						
1.	*Crisia elongata*		+	+		

A.S = Arabian Sea; B.B = Bay of Bengal; C.P = Cosmopolitan

I.P = Indo-Pacific; ANT = Antarctic

Table 2 Geographical distribution of Indian bryozoans : Cheilostomata - Anasca

No.	Species	ENDEMIC A.S	ENDEMIC B.B	C.P.	I.P.	ANT
1.	Aetea anguina	+		+		
2.	Aetea ligulata	+			+	
3.	Membrainpora amoyensis	+				
4.	Membrainpora savartii	+	+	+		
5.	Membrainpora perfragilis		+			
6.	Membranipora tuberculata		+			
7.	Membrainpoora villosa		+			
8.	Electra crustulenta	+	+		+	
9.	Electra bengalensis	+	+		+	
10.	Electra indica	+				
11.	Electra bellula		+			
12.	Electra pilosa		+	+		
13.	Electra tenella		+	+		
14.	Electra crustulenta arctica		+			
15.	Conopeum reticulum	+	+	+		
16.	Conopeum commensale	+	+			
17.	Conopeum eriophorum	+			+	

A.S = Arabian Sea; B.B = Bay of Bengal; C.P = Cosmopolitan

I.P = Indo-pacific;ANT = Antarctic

Table 2 (Contd.)

No.	Species	ENDEMIC A.S	ENDEMIC B.B	C.P.	I.P.	ANT
18.	*Conopeum seurati*		+			
19.	*Caleschara levensenii*	+			+	
20.	*Caleschara mexicana*	+				
21.	*Crassimarginatella kumatae*	+				
22.	*Cupuladria indica*	+			+	
23.	*Antropora erecta*	+			+	
24.	*Antropora granulifera*	+		+		
25.	*Alderina arabianesis*	+	+			
26.	*Parellisina curvirostris*	+	+		+	
27.	*Thalamoporella rozierii*	+	+		+	
28.	*Thalamoporella hamata*		+		+	
29.	*Thalamoporella gothica* var. *indica*		+		+	
30.	*Thalamoporella stapifera*		+			
31.	*Labioporella sinuosa*		+			
32.	*Smittipora abyssicola*		+		+	
33.	*Nellia oculata*	+	+		+	
34.	*Nellia tenella*		+		+	
35.	*Spiralaria serrata*		+			

A.S = Arabian Sea; B.B = Bay of Bengal; C.P = Cosmopolitan

I.P = Indo-pacific;ANT = Antarctic

Table 2 (Contd.)

No.	Species	ENDEMIC A.S	ENDEMIC B.B	C.P.	I.P.	ANT
36.	*Tricellaria peachii*		+			
37.	*Scrupocellaria maderensis*	+			+	
38.	*Scrupocellaria obtecta*	+				
39.	*Scrupocellaria mansueta*		+		+	
40.	*Scrupocellaria diadema*	+	+	+		
41.	*Scrupocellaria scruposa*	+		+		
42.	*Scrupocellaria spatulata*		+		+	
43.	*Scrupocellaria delilii*	+				
44.	*Scrupocellaria bertholetii*		+	+		
45.	*Scrupocellaria talonis*		+			
46.	*Synnotum aegyptiacum*		+	+		
47.	*Bugula neritina*	+	+	+		
48.	*Bugula robusta*	+	+			
49.	*Bugula flabellata*		+			
50.	*Bugula plumosa*	+				
51.	*Bugula cucullata*	+				
52.	*Bugula crosslandi*	+	+			
53.	*Bugulella clavata*		+		+	
54.	*Crepis verticillata*	+			+	
55.	*Reginella mattoidea*	+				

A.S = Arabian Sea; B.B = Bay of Bengal; C.P = Cosmopolitan

I.P = Indo-pacific;ANT = Antarctic

Table 3. Geographical distribution of Indian Bryozoans : Cheilostomata: Ascophora

No.	Species	ENDEMIC A.S	ENDEMIC B.B	C.P.	I.P.	ANT
1.	*Celleporaria aperta*		+		+	
2.	*Celleporaria pilaefera*		+		+	
3.	*Celleporaria granulosa*		+		+	
4.	*Tremogasterina granulata*		+			
5.	*Tremogasterina lanceolata*	+				
6.	*Tremogasterina ventricosa*		+			
7.	*Mucropetraliella philippinensis*		+		+	
8.	*Savignyella lafontii*	+	+	+		
9.	*Adeona foliacea*	+			+	
10.	*Lagenicella punctualata*	+			+	
11.	*Turbicellipora redoutei*	+	+		+	
12.	*Parasmittina signata*	+				
13.	*Parasmittina tubula*		+			
14.	*Parasmittina elongata*		+			
15.	*Parasmittina parsevalii*	+	+		+	
16.	*Parasmittina aviculata*	+				

A.S = Arabian Sea; B.B = Bay of Bengal; C.P = Cosmopolitan

I.P = Indo-pacific;ANT = Antarctic

Table 3 (Contd ...)

No.	Species	ENDEMIC A.S	B.B	C.P.	I.P.	ANT
17.	*Parasmittina egyptiaca*	+			+	
18.	*Parasmittina tropica*	+			+	
19.	*Parasmittina californica*	+				
20.	*Parasmittina projecta*	+				
21.	*Microporella orientalis*	+	+		+	
22.	*Microporella ciliata*	+		+		
23.	*Fenestrulina malusii*	+		+		+
24.	*Hippopodina feegeensis*	+		+		
25.	*Hippopodina californica*	+				
26.	*Shizoporella unicornis*	+			+	
27.	*Shizoporella cochinensis*	+				
28.	*Cleidochasma biavicularium*	+			+	
29.	*Cleidochasma flallax*	+			+	
30.	*Shizomavella inclusa*	+			+	
31.	*Shizomavella linearis var. inarmata*	+				
32.	*Clayptotheca tenuata*	+			+	
33.	*Claypotheca parcimunita*		+		+	

A.S = Arabian Sea; B.B = Bay of Bengal; C.P = Cosmopolitan

L.P = Indo-pacific;ANT = Antarctic

Table 3 (Contd.....)

No.	Species	ENDEMIC A.S	B.B	C.P.	I.P.	ANT
34.	*Codonellina montferrandii*	+				
35.	*Watersipora subovoidea*	+		+	+	
36.	*Triphyllozoon tubulatum*		+		+	
37.	*Rhynchozoon compactum*	+	+		+	
38.	*Rhynchozoon tubulosum*	+			+	+
39.	*Rhynchozoon larreyi*		+		+	
40.	*Rhynchozoon globosum*		+		+	

A.S = Arabian Sea; B.B = Bay of Bengal; C.P = Cosmopolitan

L.P = Indo-pacific;ANT = Antarctic

Table 4 : Bryozoa from Antarctican waters

ANTARCTIC BRYOZOANS

1. ELLISINA LEVATA
2. COPIDOZOUM SPINATUM
3. ONYCHOCELLA SP
4. STEGANOPORELLA MANDIBULATA
5. CELLARIA PUNCTATA
6. CELLARIA PRAELONGA
7. CELLARIA SP a
8. CELLARIA SP b
9. MELICERITA OBLIQUA
10. BUGULA sp
11. BEANIA MAGELLANICA
12. COLLETOSIA RADIATA
13. FIGULARIA sp.
14. HINCKSIPORA sp.
15. HIPPODIPLOSIA PERTUSA
16. ARTHROPOMA CECILI
17. REPTADEONELLA PLAGIPORA
18. CELLARINELLA LAYTONI
19. CELLARINELLA sp
20. FENESTRULINA MALUSII
21. SMITTINA ARCTICA
22. SMITTINA sp
23. PARASMITTINA sp
24. MUCRONELLA LABIATA

25. RHYNCHOZOON TUBULOSUM

26. PHIDOLOPORA AVICULATUM sp. nov.

27. TUBULIPORA FLEXUOSA

28. HORNERA PINNATA

29. PLAGIOECIA PATINA

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