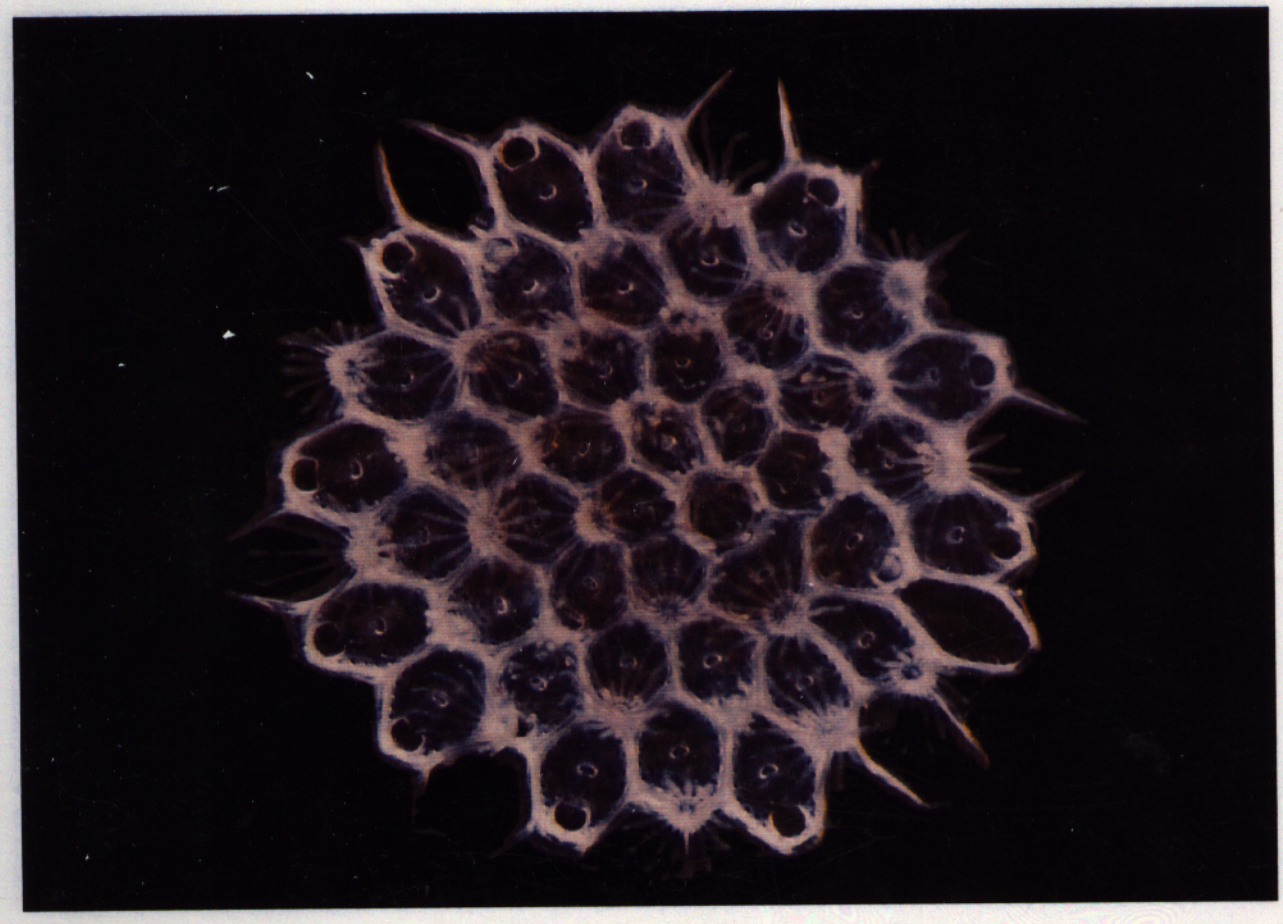
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MMS 95-0064

Taxonomic Atlas of the Benthic Fauna of the Santa Maria Basin and Western Santa Barbara Channel

FINAL REPORT
Volume 13 of 14

The Bryozoa



U.S. Department of the Interior
Minerals Management Service
Pacific OCS Region

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TAXONOMIC ATLAS OF THE BENTHIC FAUNA OF THE SANTA MARIA BASIN AND WESTERN SANTA BARBARA CHANNEL

FINAL REPORT
Volume 13 of 14

The Bryozoa

Edited by:

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For:

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Minerals Management Service
Pacific OCS Region
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DISCLAIMER

This report has been reviewed by the Pacific Outer Continental Shelf Region, Minerals Mangement Service, U.S. Department of the Interior and approved for publication. The opinions, findings, conclusions or recommendations expressed in this report are those of the authors, and do not necessarily reflect the view of the Minerals Management Service. Mention of trade names does not consitiute endorsement or recommendation for use. This report has not been edited for conformity with Minerals Management Service editorial standards.

TAXONOMIC DISCLAIMER

This report is not deemed nor intended to be a valid publication for the naming of new taxa as stipulated in the International Code of Zoological Nomenclature, Article 8b.

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BACKGROUND: The Taxonomic Atlas of the Santa Maria Basin and western Santa Barbara Channel is an extension of the benthic reconnaissance (Phase I) and monitoring programs (Phase II) that were conducted by the MMS since 1983. The organisms that were collected as part of those programs provide the material on which the Atlas is developed. In order to fully document the fauna collected by those programs, a series of 14 volumes will be prepared that provide keys, descriptions, and illustrations of the benthic fauna of the hard and soft substrate environments. A team of 40 experts on the fauna has been assembled to carry out this work and their contributions are distributed among the 14 volumes.

OBJECTIVES: The objectives of Volume 13 are to provide keys, descriptions, and illustrations to the bryozoans of the Santa Maria Basin and western Santa Barbara Channel.

DESCRIPTION: This compilation of the Bryozoa from the Santa Maria Basin and western Santa Barbara Channel is the first major survey of this fauna since the monographs by Raymond Osburn (1950-1953). The present work consists of an introduction which discusses the morphology and taxonomy of marine bryozoans and includes a glossary and taxonomic key, followed by species descriptions arranged phylogenetically. This survey extends the geographic ranges of some species previously thought restricted either to localities further north, such as Puget Sound, or further south, such as Mexico and Central America. A total of 128 species are figured by multiple scanning electron micrographs. Of these 44 species were identified as new to science and are described herein. Five new genera in the Cheilostomata: Ascophora and one new genera in the Cyclostomata are also described. Groups of marine byrozoa not covered in the present study include the Ctenostomata and the cyclostome families Lichenoporidae and Heteroporidae.

SIGNIFICANT CONCLUSIONS: The keys, detailed descriptions, and illustrations to the 124 species treated in this volume represent a major contribution to bryozoan systematics for the eastern Pacific. Many poorly known species are newly defined with new illustrations. The use of the scanning electron microscope to illustrate these species has provided the means to not only update older descriptions, but also to provide a mechanism to resolve fine details of morphology permitting identification of heretofore unrecognized species.

STUDY RESULTS: The fauna of the Santa Maria Basin and western Santa Barbara Channel is evaluated from samples that were taken from depths of about 50 to 1,000 m. Organisms were collected from soft sediments using box cores and from rocks using manipulator arms of submersibles and remotely operated vehicles. The collections are organized into sets of vouchers from Phase I and II that have been made available to the team of investigators. Additional material from the bulk collections now archived with the Natural History Museum of Los Angeles County is also being examined. The total number of species treated in the entire Taxonomic Atlas (14 volumes) may exceed 1,000 species.

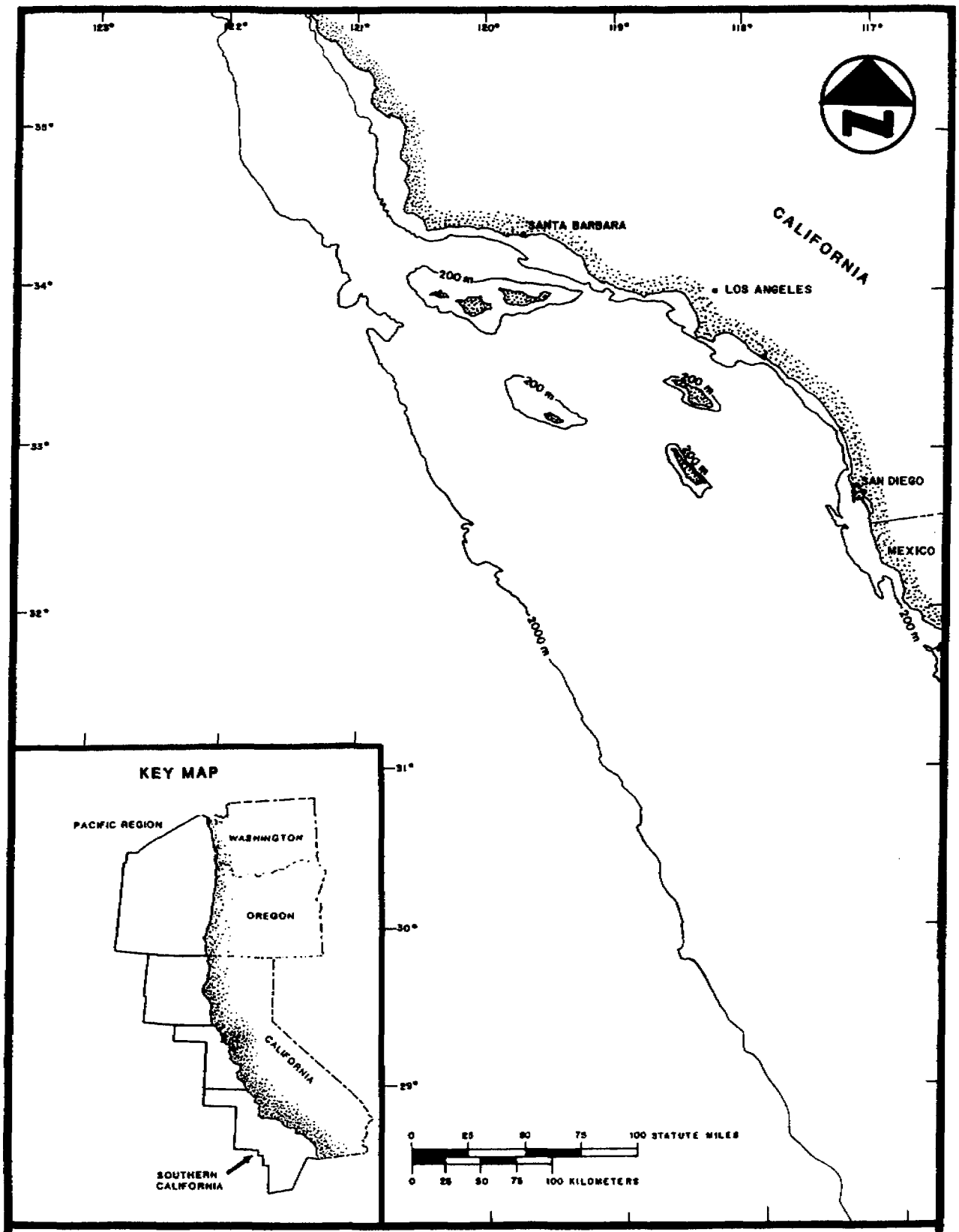
A total of 124 bryozoan species in 57 genera and 30 famlies are treated as part of volume 13. The scope of this volume includes materials from the MMS surveys as well as additional materials from the eastern Pacific accumulated by the authors over many years. The authors have also examined numerous type specimens of problematic species and along with the collections treated have produced a monograph that will be applicable to the marine environment of western North America. In this regard, the volume becomes the most important compilation of data on eastern Pacific bryozoans since the monographs of Osburn were published in the early 1950s. In addition to being an important taxonomic contribution, this study is a valuable contribution to understanding the distribution and zoogeography of bryozoans in the eastern Pacific. The ranges of many species are extended; others restricted.

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This compilation of the Bryozoa from the Santa Maria Basin and western Santa Barbara Channel is the first major survey of this fauna since the monographs by Raymond Osburn (1950-1953). The present work consists of an introduction which discusses the morphology and taxonomy of marine bryozoans and includes a glossary and taxonomic key, followed by species descriptions arranged phylogenetically. This survey extends the geographic ranges of some species previously thought restricted either to localities further north, such as Puget Sound, or further south, such as Mexico and Central America. A total of 128 species are figured by multiple SEM micrographs. Of these 44 species were identified as new to science and are described herein. Five new genera in the Cheilostomata: Ascophora and one new genera in the Cyclostomata are also described. Groups of marine byrozoa not covered in the present study include the Ctenostomata and the cyclostome families Lichenoporidae and Heteroporidae.

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LIST OF ACRONYMS

AHF	Allan Hancock Foundation, University of Southern California.
BMNH	British Museum (Natural History); now The Natural History Museum, London.
BRA	Refers to a station designation from the MMS Phase I Reconnaissance: Benthic Rocky, transect A/B.
BRC	Refers to a station designation from the MMS Phase I Reconnaissance: Benthic Rocky, transect C/D.
CAS	California Academy of Sciences, San Francisco.
MMS	Minerals Management Service, U. S. Department of the Interior.
SBMNH	Santa Barbara Museum of Natural History, Santa Barbara, California
USNM	United States National Museum, Smithsonian Institution.

THE BRYOZOA

by

Dorothy F. Soule[1], John D. Soule[1] and Henry W. Chaney[2]

1. INTRODUCTION

The Bryozoa are sessile, colonial organisms that inhabit all seas from intertidal to abyssal depths. Although a few species occur in brackish or fresh water, there are probably about 6,000 living marine species and many more fossil species, which have an extensive record, especially in the Paleozoic Era. Bryozoans are frequently overlooked because individual members (zooids) in a colony are generally less than a millimeter in length, although colonies may form patches averaging 7-10 centimeters in diameter on suitable flat substrates or may rise from the substrate in stolonate, arborescent or foliate colonies. Fossil colonies were much larger and some were capable of forming reefs. Modern species have an important role in the stabilization of coral and algal reefs by forming protective coatings or energy reducing surficial mats and tufts. Colony form is not necessarily a valid taxonomic criterion for species identification, since some species are capable of forming recumbent colonies under turbulent water conditions and arborescent ones in calmer waters. Encrusting colonies are often mistaken for colonial tunicates or sponges, while erect colonies often resemble hydroids or algae. The details of external structures, on which most taxonomic decisions are based, are sometimes only a few micrometers in size, making identifications difficult without good light microscopy or scanning electron microscopy (SEM).

Phylogeny and Ontogeny

Bryozoa are usually included in the lophophorate phyla, along with the less diverse Phoronida and Brachiopoda. These three phyla are adapted to a sessile adult stage by the use of a crown of hollow (coelomate), ciliated tentacles which direct food into the terminal mouth by generating water currents. They feed on algal detritus, or on bacteria coating the detritus, and on nanoplankton (protists, algal spores, etc.), although they have been known to capture larger prey such as tiny worms and crustaceans (authors' observations). The lophophore can be withdrawn into the body cavity as an introvert, thus protected, at least partially, from external predation. The introvert is still technically outside, exposed to seawater, but is depressed into the body so that body wall can be closed over it by a "purse string" closure or a lidlike operculum.

The lophophorates seem to form an intermediate group in evolution between the annelid-arthropod line of invertebrates, or protostomes, and the primitive line leading to deuterostomes, the chordate lineage. Phylogenetic relationships are often more easily revealed in the first stages of life, as the ovum undergoes cleavage and begins to organize into various tissue layers of the organism, than in the adult stages in which adaptations to life style and habitat are dominant. In the protostomes, cleavage is spiralian, formation of the internal lining of the coelom is determined by a single cell, and the blastopore (the protostome or "first mouth") of the developing ovum becomes the larval mouth. If the first four cells are separated mechanically, only one quarter of an animal will begin to develop. In deuterostomes, cleavage is radial, formation of the mesoderm is not determined by a single cell, the blastopore becomes the anus and the mouth is formed elsewhere ("other mouth"). If the first four cells are separated, each cell will develop a complete animal.

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The Bryozoa are unique in having biradial cleavage, in which the first eight cells are aligned in two rows, forming an oblate, not a round, spheroid. If the first four cells are separated mechanically, all may develop into individual larvae; however, in some of the Stenolaemata (Cyclostomata), natural fission may continue until there are many identical larvae. The fate of the blastopore in the Bryozoa is obscured by dissolution of the internal cells in the larva.

Adult bryozoans are usually hermaphroditic, but may be sequentially so, which would prevent self-fertilization, although there is some evidence that self-fertilization does occur in some species. A few species have male and female individuals. All species reproduce asexually as well, by budding, which produces isogenous colonies from a single, sexually produced larva. Larvae of some species are planktonic, providing substantial numbers to the meroplankton, which is composed of invertebrate larvae that settle out of the plankton on metamorphosis. A few bryozoan species have fairly long-swimming larvae, with bivalve, triangular shaped shells, called **cyphonautes**, perhaps the most primitive type, while other shelled larvae are non-feeding. Still other larval types are coronate, but vary by having a ciliate corona restricted to a band or spread over almost the entire surface, although they all share a common suite of morphological characters (Zimmer and Woollacott, 1977). Most coronate larvae swim only long enough to test for a suitable substrate. These larval types do not conform to family groupings of species based on adult morphologies, perhaps due to differences in selection pressures on larvae as compared to adults. In some species where the larvae are brooded until maturity, the larvae simply exit the parental zooid and settle on the adjacent surface, be it the parent colony or another substrate, and resemble miniature adults.

Higher Taxa

The Phylum Bryozoa was divided into the Classes Entoprocta and Ectoprocta in older literature, and a few present day investigators still treat them as such, but most consider the two taxa as separate phyla. The Bryozoa were also called Polyzoa, mostly in some of the British literature. The Entoprocta were placed in the Bryozoa largely because they are small, occupy some of the same habitats, are superficially similar to some of the soft bodied Ectoprocta, and often just because the same investigators worked on both groups. Since the publication of Hyman (1959), most authors have separated the two groups at phylum level; Nielsen (1977) discussed the characteristics shared by the two groups and favors a closer relationship. Some authors refer to Entoprocta as Kamptozoa. These various names may be encountered in invertebrate textbooks as well.

In the Entoprocta the tentacle crown cannot be withdrawn into the body cavity; rather, it consists of a calyx atop a stalk and the tentacles are rolled inward toward the center of the calyx when contracted. Tentacles are not hollow, but are filled with mesenchyme. Because of the sessile mode, the mouth and anus are both on the calyx, and both openings are within the tentacle circle; hence the name *ento* -, inside, and -*procta*, referring to the anus.

In the Ectoprocta, the lophophore can be retracted, and the anus lies outside the circle of tentacles surrounding the mouth (*ecto*-, outside, -*procta*, anus). Hyman (1959) advocated eliminating the name Bryozoa and elevating the Ectoprocta to phylum status, but most authors reverted to the term Bryozoa for Ectoprocta within a few years, in large part because of the formation of the International Bryozoology Association. Researchers in the group have published a series of I.B.A. symposium volumes (Annoscia, 1968; Larwood, 1973; Pouyet, 1975; Larwood and Abbott, 1979; Larwood and Nielsen, 1981; Nielsen and Larwood, 1985; Ross, 1987; Bigey and d'Hondt, 1991; Hayward, Ryland and Taylor, 1994). Hyman's volume stands as the most comprehensive review of the Ectoprocta in existence, although some aspects, such as structural development, have been more exhaustively described in Boardman et al., (1983). Woollacott and Zimmer (1977) present an overview of morphology, physiology, reproduction and habitat. For less rigorous detail, a number of invertebrate textbooks summarize the general features of the Bryozoa, such as Barnes (1987),

Brusca and Brusca (1990), and Ruppert and Barnes (1994).

The living marine species of the Class Gymnolaemata, which are the most numerous, and the less numerous Class Stenolaemata, all have a circular lophophore, while most freshwater species in the Class Phylactolaemata have a horseshoe-shaped lophophore. The bryozoan lophophore is extruded slowly by complex musculature that makes use of hydrostatics. In the Anasca, the exposed ventral (frontal) surface bears an uncalcified frontal membrane and the subterminal aperture (orifice). The frontal membrane is contracted against the coelomic fluid and complex digestive tract, helping to force the lophophore out. In some of the Ascophora, a membranous sac (ascus) underlying the calcified frontal membrane (frontal wall or shield) accomplishes the same action. Retraction is extremely rapid; muscles controlling the membranous frontal, or the ascus beneath the calcified frontal wall, relax and retractor muscles pull the digestive tract and lophophore (the polypide) inside. Extrusion of the lophophore is often slower. The mode of eversion in cyclostomes (Stenolaemata) is more complex and less clear (Taylor, 1981).

The members of the Class Stenolaemata, with only extant members of the Order Cyclostomata (= Tubuliporata), are composed of calcified tubular individual zooids with terminal apertures and may have individuals modified as brood chambers (gonozooids) or a communal chamber for a number of individuals. This class has an extensive fossil record with some 500 genera, but the living genera are few. The extinct Stenolaemata, including some Cyclostomata, have a fossil record extending to the Ordovician (McKinney and Jackson, 1989).

The Class Gymnolaemata is usually divided into soft bodied, tubular species of the Order Ctenostomata, which have a sparse fossil record due to their lack of calcification, and the partly or fully calcified species of the Order Cheilostomata. The certain fossil Ctenostomata from the Paleozoic are those which penetrated shell to form colonies, leaving molds or spaces that can be molded. The Recent penetrating and non-penetrating genera date from the mid-Jurassic (Boardman et al., 1983) and Cretaceous (e.g., Voigt, 1968, 1973; Voigt and J. Soule, 1973). Recent southern California forms are discussed in Soule (1953) and J.D. and D.F. Soule (1969, 1976 a, b). No Ctenostomata were collected in the MMS surveys and no ctenostome specimens available in the AHF Collections were suitable for SEM. The Cheilostomata are the most successful of the modern groups, with a less ancient fossil record, dating from the Jurassic; they are lightly or heavily calcified with subterminal apertures closed by a modification of the frontal membrane, the operculum.

In the literature, the Order Cheilostomata has usually been divided into the Suborder Anasca, with uncalcified frontal membranes often bordered by spines, and Suborder Ascophora, with the frontal wall protected by calcification, with or without pores and with spines, if present, confined usually to the apertural region. A third group, members of the Cribrilinidae and related families, were included in the Anasca in older literature, and later placed in the Ascophora. More recently they have been separated as the Suborder Cribrimorpha, because of their different approach to protecting the frontal membrane by fusing the spines above the membranous frontal into a frontal shield. The space between the shield and the frontal membrane creates a hydrostatic space similar to the ascus.

The major factors on which division into classes, orders and suborders are based is presented below in the Key to the Higher Taxa.

Structure

The study of Bryozoa has been afflicted by a proliferation of morphological terminology which may may appeal to the elitism or erudition of some authors but serves only to confuse those seeking just to identify specific taxa.. It will be noted that we have included some terms herein that may now be considered obsolete. However their discussion is important because they will be encountered in the cited literature.

The colony (**zoarium**) is a functional grouping composed of tubular or boxlike individual units (**zooecia**). The zooecium is technically only the external wall or exoskeleton, whereas the term **zooid** (= **zoid**) includes the soft parts and exoskeleton. In specimens prepared for microscopy with sodium hypochlorite (bleach) to remove the soft parts, the zooecium is the remaining structure, although it is commonly referred to as the **zooid** (many authors wish to use the terms **colony** and **zooid** exclusively but the terms **zooecium/ zooecia** are common in the literature). In the Ctenostomata, the tubular zooids may be arranged along modified non-feeding individuals (**stolonate**), or they may be arranged contiguously in a gelatinous matrix (**carnose**). In the Cheilostomata, the zooids are box like, lightly or heavily calcified, with the aperture subterminal on the **frontal (ventral) wall (frontal shield)**. The zooids may be arranged uniserially or in multiserial branches, or in sheetlike, encrusting or foliate colonies.

In ctenostomes, the opening for the extrusion of the mouth and tentacles (**aperture**) is closed by a muscular contraction that gives a purse-string appearance, but in the cheilostomes the subterminal aperture is closed by an **operculum**, either formed as a continuation of the **frontal membrane** or derived from it. The **lophophore** consists of the mouth and hollow, ciliated tentacles surrounding it, and the **introvert**, the portion of the body wall and musculature that is extended when the tentacles are extended or becomes hidden when they are withdrawn. The digestive tract is U-shaped in deference to the sedentary lifestyle, and complex, consisting of an esophagus, sometimes a gizzard, a stomach and intestine. Together with the reproductive organs, the lophophore and digestive tract comprise the soft parts known as the **polypide**. The soft tissues lining the calcareous walls are known as the **cystid**. The **funiculus** is a mesenchymous cord of tissue which acts as a combined nerve pathway and nutrient transport system for the zooids and colony. In cheilostomes the funiculus is connected interzooidally by club shaped cells through pores or pore plates in the lateral and transverse walls, and connects to the base of the polypide. Bryozoa have no excretory organs but provide for external dissolved nutrients and gaseous exchanges through the ciliated tentacles and exposed membranes. When metabolic wastes accumulate in the body cavity, some species include them in a **brown body** formed of a degenerating polypide, which may remain in the body cavity or, if that individual is to remain alive in the colony, be surrounded by a new stomach and evacuated when a new polypide is generated from the cystid.

The individual **zooids** (pronounced 'zo-ids' by Americans and 'zoo-ids' by the British) containing feeding polypides are known as **autozooids,** whereas **heterozooids** are zooids modified for various other functions. **Kenozooids** are essentially space fillers to allow for irregular substrates and expansion of rows or crowding, or acting as anchors or stalks (**rootlets, rhizoids, radicles**). **Avicularia** (singular, avicularium) are zooids that are modified with pincer-like chitinous mandibles for protection and/or cleaning of the colony and do not usually contain a feeding polypide, although avicularia may have evolved from autozooids that developed a toothed operculum. **Ovicells** are reduced heterozooids budded at the end of fertile zooids and modified to provide brood chambers which receive the ova produced within the body cavity. In some species ova maybe extruded through an intertentacular pore in the lophophore while in others the polypide dies and the ovum is released through the aperture into the ovicell. Other heterozooids include modified avicularia with the mandibles becoming whiplike **vibracula**. A chitinous cuticle (**ectocyst**) covers the exterior of the calcareous colonies, which obscures many features. It can usually be removed by sodium hypochlorite (bleach), but care must be taken not to dissolve algal substrates or the chitinous connections that hold some colonies together. The cuticle also forms the operculum and avicularian mandibles. It is a noncellular layer composed of glycosaminoglycans (mucopolysaccharides) linked with a protein core (positive Periodic Acid Schiff test), as is chitin in arthropods and other invertebrates.

The general structural characters discussed above and used in the taxonomic descriptions are illustrated within the Glossary. External morphology generally provides the significant characters for taxonomic determinations, since usually aspects of the internal anatomy are not available in collected materials. Generally the internal parts are quite similar throughout the Bryozoa, although species may differ in such aspects as the number of tentacles, presence and nature of the gizzard, the musculature and reproductive structures. Materials must be immediately preserved in the field, preferably in buffered formalin, to permit the making of whole mounts or histological sectioning.

Oceanographic Influences

Until a few decades ago, northeastern Pacific waters were considered to consist mainly of cool temperate currents originating in the Gulf of Alaska and flowing southward along the coast to become the California Current. In this scenario, organisms that colonized cooler shallow waters in the north might occur at greater, cooler depths in the warm temperate zone beginning somewhere off central California. Warm temperate waters would extend southward until mixed with subtropical and tropical equatorial waters between southern California, Mexico and Central America. The biotic provinces were considered to be rather stable along the temperature gradient.

It has been known for years that subtropical waters flow northward along the coast as the Davidson Countercurrent, or Undercurrent, generally surfacing at times during the winter south of Point Conception. Point Conception acts as the northern boundary of the Channel Islands region. Here the California Current flows to the outside of the islands, although it splits off gyres that may enter the littoral drift, with waters that are pushed northward along the coast by prevailing winds and other factors.

In more recent years, increased knowledge of the global implications of the El Niño-Southern Oscillation (ENSO) events has led to recognition of the incursions of tropical waters, coupled with the Davidson Countercurrent. The El Niño tropical flow may last for only a few months or up to two years, and has occasionally been tracked as far north as the Columbia River in Washington and even into British Columbia. A large body of data and information has come out of the ENSO events that lingered in southern California long after the equatorial flows had returned to normal, indicating the many fluctuations in the northward flow of warm waters. During such warm events, upwelling of cold waters is likely to stop, resulting in dramatic effects on the cool temperate fauna of California.

The importance of variations in current direction and water temperature to taxonomic research is that organisms have a far greater potential for coastal transport than was previously thought. Except for a few species, bryozoan larvae either are not planktonic or do not remain in that stage for more than a few days. However, established bryozoan colonies are transported on shells, in sediments and on floating debris. Of course, manmade mechanisms also transport organisms, particularly by encrusting the hulls or ballast of ships. Over a period of years a species may be carried far beyond its original range, and may survive if it finds a suitable microenvironment. Power plant plumes furnish warm water habitats that may be isolated by normally cool water regimes, or cool water species may survive inshore along coasts where upwelling is usual, until such time as upwelling ceases during an ENSO event. Collecting thus may never be representative of species that are always, or even sometimes, present simultaneously.

Isolation of small populations may ultimately result in speciation, as has apparently occurred along the Pacific coast. There are a number of forms that we now recognize as distinct taxa that are superficially similar, and in fact, in the past were considered as belonging to a single highly variable species.

Minerals Management Service (MMS) Records

This bryozoan survey has extended the geographical ranges of some species previously only known north of the Puget Sound-Vancouver region, or from the south northward to Monterey Bay or San Francisco Bay. The dearth of historic surveys along the coasts of northern California, Oregon and Washington has perhaps given a false picture of barriers between faunas that do not really exist. The extension of ranges of some species from British Columbia or California to Central America and the Galapagos Islands in earlier literature provides a mixed picture; some nominal species are now recognized as being, instead, composed of a cluster of similar species while others continue to maintain apparently stable characters over a range of

thousands of miles. Very few northeastern Pacific species that were originally cited as the same as those described from Britain or the Mediterranean still retain their continuity, however, and those may be revised in the light of future research.

Taxonomic Approaches

Changing philosophical approaches to taxonomy are quite evident in the study of Bryozoa. The tendency to identify somewhat similar forms as the same species but with an ever widening range of variation has made it difficult to determine the original identity of some commonly cited species. The identification of some taxa as cosmopolitans has obscured the sometimes minor but nevertheless consistent differences among populations in such diverse areas as the Mediterranean, Britain, Alaska or the Galapagos Islands. In the century prior to when Osburn (1950, 1952, 1953) published his monographs on the Pacific coast bryozoans, many investigators were biased toward the similarities rather than the differences, and the concept of cosmopolitan species was widely used. Certainly the dearth of southern California literature made Osburn's task difficult, as did the inability to travel for research on other collections due to World War II and his advancing age. He completed the monographs in his eightieth year.

Changes in preparation techniques have improved by the use of sodium hypochlorite (bleach) to remove organic material from specimens and ultrasonic vibrators for gently cleaning off debris. Most of all, the use of scanning electron microscopy (SEM) has enhanced the recognition of differences between similar forms, reducing the formerly expanding "wide range of variation", and resulting in the description of a number of new species. Examination by SEM and crystallography of the interior surface of the frontal wall has recently revealed evidence of the polyphyletic nature of the ascophoran bryozoans.

There is, at present, a lack of consensus on the validity of a number of families and the placement of genera in them. The Bryozoan volume of the *Treatise on Invertebrate Paleontology* by Bassler (1953) summarized very briefly (too briefly, in most cases) the characters of the fossil and living genera. It has been obsolete for years, and Volume I of the revised *Treatise* by Boardman et al. (1983) dealt in great depth with the characters of the phylum in an introduction and only with the fossil Stenolaemata orders Cystoporata and Cryptostomata. Currently there is a project underway to revise and update the Bassler *Treatise* with descriptions of *Cheilostomata* genera. While not all bryozoan systematists will agree with all our decisions, we have tried to reduce the effort for those who wish to identify species without having to engage in more esoteric debates about higher taxa.

Glossary

The definitions herein are intended only for assistance in identification of species, based on the sometimes specialized (unduly complex) vocabulary used in the literature. Changes are being made in terminology and interpretations by various authors. The following definitions apply to structures as used in the present paper. For more detailed definitions, see Boardman et al., 1983, for examples. Ryland and Hayward (1977) and Hayward and Ryland (1979) present concise glossaries. Changes in fashion also affect the literature by supressing use of some terms that are still valid and found in the referenced literature; others represent new understanding of developmental processes and structural morphology.

Anasca (Anascina). Suborder of cheilostomes having a hydrostatic system composed of a flexible frontal wall activated by parietal muscles; Latin meaning "without an ascus". Species with a frontal membrane and usually little calcified frontal wall; if present, the calcified portion lies beneath the frontal portion.

Ancestrula. The initial zooid of a colony, produced by settlement of a sexually produced larva.

Aperture. The opening in the body wall through which the tentacles are extruded; area closed by the operculum; also termed **orifice**.

Areola. In ascophorans, tissue filled pore occurring in one or more rows around the margin of the zooid frontal wall. Plural, **areolae**.

Areolar pore. Equivalent to areola; or, sometimes used only for the opening at the base of the areola connecting to the interior visceral coelom.

Ascophora (Ascophorina). Suborder of cheilostomes originally described as having a hydrostatic system consisting of a sac (ascus) beneath a calcified frontal wall (shield); presently known as an artificial division, with the hydrostatic function achieved by several different developmental modes (see **cryptocystidean, gymnocystidean, umbonuloid and cribrimorph.**



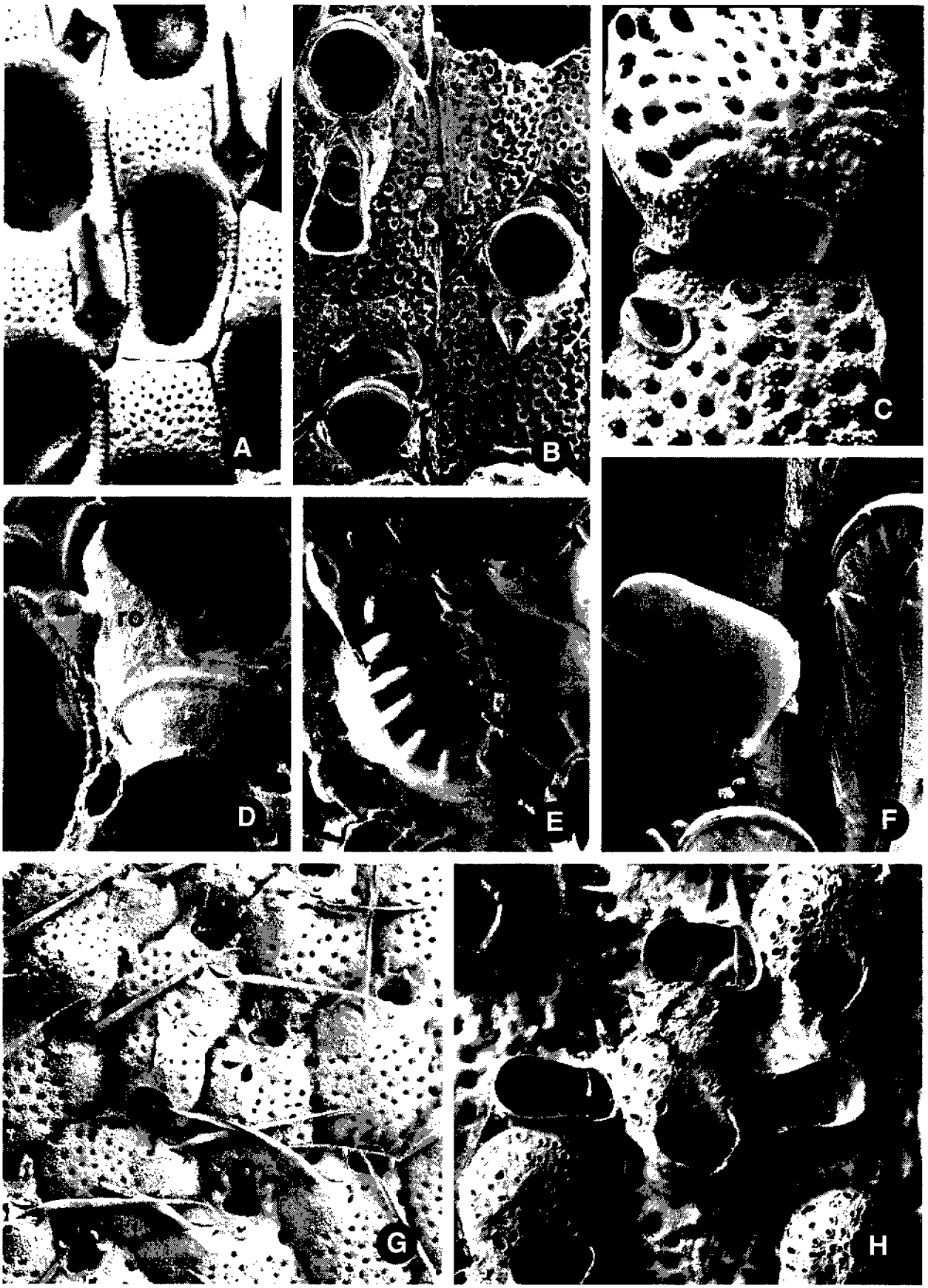
Figure 1. *Fenestrulina farnsworthi* (Ascophora). Views of **ancestrula** (an) and early **astogeny** of forming colony. **Aperture** (ap), **ascophore** (asc) and **operculum** (op).

Ascopore. A median frontal opening of the ascus (compensation sac) in some ascophorans, proximal to the aperture in some genera; opening is otherwise inside the aperture below the proximal lip.

Ascus. A flexible sac (asc) beneath the frontal shield that is opened by the ascopore; the sac functions hydrostatically in extension and retraction of the lophophore bearing the mouth and tentacles.

Astogeny. Mode of development (changes) in colony formed by asexual budding from ancestrula through first few "generations" of zooids to reach mature, stable forms of zooids.

Autozooid. A feeding zooid.


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Avicularium. A highly modified zooid, provided with an articulated, flexible, chitinous mandible, homologous to the operculum, usually lacking a feeding polypide; functions in defense, capture of prey or cleaning of colony. Plural, **avicularia.**

Basal wall. The dorsal surface, the attached side of encrusting cheilostomes, the aboral side from that bearing the subterminal aperture.

Cardelles. Lateral hinge "teeth" on which the operculum pivots in the aperture (= **condyles**).

Chitin. An amorphous cuticular substance; glycosaminoglycans (mucopolysaccharides) linked covalently with a protein core; a long chain polymer of N-acetylglucosamine units.

Chitinous. Chitin-like.

Communication pore. Opening between vertical walls, tissue filled (= mural pore).

Condyles. Lateral "teeth" in aperture on which the operculum pivots when opening or closing.

Costa. A modified hollow spine (rib) arching over the frontal membrane in cribimorph cheilostomes, fused variously with adjacent costae to form frontal shield; hollow interior connected to viseral coelom. Plural, **costae**.

Costate. Ribbed in appearance.

Cribrimorph. Mode of frontal shield formation derived by fusion of costae above frontal membrane.

Cryptocyst. Calcified horizontal frontal shelf or frontal shield developed by secretion from the epithelium of the interior vertical walls beneath the frontal membrane, separated from it by a coelom.

Cryptocystidean. Mode of frontal development as a cryptocyst in some ascophoran cheilostomes. See also **cribrimorph, gymnocystidean** and **umbonuloid.**

Cuticle. The acellular external layer, composed of glycosaminoglycans (mucopolysaccharides), secreted by the epithelium; (=**ectocyst**).

Cystid. Vaselike or boxlike body wall, including the calcified wall, the cellular lining and associated musculature. Contains the **polypide** (viscera).



Figure 3. *Reginella furcata* (Cribimorpha). Ovicelled zooid of a typical **cribimorph**. Hollow ribs or **costae** (co) bearing **intracostal pores** (ic) delineated by rows of **intercostal pores** (ec).

Dental ledge. In some ascophorans, the visible primary layer of the apertural rim that forms condyles, median denticles, or some sinus margins, if present, or may show only as a rim on which the operculum rests.

Denticle. Median suboral tooth (**lyrula**), or hinge teeth (**condyles, cardelles**), on primary aperture.

Dietella. Minute cavity in the zooidal wall containing one or more pores which contain specialized cells that communicate between adjacent zooids, connected to internal funicular tissue. Plural, **dietellae.** (Sometimes used as equivalent of **pore chamber, communication pore, septulum**).

Figure 2 A-H. Various forms of **avicularia**. A. Interzooecial avicularia of *Copidozoum adamantum* (Anasca); B. Two types of suboral adventitious avicularium, spatulate (left) and acute (right), oriented proximally on *Codonellina hastingsae* (Ascophora); C. Small adventitious avicularium oriented dorso-laterally on *Microporella catalinensis* (Ascophora); D. Large interzooecial avicularium with prominent rostrum (ro), also small lateral avicularia on *Tegella cassidata* (Anasca); E. Bulbous avicularia on stalks on *Cauloramphus echinus* (Anasca); F. "Bird's head" avicularium attached to proximal end of zooid of *Bugula pacifica* (Anasca); G. Adventitious avicularia with mandibles as **vibracula** on *Microporella vibraculifera* (Ascophora); H. Large transverse frontal avicularia combined with small, round suboral avicularium on *Smittina landsborovii* (Ascophora).

Distal. Toward the oral end of the zooid, the area away from the point of development.

Ectocyst. A thin, acellular outermost covering of a zooid. See also **cuticle.**

Ectooecium. The outer layer of the ovicell wall.

Endozooecial ovicell (ooecium). An ovicell immersed, internal, intruding beneath the distal zooid.

Entooecium. Inner layer of the ovicell wall; **endooecium** of some authors.

Fenestra. Any large pore (foramen); spaces between zooecia; an uncalcified area in the outer wall (ectooecium) of ooecium. Latin, meaning window. Plural, **fenestrae.**

Foramen. See **Fenestra.** Plural, **foramina.**

Frontal shield. Calcified ventral, frontal surface (the side with the aperture in cheilostomes), not homologous in all groups, an extension of the body wall, but formed by calcium deposition in tissue either in partition below frontal membrane, or in frontal body wall folds, or by fusion of spines above the wall.

Frontal wall. The exterior body wall on the ventral surface bearing the aperture, may or may not be calcified.

Gonozooecium. Zooecium modified as a brood chamber, in stenolaemates.

Gonozooid. Zooid modified as a brood chamber, in stenolaemates.

Gymnocyst. In some cheilostome families, the calcified frontal wall formed as an exterior wall, secreted from the inner side of a fold to form the exterior body wall. See also **cryptocyst.**

Gymnocystidean. Mode of development in ascophorans in which the frontal shield develops as a gymnocyst. See also **cryptocystidean, umbonuloid, cribrimorph** for contrasting method.

Heterozooid. Zooid specialized in function, usually lacking a polypide; see **avicularium, vibraculum, ovicell.**

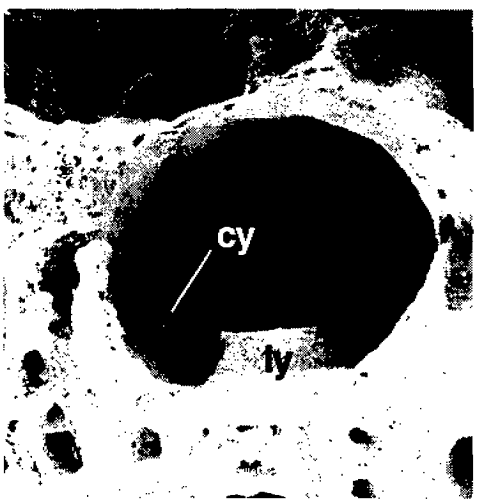


Figure 4. *Smittina ovirotula* (Ascophora). Detail of zooid aperture showing type of **denticles**, anvil shaped **lyrula** (ly) and **condyle** (cy), one of a pair.

Hyperstomial ovicell. Ovicell which is distal to the aperture and rests on the next distal zooid.

Intercostal pores. Pores between the costae on cribrilinids.

Intracostal pores. Pores (pseudopores) penetrating the surface of costae in cribrilinids.

Kenozooid. Specialized zooid usually lacking a polypide, aperture or musculature, serving as a spacer in adapting to substrate contours, or in response to intercolonial competition for substrate; also modified as anchoring devices (rhizoids, radicles, rootlets).

Lacuna. Intercostal pore or space between costae of cribimorphs; or, suboral space between proximal rim of aperture and first pair of costae, in cribrimorphs; Latin for space, hole, or pond. Plural, **lacunae.**

Lophophore. The tentacles, tentacle sheath and vestibule that are extruded from the body during feeding.

Lophophorate phyla. Phyla with a lophophore; Bryozoa, Brachiopoda, and Phoronida.

Lucidum. Lightly calcified area bordered by heavier calcification; the unfused space between the **ectooecium** and **entooecium** layers on some species.

Lumen. Interior passageway of a tubule; or, a cavity in a structure. Plural, **lumina.**

Lyrula. A calcified median "tooth" or **denticle** on the proximal margin of the aperture.

Mural rim. In anascans, the frontal interior margin of the side walls, often bearing spines.

Occlusar laminae. Calcified layers like shelves beneath **cryptocyst** where muscles that close the operculum are attached; in chaperiids.

Olocyst. Primary calcified layer of frontal wall (obsolete term). See **pleurocyst, tremocyst**.

Ooecium. Structure (= **ovicell**) that develops to contain larvae, in cheilostomes; a brood chamber. Plural, **ooecia**. See **ovicell.**

Ooeciostome. In stenolaemate bryozoans, the peristome of a gonozooid; gonozooid aperture.

Operculum. In cheilostomes, a hinged chitinous plate attached with occlusor muscles that close the aperture. Plural, **opercula**.

Opesia. In anascans the uncalcified opening below the frontal membrane, distal to the cryptocyst (or asused by some authors), distal to gymnocyst rim in anascans lacking a cryptocyst). Plural, **opesiae**.



Figure 5. *Micropora santacruzana* (Anasca). Zooids with paired **opesiules** (ops), ovicell with median **umbo** (u).

Opesiule. Small indentations in the proximal opesial margin or openings through the cryptocyst proximal to the opesia for the passage of muscles between the frontal membrane and the basal or lateral walls.

Orifice. Opening, of mouth; **aperture** of some authors.

Ovicell. In cheilostomes the structure containing the egg or larva resulting from sexual reproduction (= brood chamber, **ooecium**).

Pelma. Intracostal pores; uncalcified areas on frontal surface of costae, covered by cuticle. Dim. **Pelmatidia**.

Pericyst. In cribrimorphs, a calcified frontal shield above the ectocyst, frontal membrane.

Peristome. The secondarily calcified collar or rim surrounding the primary aperture (orifice).

Pleurocyst. In ascophorans, secondary calcified layer of the frontal which begins at the border of the zooid and grows toward the center of the frontal (obsolete term).

Polypide. In autozooids, the organs and tissues of a zooid; includes the tentacles, complex alimentary tract and its associated musculature, reproductive organs, and nervous system.

Pore chamber. See **dietella**.

Pore plate. Plate in interior or exterior wall that contains one or more pores.

Proximal. The region toward the growth site or ancestrula, away from the aperture.

Pseudopore. Tissue filled pore that penetrates all or part of the skeletal layer but not the **cuticle** (= pore).

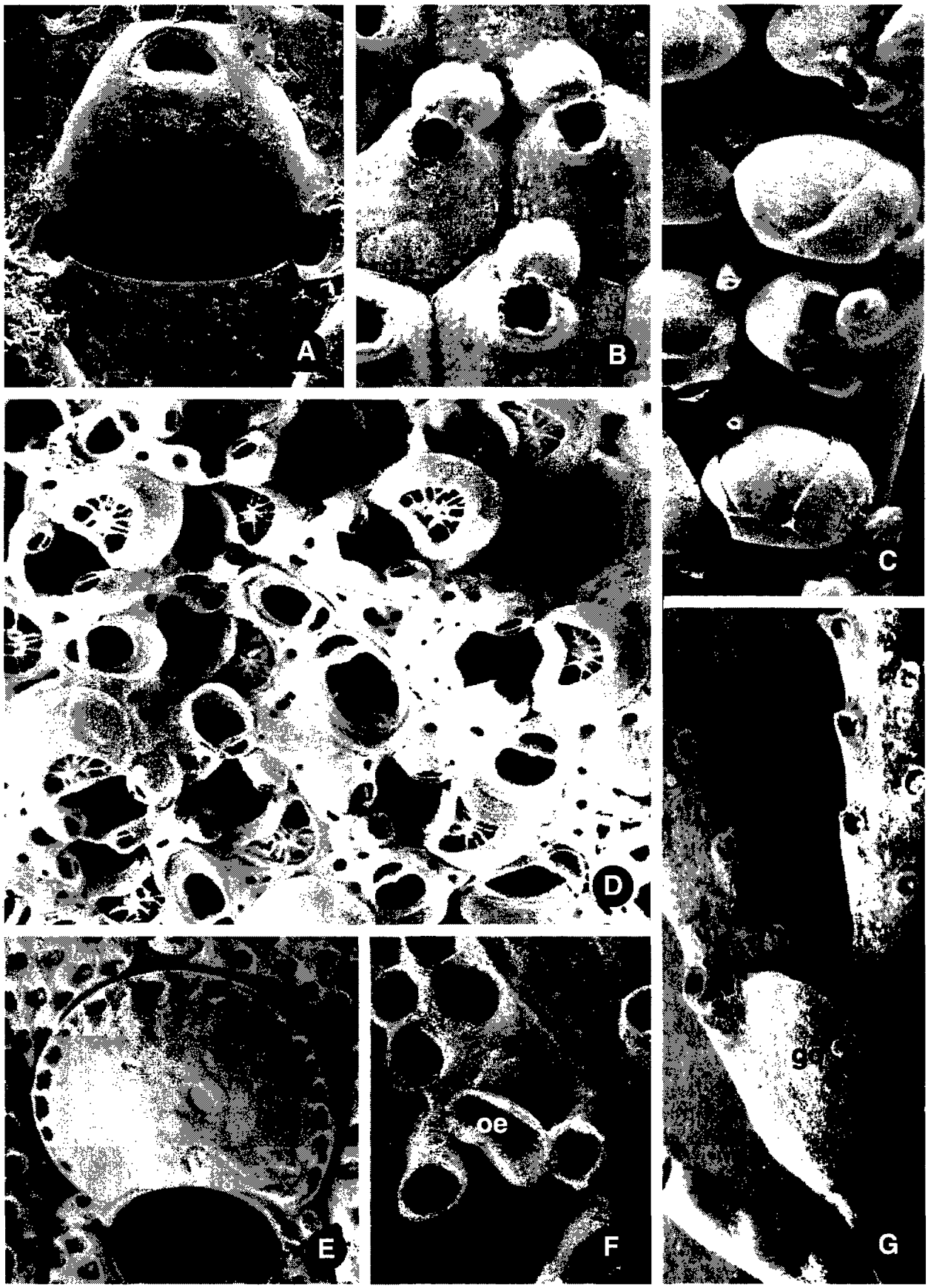
Rimule. Suboral cleft in secondary peristomal collar. See **spiramen**.

Rosette plate. Multiporous subcircular openings in vertical walls (= multiporous septulum).

Scutum. In anascans, modified spine overhanging the frontal membrane.

Septulum. Uniporous or multiporous openings in the body walls of cheilostomates for passage of cellular material between zooids, or to connect coelomic cavities. plural **septula**; also in use as **septula, -ae**.

Sinus. A slit, notch, or curve in the proximal edge of the primary calcified aperture in some ascophorans, in some species covered by an extension of the operculum; sometimes used for a cleft (**rimule**) in the secondarily calcified peristome.


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Spiramen. In ascophorans, a median pore in the proximal wall of the **peristome**. Plural, **spiramina**. Also used for opening remaining in secondary peristomal collar when cleft (rimule) closes at top.

Tremocyst. Calcareous layer of frontal wall containing numerous pores (**tremopores, pseudopores**) of the frontal wall in ascophorans (obsolete term).

Tremopore. Pores in more or less uniformly porous frontal wall; also called **pseudopores** as they are filled with tissue and covered by cuticle.

Umbo. A raised, sometimes knoblike process on the frontal wall, often just proximal to the aperture or upon the ovicell. Plural, **umbones**.

Umbonuloid. Ascophorans in which autozoids have frontal wall (frontal shield) formed by calcification on basal side of a raised, epifrontal fold, above frontal membrane.

Vibraculum. In cheilostomes an avicularian mandible modified into an elongate, whiplike structure. Plural, **vibracula**.

Zoarium. The bryozoan colony, or skeleton of the colony, consisting of member zooids (individual units) derived by budding from a single, sexually produced ancestrula. Plural, **zoaria**; term no longer much used for colony.

Zooecium. The skeleton of the zooid (calcified in anascan, ascophoran and cyclostome bryozoans). Plural, **zooecia**.

Zoid (zo-id). Individual unit/member of a colony, produced by asexual budding from sexually produced ancestrula; (from "Bryozoid", Reichert, 1870: Banta, 1995).

Zooeciule. A small zooecium.

Zooid (zoo-id). Individual unit member of a colony, produced by asexual budding; see also autozooid, kenozooid, heterozooid and gonozooid; (an "animal-like thing" from Huxley, 1851: Banta, 1995).

Figure 6 A-G. Various types of **ovicells**. A. Ovicell with central pore, of *Eurystomella bilabiata* (Ascophore); B. Ovicells on distal side of raised **peristomes**, of *Haywardipora rylandi* (Ascophora); C. Typical bugulid ovicells alternating with avicularia, of *Bugula californica* (Anasca); D. Ovicells with radiating ribs, of *Celleporina robertsonae* (Ascophora); E. Ovicells with marginal pores, of *Fenestruloides morrisae* (Ascophora); F. Detail of flared **ooeciostome** (oe), of *Tubulipora tuba* (Cyclostomata); G. Conspicuous **gonozooid** (go), of *Crisulipora occidentalis* (Cyclostomata). Refer to Figure 2 A, C, D, G, H for other examples.

Keys to Higher Taxa and Species of Bryozoa

A dichotomous key is an artificial device, sometimes creating pairs of unlike structure in order to achieve a two-part choice. Care must be taken not to attempt to insert other species not included in the text at any given paired choice in the key.

1 Tentacular crown (lophophore) usually horseshoe shaped; freshwater only; free hibernating bodies (statoblasts) occur; not represented herein ..... CLASS PHYLACTOLAEMATA

Tentacular crown circular; marine and estuarine; no free hibernating bodies 2

2 (1) Zooecium (exoskeleton of individual) calcareous, tubulular, with terminal circular aperture ..... CLASS STENOLAEMATA 6

Zooecium other than a calcareous tubule with terminal circular aperture ..... CLASS GYMNOLAEMATA 3

3 (1) Zooecium soft bodied, tubular or saccate, with terminal aperture closed by puckering membrane; colony stolonate, or with zooecia contiguous; some with free swimming, non-brooded larvae, others with brooding in internal or external membranous sac; no ovicells, no avicularia or vibracula; not included herein ..... ORDER CTENOSTOMATA (CTENOSTOMIDA)

Zooecium lightly or heavily calcified, mostly boxlike with subterminal aperture on ventral (frontal) surface, closed by chitinous operculum; some with free-swimming larvae, others brooded in internal or external ovicells; heterozooids (avicularia, vibracula) present or not ..... ORDER CHEILOSTOMATA, (CHEILOSTOMIDA) 4

4 (3) Frontal (ventral surface) an exposed flexible membrane, contracted to extrude tentacular crown;frontal membrane bordered by calcified rim; shelf or shield (cryptocyst) originating beneath frontal membrane, and/or limited gymnocyst forming marginal rim, tubular body wall; or with spines fused as external shield above frontal. Gymnocystal rim sometimes bearing spines; operculum a hinged flap of frontal membrane, lightly or heavily chitinized; lacking an ascus for tentacle eversion 5

Frontal surface calcified above or beneath frontal membrane (gymnocyst or cryptocyst), sometimes in multiple layers with central or peripheral pores; sometimes a compensation sac (ascus) between calcified frontal and frontal membrane with opening (ascopore) within the apertural peristome or proximal to it on frontal membrane ..... SUBORDER ASCOPHORA (ASCOPHORINA)

5 (4) Calcified frontal wall formed by fusion of spines into a shield (pericyst) above frontal membrane with coelom between shield and membrane .... SUBORDER CRIBRIMORPHA (CRIBRIMORPHINA)

Frontal wall a membrane with calcified rim sometimes bordered by body gymnocyst, with or without spines; or with cryptocystal rim or shelf beneath frontal membrane; no ascus ..... SUBORDER ANASCA (ANASCINA)

6 (2) Living species with or without calcified frontal exterior walls, tubular zooids with terminal peristomes, brooding in gonozooids or colonial brood chambers ..... ORDER CYCLOSTOMATA (CYCLOSTOMIDA, TUBULIPORATA)

Fossil orders without calcified frontal exterior walls (not represented herein) ..... ORDERS CRYPTOSTOMATA, TREPOSTOMATA, CYSTOPORATA, FENESTRATA

Order Cheilostomata (Cheilostomida)

Suborder Anasca (Anascina)

1 Colonies stolonlike, creeping, with long erect zooidal tubules at intervals; with enlarged base, uncalcified frontal membrane area, aperture subterminal; operculum part of frontal membrane; no frontal budding; ovicell a temporary membranous sac hung outside from apertural area to brood ova; no avicularia, no vibracula (whips) or spines 2

Colonies mostly not stolonlike, or if stolonate, not with long tubules rising at intervals; ovicell, if present, not an external membranous sac 3

2(1) Zooids very long, >1,200 µm, narrow, the distal 20-25% bearing membranous area, bent forward as "nodding head" (snakes's head), stalk sometimes finely striated, with tiny spines ..... ***Aetea pseudoanguina*, new species**

Zooids ±700 µm long, membranous area > 50% of stalk length, ligulate (narrowed) at base of membrane and opercular areas, lower stalk widely annulate ..... ***Aetea paraligulata*, new species**

3(1) Colony stolonate with zooid a short base enlarging distally to ovoid shape with large frontal membranous area; new zooids budded from frontal or distal ends to form chains; ovicell a shorter zooid (not represented herein) ..... SUPERFAMILY SCRUPARIINA (SCRUPARIOIDEA)

Colony otherwise 4

4(3) Colony encrusting, or rising from encrusting base in multiserial fronds; cryptocyst and gymnocyst limited, large opesia distal to cryptocyst beneath uncalcified frontal membrane area 5

Cryptocyst more developed 10

5(4) Ovicells entirely absent 6

Ovicells present, internal (endozooecial) or external (hyperstomial), distal to aperture 7

6(5) Gymnocyst absent or slightly developed; ancestrula twinned 8

Gymnocyst well developed; no ovicells, no avicularia; ancestrula single 9

7(5) Ovicell endozooecial (beneath surface, extending under frontal wall of next distal zooid) 13

Ovicell hyperstomial (above "mouth"), above next distal zooid 17

8(7) Zooid boxlike, cryptocyst narrow with serrate margin; 2 short distal tubular spines; some tiny irregular spinules projecting medially from cryptocyst ..... *Membranipora serrilamella*

Zooids more rounded, two large, heavily calcified tubercles ("spines"), sometimes merging in middle; small spinules sometimes projecting medially from cryptocyst rim ..... *Membranipora tuberculata*

9(6) Gymnocyst, cryptocyst narrow, with 3-6 pair of tiny gymnocystal spines, no proximal spine; with small oval "dwarf" zooids with large opesiae, lying between some autozooids, in central California specimens ..... ***Conopeum osburni*, new species**

Gymnocyst more extensive, covering proximal end; rim of opesia slightly crenulated, a short tapered spine at proximal end; in Alaska small rectangular kenozooids present between some autozooids; in California, frontal buds found ..... *Electra venturaensis*

10(4) Cryptocyst covering most of frontal area; opesia, gymnocyst reduced or absent 11

Gymnocyst more extensive, cryptocyst reduced or absent 25

11(10) Colonies encrusting, lateral walls raised, cryptocyst with many small pores, 2 larger slitlike opesiules at margins proximal to aperture, lateral walls resembling vase handles; small frontal pores rimmed with tiny spinules; small transverse avicularium lying between zooids, chamber rounded with acute mandible, complete hinge bar; ovicell with small pores and an umbo ..... ***Micropora santacruzana*, new species**

Colonies erect, branched, with chitinous joints, long internodes between joints; no opesiules; no spines; zooids diamond shaped with raised lateral walls; avicularia replace zooids in series; ovicell embedded in distal zooid, opening separate 12

12(11) Avicularia much smaller than autozooids, square, with semicircular mandible ..... *Cellaria diffusa*

Avicularia much wider than autozooids, with large semicircular mandible ..... *Cellaria mandibulata*

13(7) Ovicell endozooecial, shallow, inconspicuous; no spines, no avicularia; no dietellae in lateral walls ..... *Aplousina ? major*

Endozooecial ovicells small but visible on external surface; avicularia large, interzooecial, or paired on lateral walls 14

14(13) Avicularia large, interzooecial 15

Avicularia on margins of lateral walls 16

15(14) Avicularia long triangular, tips setiform but without alae; 8-10 short spines arching over opesia; ovicell small, rounded, longer than wide ..... *Hincksina pallida*

Avicularia large, setiform, mandible with alae (wings) on sides of main shaft; ovicell a wide, shallow, endozooecial hood ..... *Hincksina ? alba*

16(14) 10-12 short spines directed over opesia, 4 short spines distal to aperture; avicularium pedunculate, stalk slender with bulbous tip (rostrum), acute mandible; deep grooves between oval zooids ..... *Cauloramphus echinus*

13-15 long, stout spines, some overlapping above opesia; avicularia numerous, hardly distinguishable from spines, wider at rostrum tip, with tiny mandible; cryptocyst narrow, a thick, rolled rim ..... ***Cauloramphus californiensis*, new species**

17(7) No avicularia, no spines, but truncate hollow tubercles at distal corners; cryptocyst wide, crenulate, coarsely granular; ovicell hyperstomial, indistinct from zooid, finely granular, embedded between tubercles; large single pore plates in lateral walls ..... *Alderina ? brevispina*

Avicularia and/or spines present 18

18(17) Avicularia interzooecial (between zooids) 19

Small avicularia on zooids (adventitious), not interzooecial. Zooids with distinct grooves between; cryptocyst crenulate, 2-3 pairs of long, stout spines beside aperture curving outward, 3-4 pairs of shorter spines around opesia; avicularia minute, on rim outside of spines, mandible a short triangle directed outward; ovicell shallow, wide with 2 layers visible, rough granular surface ..... *Callopora corniculifera*

19(18) Large interzooecial avicularia between lateral walls parallel to zooids; with or without spines 20

Avicularia smaller, at/between transverse walls, overlapping ovicells or not; ovicells granular, with two incomplete layers 21

20(19) Species lacking spines; zooids ovate, narrowed at operculum; ovicell raised, granular with many tiny pores; avicularium with diamond shaped base, rostrum directed distally, with large articular hinges, long setose mandible, rostral tip raised into spout; multiporous septula (rosette plates) in distal, lateral and basal walls ..... ***Copidozoum adamantum*, new species**

Species with spines; spines a distal pair and pair beside operculum, plus 1-2 pair of large spines branched like elk antlers arching over opesia, sometimes fusing; avicularia large with narrow raised rostrum, mandible vibraculoid; ovicell small, granular, inconspicuous ..... *Copidozoum ? protectum*

21(18) Zooids separated, connected by tubules; areolae large; short spines, 2 flanking aperture plus 3-4 pairs extending part way over opesia; cryptocyst narrow; a medium sized avicularium between transverse walls, directed proximally when distal to infertile autozooid, or becoming large, directed distolaterally, curved when overlapping proximal ovicell; ovicell large with 2 incomplete layers, sometimes a barlike transverse thickening across margin of outer layer ..... *Tegella circumclathrata*

Zooids contiguous, not connected by tubules; few spines flanking aperture; interzooecial avicularium overlapping proximal ovicell or not; ovicell showing 2 layers, outer layer (ectooecium) shorter than inner layer (entooecium), separated by space (lucidum) 22

22(21) Cryptocyst narrow; a pair of distal spines; one or a pair of small acute avicularia on lateral walls at base of aperture, directed proximally 23

Zooid with wide, raised cryptocyst proximally, narrowing distally; below that paired calcified ledges (occlusar laminae) at distal corners for attachment of opercular muscles; 3-4 pairs of stout spines flanking aperture; small acute avicularium distal to some autozooids; ovicell a large hood, layers not fused; colony covered with thick, reddish brown cuticle (ectocyst) ..... *Chaperiopsis patula*

23(22) One or 2 lateral oral avicularia on lateral wall directed proximolaterally; a large spine or spine scar proximal to avicularium; large avicularium between transverse walls, resting on top of ovicell ... 24

Two to 3 large spines on one side of aperture, sometimes fused, one on other side distal to avicularium on lateral wall near mid-opesia; large avicularium distal to non-ovicellate zooids erect, truncate..... ***Tegella larusiensis*, new species**

24(23) Large spine often replacing a lateral avicularium; pair of tiny spines flanking ovicell; ovicell with narrow horizontal lucidum slit flanked by pair of pores; large transverse avicularium bluntly acute ..... *Tegella armifera*

Paired avicularia along lateral wall raised, conical, with large spine proximal or interior to one avicularium, no tiny spines flanking ovicell; ovicell with wide, arched lucidum; zooid plus ovicell and avicularium very large ..... *Tegella cassidata*

25(10) Zooids usually in biserial rows; sessile marginal avicularia only; a marginal spine modified into flattened, narrow, shield (scutum) paddle shaped or multipronged 26

Avicularia on stalk (pedicellate), or absent 30

26(25) Colony bushy, up to 35 mm high; no dorsal (back side) vibracula (whips) or other avicularia; internodes usually composed of 3 zooids but up to 7 possible near tips 27

Vibracula or other avicularia on dorsal side 28

27(26) Scutum like a narrow spine, usually with 1-3 points, up to 8 in some southern populations, attached well below middle of membranous frontal margin, curved over opesia; large lateral avicularium with triangular hooked mandible directed outward, no frontal avicularia; 3 stout outer spines, 3 inner spines; ovicell large, with few pores ..... *Tricellaria occidentalis*

Scutum a flattened spine with 2-3 prongs attached at middle of membranous frontal margin or more distally; joints between internodes light colored; usually 2-3 outer spines, 1-2 inner spines on margins ..... ***Tricellaria circumternata*, new species**

28(26) Colony not regularly jointed; vibracula in large, lengthwise bundles on dorsal surface with long, barbed, setose ends extending across frontal surface ..... *Caberea ellisi*

Colony biserial, regularly jointed at bifurcations; dorsal vibracula not in lengthwise dorsal bundles; usually an oval or forked frontal scutum; ovicell imperforate, with a ridge where ectooecium ends, not covering entire entooecium..... 29

29(28) Colony erect, tufted; uncalcified frontal membrane area a long oval; scutum small oval, paddle shaped, sometimes with an extra prong; small or large lateral avicularia, small proximal frontal avicularium; ovicell imperforate with incompletely calcified central area (lucidum); 2 outer, 1-2 inner lateral oral spines; small vibracula, radicles (rootlets) coming from same dorsal chamber. ..... *Scrupocellaria californica*

Colony low, bushy; uncalcified frontal membrane area elongate, scutum with 2-3 prongs; 2-3 small outer, 1 inner lateral oral spines; lateral avicularia arise mid-frontal, extended distally in long curved trough, small proximal frontal avicularia sometimes present; vibracula chambers small, with transverse groove, setae short, weak; radicle base on vibraculum chamber. Ovicell imperforate, irregular, with transverse striations ..... *Scrupocellaria varians*

30(25) Colony frondose, loosely recumbent, attached by a few radicles; multiserial; zooidal walls thickened at distal corners; uncalcified frontal membrane area large, elongate, operculum thin; paired distal and lateral spines; with or without avicularia; dorsal surface show transverse line between zooids 31

Colony erect, not frondose; dorsal surface shows line between zooids is oblique or forked, not transverse 34

31(30) Pedunculate avicularia present on margins and interzooidally; hooked mandible tips; 2 pair distal spines, 1 pair of very small lateral spines or none; ovicell imperforate but with irregular thin ovoid spots (lucida) where outer layer is not completely calcified; radicles very stout, attached laterally . ..... *Dendrobeania curvirostrata*

Avicularia absent 32

32(31) Zooids large, sometimes with fenestrae between zooids, but not connected by tubules; 2 erect stout distal spines, 4-6 pair heavy lateral spines folded as a thicket over frontal membrane; many radicles tangled with spines; ovicell globular ..... *Dendrobeania longispinosa*

Colony with wide, spreading fronds (lichen-like); radicles on dorsal side; zooidal walls thin; 1 pair strong distal spines, 2-3 pair thin short lateral spines ..... *Dendrobeania lichenoides*

34(30) Colony erect, bushy, without segmented stalk; proximal end of zooid on dorsal side a forked line 35

Colony erect, segmented with kenozooid (non-feeding zooid) joints; proximal end on dorsal side a slanted line 39

35(34) Colony reddish purple; zooids with very large membranous frontal area; lateral walls form raised tips (spines) distally; no avicularia; ovicells large, attached at inner distal corner ..... *Bugula neritina*

Colony otherwise; avicularia present 36

36(35) Large pedunculate avicularium attached at proximal end of zooid; body wall curved upward around opesia, 4 prongs at distal end; ovicell a shallow hood attached to distal end at an angle .... *Bugula pacifica*

Avicularium attached more distally on zooidal margin 37

37(36) Avicularia long, half the zooidal length, slender, terete (sweet potato shaped) .... *Bugula longirostrata*

Avicularia not long, slender 8

38(37) Colony in spiral whorls, zooids arranged biserially; avicularia stout ("bird's head"), on inner or outer wall; 3 outer stout prongs; ovicell globular, attached in center of distal end ..... *Bugula californica*

Colony not in whorls; zooids multiserial; avicularia on outer lateral wall, strongly hooked; 1 pair short distal spines; no ovicells but corners of some zooids folded over as if to protect an egg ..... *Bugula pugeti*

39(34) Zooids long, slanted outward at distal ends, uncalcified membranous frontal area extensive, 1 pair of small distal spines; avicularium small, facing outward at proximal end of zooid ..... *Caulibugula californica*

Uncalcified frontal area smaller, rounded, facing outward, tilted up; 4-5 large curved spines on outer margin, sometimes 1-2 on inner margin; avicularium near proximal end; ovicell short, wide, slanted outward ..... *Caulibugula ciliata*

Suborder Cribrimorpha

1. Zooids small, 350-550 μm long; distal apertural rim curved, proximal rim straight, both rims originate from distal gymnocyst; modified costae border proximal lip, leaving space (lacuna) below aperture; 5 apertural spines present; interzooecial acute avicularia; ovicells with or without pores 5

Zooids large, 600-900 μm long; distal apertural rim a curve formed from distal gymnocyst; proximal rim formed by fusion of modified frontal costae; no suboral lacunae; no apertural spines; ovicell with large costal pores 2

2(1) Frontal with 7 large flat costae in distal frontal area, 1 large pyriform pore near center of each costa, 1 or 2 intercostal pores; distal apertural rim a deep curve ending at tiny condyles, proximal rim curved; gymnocyst extensive; ovicell a kenozooid with modified costae, 2 large pores, median suture; no avicularia known ..... *Reginella (Figularia) hilli*

Frontal formed of 12-16 costae, costal pore reduced, at outer end of costa; intercostal pores 4 or more 3

3(2) Interzooecial avicularium almost as large as autozooid, parallel to it, mandible spatulate; ovicell a small kenozooid with costae and 2 large pores, 1 intercostal pore; first pair costae extending distally at outer ends of proximal rim of aperture shaped like lyre (small harp) turned on side ..... *Reginella (Jullienula) hippocrepis*

No avicularia, no spines; aperture bell shaped, proximal rim formed of modified costae turned distally around sides, raised; row of intercostal pores almost straight across in mid-zooid; ovicell large, with numerous pores 4

4(3) Tips of rim below proximal aperture bifurcate, raised; 2 costal pores ..... *Reginella (Reginella) furcata*

Proximal rim tips not usually raised, bifurcate; 3 small costal pores; ovicell pores obscure ..... *Reginella (Reginella) nitida*

4(3) Gymnocyst hardly visible, 15-17 costae, 1 tiny costal pore near knob at end of costa; intercostal pores small, 3 on each side below proximal rim, 5 in mid-zooid (10 across); costal pores not seen; 1 large lacuna, flanked by 2 small ones (may be merged) between apertural bar and first pair of costa; ovicell with 1-2 pairs of spines, hood with large pores ..... *Puellina (Cribrilaria?) perplexa*

Gymnocyst wider, 13-16 costae rising vertically from gymnocyst (buttresses) to cross frontal horizontally in radiate pattern; 4-5 intercostal pores below first costa, 5-7 in widest part (10-14 across); one lacuna, may be connected to space below proximal apertural rim if apertural bar costae are immediately merged; ovicell without pores ..... ***Puellina (Cribrilaria) californiensis*, new species**

Suborder Ascophora

1 An external ascopore opening in calcified frontal wall 2

No external ascopore opening in calcified frontal wall 16

2(1) Ascopore separated from proximal apertural lip by large frontal pores; avicularia usually absent 11

Ascopore not separated from aperture by pores 3

3(2) Ascopore with denticulate margin or cribrate plate; frontal pores denticulate 4

Ascopore without denticulation but frontal pores with cribrate plates, paired setiform lateral avicularia present ..... *Microporella setiformis*

4(3) Ascopore filled with cribrate plate ..... *Microporella cribrosa*

Ascopore with denticulate margins 5

5(4) Avicularium replaced by single bulbous rostral chamber with vibraculum longer than zooid .... *Microporella vibraculifera*

Avicularium otherwise 6

6(5) Frontal wall with median umbo, plus 2 lateral suboral umbones overgrowing first pair of oral spines 7

Frontal wall with one median umbo, or none 8

7(6) Frontal wall with large pores, one avicularium; lateral umbones leaning over aperture, large median umbo obscuring ascopore ..... *Microporella umbonata*

Frontal wall with tiny pores; 1, 2 or no umbones; none leaning over aperture .... ***Microporella umboniformis*, new species**

8(6) Zooids usually with 4-5 spines; 2 avicularia 9

No spines known; 1 lateral avicularium proximal to ascopore, or absent; large frontal pores, large areolar pores; small ascopore ..... ***Microporella catalinensis*, new species**

9(8) Zooid with large ascopore, large frontal pores; avicularia paired, beside ascopore, umbo present 10

Zooids flattened, frontal pores small, areolae large; paired avicularia originating slightly proximal to small ascopore ..... ***Microporella planata*, new species**

10(9) Umbones small, frontal pores lacking extra infundibuliform lining ..... *Microporella californica*

Umbones very large, reticulate to tips, pores with extra calcified infundibuliform lining .... ***Microporella infundibulipora*, new species**

11(2) Zooids with gymnocystal rim around margin, 1 row of pores next to margin; ascopore highly denticulate, separated from aperture by 1-2 rows of pores, a few other scattered frontal pores, with interior denticulate plates ..... ***Fenestrulina farnsworthi*, new species**

Zooids with little or no marginal gymnocyst showing except around ovicell; frontal becoming completely covered with pores except in some species with imperforate area proximal to umbo or elevated ascopore; pores with few or many denticles; rarely a proximal frontal avicularium; ovicells usually imperforate except for large marginal pores 12

12(11) Frontal of mature zooids entirely or partly covered with pores containing denticles or cribrate plates; ascopore at apex of inflated frontal wall 13

Ascopore not raised, with an umbo raised proximal to ascopore; frontal pores heavily denticulate 14

13(12) Frontal wall not much inflated, ascopore raised; 3-4 distal spines; frontal pores cribrate, all over frontal in mature zooids; one avicularium seen; ovicell with closed pores in center .... ***Fenestruloides morrisae*, new genus, new species**

Frontal pores with coarse, irregular denticles; 2-3 distal spines; ascopore raised, median projection almost filling ascopore ..... ***Fenestruloides eopacifica*, new species**

14(12) Frontal pore denticles fragile; 4-5 distal spines; median projection not filling ascopore; umbo present or not proximal to ascopore ..... ***Fenestruloides miramara*, new species**

1-2 distal spines 15

15(14) Ovicell embossed, with appearance of pair of ribs fused across front margin; ascopore projection filling ascopore; umbo a discrete projection ..... ***Fenestruloides umbonata*, new species**

Ovicell smooth with 2 large lateral apertural spines; kenozooidal "bumps" bearing pores between and on zooids; umbo diffuse or distinct ..... ***Fenestruloides blaggae*, new species**

16(1) Aperture bell shaped, no spines; pores surrounding distal, lateral margins of aperture; ovicell absent ..... *Cryptosula pallasiana*

Aperture otherwise; ovicells present 17

17(16) Three kinds of zooids present: large autozooids, smaller female zooids with large ovicells, smaller male zooids; 18

Not having three kinds of zooids 19

18(17) Large autozooids, foreshortened females with large, perforate ovicells, small male zooids; frontal wall with transverse striations; proximal aperture sinuate ..... *Celleporella hyalina*

Autozooids, very large ovicelled females, small zooids, interzooecial avicularia; frontal wall with large pores, ovicells with small pores ..... *Trypostega claviculata*

19(17) Aperture a wide arch with a wide, shallow sinus or not proximally; suboral pore or avicularium within low peristome; ovicell imperforate or with few small pores.....20

Aperture, ovicell otherwise 21

20(19) Zooids large, distal apertural rim low, proximal lip a wide, shallow sinus; ovicell ribbed ..... *Hippoporina insculpta*

Zooids moderate, aperture rim raised distally and laterally, straight proximally or lightly arched inward above suboral pore or avicularium; ovicell nodular ..... ***Hippoporina mexicana*, new species**

21(19) Zooids subhexagonal, frontal wall imperforate; aperture occupying more than half of zooid, wide, shallow, with rounded openings at ends for opercular muscles; ovicells shallow, subtriangular with median distal pore ..... *Eurystomella bilabiata*

Frontal wall and aperture otherwise 22

22(21) Primary aperture symmetrical, distal rim not beaded, secondary aperture (if present) symmetrical.. 23

Primary aperture symmetrical, distal rim beaded, secondary aperture asymmetrical or not; ovicell with frontal calcified entooecial labellum 59

23(22) Aperture with median denticle in proximal lip, or with primary dental ledge having deep sinus; avicularia present 37

Aperture without a median denticle; without deep sinus; without avicularia 24

24(23) Aperture elliptical, wider than high, with a shallow sinus or a curved proximal rim; no avicularia.. 25

Aperture otherwise; avicularia present or not 28

25(24) Ovicell with single large pore or multiple irregular pores; proximal aperture a shallow curve, condyles small or absent ..... *"Dakaria" dawsoni*

Ovicell with fan shaped array of pores in front margin; hood covered distally with imperforate secondary calcification; condyles large 26

26(25) Proximal apertural rim with wide shallow sinus ... ***Neodakaria islandica*, new genus, new species**

Proximal aperture otherwise 27

27(26) Proximal rim with shallow V-shaped sinus; ovicell pores a narrow triangular central area .... *Neodakaria ordinata*

Proximal rim a wide curve; large suboral umbo present ..... ***Neodakaria umbonata*, new species**

28(24) Primary aperture rounded 53

Aperture with distinct sinus 29

29(28) Frontal wall with few scattered pores and marginal areolar pores 61

Frontal wall with pores over all 30

30(29) No avicularia present: ovicell with many pores, sunken, sinus of ooecia shallower than in zooids; frontal wall with many pores, apertures higher than wide, condyles very large, curved downward, ridged ..... *Schizoporella inarmata*

Avicularia present 31

31(30) Avicularia paired or single, placed lateral or proximolateral to aperture, directed distally or distolaterally 32

Avicularium median suboral, sometimes also with lateral oral avicularia 34

32(31) Ovicell with large imperforate oval area in middle of hood, surrounded by ectooecium; frontal wall rugose; paired subacute avicularia raised on large umbones; aperture higher than wide, large condyles ..... *Schizoporella ? cornuta*

Ovicell otherwise 33

33(32) Ovicell frontal wall porous, strongly ridged; avicularia paired, directed distally or distolaterally, with short, acute mandibles, sometimes single or absent over part of colony; a wide or narrow U-shaped sinus in dental ledge, condyles small, almost horizontal; with a small nodular median suboral umbo ..... *Schizoporella unicornis*

Ovicell frontal wall not strongly ridged, frontal pores irregular; avicularia paired single, or absent, acute, directed distally or distolaterally, no larger acute avicularia; aperture with widely arcuate sinus, condyles acute, erect, directed distomedially ..... ***Schizoporella pseudoerrata*, new species**

34(31) Aperture pyriform, higher than wide, with large dental ledge containing small sinus and small round suboral avicularium; 2-4 spines; frontal wall porous; ovicell with 2-3 rows of irregular pores bordering front of hood (not found in eastern Pacific) ..... *Schizomavella auriculata*

Aperture wider than high, avicularium not part of dental ledge 35

35(34) Median suboral avicularium acute, small or elongate, directed proximally; condyles large, burred; ovicell with large irregular pores ..... *Schizomavella acuta*

No elongate suboral avicularia 36

36(35) Suboral avicularium almost round, outside of wide shallow sinus; frontal rugose with umbo proximal to avicularium; ovicell rugose, porous ..... ***Schizomavella robertsonae*, new species**

One small oval suboral avicularium; ooecia with 3 avicularia, 1 median, 2 flanking aperture; aperture with 3 distal spines; ovicell with pores at front margin of hood ..... ***Schizomavella triavicularia*, new species**

37(23) Frontal wall perforate over all or in part 38

Frontal wall imperforate or with single row of marginal areolar pores 49

38(37) Ovicell perforate, rimmed distally by ectooecium or not 39

Ovicell otherwise 42

39(38) A small suboral avicularium on or proximal to lyrula (median denticle) 40

Dental ledge containing U-shaped sinus instead of projecting lyrula, strong, flattened condyles; 5 distal spines; a spout shaped suboral avicularium; ovicell with 4-12 pores bordered distally by ectooecium ..... ***Schizosmittina pedicellata*, new species**

40(39) A small rounded suboral avicularium placed below high peristome, closed or not medially; sometimes a large shoeshaped avicularium placed transversely on frontal wall; ovicell large, perforate (not found in southern California) ..... *Smittina landsborovii*

Small suboral avicularium placed partly inside peristome on lyrula (denticle) 41

41(40) Small ovoid avicularium resting on very wide lyrula; frontal wall pores small, peristome a rolled collar; ovicell small, compressed, with small pores ..... ***Smittina veleroa*, new species**

A shoe shaped avicularium directed proximally, resting on wide dental ledge; frontal pores large, areolae larger (not found in southern California) ..... *Smittina spathulifera*

42(38) Ovicell with circular area of pores resembling spoked wheel ..... ***Smittina ovirotula*, new species**

Ovicell otherwise 43

43(42) Ovicell composed of 1-3 frontal wall flaps 44

Ovicell imperforate or with scattered tiny pores 46

44(43) Ovicell with one large distal flap bearing a single medial pore; small oval avicularium on small lyrula inside rolled peristome ..... ***Dengordonia uniporosa*, new genus, new species**

Ovicell composed of 3 flaps: 1 distal, 2 lateral, meeting rolled peristome rim; ovicells becoming submerged; most species with denticulate frontal pores 45

45(44) Avicularium mostly outside peristome; lyrula small, large hooked condyles; ovicell wider than high ..... ***Raymondcia osburni*, new genus, new species**

Avicularium mostly inside peristome on wide, anvil-shaped lyrula; ovicell higher than wide, lateral flaps prominent ..... ***Raymondcia macginitiei*, new species**

46(43) Frontal wall perforate over all; peristome erect, formed of fused spine bases, long spines usually lost; ridge running down inside peristome to meet wedge shaped lyrula; ovicell imperforate or not 48

Frontal wall not perforate over all; apertures erect or not, with spines 47

47(46) Frontal rugose, 3 rows of pores, pores with interior spicules; apertures more or less recumbent, with 4-6 spines; frontal mucro not connected to lyrula by interior ridge; ovicell coarsely granular ..... ***Haywardipora rugosa*, new genus, new species**

Frontal wall smooth, inflated, with 2-3 rows of marginal pores, aperture with 10 spines, bases fused into peristome, a median ridge running down inside peristome to wide anvil-shaped lyrula; frontal pores tubular, infundibuliform, closed by membrane; ovicells smooth ..... *Haywardipora major*

48(46) Frontal wall appearing perforate all over; peristome erect, with 10 spine bases becoming fused into tall peristome; ridge from exterior pointed mucro extending down inside to wide anvil-shaped lyrula; ovicells large, appearing imperforate but with small pores beneath ectocyst ..... ***Haywardipora orbicula*, new species**

Frontal wall with numerous small pores except proximal to aperture; 8 spines, median proximal mucro, without interior ridge, lyrula narrower, anvil-shaped; ovicells small with scattered small pores, or dimpled, or imperforate ..... ***Haywardipora rylandi*, new species**

49(37) Avicularia paired or single lateral oral, never median suboral; ovicell perforate, becoming rimmed by ectooecium, frontal wall imperforate with marginal areolae only; peristome tubular, notched proximally, lyrula narrow, anvil shaped ..... *Parasmittina tubulata*

Avicularium median, suboral, others sometimes present; frontal wall imperforate except for pores at base of avicularium in some; ovicell imperforate 50

50(49) Avicularium base on lyrula within secondary apertural (peristomal) rim 51

Avicularium mostly proximal to secondary apertural rim, not on lyrula base; other small subacute avicularia present 52

51(50) Zooids flat, areolar pores small, 6-10 on each side; no apertural spines; avicularium base on lyrula inside peristome, condyles tiny; no basal pores on avicularium; ovicell imperforate ..... *Porella major*

Areolar pores large, forming large buttresses; no avicularia in addition to median suboral avicularium, bluntly acute avicularium on base of lyrula raised; peristome tubular; ovicell small, imperforate .... *Porella columbiana*

52(50) Suboral avicularium small, ovoid; many small avicularia between zooids on mounds with their own areolae, encroaching on adjacent zooid apertures ..... *Porella porifera*

Suboral avicularia varied, small subacute or longer subacute; additional small, blunt avicularia, at distal corners of aperture or along lateral wall; median denticle tiny, acute ..... ***Porella taylori*, new species**

53(28) Colony erect, branching, cylindrical, or recumbent; tall secondary peristome; paired avicularia flanking secondary aperture; ovicell on back of peristome imperforate distally, large porous frontal area with peristomal brim 54

Colony unilaminar, encrusting; aperture rounded with small condyles; median suboral avicularium sometimes skewed to side; ovicell entirely perforate 56

54(53) Colony recumbent, branching, zooids flasklike, coarsely punctate (reticulate) with erect peristomes, bearing paired small avicularia at tops ..... *Lagenicella neosocialis*

Colony erect or semierect 56

55(54) Colony erect, branched, sometimes cylindrical; zooids flask shaped, reticulate, with peristomes projecting, appearing like fused spines, no irregular spines around secondary aperture ..... *Lagenicella punctulata*

Peristomes like fused spines, erect, tall with 4-6 spinelike projections, paired pedicellate avicularia at tops ..... *Lagenicella spinulosa*

56(53) Frontal wall entirely porous 57

Frontal wall with marginal pores only 58

57(56) Small median acute avicularium sometimes replaced by giant avicularium with wide tip; condyles tiny ..... ***Codonellina hastingsae*, new species**

Median avicularium long, narrow acute, sometimes skewed to lateral suboral position ..... ***Codonellina santabarbara*, new species**

58(56) Frontal walls with 1 row of marginal pores, a few extra scattered pores ..... *Pleurocodonellina longirostrata*

Frontal wall with 2-4 rows of marginal pores, central portion imperforate ..... ***Pleurocodonellina californica*, new species**

59(22) Primary aperture beaded distally, ovicell with frontal entooecial calcified labellum 60

Primary aperture not beaded, secondary aperture eccentric due to small avicularium sometimes becoming tall pillar; giant spatulate interzooecial avicularium with dark brown mandible; ovicell a shallow hood ..... *Celleporaria brunnea*

60(59) Colony erect, fenestrate; primary aperture with small median notch (pseudosinus) proximally; secondary aperture peristome high, with median proximal depression, collar sometimes meeting to form spiramen; no suboral avicularium, scattered large acute avicularia ..... *Phidolopora pacifica*

Colony encrusting; primary aperture with small avicularium in proximal margin directed laterally, its base becoming enlarged, umbonate; ovicell with frontal entooecial labellum ..... *Rhynchozoon rostratum*

61(29) Ovicell immersed, with single pore; frontal wall with few pores; apertures wider than high, sinus distinct, with condyles formed by primary apertural rim; secondary apertural rim thickened by encroaching frontal wall; no avicularia ..... ***Stomachetosella condylata*, new species**

Ovicell otherwise; paired lateral oral avicularia, other frontal avicularia present 62

62(61) Ovicell with horseshoe shaped ectooecial frontal area bound by a row of tiny pores separated by ridges; frontal wall vitreous with few scattered pores; aperture deep V-shaped sinus, curved condyles flush with apertural rim; paired lateral oral avicularia with acute or rounded mandibles, raised; larger frontal avicularium with longer acute mandible ..... *Buffonellaria vitrea*

Ovicell with semilunar frontal area open, with irregular bars radiating from center; paired lateral oral or suboral avicularia on pillars; operculum resting on shelflike condyles beside V-shaped sinus 63

63(62) Primary aperture with shallow sinus, becoming immersed; lateral oral avicularia bulbous with round mandibles directed inward or upward, additional bulbous round avicularia median suboral, or distal in zooids without ovicells; very large interzooecial avicularia paddle shaped, about 200 µm long, or erect columns with rounded opercula-like trap door; ovicells large, 300-350 µm wide ..... *Celleporina souleae*

Primary aperture with elongate, deep, V-shaped sinus, aperture becoming surrounded by tall peristome bearing bilateral oral avicularia with ovoid mandibles directed outward or inward; some zooids with additional similar medial proximal or distal avicularia; interzooecial avicularia shoe shaped, 250-500 µm long with complete hinge bar, tan mandible; ovicell smaller, 200-280 µm wide ..... ***Celleporina robertsoniae*, new species**

Order Cyclostomata (Tubuliporata)

1(5) Colony (zoarium) erect from first individual zooid (ancestrula) 2

Colony recumbent (adnate), not erect from first individual; colony shape uniserial to flabellate, apertures on frontal ..... SUBORDER TUBULIPORINA 3

2(1) Colony always erect, with joints, branching, attached by jointed rootlets or radicles; gonozooid a single, enlarged individual, opening (ooeciostome) a short tube; frontal wall simple, with pseudopores SUBORDER ARTICULATA 4

Colony erect, branching, treelike but never with joints; body wall thick, frontal wall lacking pseudopores (not represented herein) ..... SUBORDER CANCELLATA

3(1) Colony erect, branching, treelike but never with joints, or sheetlike, encrusting 5

Colony lobate, encrusting; peristomes immersed or rising into branches 10

4(2) One zooid per internode (between joints); long, filiform (slender) whiplike spines on colony margins ..... ***Bicrisia robertsonae*, new species**

More than one zooid per internode, no spines or processes 6

5(3) Tubular zooids immersed in crust, peristomes little extended above; colony encrusting; gonozooid ooeciostome small, short ..... ***Diplosolen harmelini*, new species**

Zooids very large, fasciculate, in branched clusters adnate or rising from base, colonies large, more erect in deep water; gonozooid spread around autozooids below bifurcation of branch, ooeciostome with flared lip, opening as large as autozooid peristomes ..... ***Diaperoforma californica*, new genus**

6(4) One to 3 zooids in sterile internodes, 3 to 5 in internodes bearing gonozooid (ovicell); gonozooid adnate, fused to other zooids, ooeciostome terminal, elliptical. ..... *Filicrisia franciscana*

Internodes with 3 to 40 zooids 7

7(6) Zooids in 2 alternating series; gonozooid distinct, elongate, expanded dorsoventrally 8

Zooids randomly arranged, partly immersed; gonozooid expanded between peristomes, flattened, ooeciostome short, opening somewhat hooded ..... *Crisulipora occidentalis*

8(7) Colony bushy tufts, internodes composed of 12-30 long slender autozooids; gonozooid a simple expanded zooid, ooeciostome curved or bent forward, opening elliptical ..... *Crisia serrulata*

Ooeciostome short, straight, may be curved at opening 9

9(8) Colony tufted, internodes with 3-5 zooids near base, up to 12 or more at distal ends, curved inward; joints between internodes white to yellow; ooeciostome opening round or slightly elliptical, centered ..... *Crisia occidentalis*

Colony stiff, straight branches, coarse; internodes long, 12-20 near base, up to 40 distally; older joints between internodes dark brown; autozooids immersed with short peristomes; gonozooid flattened, ooeciostome short, opening at margin round, tilted forward ..... *Crisia maxima*

10(3) Peristomes large, irregularly fasciculate, fused to ends (connate); gonozooid with fine pseudopores between tubules; ooeciostome tall, fused to peristomes, opening narrowly compressed, flared ..... *Tubulipora tuba*

Peristomes small, fasciculate or not 11

11(10) Colony fan-shaped, base not denticulate in appearance; peristomes mostly in fasciculate rows; gonozooid at base of tube, opening rectilinear, compressed with flared lip ..... *Tubulipora pacifica*

Colony bifurcate, base denticulate in appearance, peristomes not fasciculate, not in rows; gonozooid an inflated tube, opening slanted, lip flared ..... ***Tubulipora aliciae*, new species**

***Note*:** Other suborders of Cyclostomata (Tubuliporata) not represented in the present central California collections, but which might possibly be found there are as follows:

Suborder Rectangulata. Encrusting circular or subcircular, buttonlike colonies originating on a basal disk, sometimes becoming complex with vertical or lateral budding; peristomes erect (at right angles to the base), fused in rows, radiating from a central area lacking autozooids; brood chamber in center of colony, complex, sometimes extending between rows, serving colony, covered with a mesh-like layer of larger openings (cancelli, alveoli). May be mistaken for small coral colonies ..... Family Lichenoporidae

Suborder Cerioporina. Colonies recumbent, semierect or erect, forming large anastomosing branches or clumps; 2 types of apertures: autozooid peristomes and kenozooids (zooids without internal organs, polypides) in about equal numbers; brood chamber serving colony, subcircular in outline, pierced by autozooids ..... Family Heteroporidae

New Taxa

Listed below are new genera and species which are described and figured in the present work. The complete authorship citation for each of these taxa is : "D.F. Soule, J. D. Soule and H. W. Chaney, 1995".

ANASCA

Aetea paraligulata
Conopeum osburni
Micropora santacruzana
Cauloramphus californiensis
Copidozoum andamantum
Tegella larusiensis
Tricellaria circumternata

CRIBIMORPHA

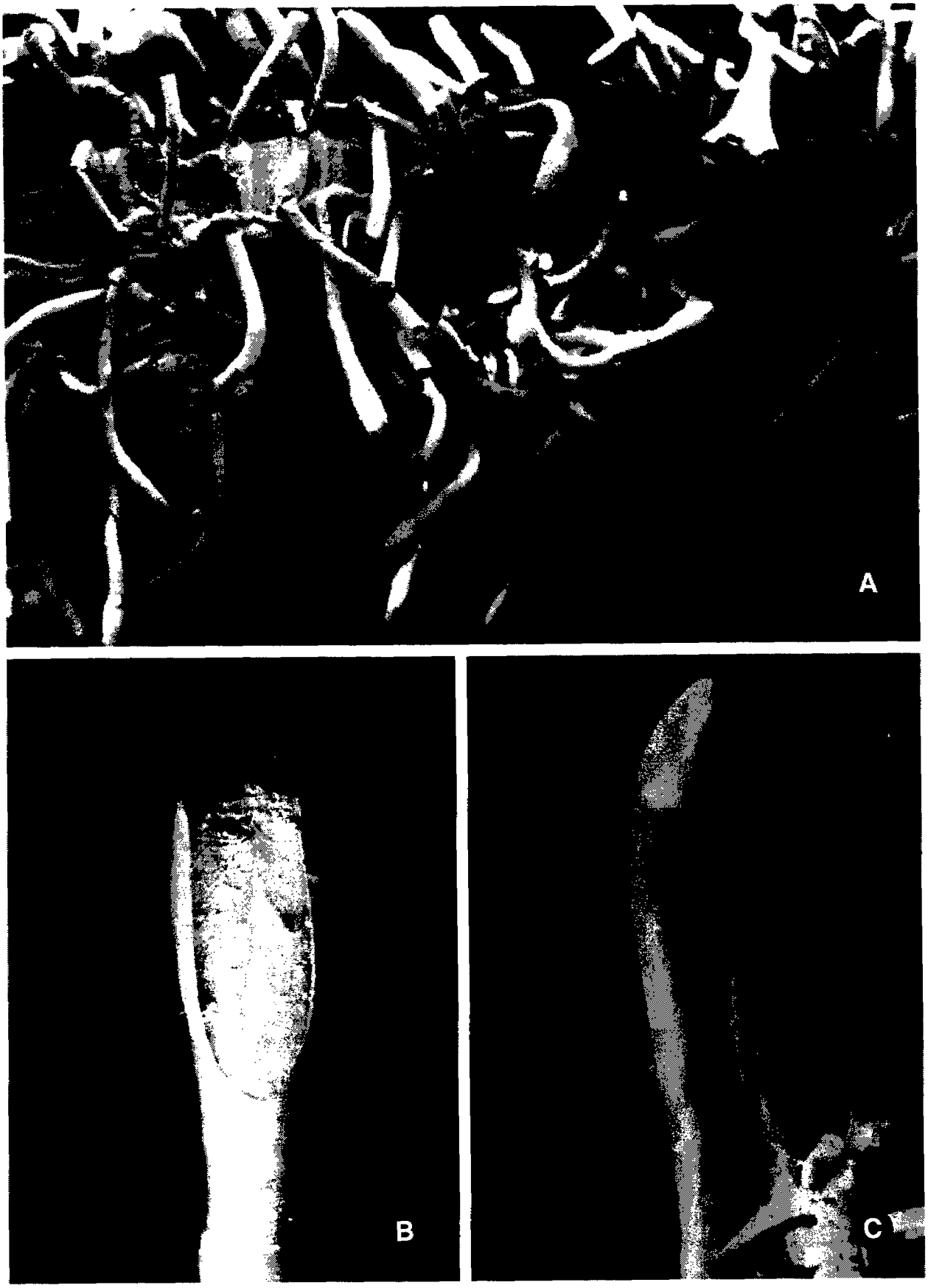
Puellina (Cribrilaria?) perplexa
Puellina (Cribrilaria) californiensis

ASCOPHORA

Microporella catalinensis
Microporella infundibulipora
Microporella planata
Microporella umboniformis
Fenestrulina farnsworthi
FENESTRULOIDES
Fenestruloides morrisae
Fenestruloides eopacifica
Fenestruloides blaggae
Fenestruloides miramara
Hippoporina mexicana
NEODAKARIA
Neodakaria islandica
Neodakaria umbonata
Schizoporella pseudoerrata
Schizomavella robertsonae
Schizomavella triavicularia
Smittina veleroa
Smittina ovirotula
Schizosmittina pedicellata
RAYMONDCIA
Raymondcia osburni
Raymondcia macginitiei
DENGORDONIA
Dengordonia uniporosa
HAYWARDIPORA
Haywardipora rugosa
Haywardipora rylandi
Haywardipora orbicula
Porella taylori
Stomachetosella condylata
Codonellina hastingsae
Codonellina santabarbara
Pleurocodonellina californica

CYCLOSTOMATA

Diplosolen harmelini
DIAPEROFORMA
Tubulipora aliciae
Bicrisia robertsonae


A
B
C

2. Description of Species

Class Gymnolaemata

Order Cheilostomata

Suborder Anasca

Family Aeteidae Smitt, 1867

Colonies uniserial, zooids composed of adherent basal portion, erect, cylindrical stem, and enlarged distal portion with ventral membranous frontal with an operculum flap and spoon-shaped, convex dorsal surface. Colonies appear stolonate, but formed of contiguous bases of zooids, with some kenozooids between, strengthening base.

Aetea pseudoanguina, new species

Plate 1 A-C

Aetea anguina: Robertson, 1905: 244, pl. 4, figs. 1-4. — Osburn, 1950: 11, pl. 1, fig. 3. (in part).
? *Aetea anguina*: J. D. Soule, 1959: 2.

Material examined. MMS Station: BRA-13. AHF Collections.

Diagnosis/Description. Whitish, tangled colonies formed by creeping, uniserial, terete, stolonate basal portions of zooids adherent to substrate, each giving rise to erect tubular structure 1,200 - 1,500 μm long, 60-80 μm in diameter. Stalk sometimes showing minute striations with tiny tubercles or spines, distal 20 - 25% of stalk inflated, bent forming "snake's head" appearance; lower side of head bearing flattened, frontal membrane area with distal operculum having curved distal margin and straight or slightly curved proximal margin. Polypide (tentacles and viscera) can be withdrawn into the basal portion of zooid.

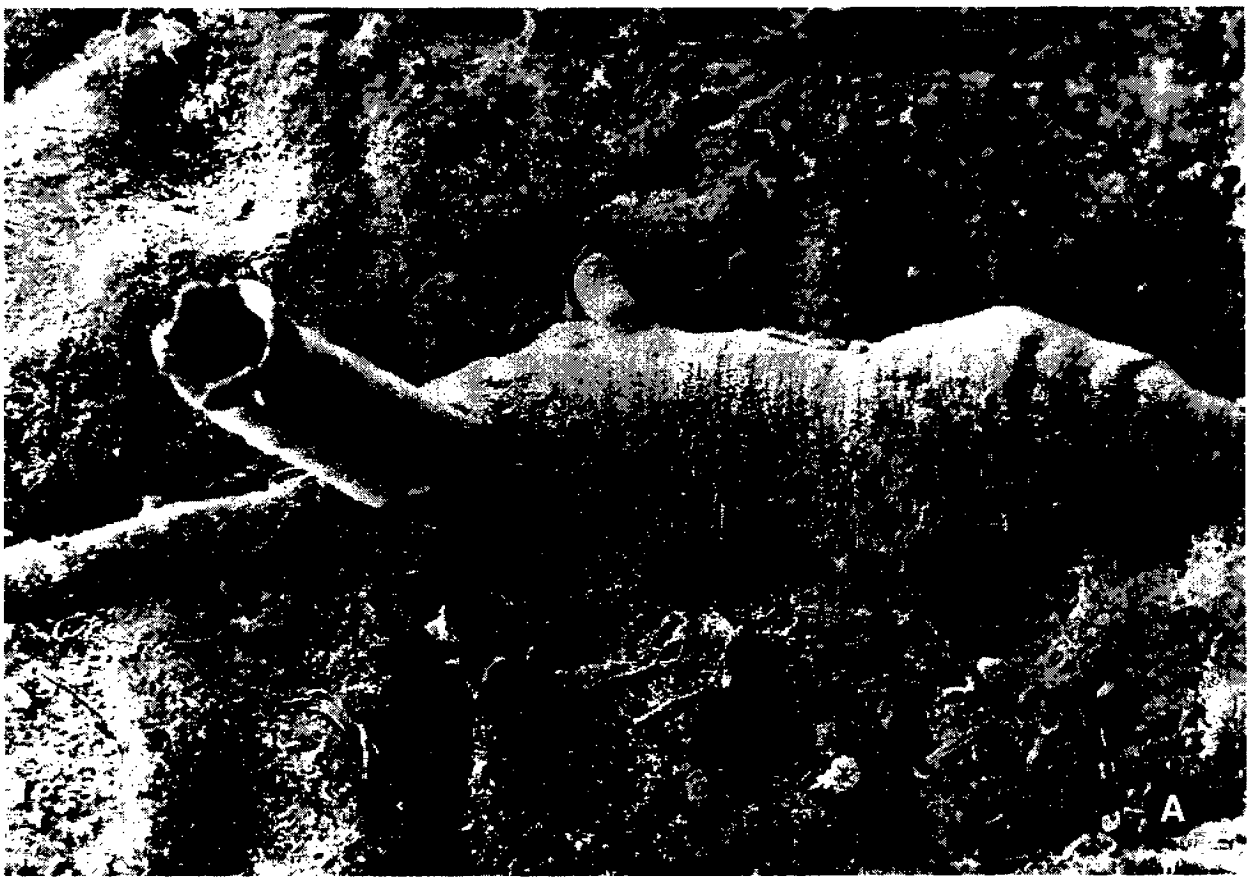
Etymology. Named for the resemblance to the European species *Aetea anguina* (Linnaeus, 1758).

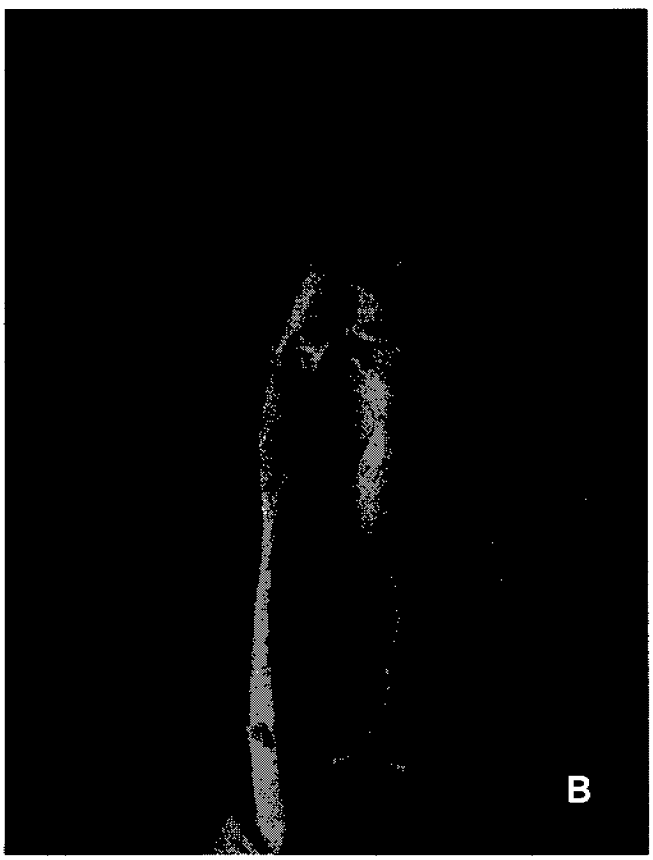
Biology. *Aetea anguina, sensu lato* has been reported from shallow water to 60 m; the MMS station depth of the new species is 92-100 m. Substrates include algae, rock and other bryozoans.

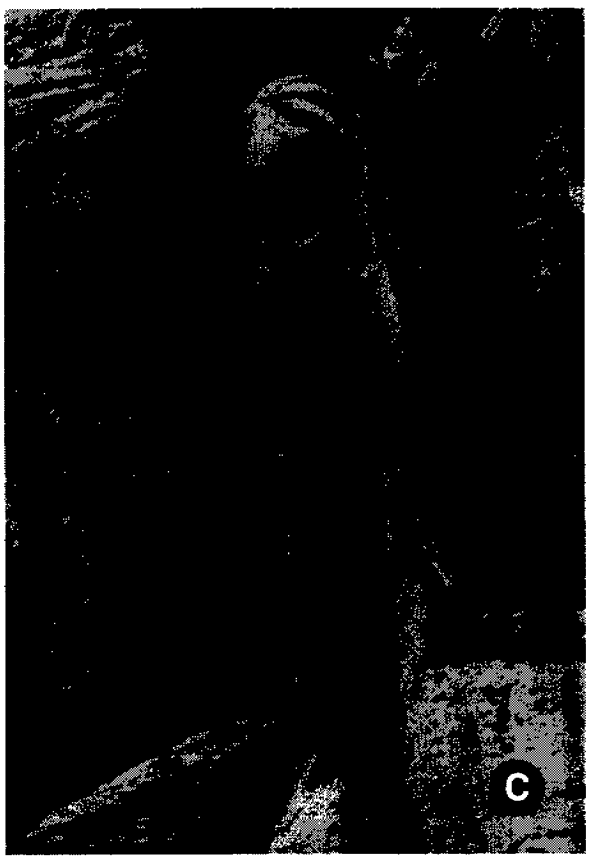
Taxonomic Remarks. The new species differs from *Aetea anguina* in having a much longer, narrower stalk (1,200-1,500 μm compared to 567-827μm) and a shorter membranous area; the presence of tiny tubercles or spines on the head and stalk differs from the pseudopores on the head of *A. anguina* (see Ryland and Hayward, 1977). Osburn (1950) noted the tubercles and spines but ascribed them to misinterpretations of pores.

The basal portion of the zooid with the erect tubule broken off gives the striated appearance of some *Hippothoa* species. *A. anguina* has been reported around the world in all except polar seas but the actual distribution of that species is open to question; the "snake's head" appearance has probably been the basis for most identifications. Robertson (1905) suggested that her specimens might belong to a new species.

Plate 1. *Aetea pseudoanguina.* Santa Rosa Island. A. Colony, showing "snake's head" appearance. B. Ventral view, showing membranous frontal, operculum, spine. C. Lateral view.


A


B


C

The aeteids appear to be more closely related to the soft bodied Ctenostomata than to most of the Cheilostomata, based on their tubular structure and terminal or subterminal aperture, the transitory presence of a membranous sac for an ovicell and a setose collar around tentacle sheath when it is everted. They differ in having a membranous frontal extending down one side of the calcareous stalk.

Type Locality and Type Specimens. Santa Rosa Island, California. SBMNH-AHF Bryozoa Holotype No. 200.

Distribution. Central and southern California. The MMS station is offshore between Point Arguello and Purisima Point. Material from Baja California was too worn to differentiate between *A. anguina* and the new species.

Aetea paraligulata, new species

Plate 2 A-C

? Aetea ligulata Busk, 1852: 31, pl. 42, figs. 1, 2.— Hincks, 1882: 460.— J. D. Soule, 1959: 4.
Aetea ligulata: Osburn, 1950: 13 (in part).

Material Examined. MMS Station: BRA-13. Other collections: AHF and BMNH.

Diagnosis/Description. Basal portions of the zooids are irregularly terete, with stolonlike connections, finely or coarsely annular, with tubercles along lower margins, and with tubules rising from distal areas; erect stalks widely annulate for about 50% of length, with creases (ligulations) at or near base of frontal membrane of terminal section and at base of opercular area. Aperture terminal distally, extending down stalk proximally in a curve, also with a constriction at base of aperture; upper stalk not annulated but may bear tiny tubercles or spines; total erect stalk length about 700 μm.

Etymology. Named for the similarity to *Aetea ligulata* Busk, 1852.

Biology. Previously known from shallow water to 85 m, on algae, rock and shell; the MMS record is 92-100 m.

Taxonomic remarks. The original description of *Aetea ligulata* by Busk (1852) is very brief: "Cells very long, truncate at the extremity, straight; mouth terminal; surface not ringed; cells constricted immediately below the aperture." It was well illustrated and there are some differences between *A. ligulata* and the new species; *A. paraligulata* has an aperture that is mostly subterminal, with only a small part turned across the terminal portion. Zooids are larger than those illustrated by Busk, which were about 450 μm long whereas those of the new species are about 700 μm. The ratio of the frontal membrane portion to the entire stalk in Busk's illustration is from about 38% to 50%, whereas the ratio is 50% or greater in the new species.

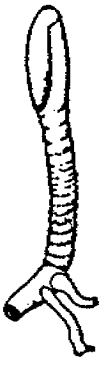
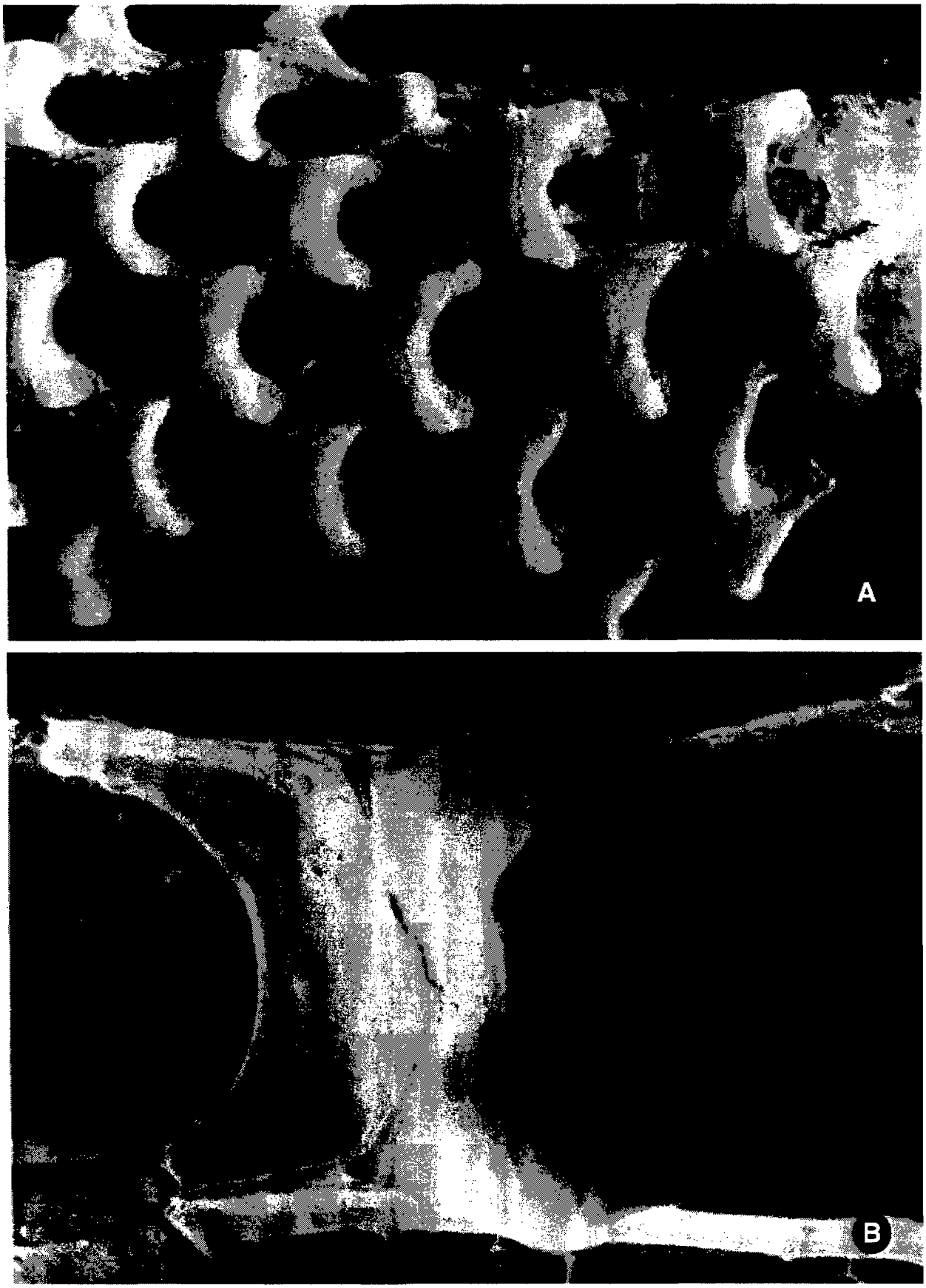


Figure 7. *Aetea ligulata.* From Osburn,1950, pl. 1, fig. 4

The condition of many collected and preserved aeteids is poor, making identifications difficult. The illustration in Osburn (Figure 7) is probably not the *A. ligulata* of Busk, since it is distinctly annulated, as is the new species. Busk specified that his species was not "ringed" (annulated). The *Aetea truncata*

Plate 2. *Aetea paraligulata*. Santa Catalina Island, AHF Sta. 115-40. A. Terete basal portion, annulated lower portion of zooid. B. Upper portion of zooid with membranous frontal. C. Membranous frontal, opercular area.


A
B

(Landsborough, 1852) of Osburn is also not that species, based on the illustrations of Hincks (1880: pl.1 figs. 8-10) and Ryland and Hayward (1977: fig. 15) which show partially free growth with stolonate processes and new zooids extending like branches from the upright portion of the regular zooids. Consequently a number of the distribution records of *A. truncata* on the Pacific coast may be erroneous. *Aetea recta* Hincks, 1880 of Osburn (1950) is synonymized with *Aetea sica* (Couch, 1844) by Ryland and Hayward (1977), a concept rejected by Osburn due to the condition of Couch's specimens. *Aetea sica* is usually characterized by its long (800 to 1,800 μm) straight stalk, finely annulated, and a straight terminal distal end.

Type Locality and Type Specimens. Off Santa Catalina Island, California, AHF Station 1153-40. SBMNH-AHF Bryozoa Holotype No. 201.

Distribution. Central and southern California. *Aetea ligulata* was first collected by Darwin (Busk 1852) from the tip of South America, and subsequently reported in the Queen Charlotte Islands, British Columbia (Hincks (1882); it may be a cold water species (or group of species). Osburn's records from southern California and Galapagos Island locations and those of J. D. Soule (1959) in the Gulf of California are probably of the new species, with a warm temperate to tropical distribution. The MMS station is offshore between Point Arguello and Purisima Point.

Family Membraniporidae Busk, 1854

Colonies erect or encrusting; zooids with frontal gymnocyst reduced or absent, cryptocyst usually also reduced. In two genera included herein, tubercles may be present at corners of zooids and cryptocystal spinules may project into opesia in *Membranipora* spp., all with twinned ancestrulae, while *Conopeum* spp. may have gymnocystal spines and a single ancestrula. There are no ovicells; larvae are of the cyphonautes type.

Membranipora tuberculata (Bosc, 1802)

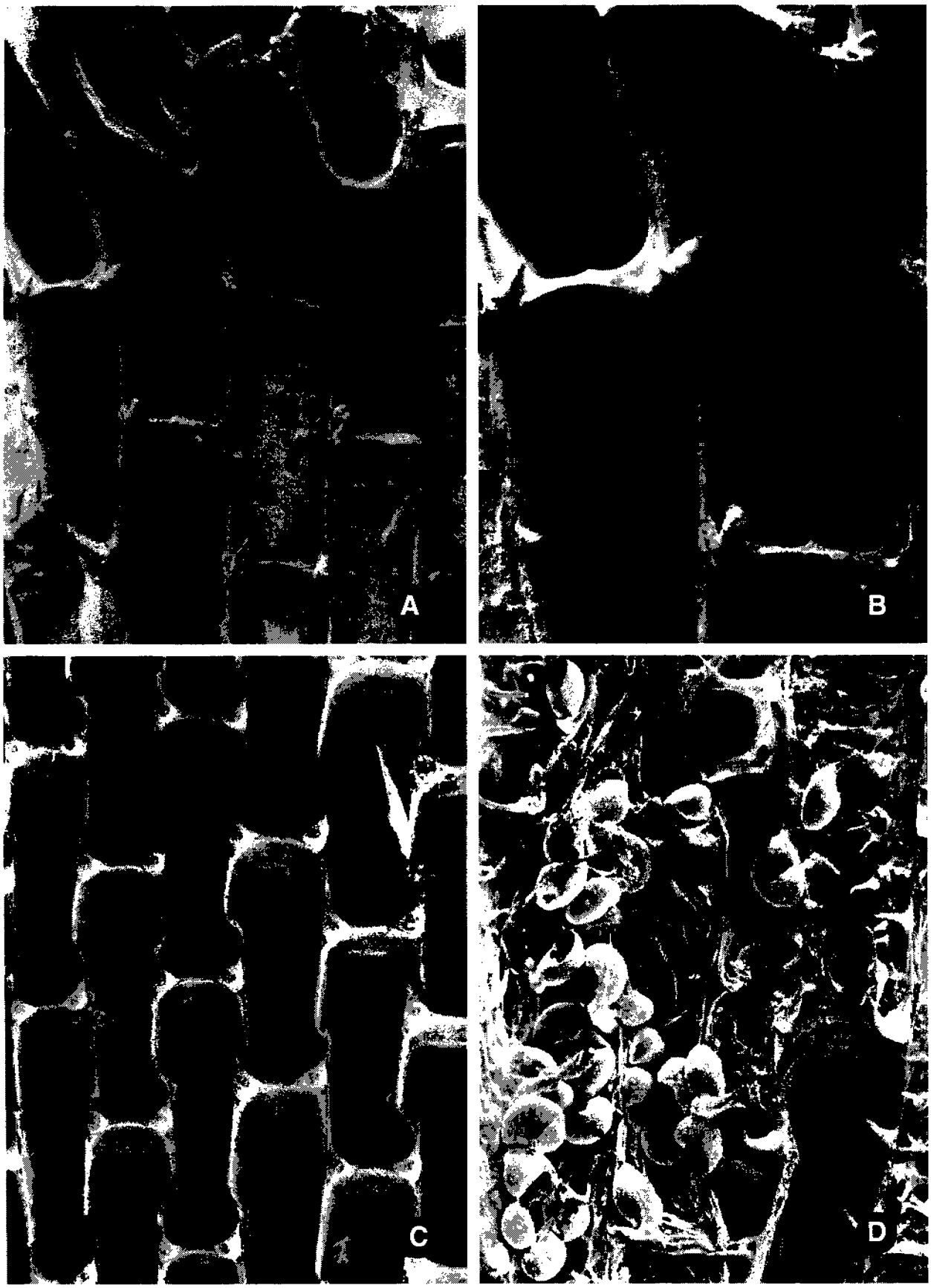
Plate 3 A-D

Flustra tuberculata Bosc, 1802: 118, (in part).
Flustra tehuelcha d'Orbigny, 1847: 17, pl. 8, figs. 10-14.
Membranipora tehuelcha: Robertson, 1908: 265, pl. 15, figs. 16, 17, pl. 16, fig. 18.
Membranipora tuberculata: Canu and Bassler, 1923: 22, pl. 33, figs. 3-5. — Osburn, 1950: 23, pl. 2, figs. 4-6. — J.D. Soule and Duff, 1957: 88. — J.D. Soule, 1959: 4. — D.F. and J.D. Soule, 1964: 9.
Nichtina tuberculata: Hastings, 1930: 706, pl. 3, figs. 9, 10.

Material examined: AHF and BMNH Collections.

Description. Colonies range from glistening white to tan encrustations, primarily on floating *Sargassum*. Zooids rectangular, 200-230 μm long, 100-110 μm wide. Opesia oval, covered by thin frontal membrane. Cryptocyst narrow laterally, coarsely granular, crenulate, wider proximally, with short spinules extending into opesial opening. The transverse walls on mature zooids bearing a pair of prominent tubercles which may merge medially, giving colony a reticular appearance at low magnification, a diagnostic characteristic. Young colonies lightly calcified, sometimes with tubercles incomplete, partly open.

Plate 3. *Membranipora tuberculata*. Mussel Pt., Monterey Bay, California. A. Colony with well developed tubercles at proximal end of zooids, crenulated cryptocyst. B. Distal end of zooid to left of transverse (vertical) body wall; to right, developing hollow tubercles, arcuate developing basal wall.


A
B
C
D

Biology. Recorded from temperate and tropical shallow waters to 50 m. Occurring on wide variety of substrates: wood, shell, rock, snake's eyelids; widely distributed on floating *Sargassum* and other algae and by fouling. While predominantly a shallow water species, it can occur in deeper waters.

Taxonomic Remarks. *Membranipora tuberculata* has been cited in numerous publications; the citations given above primarily include the eastern Pacific literature. The species is distinctive when heavily calcified, but young or lightly calcified colonies may be more difficult to recognize. Harmer (1926) and others considered the tubercles to be proximal structures (e.g., Gordon, 1984), while Osburn (1950) and other authors considered them to be distal; we interpret them as proximal, since they develop distal to a transverse wall and are initially open toward the developing zooid at the growing margin.

Type Locality and Type Specimens. On "Gulfweed" in the Atlantic Ocean. No type has been designated.

Distribution. Common on *Sargassum* in the warmer waters of the Atlantic. Known in the Pacific from northern California southward to Peru; rarely found in Hawaii, where it may be periodically introduced without establishing permanent colonies.

Membranipora serrilamella Osburn, 1950

Plate 4 A-D

Not *Membranipora serrata* MacGillivray, 1869: 131.
Membranipora membranacea form *serrata* Hincks, 1882b: 469.
Membranipora serrata: Robertson, 1908: 268, pl. 16, figs. 20, 21, 21a.— C.H. and E. O'Donoghue, 1923: 26; 1925: 96; 1926: 29.
Membranipora serrilamella Osburn, 1950: 22 pl. 1, figs. 12, 13.

Material Examined. AHF and BMNH Collections.

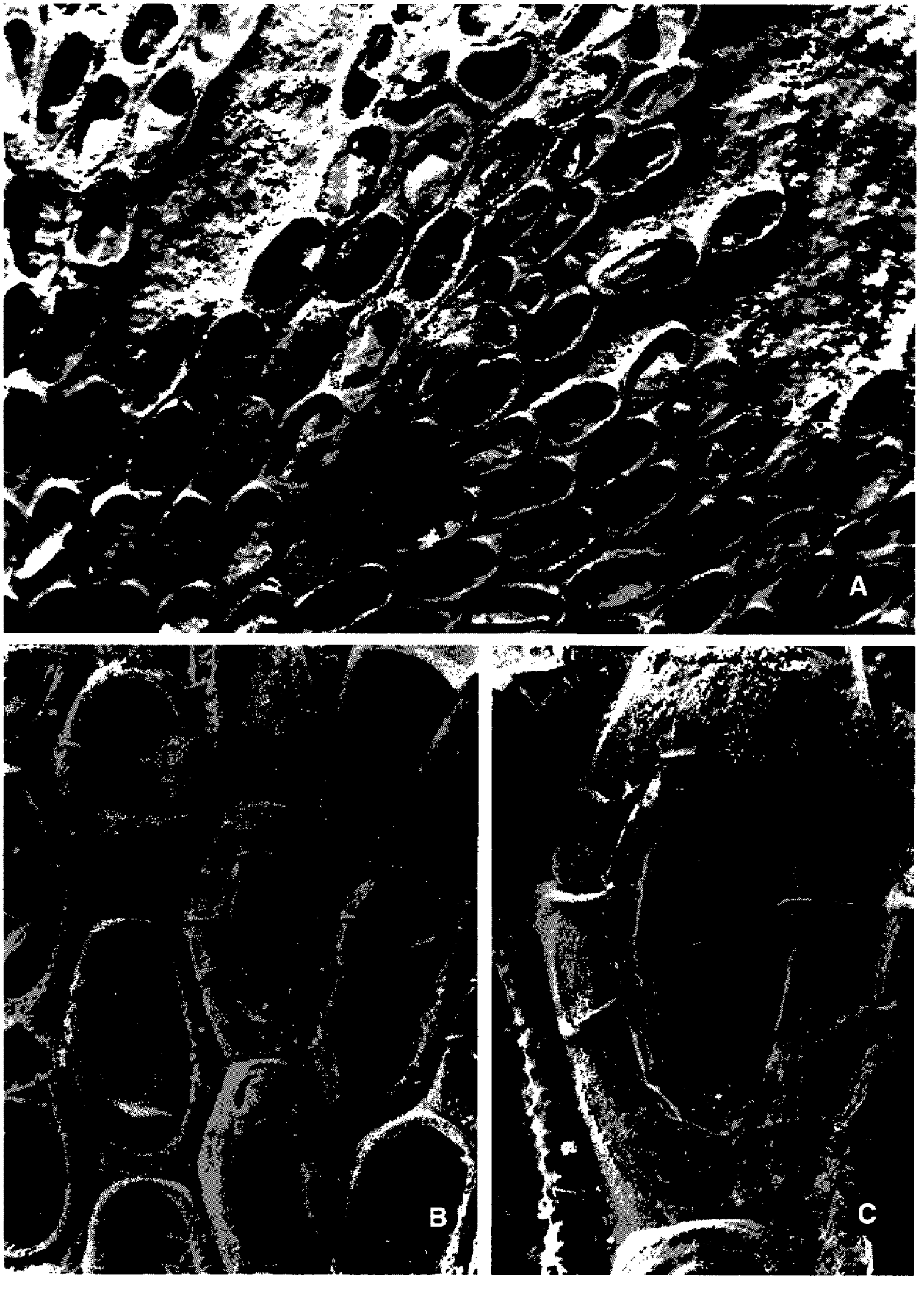
Description. Irregularly rectangular zooids, 700-800 μm long, 210-300 μm wide. Operculum distinct although continuing from frontal membrane. Cryptocyst wider distally, granulate or serrate, narrow laterally and proximally, with short lateral spinules especially near proximal end; distal walls bearing a short hollow spine at each corner.

Biology. Colonies usually encrusting algae. Recorded from shallow water to 30 m, but may extend to the bottom of the photic zone.

Taxonomic Remarks. The species of *Membranipora* are often confusing. In our opinion, *M. serrilamella* differs from *Membranipora membranacea* (Linnaeus, 1767) in having short spines at the distal corners instead of small knobs with papillae. Originally described by Hincks (1882b) as *M. membranacea* form *serrata*, that name cannot be elevated to species level, as did Robertson and C.H. and E. O'Donoghue, because it was preoccupied by a different form as *M. serrata* MacGillivray, 1869. Osburn renamed the eastern Pacific form as *M. serrilamella*.

Membranipora membranacea (Plate 4, figure C, from Roscoff, France) heavily encrusts the huge kelp fronds up to 20-30 m long in the northern Atlantic and English Channel. It may occur rarely, or not at

Plate 4. *Membranipora serrilamella*. Belmont Pier, Long Beach, California. A. Colony with thin vertical body walls, distal small spines on corners. B. Enlarged view showing narrow cryptocyst with small spinules projecting inward. C. *Membranipora membranacea* from Roscoff, France, showing typical widened apertural area, narrower proximal area. D. *Membranipora villosa* with curved calcified spines on body wall, chitinous spines on frontal membranes where predators are shown browsing.


A
B
C

all on the Pacific coast, having been confused with *M. serrilamella*. Typically the *M. membranacea* zooids are large, wide distally around the small apertures and narrowed medially, widening proximally, arranged in alternating rows that are irregular due to crowding. Narrowing occurs at a hingelike point opposite where the corner knobs occur. The cryptocyst of *M. membranacea* is almost absent, with or without tiny spinules. Sometimes chitinous tower cells arise on transverse walls which may have a function in creating currents over the surface of the colony. Patches of non-feeding zooids on colonies of many species apparently create excurrent "chimneys" that cause water to flow across the colony surface and out, transporting food and preventing recycling of suspended matter (e.g., Banta et al., 1974; Cook, 1977; Lidgard, 1981).

The form known as *Membranipora villosa* Hincks, 1880 has rectangular zooids or they may be rounded distally, and may have curved calcareous spines on the corners with spinules around the cryptocyst; where they are infested with newly settled molluscan predators, the frontal membranes become covered with chitinous spines and branched spinules (Plate 4, figure D, from Los Angeles Harbor). Yoshioka (1982) reported on predator-induced polymorphism in *Membranipora membranacea*, tallying occurrences of three presumed species in the field and speculated that *M. serrilamella* and *M. villosa* might be conspecific morphs of *M. membranacea*. However, when we visited his lab at the time we were not convinced that the species was in fact identical to the European *M. membranacea* such as we had collected at Roscoff, but was probably *M. serrilamella*. Harvell (1984) tested the same Pacific form identified by her as *M. membranacea*, and was able to demonstrate induction of spinules under predation by nudibranchs. Confused with "*M. villosa*" has been a South American species, *Membranipora isabelleana*, which grows in a curious, raised, circular pattern and may also have both calcareous and chitinous spines (Moyano, 1966). The shape of the zooids in *M. isabelleana* is more similar to that in *M. membranacea* than to the form "*M. villosa*".

Type Locality and Type Specimens. Virago Sound, Queen Charlotte Islands, British Columbia. Hincks' material of *Membranipora membranacea* form *serrata* is in the BMNH Collections.

Distribution. *M. serrilamella* occurs from British Columbia to southern California. Questionably reported in Brazil (Marcus, 1937) and Japan (Okada, 1929, 1934).

Conopeum osburni, new species

Plate 5 A-C

Electra crustulenta: Osburn, 1950:35 (in part), pl. 3, fig. 5. — J.D. Soule, 1959: 9.

Material Examined. AHF and Soule Collections.

Diagnosis/Description. Colony encrusting, in uniserial or multiserial rows. Zooids hexagonal to ovoid, with coarsely granular, rolled cryptocyst, extending inward at proximal margin of operculum, cryptocyst surrounded by narrow gymnocyst; zooids 380-420 μm long, 180-210 μm wide. Zooids separated by deep grooves, sometimes with interzooecial spaces at distal corners. Two small spines at distal corners between gymnocyst and cryptocyst, 3-6 pairs of short, slender spines extending over cryptocyst and opesia. Some regenerated or repaired zooids having a wider, thicker cryptocyst, heavier frontal membrane and operculum; occasionally, other small ovoid kenozooids present in some colonies.

Plate 5. *Conopeum osburni*. Cape Arena, Oregon. A, Loosely connected, ovate zooids forming encrusting colony. B. Zooids usually with narrow, rolled, granular cryptocyst with narrow gymnocystal rim bearing tiny spines; some zooids with wider, possibly regenerated, cryptocyst, heavy frontal membrane. C. Zooid with wider cryptocyst.

Etymology. Named for the late Raymond C. Osburn, who noted and figured this form as a variation of *E. crustulenta.*

Biology. Found encrusting shell; intertidally in Oregon and northern California waters to 37-73 m in Baja California waters.

Taxonomic Remarks. As discussed above, Osburn (1950) remarked that this form was a variety of *Electra crustulenta* (see Figure 8 below). Shier (1964) described *Electra laciniosa*, taken from shallow waters off northwest Florida. His species is similar to *C. osburni* but has 12 to 18 spines, with zooids widest at the distal end tapering proximally. His zooids were about the same size as those in *C. osborni* and he did not record any regenerated or repaired zooids or kenozooids. Spination may be environmentally stimulated, according to Poluzzi and Sabelli (1985), based on the variation they observed in the European estuarine and brackish water species *Conopeum seurati* (Canu, 1928), a species somewhat similar to *E. laciniosa* and *C. osburni.* Poluzzi and Sabelli coined the term "kleistozooids" for clusters of zooids that were covered with a thick, chitinized, imperforate veneer, and hypothesized that they were degenerated zooids transformed for storage of proteinaceous reserves for reproduction. Our specimens were not so well chitinized nor were they clustered. Also they were not treated to remove the frontal membrane. An alternative suggestion is that the clusters of kleistozooids may form a passive excurrent function for the colony (Banta *etal.*, 1974; Cook, 1977).

The regenerated (or degenerated) zooids in *Conopeum osburni* resemble the cryptocyst, gymnocyst and spines found in *Conopeum reticulum* (Linnaeus, 1767), but lack the almost uniform presence of distal, or interzooecial, kenozooids with triangular or ovoid opesiae that are so characteristic of *C. reticulum*, and according to Osburn, characteristic of the genus. However, the European *C. seurati* lacks them. Osburn and Shier placed their forms in the genus *Electra*, probably based on the absence of the kenozooids and the similarity to *E. crustulenta*. Other *Electra* species have more extensive gymnocyst development, reduced cryptocyst, smaller opesiae and stouter spines.

Type Locality and Type Specimens. AHF 1487-42, Cape Arago, Oregon, intertidal. SBMNH-AHF Bryozoa Holotype No. 202.

Distribution. Cape Arago and Yaquina Bay, Oregon; Dillon Beach, San Francisco, and Monterey Bay, California; Coronados Island, north of Carmen Island in the Gulf of California and Los Frailes Bay, in the Gulf near the tip of Baja California.

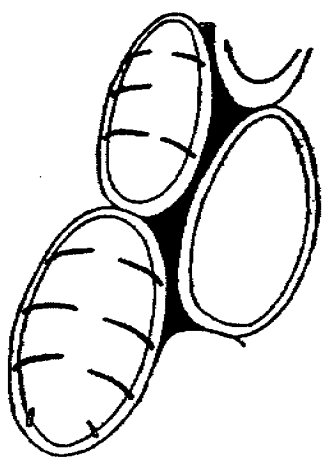


Figure 8. *Electra crustulenta*, variety. From Osburn, 1950, pl. 3, fig. 5.

Family Electridae Stach, 1937
(=Electrinidae d'Orbigny, 1852; Electridae Lagaaij, 1952)

Colonies mostly encrusting; gymnocyst well developed, perforate or not, covering one-third to one-half of zooids, cryptocyst reduced; spines present or absent; no ovicells, avicularia or vibracula. Type species of *Electra, E. pilosa* (Linnaeus, 1767), with a perforate frontal wall, but other Electridae may not.

Electra venturaensis Banta and Crosby, 1994

Plate 6 A-B

Not *Eschara crustulenta* Pallas, 1766: 39.
? *Membranipora crustulenta* var. *arctica* Borg, 1931: 27, pl. 1, figs. 3-5.
? *Membranipora lacroixii*: C.H. and E. O'Donoghue, 1923: 25 (? part).
Electra crustulenta var. *arctica*: Osburn, 1950: 36 (in part), pl. 3, fig. 4.
? *Electra crustulenta*: Dick and Ross, 1985: 89. — Dick and Ross, 1988: 31, pl. 1, fig. B.
Electra venturaensis Banta and Crosby, 1994: 544, figs. 1-3.

Material Examined. AHF and BMNH Collections. BMNH slide 1966.1.8.7.

Description. Colonies encrusting. Zooids elliptical, 350-450 μm long, 200-250 μm wide, separated by deep grooves. Frontal membranous, a large oval opesia with narrow crenulated cryptocyst; smooth gymnocyst curved inward around cryptocyst to form a rim. Operculum large, lightly calcified, with straight proximal border. A single, strong, median, cone shaped base or "boss" topped by a longer chitinous spine, sometimes becoming calcified, on the gymnocyst proximal to the opesia. No other spines. Smaller oval kenozooids or dwarf individuals sometimes present which may bear an opesia. Frontal buds originating in a distolateral gymnocystal window sometimes present; seen on older, crowded, multilaminar colonies.

Biology. Reported from shallow waters to over 30 m, encrusting shell and rock. The Pacific coast distribution includes possibly the estuarine waters of San Francisco Bay as well as fully marine habitats, indicating that *Electra venturaensis* differs from *E. crustulenta* (Pallas, 1766) of the North Atlantic, which is limited to estuarine habitats, according to Ryland and Hayward (1977). In Britain that species reproduces between March and July, liberating eggs and sperm simultaneously from each zooid. The larva is a shelled, ovoid to triangular, planktonic *cyphonautes*.

Taxonomic Remarks. The identity of *Electra crustulenta* has been widely confused, with a number of varieties being described. Ryland and Hayward (1977) reported *E. crustulenta*, which has a proximal spine, on various substrates including fucoids and the stems of *Ruppia maritima*, and indicated that it is limited to estuarine habitats, although it is euryhaline in tolerance; e.g., 13.7-27.3 0/00. Borg's variety *arctica*, which also has a strong proximal spine as a principal diagnostic character, is considered to be marine and circumpolar (Kluge, 1962, 1975). A Baltic "subspecies" survives at 2 0/00. Borg (1931) stated that the typical form of *E. crustulenta* has much longer and wider zooids, about 720 μm long and 290 μm wide, as compared to the California specimens. He described the arctic form as having zooids averaging about 620 μm long and somewhat wider, about 330 μm. These are both considerably larger than the Pacific coast specimens observed by us and described by Banta and Crosby (1994). The size difference suggests that the Pacific coast material consists of one or more new species, regardless of the presence or absence of the heterozooids described by Banta and Crosby or those noted by us in the San Francisco material.


A
B

The Alaskan *"E. crustulenta"* material of Dick and Ross (1988), possibly of *E. venturaensis*, has small rectangular kenozooids that had been previously undescribed, which they interpreted as possible overwintering bodies (hibernacula). AHF material from San Francisco Bay has oval kenozooids or "dwarf" zooids. Banta and Crosby (1994) described *E. venturaensis* as a new species including AHF Collection specimens identified previously by Osburn, Soule or Banta as *E. crustulenta* var. *arctica*. In material Banta collected in the shallow subtidal off Rincon beach, north of Ventura, California, Banta and Crosby describe the formation of heterozooids budded upward from distolateral gymnocystal windows. There was no evidence of this on material we examined, except for a few such buds on a multilaminar colony from Nunivak Island, Alaska. It is possible that the heterozooids are the result of crowded substrate in older colonies, or may be an overwintering phenomenon, as proposed by Dick and Ross, since Banta's specimens were collected in winter.

The variety of *E. crustulenta* with mural spines and no proximal spine from Cape Arago, Oregon, Dillon Beach, California (Osburn, 1950, pl. 3, fig. 5) and the Gulf of California (Soule, 1959) is described above as the new species *Conopeum osburni*. The geographic ranges of *E. venturaensis* and *C. osburni* overlap in central California and Oregon.

Type Locality and Type Specimens. The type locality of *E. venturaensis* is Rincon Beach, five miles north of Ventura, California. There is no type or type locality for *E. crustulenta*. Borg's variety *arctica* was described from Spitzbergen.

Distribution. The distribution of *E. venturaensis* is theoretically from Alaskan waters to southern California. *Electra crustulenta* was originally described from the "oceanus Atlanticus"; it is found on both sides of the north Atlantic (Osburn, 1950).

Family Microporidae Hincks, 1880

Colony covered by glistening, continuous membrane; gymnocyst nearly absent, cryptocyst perforate or not, extending to form straight proximal lip of apertural area identical to opesia, cryptocyst descending downward toward basal wall, forming 1 or more pairs of lateral openings (opesiules) beside lateral walls; ovicells and avicularia present or absent.

Micropora santacruzana, new species

Plate 7 A-C

?*Micropora coriacea*: Hincks, 1882b: 470. figs. 4, 5. — Robertson, 1908: 275, pl. 17, fig. 26. — C.H. and E. O'Donoghue, 1923: 30. — C.H. and E. O'Donoghue, 1925: 100. — Osburn, 1950: 105 (in part), pl. 11, fig. 3.

?*Micropora (Flustra) coriacea*: C.H. and E. O'Donoghue, 1926: 49.

Material Examined. MMS Station: BRA-17 (as *M. coriacea*). Other collections: AHF and BMNH.

Plate 6. *Electra venturaensis*. San Francisco Bay. A. Two colonies growing into each other, opesiae oval, a few with small spine at proximal end. B. Enlarged; oval cryptocyst rims opesia, spine at proximal border; kenozooid to upper left, dwarf zooid with opesia at right.

Diagnosis/Description. Colonies encrusting. Zooids distinct, irregularly elliptical to diamond shaped, 420-525 μm long, 280-360 μm wide. Lateral walls raised, granular, ridged, forming a pair of knob-like tubercles distally, adjacent to the straight proximal rim of the aperture. Frontal wall slightly raised, finely granular, with numerous small pores rimmed with minute spinules. Two small opesiules present immediately below the aperture. Avicularia with ovoid rostra located distal to many apertures, mandibles bluntly acute, directed distolaterally. Ovicells prominent, subglobular, finely perforate, often with apical umbo; ovicell closed by zooidal operculum.

Etymology. Named for Santa Cruz Island, California, close to the type locality.

Biology. The MMS depth is 160.5-168 m; the type locality depth is 42 m.

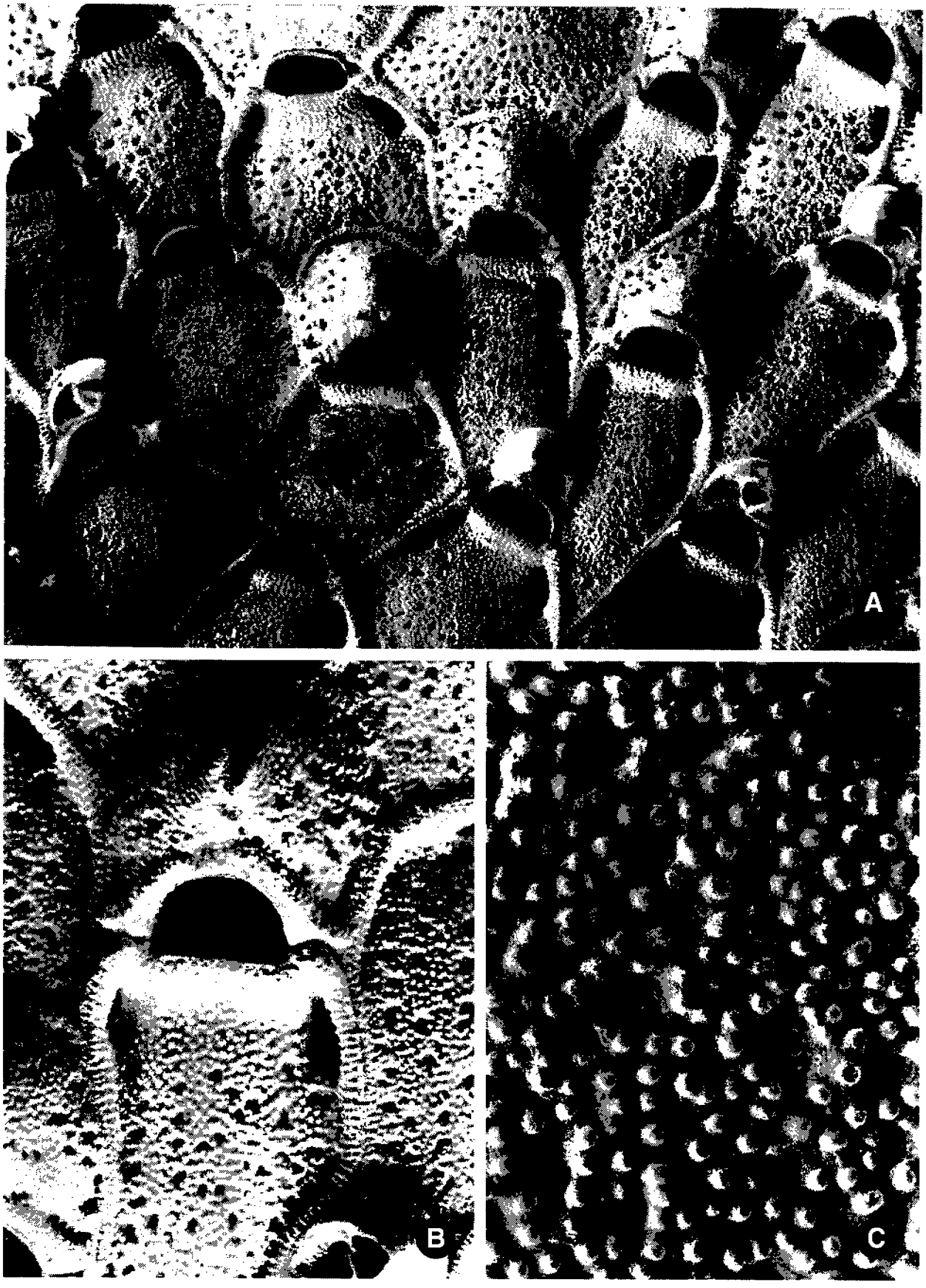
Taxonomic Remarks. MMS BRA-17 was originally recorded as *Micropora coriacea*, a species which lacks avicularia and has been widely recorded from temperate and warmer waters. Pacific coast material resembles the British *Micropora normani* Levinsen, 1909, in the presence of the distinctive avicularia. Ryland and Hayward (1977) reported the frontal pores of *M. normani* as numbering about 15; Pacific material has many more pores (30-45), as does *M. coriacea* (Johnston, 1847). The spinules in *M. santacruzana*, rimming the pores (Plate 7C) have not previously been reported to our knowledge. The ovicells of *M. normani* are imperforate and granular, whereas there are numerous perforations on the ovicells of *M. santacruzana*, similar to the perforations on the frontal.

In the absence at that time of a type for *M. coriacea*, Osburn (1950) modified the original description by adding the presence of avicularia; J. D. Soule (1959), following Osburn's lead, identified material from the Gulf of California that lacks avicularia as *M. coriacea inarmata*. However, the original *M. coriacea* had no avicularia and thus the subspecies *inarmata* appears to be redundant. MacGillivray (1887a) described *Micropora coriacea* var. *angusta* from New South Wales, Australia, which is similar to *M. normani* (L.R. Thomas Collection, BMNH 1965.8.12.11) in having distal (interzooecial) avicularia. Ryland and Hayward (1992) elevated it to species status. The avicularium in *M. angusta* faces proximolaterally, while that of *M. normani* faces distolaterally. The type locality of *M. coriacea* is Hastings, England; BMNH slide 1911.10.16.23 is labeled as the neotype.

Moyano (1994) illustrated three species from the Magellan Straits: *M. brevissima* Waters, 1904, and new species *M. karukinkaensis* and *M. selknami*. *Micropora brevissima* has a wide but very shallow aperture with a pair of distal spines, with two main opesiules and two or more smaller ones proximally. The gymnocyst forms the distal aperture and a pair of small knobs. Avicularia are few, rhomboidal, distal to the autozooids (interzooecial), with a triangular mandible directed distolaterally. The ovicell is small, not distinguished by pores or umbo. *Micropora karukinkaensis* has distinctive, inwardly curving gymnocystal knobs, two small opesiules and an ovicell with a large distal pore. Interzooecial avicularia are scarce, distal to the autozooid, with the mandible triangular, directed distolaterally and with a complete hinge bar. *Micropora selknami* has larger distal knobs, and elongate opesiules. Avicularia are common, with the mandible directed distolaterally and a complete hinge bar. The ovicell is distinctive, kenozooidal, with two lateral slits like opesiules, an umbo partly covered with cryptocyst, and the distal rim of the zooidal aperture forming an erect brim.

Moyano (1994) states that the *Micropora* species of both the warm temperate and cold temperate waters of the southern hemisphere have larger avicularia without crossbars (hingebars) and longer mandibles. Whether lack of crossbars is, as he states, "more primitive" is open to question; for example, *Thalamoporella howchini* Stach, 1936 from the Pliocene of Australia (illustrated in Soule *etal.*, 1992) had rows of avicularia with large hinge bars. Moyano further reports that *Micropora* with small, triangular, distolaterally directed avicularia with hinge bars complete are found in warm and temperate waters in both hemispheres, and those

Plate 7. *Micropora santacruzana.* Santa Cruz Island. A. Colony with avicularia distal to some zooids without ovicells; ovicells with medial umbo on fertile zooids. B. Zooid with paired opesiules; knobs beside proximal lip of aperture. C. Enlarged frontal pores with spinules projecting into pores.


A
B
C


A
B
C

with proximally directed (reversed) avicularia inhabit northern hemisphere cold waters. He states that all Microporidae species with dependent avicularia (e.g., *Andreella* spp.) that occur in the Magellanic area have a stout, arched hinge bar.

Type Locality and Type Specimens. AHF Station 1662-48, 1.75 nautical miles southeast of Santa Cruz Island, California Channel Islands. SBMNH-AHF Bryozoa Holotype No. 203.

Distribution. Probably found from British Columbia to the Channel Islands off southern California; more southerly citations may be the originally described, unarmed *M. coriacea* or an as yet undescribed species. The MMS station is offshore between Purisima Point and Point Sal.

Family Cellariidae Hincks, 1880

Colony erect, with or without joints. Zooids hexagonal or ovoid, in longitudinal series, usually alternating around branch. Zooid walls raised, cryptocystal frontal wall depressed, covered by clear to tan frontal membrane; opesia reduced to area of operculum closing the aperture. Aperture without spines, straight proximally or arched, flanked by large or small condyles. Avicularia interzooecial. Ovicell immersed, indicated only by a large pore distal to the aperture.

Cellaria diffusa Robertson, 1905

Plate 8 A-C

Cellaria diffusa Robertson, 1905: 289, pl. 15, fig. 90, pl. 16, fig. 104. — Canu and Bassler, 1923: 86, pl. 34, figs. 19, 20. — C.H. and E. O'Donoghue, 1923: 165. — Osburn, 1950: 117, pl. 12, fig. 9. — J. D. Soule and Duff, 1957: 101.
? *Cellaria fissurifera* Canu and Bassler, 1923: 85, pl. 34, figs. 15-18.
Cellularia diffusa: C.H. and E. O'Donoghue, 1925: 100; 1926: 96.

Material Examined. MMS Station: 014-BRC. AHF Collections.

Description. Colonies erect, branching, internodes club shaped, lengthy, joints brown to black. Zooids elongate, bluntly diamond shaped with distal and proximal walls arched, walls raised steeply, sometimes with irregularly spaced separations between adjacent lateral walls; frontal cryptocyst much depressed; sizes ranging from 520-750 µm long, 250-300 µm wide. Aperture arched distally and proximally, with raised rim, having paired, short, stout denticles on the proximal border sometimes extra, smaller, rounded denticles along distal rim. Interzooecial avicularia lying between transverse walls, much smaller than zooids, almost square, 200 µm wide, rostrum elliptical, with pale, semicircular mandible. Ovicell internal, opening via large rounded or oval pore distal to oral aperture; pore may erode with age until larger than the avicularium.

Biology. Found on hard substrates. Depths previously reported from intertidal to 216 m; the MMS record is 96-105 m.

Plate 8. *Cellaria diffusa*. Hueneme, California. A. Erect colony having zooids with raised lateral walls, ovicell with eroded large pore in center, and avicularium between zooids above ovicell. B. Aperture viewed from side, with distal rim to left bearing denticles to support operculum when closed; proximal lip, to right, with two large denticles (cardelles) acting as hinge teeth for operculum. C. Aperture with denticles and ovicell with normal oval pore.

Taxonomic Remarks. Osburn (1950) placed *C. fissurifera* Canu and Bassler, 1923 in synonymy with *C. diffusa* and combined the descriptions. Zooids of the former have a much more pronounced diamond shape, with acute proximal and distal ends and more slitlike spaces between zooids, as figured by Canu and Bassler (1923), in their Plate 34, Figures 16 and 17, whereas the specimen in Figure 15 is too eroded for discrimination between the two species. In AHF collections stems of both sorts are found at the same locality, but both types of zooids have not been seen on the same branch fragments. We have not been able to locate intact colonies to verify that the two species are synonymous.

Type Locality and Type Specimens. Robertson originally reported *C. diffusa* from Vancouver Island, British Columbia, and from San Juan Island, Puget Sound, Washington, San Pedro and San Diego, California. Robertson's types have apparently been lost, mixed in with other specimens at the California Academy of Sciences (CAS), San Francisco.

Distribution. Originally reported from Puget Sound, Washington, San Pedro and San Diego, California, this species is common, apparently ranging through the Channel Islands southward to Mexican waters and the Galapagos Islands. The MMS record is from west southwest of Purisima Point. Canu and Bassler recorded *C. diffusa* as *C. fissurifera* from the Pleistocene of Santa Monica, California, and Soule and Duff (1957) reported *C. diffusa* from the same area.

Cellaria mandibulata Hincks, 1882

Plate 9 A-C

Cellaria mandibulata Hincks, 1882: 463. — Hincks, 1884a: 209, pl. 9, fig. 7. — Robertson, 1905: 288, pl. 15, figs. 87-89, pl. 16, fig. 103. — Canu and Bassler, 1923: 86, pl. 34, figs. 11-14. — C.H. and E. O'Donoghue, 1923: 165. — Osburn, 1950: 116, pl. 13, fig. 1. — J. D. Soule and Duff, 1957: 100.

Material Examined. MMS Station: BRC-14. Other collections: AHF and BMNH.

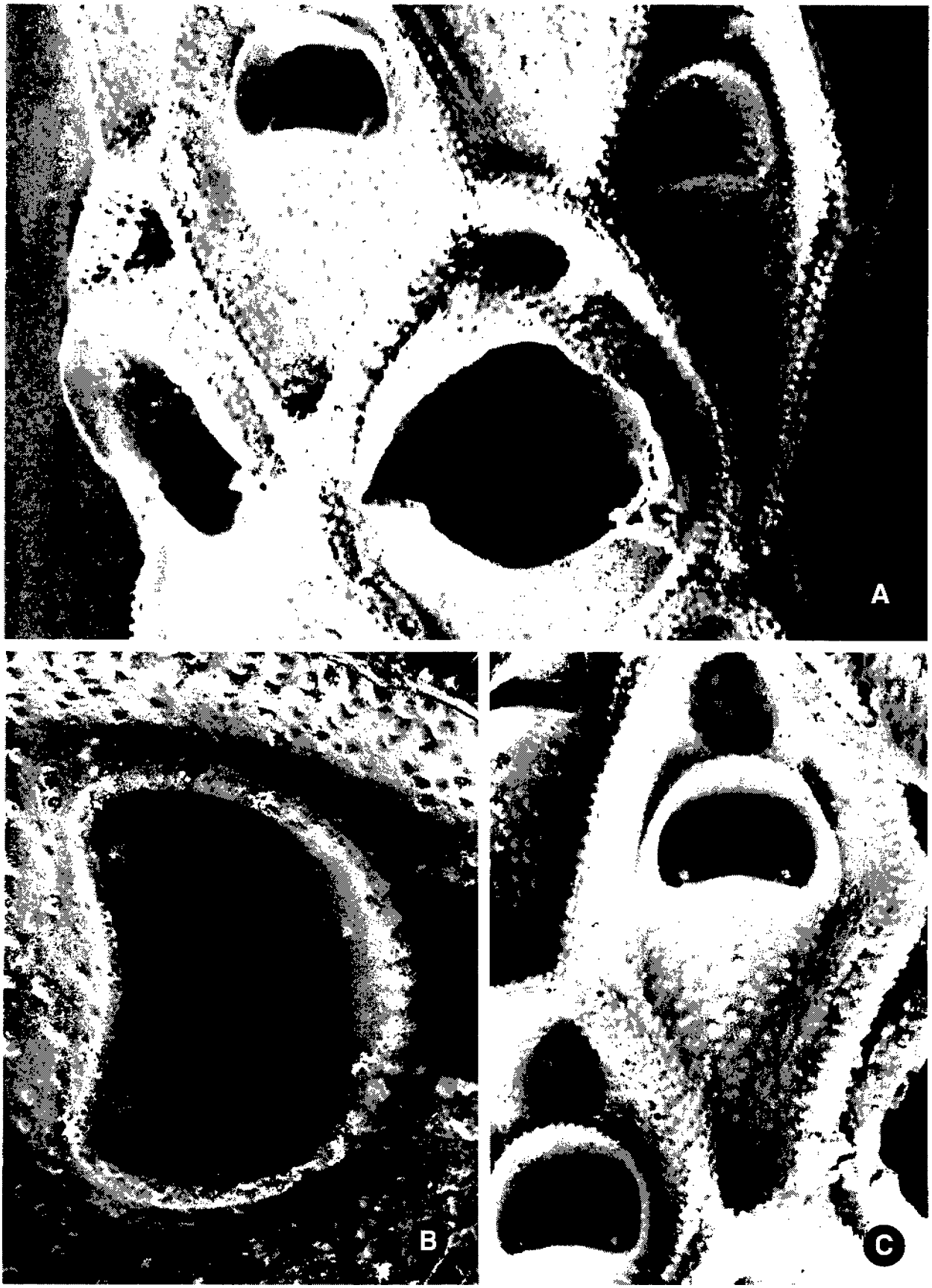
Description. Colonies erect, branched internodes slender, relatively short, joints brown to black. Zooids diamond shaped, ranging in size from 400-600 μm long, 200-250 μm wide. Marginal walls thick, raised; cryptocyst and walls coarsely granular, sunken around apertural area. Aperture large with raised rim, proximal lip slightly curved distally, with large paired denticles (condyles) on the proximal border, distal rim a semicircular arch. Avicularium distinctive, interzooecial, much wider than zooid, 450-600 μm long, 350 μm wide, with raised distal rim, brown, chitinous semicircular mandible. Ovicell internal, ooecial pore a large opening distal to aperture.

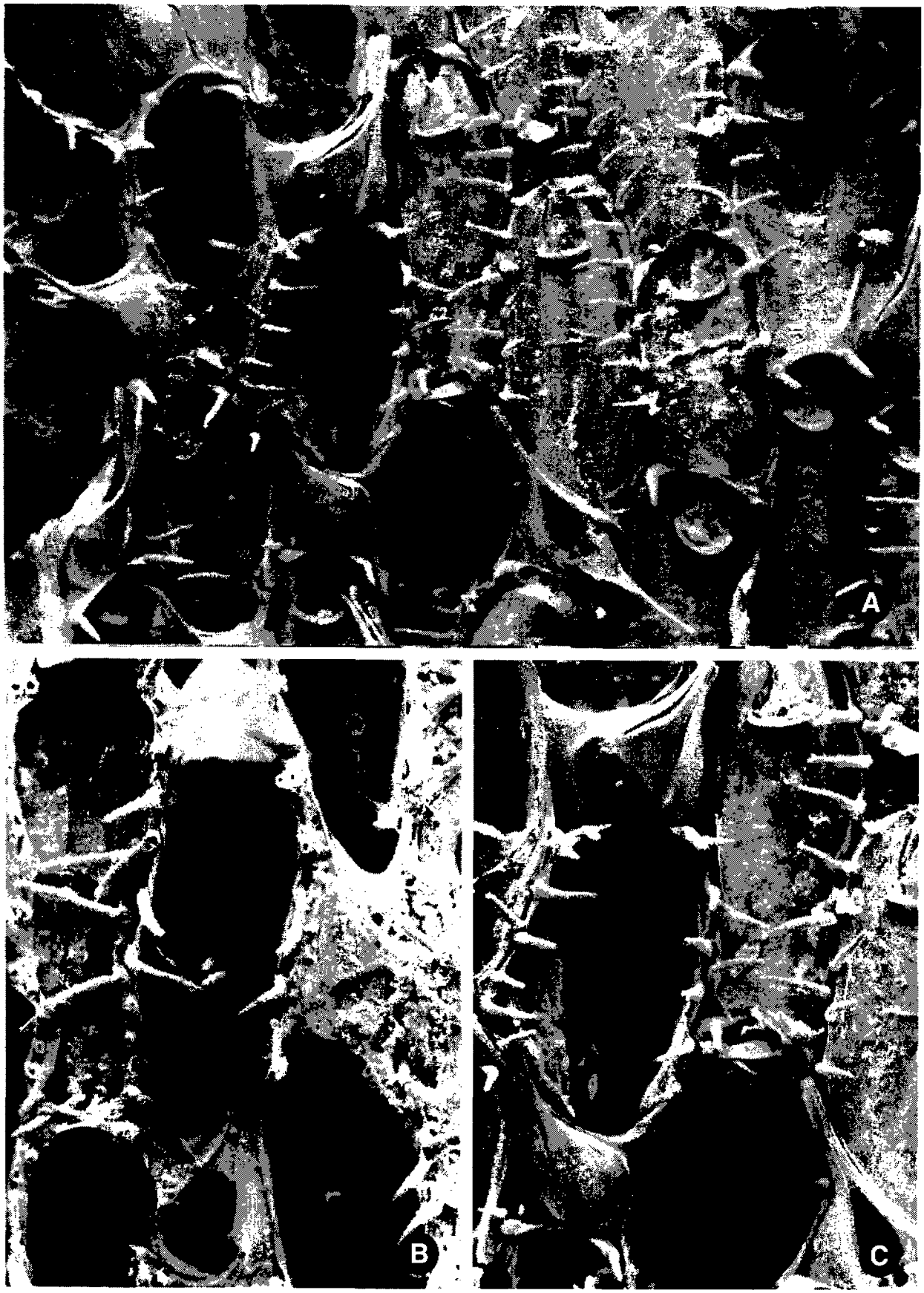
Biology. Depths previously reported from intertidal to over 140 m, on hard substrates. The MMS record is from 96-105 m.

Taxonomic Remarks. The avicularia of this species are so distinctive that no conflicting synonymies seem to have been recorded, although more subtle differences might be found if more extensive SEM comparisons could be made of synoptic collections.

Type Locality and Type Specimens. Described from Houston-Stewart Channel, Virago Sound, Queen Charlotte Islands, British Columbia. BMNH type 1886.3.6.43.

Plate 9. *Cellaria mandibulata*. MMS station off Purisima Point. A. Part of internode, zooids diamond shaped with cryptocyst sunken below lateral walls; large avicularium in lower center. B. Side view of aperture, proximal lip with two denticles (cardelles) to left, distal rim to right. C. Zooid with sunken cryptocyst, ovicell pore distal to aperture.


A
B
C


A
B
C

Distribution. Reported from British Columbia southward; common in southern California, extending to Point San Eugenio, Baja California, Mexico. The MMS station is west southwest of Purisima Point. Also recorded from the Pleistocene by Canu and Bassler (1923) and Soule and Duff (1957).

Family Flustridae Smitt, 1868

Originally limited to erect colonies arising from an encrusting base, composed of flattened, flexible fronds, narrow or broad, unilaminar or bilaminar; completely encrusting species of *Hincksina* were later included. Zooids usually rectangular, with minimal gymnocyst or cryptocyst visible. Spines present or absent; Avicularia interzooecial, in longitudinal rows or between transverse walls, or absent. Ovicells endozooecial, sometimes visible as a small cap-like structure.

Hincksina pallida (Hincks, 1884)

Plate 10 A-C

Membranipora pallida Hincks, 1884a: 210. — C.H. and E. O'Donoghue, 1923: 25.
Membranipora acifera MacGillivray form *multispinata* Hincks, 1884a: 209;
1884b: 8, pl. 19, fig. 14 (revision of 1884a).
Hincksina pallida: C.H. and E. O'Donoghue, 1926: 31. — Osburn, 1950: 45, pl. 23, fig.2.

Material Examined. MMS Station: BRA-21. Other collections: AHF and BMNH.

Description. Colony thin, loosely attached by dorsal processes. Zooids elongate, 650-800 µm long, 250-300 µm wide. Cryptocyst absent, gymnocyst small, lateral walls narrow, bearing 5-8 pairs of slender spines, all but the most distal pair leaning over the opesia. Interzooecial avicularium located between transverse walls of many zooids, with almost square chamber, lengthy mandible tapering to thin needlelike point, directed distolaterally. Ovicells endozooecial, small, shallow hooded, visible at surface.

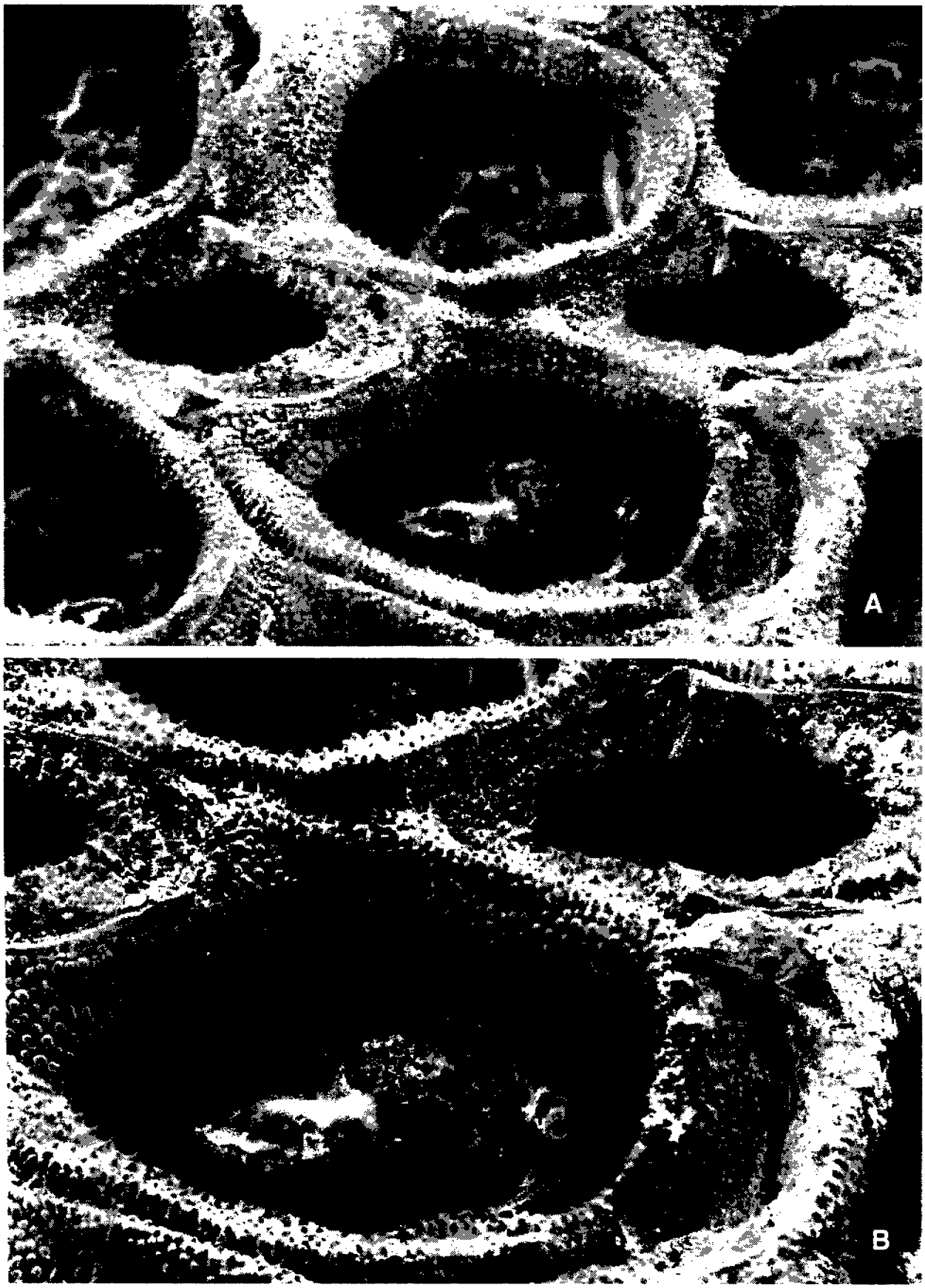
Biology. Colonies encrusting, loosely attached to hard substrates. Depths from shallow waters to 90 m.

Taxonomic Remarks. The placement of the acute avicularia between transverse walls and the presence of spines on the opesial rim are reminiscent of species of *Callopora* and *Tegella* in the family Calloporidae, but the ovicells of *Hincksina* are endozooecial, smaller and less conspicuous. The attachment by dorsal processes distinguishes *H. pallida* from other species.

The definition of the Family Flustridae has been widened by various authors (e.g., Prenant and Bobin, 1966; Ryland and Hayward, 1977) to include both frondose, erect, bilaminar species and encrusting species, with or without spines, and with or without avicularia and ovicells. We remain of the opinion that the Family Hincksinidae Canu and Bassler, 1927, is appropriate for the encrusting species such as the *Hincksina*, as used by Osburn, 1950, but that usage seems to be considered at present as a junior synonym of Flustridae. Gordon (pers. comm) would place *H. pallida* in the Genus *Gregarinidra* Barroso, 1949; the type species, *Membranipora gregaria* Heller, 1867, has been placed in a number of genera (see *Spiralaria* (pars) Busk in Prenant and Bobin, 1966). If one restricts *Hincksina* to round avicularia only, as Gordon suggests,

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Plate 10. *Hincksina pallida*. Friday Harbor, Washington. A. Colony with oval zooids, interzooecial avicularia; lower avicularium has an open mandible. B. Zooid with small distal ovicell. C. Zooid with interzooecial avicularia between transverse walls.


A
B

then the acute, angled avicularia of *H. pallida* would be excluded, although few genera are so restricted. However, the species is very similar to that part of *Spiralaria* under which Prenant and Bobin (1955) synonymized *Gregarinidra*. Their illustrations are far superior to that of Barroso (1949:514, fig. 2a). Barroso, erroneously, referred to the ovicell of *Gregarinidra* as hyperstomial in his generic description of *Gregarinidra* and made that the difference between it and *Hincksina*, with an endozooecial but sometimes visible ovicell. This error suggests that *Gregarinidra* is a junior synonym of *Hincksina*. In any case, it hardly seems necessary to maintain a separate genus for species with acute avicularia.

Type Locality and Type Specimens. Virago Sound, Queen Charlotte Island, British Columbia. Type, BMNH 86.3.6.36.

Distribution. The range was thought to be limited to British Columbia and Puget Sound, Washington, until the MMS record off Purisima Point, central California.

Hincksina? alba (C. H. and E. O'Donoghue, 1923)

Plate 11 A-B.

Membranipora alba C.H. and E. O'Donoghue, 1923: 28, pl. 2, fig. 17.
Callopora alba: C.H. and E. O'Donoghue, 1926: 34.
Hincksina alba: Osburn, 1950: 41, pl. 5, fig. 2.

Material Examined. MMS Station: BRA-13. Other collections: BMNH, O'Donoghue Collection Slide No. 1963.12.30.38; AHF.

Description. Colony encrusting. Zooids 600-900 μm long, 430-480 μm wide. Lateral walls raised, cryptocyst forming granular rim, no spines, but with minute, sharp crenulations bordering a large, oval opesia. Avicularia replacing and parallel to zooids in series, tapered proximally, ovoid distally, with granular cryptocyst surrounding the opesia, strong hinge articulation grooves; 550-590 μm long, 250-350 μm wide; mandible elongate, up to 1.0 mm, with a triangular base and smooth central stem, with thin chitinous wings on both sides. Ovicells endozooecial, but visible, granular, shallow, inconspicuous, 310-350 μm wide, 150-170 μm long, with slitlike opening separate from aperture.

Biology. Colonies encrusting rock and shell (molluscan and brachiopod). Reported from shallow waters to over 100 m; the MMS depth is 92-100 m.

Taxonomic Remarks. We are uncertain of the placement of this species. Osburn placed it in the genus *Hincksina*, based on having a large opesia but lacking an extensive cryptocystal frontal wall with trifoliate opesia or opesiules. Most species of *Hincksina* are solely encrusting, have interzooecial avicularia, spines, and an endozooecial ovicell. The typical elongate winged mandible with an ovoid palate and lack of spines differentiates *H. alba* from other *Hincksina*, which has been restricted by various authors to species having round interzooecial avicularia and numerous spines. Other species illustrated by Osburn as *Hincksina* have acute interzooecial avicularia, as in *H. pallida*, or avicularia on the lateral walls with small triangular rostra and mandibles and would not belong in *Hincksina* without modifying the generic description, as he did. The type species of *Hincksina, H. flustroides* (Hincks, 1877), has short, stout spines around the opesia and rounded avicularia situated distal to zooids. This seems to be a strange restriction on generic variety,

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Plate 11. *Hincksina ? alba.* Santa Catalina Island. A. Colony with distal end to right showing two avicularia in middle row; zooid, top, with granular cryptocyst, ovicell below. B. Avicularium (above) with rounded cryptocystal palate on which mandible closes; ovicell (below) with shallow hood, narrow opening.

because other bryozoan genera include zooecial and/or interzooecial avicularia with a variety of shapes, and with or without spines, as pointed out by Gordon (1984:32). This would seem to apply to *Hincksina* as well, although Gordon does not allow that in his concept of *Hincksina*.

Gordon (pers. comm.) is of the opinion that the winged mandible on the avicularium in *H. alba* places it in the Onychocellidae, since the winged mandible is the principle character of that family. It also lacks spines and has endozooecial ovicells. Most onychocellid species have an extensive cryptocyst forming a partial frontal wall. The genera *Onychocella, Vellumella* and *Floridana*, represented in California fauna, all have trifoliate opesiae with the proximal corners incised into notches (opesiules) for passage of retractor muscles. This is not true of *H. alba*. Gordon would place the species in the genus *Rectonychocella* Canu and Bassler, 1917, which has as its type *R. solida*, an encrusting species with an extensive cryptocyst and small, irregular opesia, and a very large interzooecial avicularium with an alate mandible. While winged mandibles are not common, in our opinion, that characteristic alone should not place *H. alba* in the same genus or family with those having such an extensive cryptocyst. We therefore retain this species questionably in *Hincksina* at this time. Gordon (1984) created the genus *Onychoblestrum*, which has a trifoliate opesia and an interzooecial avicularium with a winged mandible; he placed the genus in the Calloporidae, based on having a hyperstomial ovicell and a pivot on the avicularian mandible.

Hayward (pers. comm.) suggests placement in the family Calloporidae, in the genus *Crassimarginatella (sensu lato)*. *Hinchsia alba* does not have the raised ovicell with crescentic or quadrate endozooecial area bound by ectooecium, such as that illustrated by Gordon, 1984. Ryland and Hayward (1977) illustrated *Alderina solidula* (Hincks, 1860), which lacks interzooecial avicularia in Britain, but they reported that Harmelin (1973) found interzooecial avicularia present occasionally in Mediterranean specimens, which would place the species in *Crassimarginatella*. For workers trying to place a name on a specimen, this taxonomic confusion can be very frustrating.

Type Locality and Type Specimens. Described from Protection Gap, Vancouver Island, British Columbia. No type has been designated; the BMNH specimen examined may represent the type. MMS Station 13 is southwest of Purisima Point.

Distribution. British Columbia southward to the California Channel Islands.

Family Calloporidae Norman, 1903
(= Alderinidae Canu and Bassler, 1927)

Colonies encrusting, zooids rectangular or oval; gymnocyst present, cryptocyst present, frontal membrane visible in most but sometimes obscured by spines. Avicularia present or absent. Ovicells hyperstomial, sometimes with umbones, ridges or avicularia (Ryland and Hayward, 1977).

This family has become a catchall for so many genera as to be in great need of revision. *Aplousina*, for example, is included by Gordon (1986), yet it has an almost imperceptible gymnocyst and narrow cryptocyst; it lacks spines and avicularia, and the ovicell is, in the California material, endozooecial, seen only as a small crescentic hood. Canu and Bassler (1927) created the family Hincksinidae for membraniporines with an endozooecial ovicell and Alderinidae for those with hyperstomial ovicells. Osburn (1950) placed *Hincksina* and *Aplousina*, as well other genera, in Hincksinidae, a concept which has been discarded by other authors in favor of placing *Hincksina* in the Flustridae, while *Alderina*, which lack spines and avicularia, and *Aplousina* have been placed in the Calloporidae along with genera replete with extensive spination and avicularia (e.g., Gordon, 1986). Norman (1903) gave no description of the family Calloporidae. Ryland and Hayward (1977) remarked on the heterogeneous nature of the group, of which the most constant feature is the hyperstomial ovicell, while *Aplousina* and *Alderina* ovicells are usually endozooecial or partly immersed.

Aplousina ? major Osburn, 1950

Plate 12 A-B

Aplousina major Osburn, 1950: 47, pl. 4, fig. 1.

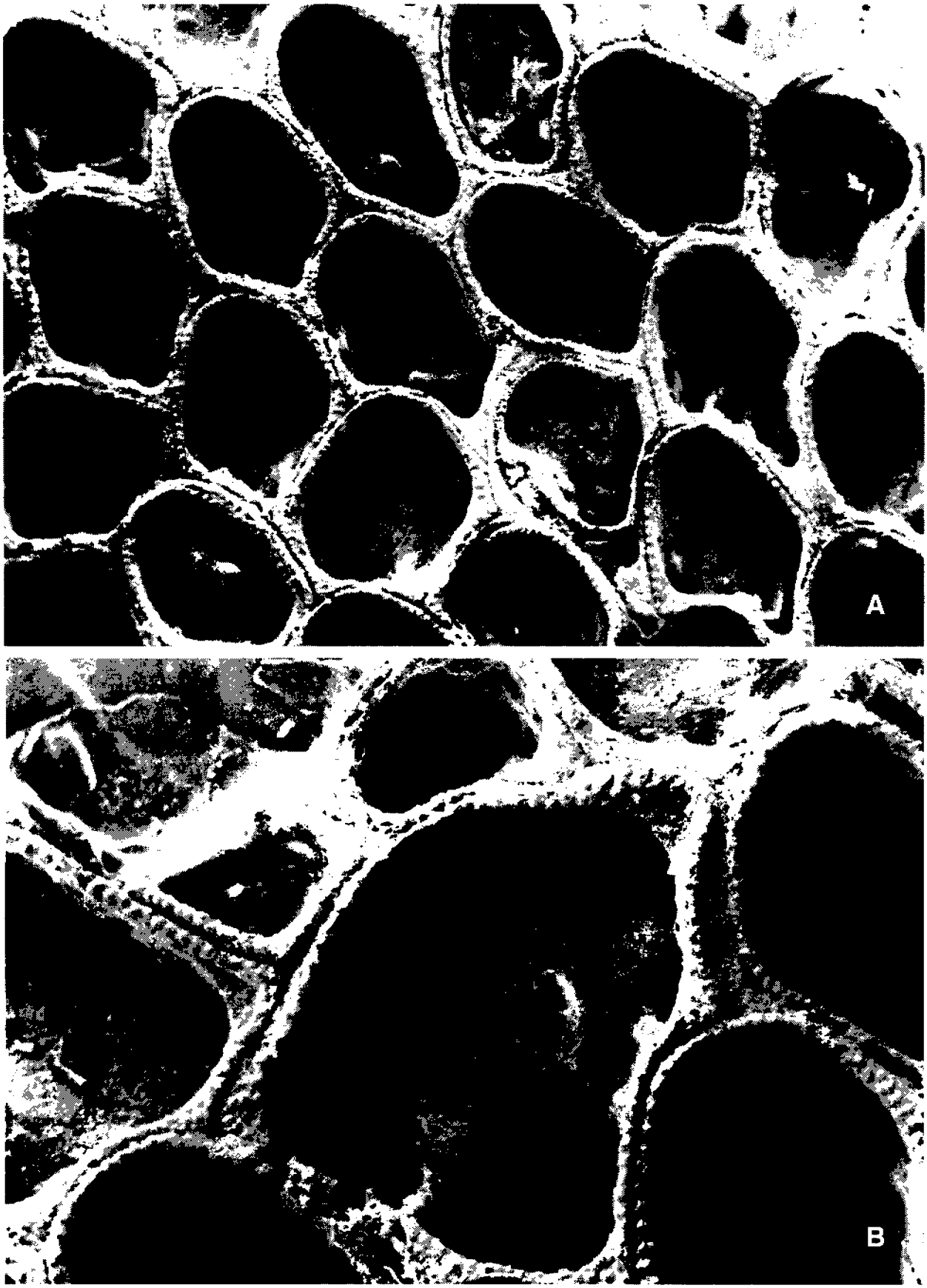
Material Examined. MMS Station: BRA-21. AHF Collections.

Description. Zooids large, 900-1,025 µm long, 600-800 µm wide; highly variable in shape, with a yellowish or brownish ectocyst, usually with a narrow brown line separating adjacent zooids; cryptocyst narrow, coarsely beaded, opesia occupying almost the entire frontal area, frontal gymnocyst very reduced. External cuticle (ectocyst) thick; operculum large, thick, darker around margin. No spines, no avicularia. Large multiporous septula numerous, separated only by small segments of vertical walls. Ovicell reported as endozooecial, tiny, raised, shallow, smooth or becoming roughened, sometimes with a small tubercle on it; not closed by the operculum.

Biology. Colonies encrusting rock and shells. The previous record for depth was 42-46 m; the MMS record extends the depth range to 75-90 m.

Taxonomic Remarks. *Aplousina major* is larger than *Aplousina filum* (Jullien, 1903), a similar species known from the Atlantic, Gulf of Mexico, Gulf of California and the Galapagos Islands (Osburn, 1950), while *Aplousina gigantea* (Canu and Bassler, 1928) from the Gulf of Mexico is even larger than *A. major*. The ovicell of *A. major* is hard to distinguish, seeming to be an extension of raised distolateral walls, with a widening of the distal wall into a very shallow hood; the ovicell of *A. filum* is more distinctive, perched distally as a tiny, more rounded hood.

Plate 12. *Aplousina ? major.* [Page 58] Anacapa Island. A. Large irregular zooids separated by grooves with brown membranous line between. A small ovicell in upper right corner. B. Enlarged view of growing colony margin with kenozooid to upper left; zooecial vertical walls beaded, no gymnocyst, cryptocyst shelf narrow or absent; note communication pores in lateral walls.


A
B


A
B
C

The genus *Aplousina* is placed doubtfully herein in the Calloporidae, although it has simple membraniporine structure, lacks spines and avicularia, has a large opesia with almost no gymnocyst and has a narrow, crenulate cryptocyst. However, the ovicell in *A. major* is very small, and appears to be endozooecial and is not closed by the operculum. Gordon (1986) placed *Aplousina* in the Calloporidae, a family more characterized by species with numerous spines, interzooecial and frontal avicularia and a hyperstomial ovicell. *"Aplousina" anxiosa* Gordon, 1986, has nodules at the corners of zooids reminiscent of some *Membranipora tuberculata* and an ovicell with large tubercles.

Type Locality and Type Specimens. AHF station 1271-41, off Anacapa Island, Southern California. SBMNH-AHF Bryozoa Holotype No. 15.

Distribution. There was no record north of Santa Rosa Island, California, prior to the MMS collections off Purisima Point.

Cauloramphus echinus (Hincks, 1882)

Plate 13 A-C

Membranipora echinus Hincks, 1882: 250.
Cauloramphus echinus: C.H. and E. O'Donoghue, 1926: 39. — Osburn, 1950: 56, pl. 5, fig. 8.

Material Examined. MMS Station: BRA-2. AHF Collections.

Description. Colonies unilaminar. Zooids distinct, loosely connected at pore chambers, irregularly elliptical, 500-570 μm long, 300-310 μm wide, opesia measuring 300 μm long; zooids narrowing proximally, covered with gymnocyst up to mural rim bearing 7-8 pair of spines; the distal 4 spines erect, the remaining 10-12 curved over the opesia; narrow cryptocyst inside spines . Avicularia single or paired, located outside of spines on gymnocyst between the first and second spine overhanging the opesia, mounted on thin stalk, rostrum bulbous, with overall length of 200-250 μm, rostrum strongly hooked, mandible acute, directed distally or distolaterally. Ovicells not seen, possibly endozooecial.

Biology. Colonies encrusting hard substrates. Depth to 46 m previously reported; the MMS material extends the depth to 110-126 m.

Taxonomic Remarks. *Cauloramphus echinus* resembles *Cauloramphus californiensis*, new species, but zooids are much narrower and mural spines are shorter and thinner. The avicularium chamber of *C. echinus* has a strongly hooked rostrum mounted on a thin stalk, whereas those of *C. californiensis* are thicker, tapered and not much hooked.

Type Locality and Type Specimens. Houston-Stewart Channel, Queen Charlotte Islands, British Columbia. BMNH Hincks Collection; holotype not designated.

Distribution. Previously reported from British Columbia (Queen Charlotte Islands) southward to Santa Rosa Island, Channel Islands off southern California. The MMS station is in the Santa Barbara Channel, south of Point Conception. The figured specimen is from Friday Harbor, Washington.

Plate 13. *Cauloramphus echinus*. [Page 59] Friday Harbor, Washington. A. Unilaminar colony with zooids loosely connected; opesia oval, cryptocyst narrow, inside gymnocystal mural rim bearing 7-8 pairs of short spines leaning over opesia, two spines distal to aperture. B. Single or paired bulbous avicularia on stalks arising outside of spines. C. Detail of single zooid with paired avicularia bearing hooked rostral tips.

Cauloramphus californiensis, new species

Plate 14 A-D

? *Membranipora spinifera*: Robertson, 1900: 324. — Robertson, 1908: 265, pl. 15, fig. 15.
Cauloramphus spiniferum: Osburn, 1950: 55 (in part), pl. 5, fig. 9.

Material Examined. MMS Station: BRA-2. Other collections: AHF and BMNH, BMNH 1899.7.1.1149.

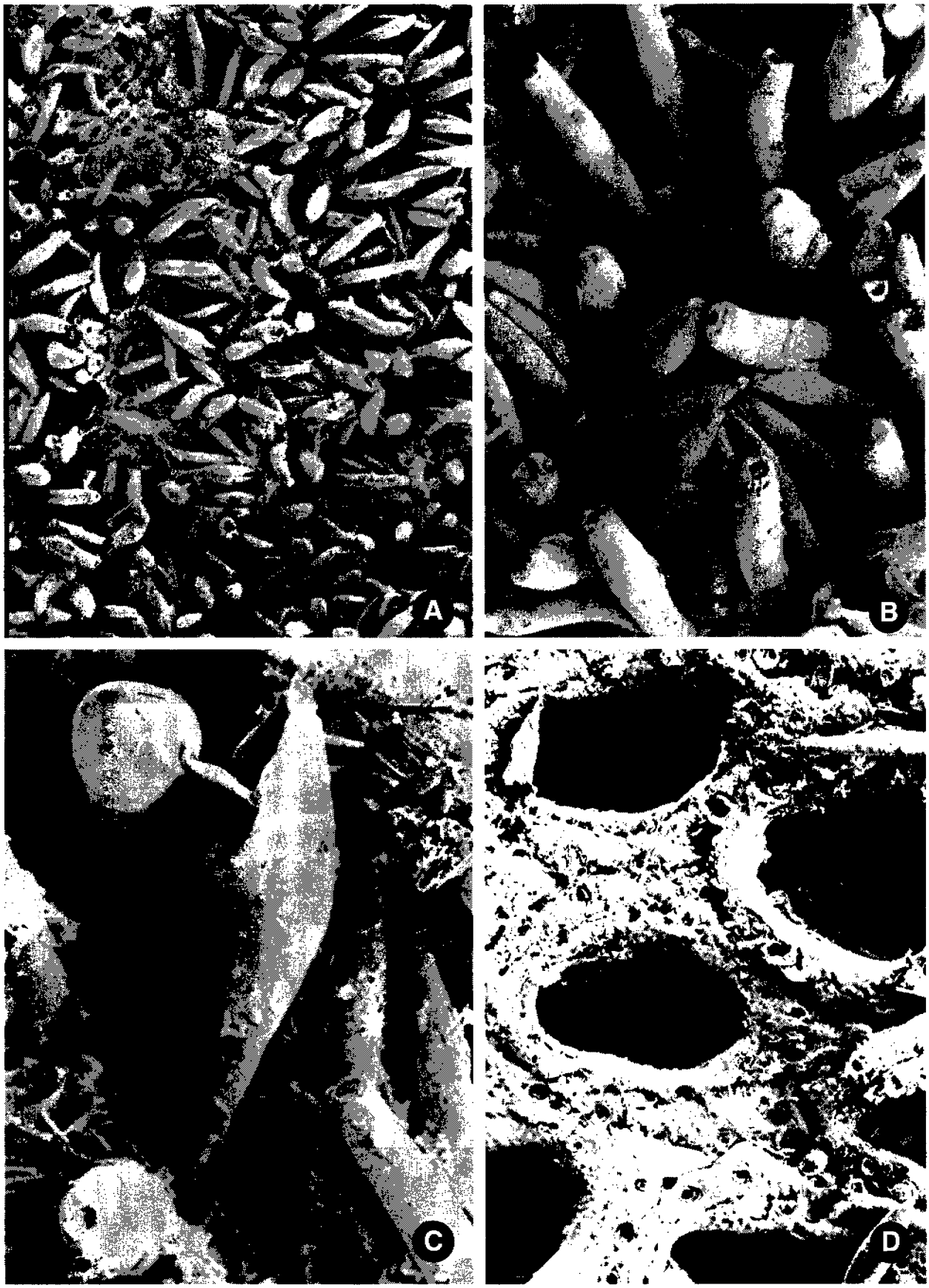
Diagnosis/Description. Unilaminar colonies, brown to tan. Zooids moderately elongate, irregularly ovoid, measuring 500-600 μm long, 350-400 μm wide. Opesia 300-370 μm long, cryptocyst narrow distally, wider proximally, coarsely granulated, gymnocyst narrow. Thick lateral walls supporting 13-15 tall, white, stout spines 240-250 μm in length, some much longer at edge of colony, 53-54 μm wide at widest part, jointed at the base; 3-4 spines placed erect distal to the operculum, 2 beside mid-opercular area, and 2 opposite proximal rim of operculum, crossing over opesia; remaining proximal spines shorter, thinner, more translucent, leaning over opesia, capable of trapping sand granules by overlapping. Paired or single avicularia pedunculate, narrower at base, tapering to form rostrum, resembling spines, 150-275 μm tall, arising outside spines and between mid-opercular spine and proximal opercular spine on narrow gymnocyst, rostra small, acute, directed outward and upward. Ovicell not seen.

Etymology. Named for the California type locality.

Biology. Colonies encrusting rock, shells and kelp holdfasts. *Cauloramphus spiniferum* (*sensu lato*) has been reported by Ryland and Hayward (1977) in the British Isles (the type locality is north of Durham), from the lower shore to the shallow sublittoral, but there is considerable question as to its depth and geographical range; it is probably a boreal, and perhaps arctic, species. Osburn (1950) gave a depth range to 30 m for material we interpret as the new species; the MMS record extends that to 110 to 126 m.

Taxonomic Remarks. *Cauloramphus spiniferum* (Johnston, 1832) has perhaps been so widely reported because of its distinctive appearance as a great thicket of spines, often laden with silt and sand. Cleaning with sodium hypochlorite removes the distinctive spines, adding to the difficulties of diagnosis. Osburn placed *Membranipora variegata* Hincks, 1881 in synonymy with *Cauloramphus spiniferum* (Johnston) 1832, but Dick and Ross (1988) placed all of Osburn's records on the Pacific Coast in *C. variegatus* (sic) because Osburn had mentioned the color in spine bases but did not indicate the geographic distribution or incidence of that feature. Hincks first described *M. variegata* in 1881:72 (p. 131 in some printings) and illustrated a specimen with 12 spines, 4 distal, 2 beside the aperture and 6 smaller proximal spines, all with a dark colored spine sockets. He missed the slender avicularia, interpreting them as spines originating near one of the large spines, projecting outward. This is clearly a *Cauloramphus*; however, Hincks gave the locality as "Santa Cruz, on shell (Miss Jelly)". Jelly worked on collections from New Zealand, Australia, Singapore, the Philippines and elsewhere, most places having one or more "Santa Cruz" locations, but it is unclear where Hincks' specimens originated; the Santa Cruz, California intertidal would have been a good source of the species. *Cauloramphus variegatum* may be a shallow water species as compared with *C. californiensis* but does not seem to be synonymous because the number of spines seems consistently fewer in *C. variegatum*.

Cauloramphus brunnea Canu and Bassler, 1930 is a tropical species. It has distinctive, stout but variously shaded brown spines, two distal and two lateral to the proximal opercular rim, and six pairs of smaller proximal spines, not closing over the opesia, and with the avicularium beside the mid-proximal spines. Worn specimens are difficult to identify due to loss of spines and avicularia.


A
B
C
D

The new species probably includes at least part of the *M. spinifera* of Robertson (1900, 1908), but the material of C.H. and E. O'Donoghue (1923) may be *C. spiniferum* and possibly more than one species; they indicate that the majority of specimens have one pair of avicularia, some have two pairs and some three pairs. Dick and Ross (1988) discussed five species of *Cauloramphus* from the vicinity of Kodiak, Alaska, two of them new. *Cauloramphus californiensis* is similar to *C. spiniferum* as illustrated by Ryland and Hayward (1977), which has 4 erect distal spines and 7-12 proximal spines directed inward over the opesia but mostly not touching; its avicularium rostrum is directed inward and upward whereas in the California material the rostrum is directed outward. Dick and Ross (1988) found 8-13 spines in Kodiak material; they reviewed other descriptions of *C. spiniferum*, noting that Mawatari (1956) cited the species as having 10-14 spines in the Kuriles, Kluge (1962) and Mawatari and Mawatari (1981) found 12-16 in northern USSR, and Androsova (1958) found 13-18 in the northern Sea of Japan. J. D. Soule (1959) recorded 12 spines on Baja California material, possibly *C. variegatum*.

Type Locality and Type Specimens. 0.75 nautical miles S.E. of Cat Rock, Anacapa Island, California Channel Islands, AHF 1271-41, 42-35.7 m. SBMNH-AHF Bryozoa Holotype No. 204.

Distribution. The species is known only from the California Channel Islands; the MMS station is in the Santa Barbara Channel between the islands and Point Conception. Robertson (1908) and Osburn (1950) reported "*C. spiniferum*" as common in shallow waters along the southern California coast, but these records may have been of more than one species.

Alderina ? brevispina (C.H. and E. O'Donoghue, 1926)

Plate 15 A-B

? Callopora brevispina C.H. and E. O'Donoghue, 1926: 35, pl. 3, fig. 27.
Alderina brevispina; Osburn, 1950: 60, pl. 6, fig. 3.

Material Examined. MMS Stations: BRA-21, BRC-2. Other collections: AHF, BMNH: O'Donoghue Collections.

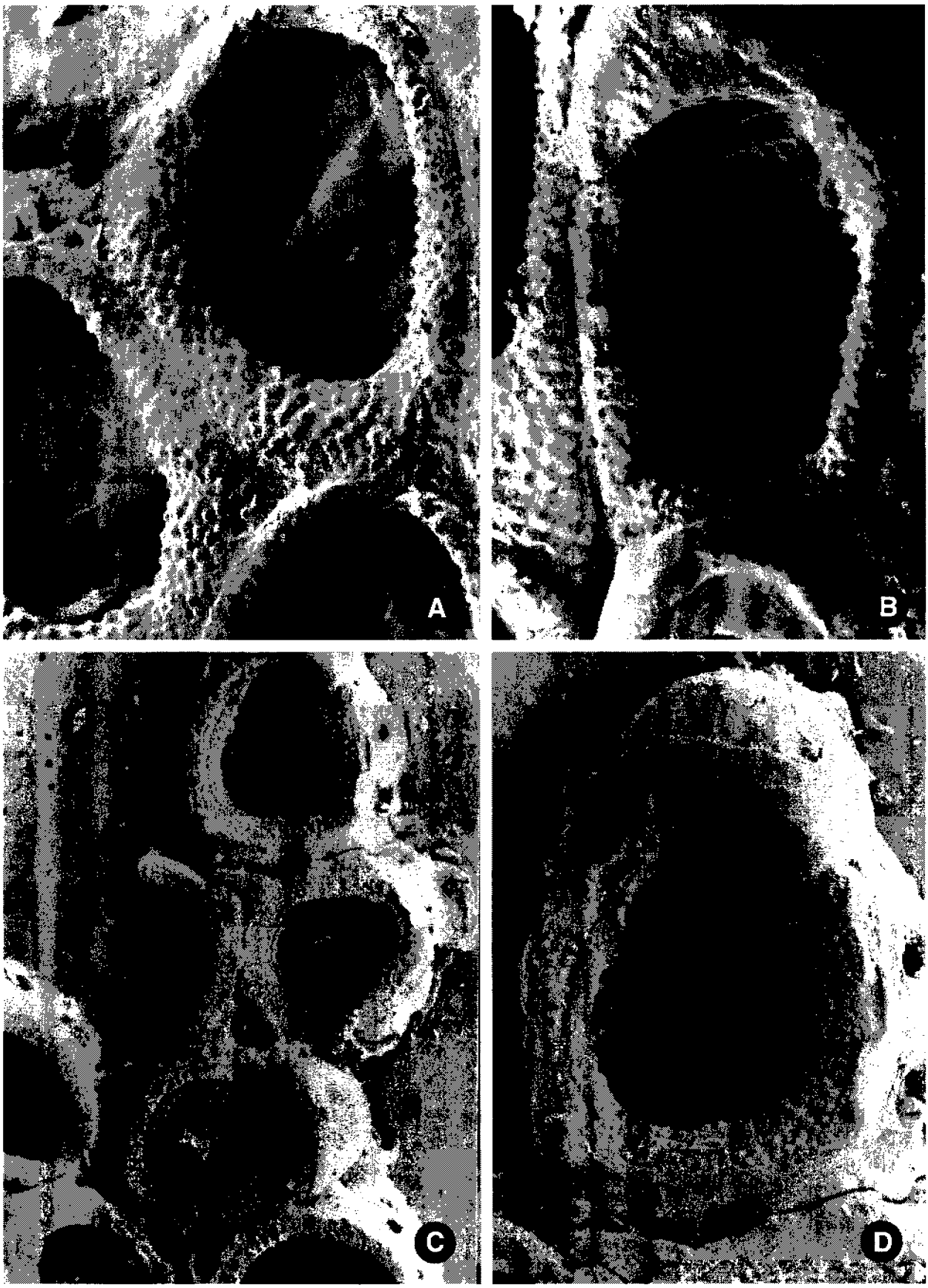
Description. Colonies encrusting. Zooids irregularly ovoid, somewhat narrower distally. Zooid 500-550 μm long, and 350-400 μm wide. Lateral walls narrow, gymnocyst almost absent; cryptocyst rolled, strongly crenulate, descending to opesia. Some zooids occasionally with 1-2 of transitory, short, curved spines flanking aperture. Very large multiporous septula in vertical walls, sometimes only separated by wall buttresses. Ovicells shallow, inconspicuous, with distal marginal ridge, granular proximal face and slit-like aperture, becoming submerged with age.

Biology. Colonies encrust hard substrate, rock, shells. Reported from shallow waters, extending down to 75-90 m at the MMS site.

Taxonomic Remarks. *Alderina brevispina* was reported to have a pair of tiny, transient spines flanking the operculum, and may have tiny spine scars between the cryptocyst and gymnocyst, although the

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Plate 14. *Cauloramphus californiensis*. Anacapa Island. A. Colony with a thicket of stout spines and avicularia. B. Single zooid with four stout spines on distal margin of aperture, two shorter, stouter spines at mid-operculum level and two flanking proximal lip; remaining spines leaning over opesia. C. Stalked (pedunculate) avicularium arising outside the spines on the gymnocyst between opercular spines, with acute mandible open. D. Colony with spines lost showing narrow cryptocyst, mural rim with spine sockets so that spines can be moved about.


A
B
C
D

genus *Alderina* was described as lacking spines and avicularia, and must be modified to include the obscure spines referred to herein. Our material had a few tiny spinous processes but not spines. Osburn (1950) gave the zooidal length of *A. brevispina* as 650-800 μm and the width as 500-600 μm, whereas our specimen is smaller and more similar to his *A. smitti* Osburn, 1950 in size, which is 450-550 μm long. It also lacks the prominent ridge across the proximal margin of the ovicell hood that is characteristic of some other species placed in the genus such as *A. smitti*.

Alderina smitti from Florida, illustrated from material kindly provided by Dr. Judith Winston (Plate15 C-D), has a distinct, raised roll across the front margin of the ovicell and a pair of stout spines flanking the aperture; the gymnocyst and cryptocyst are wider, and zooids appear to be more loosely connected. The genus *Corbulella*, (formerly a subgenus of *Crassimarginatella*, *fide* Gordon, 1984), is somewhat similar, but has large interzooecial avicularia, and both zooids and avicularia have many marginal spines. Also, the ovicell has a gap between the ectooecium and entooecium, whereas *A. smitti* has a wide bar across the lip, with the entooecium showing in the distal central area. *Crassimarginatella* species also have large vicarious avicularia. For the present, we leave these species in *Alderina* pending further study.

Another MMS specimen, *Alderina* sp., has paired distal tubercles, apparently on fertile zooids, with a tiny hollow spine distal to each tubercle, and six or more minute spine scars on the rim of the distal half of the zooids bordering a wide, crenulated cryptocyst; a tiny tooth in the center of the distal cryptocyst appears to support the closed operculum; an indistinct ovicell is coarsely granular, wide, and shallow, merging with the tubercles that flank it. Large pore plates are visible in the basal and lateral walls. The ovicell is reminiscent of that in *Aplousina anxiosa* Gordon,1986, which lacks spines and avicularia. There was insufficient intact material of this to provide adequate type material for a new species, but it appears that there is an overlapping distribution of the northern *A. brevispina* and a more southern, undescribed species, in addition to *A. smitti*, which may be limited to the tropical western Atlantic and Caribbean.

Type Locality and Type Specimens. *Alderina brevispina* was described from the Vancouver Island "region", British Columbia. No type has been designated; the O'Donoghues' Collection is deposited at the BMNH.

Distribution. British Columbia; the MMS record off Purisima Point is a southern range extension if the specimen is actually *A. brevispina.*

Plate 15. *Alderina ? brevispina.* Anacapa Island. [A-B] A. Irregular zooids with cryptocyst narrower at distal end, no visible gymnocyst; tiny spinous processes sometimes seen. B. Ovicell with inconspicuous ectooecial hood, granular entooecial lucidum and slitlike opening. *Alderina smitti* Osburn, 1950. Florida. [C-D] C. Colony showing zooids with gymnocyst outer walls, regularly beaded cryptocysts; some with two concentric cryptocysts, possibly representing regeneration. D. Ovicell with two sections of cryptocyst, spine bases flanking ovicell; ovicell has heavy proximal band of ectooecium, smooth hood distally.

Callopora corniculifera (Hincks, 1882)

Plate 16 A-B

Membranipora corniculifera Hincks, 1882: 468, pl. 20, figs. 4, 4a.
Callopora corniculifera: Osburn, 1950: 66, pl. 7, fig. 1. — Soule and Duff, 1957: 94.

Material Examined. MMS Station: BRA-27. Other collections: AHF and BMNH.

Description. Colonies encrusting. Zooids distinct, moderately large, measuring 650-700 μm long, 450-500 μm wide. Marginal walls thick, bearing 10-12 spines: 3-4 pair of shorter, thinner proximal spines, 2-3 pair of long, thick distal spines leaning over the apertural area but curving outward; opesia narrower distally, opercular area rising distally; cryptocyst narrow, or wide if regenerated or repaired. Proximal end of zooid short, gymnocyst mostly on lateral walls and mural rim. Communication pores single, in lateral and transverse walls. Avicularia small, 60-70 μm long, sessile, on outer edge of lateral wall distal of the midline, directed laterally, with a small triangular mandible. Ovicells raised, up to 300 μm wide, shallow, with the two layers not fused at edge, leaving a slitlike opening; ovicell closed by operculum.

Biology. Encrusts rock, shells. This species apparently is able undergo intramural reparative or regenerative budding interior (central) to the original wall (Taylor, 1988). Depths from intertidal to 80 m have been reported previously; MMS records extend the depth to 96-126 m.

Taxonomic Remarks. Osburn (1950) synonymized *Cauloramphus triangularis* Canu and Bassler, 1923 from the Pleistocene of Santa Barbara with *Callopora corniculifera*. Canu and Bassler described that species as having two small distal spines and eight large spines, all distal of the midline of the opesia, quite different from the placement and numbers of spines in *Cauloramphus spiniferum* or *C. californiensis*. They described the origin of the avicularia as being from a triangular opening outside the spines, as in *C. californiensis*, but giving rise to a pedunculate avicularium; this seems questionable since their fossil material illustrated was lacking spines or avicularian rostra. Their light micrographs were retouched to show the triangular avicularium scar. They describe the ovicell as having a "hole" in it, not figured, but *Cauloramphus* spp. have shallow, crescentic, immersed ovicells, and the slitlike area in *Callopora corniculifera* is not easily characterized as a hole. No doubt the two species are related, but probably not synonymous. Osburn's figure (1950: pl. 7, fig. 1) does not indicate the large size of the distal spines nor the wide cryptocyst and reduced proximal gymnocystal area.

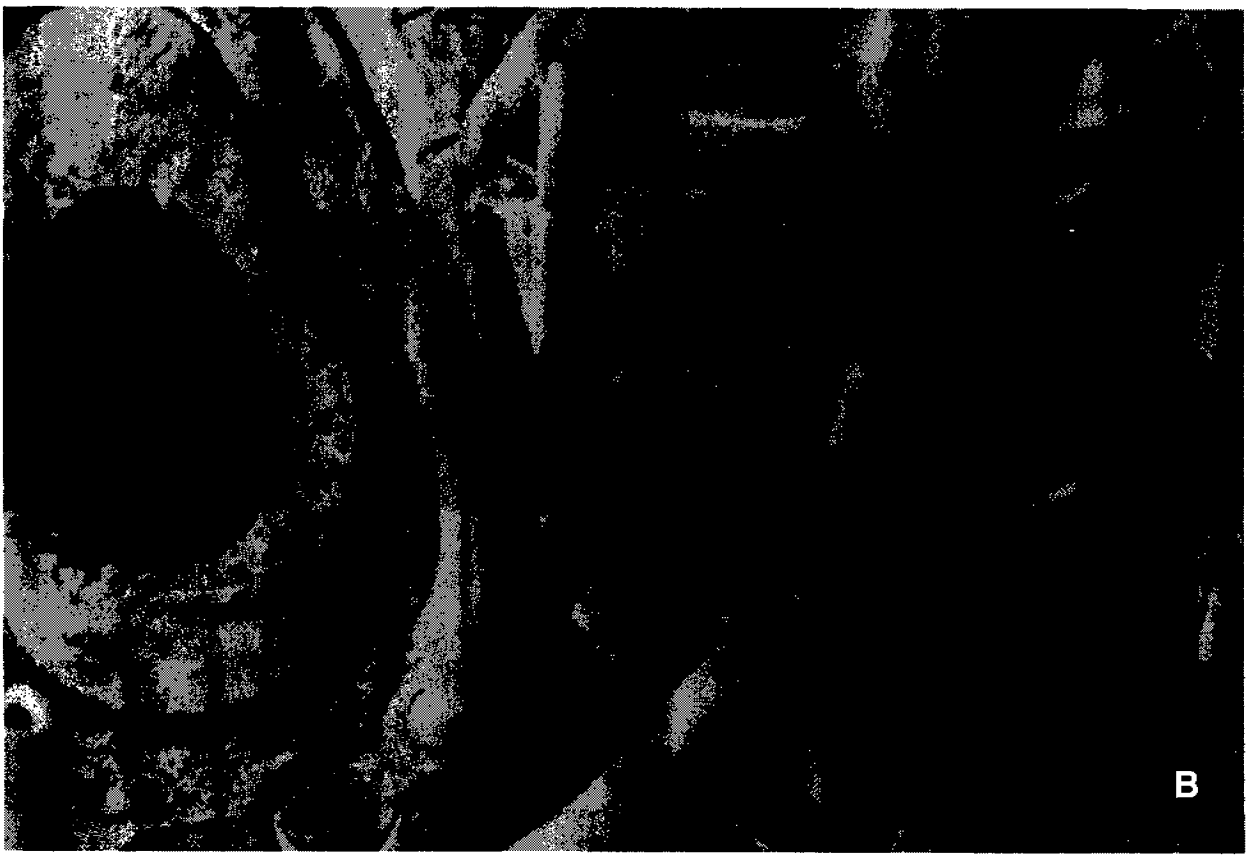
The genus *Callopora* Gray, 1848, was distinguished from *Tegella* Levinsen, 1909, by the former having single pore chambers in lateral and transverse walls, whereas the latter has multiporous septula, but this is not a consistent character (Dick and Ross, 1988), since *Tegella* spp. may have both. Ryland and Hayward (1977) state that the operculum closes the ovicell in *Callopora* whereas there is a separate closure in *Tegella*. In Pacific material the large avicularia do not encroach on the ovicells of *Callopora* spp. but do so in *Tegella* spp. These criteria cause changes in the generic designation of some species.

Type Locality and Type Specimens. Cumshewa, Queen Charlotte Islands, British Columbia. Type, BMNH 1886.3.3.29.

Distribution. British Columbia southward to Santa Catalina Island, Channel Islands, southern California; the MMS record is from northwest of Point Buchon, off Morro Bay, central California.

Plate 16. *Callopora corniculifera.* North of Pt. Buchon, central California. A. Growing margin of colony with ectocyst in place except for one zooid which has wide cryptocyst, possibly from regeneration, others have narrow cryptocyst; five or six stout, tall spines surround outer margin of aperture, smaller spines on thick walled mural rim around opesia, little proximal gymnocyst. B. Stout spines conceal ovicell with slit between ectooecium and entooecium; ovicells raised, granulate. Small, low, acute avicularia outside spines on lateral wall proximal to level of aperture.


A


B

Copidozoum adamantum, new species

Plate 17 A-C; Plate 18 A-D

Not *Membranipora tenuirostris* Hincks, 1880: 70.
Callopora tenuirostris: C.H. and E. O'Donoghue, 1926: 79.
Copidozoum tenuirostre: Osburn, 1950: 72, pl. 7, fig. 4.
Copidozoum planum: Osburn, 1950: 73.

Material Examined. MMS Station: BRA-1. Other collections: AHF; BMNH: 99.91.1118, *M. planum*.

Diagnosis/Description. Colony encrusting, zooids 340-540 μm long, irregularly ovate, distinctly separated, sometimes with fenestrae between zooids; cryptocyst raised, wide, rolled, coarsely crenulate, sometimes raised distally to acute tip; cryptocyst descending to opesia, narrowing at opercular area. Operculum large, widely curved distally with strong marginal sclerite, straight proximally with marginal sclerite continued. Large multiporous communication plates in lateral, transverse and basal walls. Avicularia parallel to zooids, base diamond shaped, elongate, widest at mandible hinge, rostrum raised, with long, acute beak, mandible with triangular base, extending into long, thin, setose stem resting in a narrow channel, hooking downward over the end of the rostrum. Ovicell raised, quadrate, with numerous pores, opening small, oval, above distal cryptocyst rim, becoming immersed. Ancestrula a small zooid observed with a single small spine on the proximal cryptocyst and 1 lateral spine; 3 small zooids budded from the distal and distolateral end, 3 larger zooids budded from the proximal and proximolateral area. Intramural budding present in some zooids.

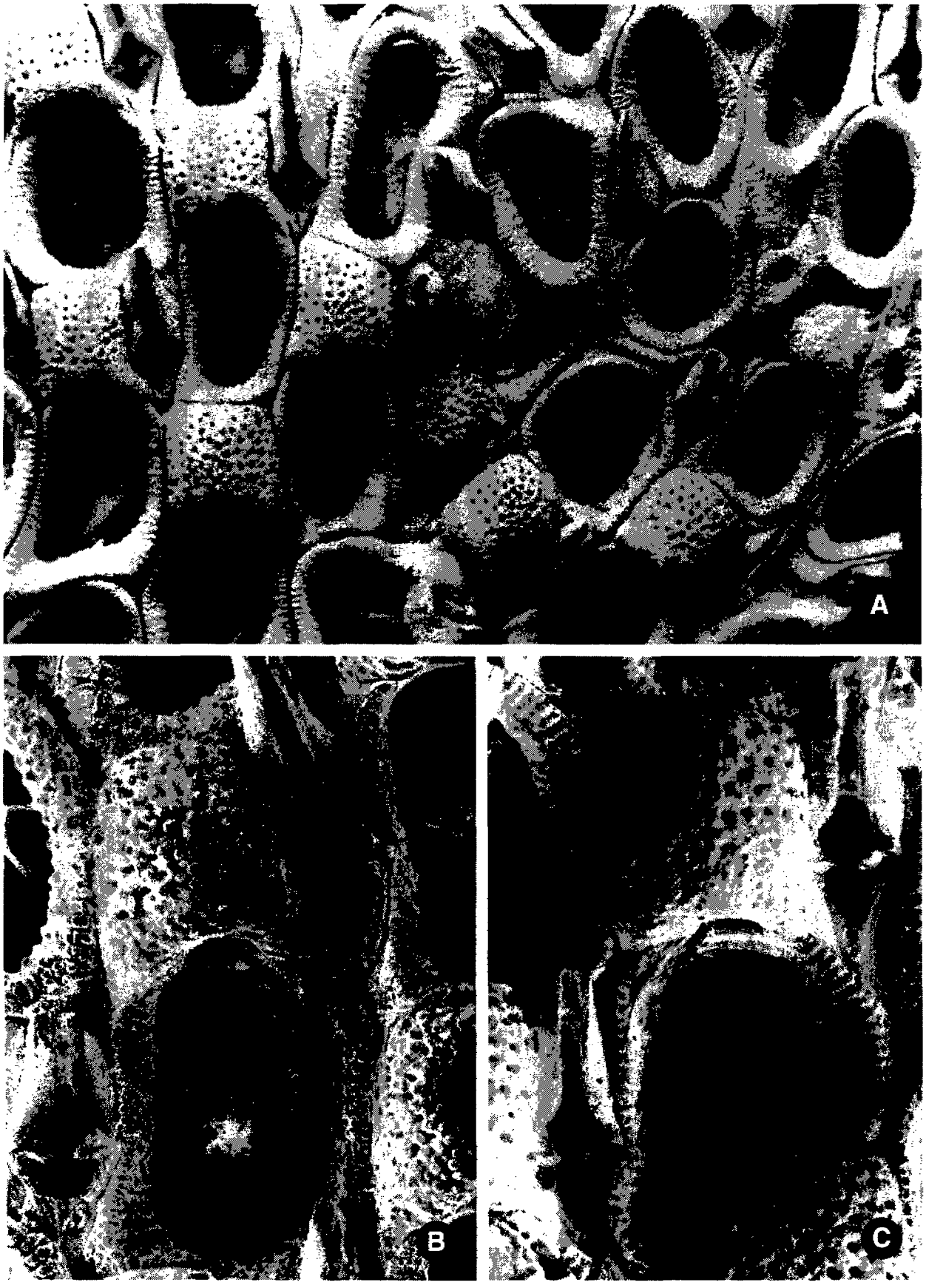
Etymology. Named for the diamond shape of the avicularium base.

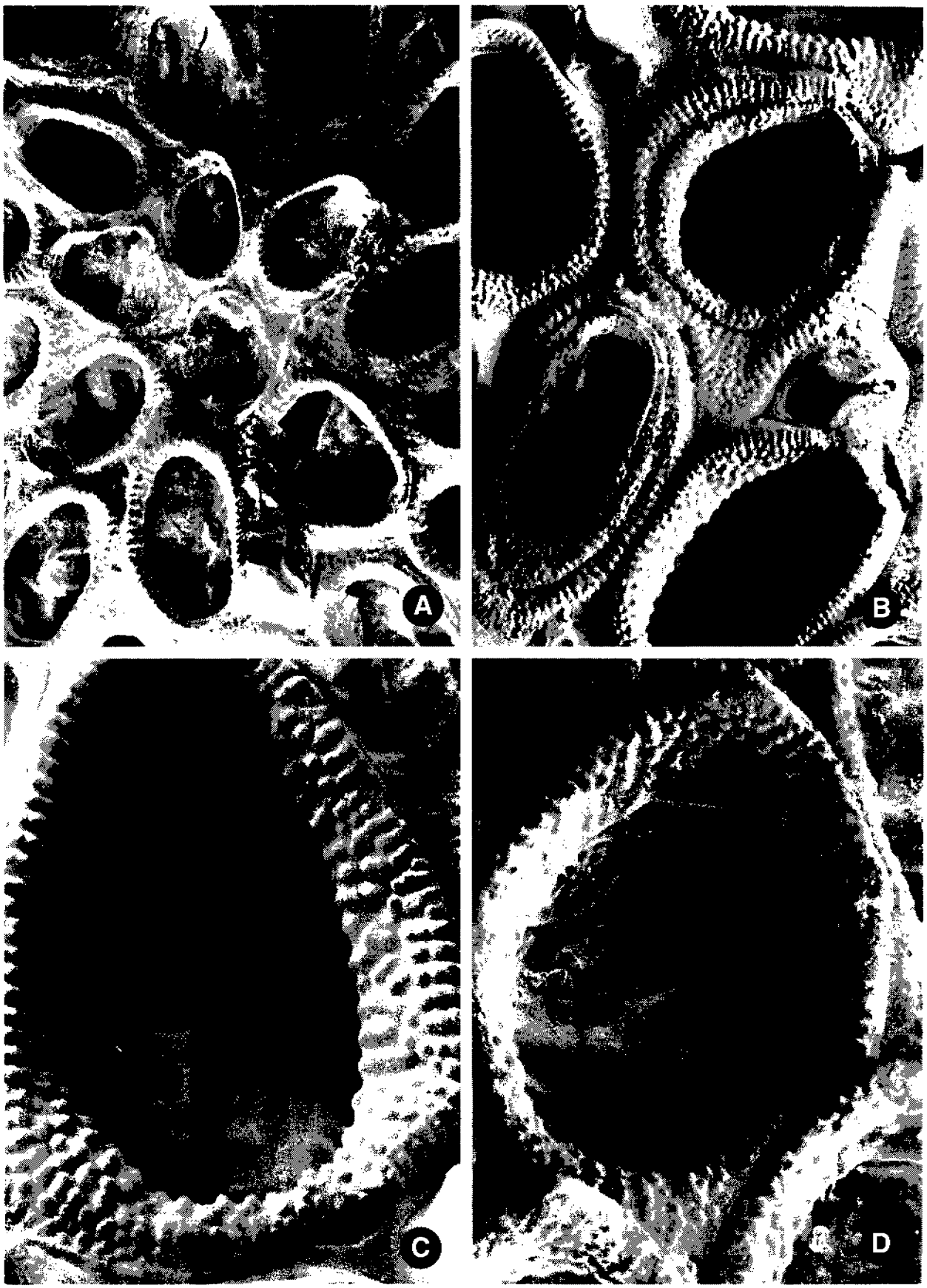
Biology. Encrusting rock, shell. Depths from intertidal to 129 m reported.

Taxonomic Remarks. The Pacific coast specimens are somewhat similar to the description of the Australian *C. planum* (Hincks, 1880a: 81), but the type of that species could not be located at the BMNH. It apparently had a narrower cryptocyst without the raised, rolled appearance and lacked the fenestrae and spaces between zooids. That species has not been reported from Australia since 1880 (S.A. Parker, pers. comm.), and Ryland and Hayward (1992) did not find it among 81 species collected at Heron Island, Great Barrier Reef. Mawatari and Mawatari (1981) reported *C. planum* from Japan as having large, flat zooids 600-700 μm long, much longer than any of the eastern Pacific material measured, but with small avicularia. D'Hondt (1987) described another Pacific *Copidozoum* from New Caledonia but that species had four tiny distal spines, unlike the present material.

Osburn (1950) used the name *Membranipora tenuirostris* Hincks, 1880a, for AHF material, distributed from northern California to Peru and the Galapagos Islands, although he suggested that all of it might belong under *C. planum*. *Copidozoum tenuirostre* Marcus, 1937, originally described from Madeira and Naples, has a proximal spine and 2-3 pairs of lateral spines, whereas no spines or spine scars can be seen on Pacific specimens. The eastern Pacific material may consist of more than one species but we are unable to separate them at this time.

Plate 17. *Copidozoum adamantum*. Mussel Pt., central California. [A-B] A. Colony with crenulate walls, variously sized acute interzooecial avicularia with channel in rostrum for setose mandible; ovicells are erect, with many small pores and granules. B. Ovicell with interzooecial avicularium beside it. C. The same, from Costa Rica.


A
B
C

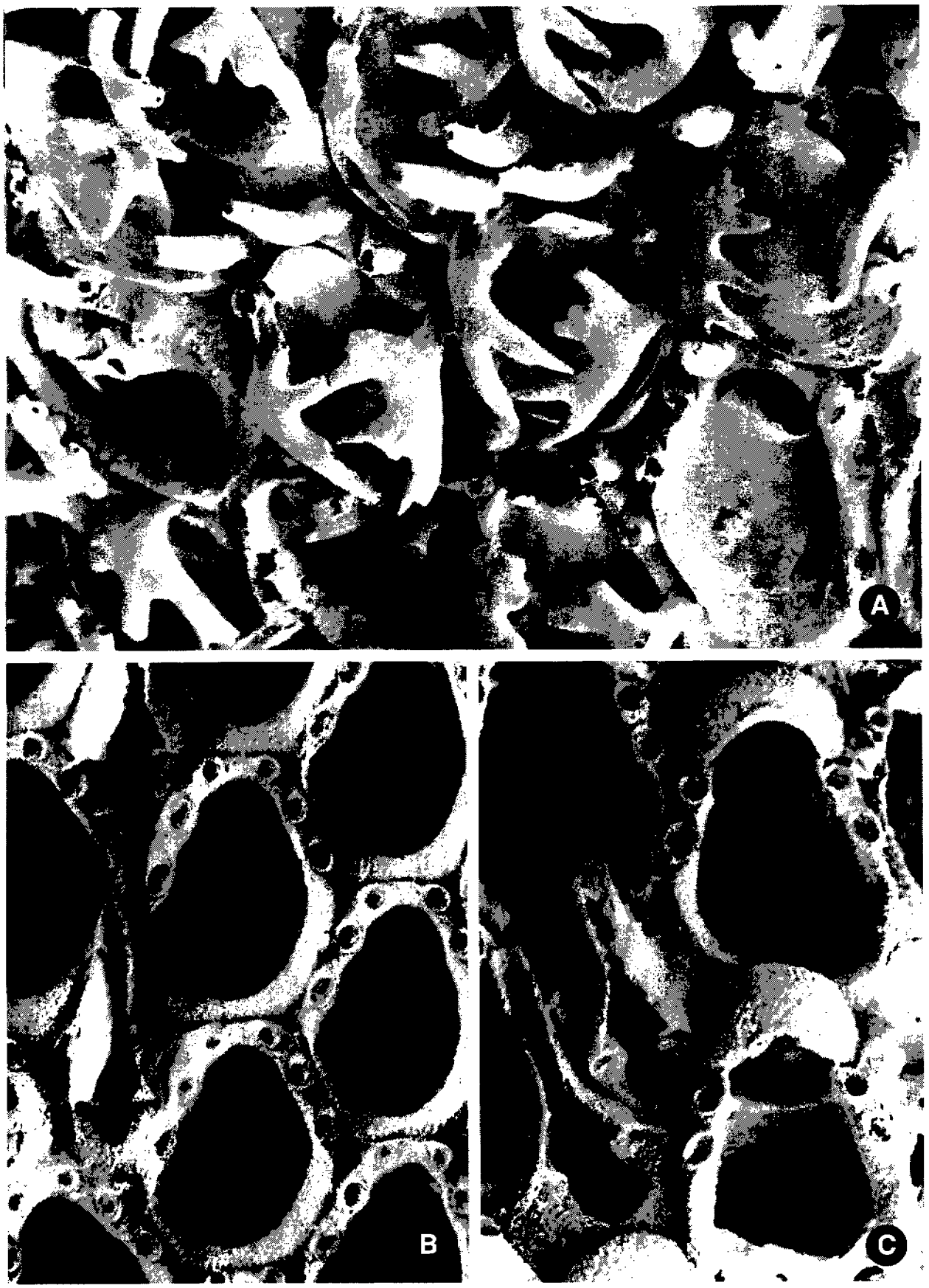

A
B
C
D

The specimen figured from Mussel Pt., California, in the Monterey Bay area (Plate17 AB), has slightly wider avicularia with very strong condyles, whereas the specimen from Secas Island, Panama has mostly smaller avicularia with smaller condyles. Zooid lengths are 340-440 μm at Mussel Pt., central California, 400-446 μm at Secas I., Panama; 425-559 μm at Alijos Rocks, Mexico; 498-540 μm at Chatham I. (Isla San Cristobal), Galapagos Islands; and 417-570 μm at Octavia Rocks, Colombia. Avicularia lengths also differ: 343-411 μm at Mussel Pt.; 164-297 μm at Secas I. (plus one at 425 μm); 296-320 μm at Alijos Rocks, Mexico; 314-387 μm at San Cristobal; and 229-288 μm at Octavia Rocks. Ovicell lengths for all specimens measured 210-240 μm, widths 210-250 μm. With sufficient comparative material, this suite of variations might eventually be justification for further divisions into several additional species of *Copidozoum*.

Type Locality and Type Specimens. Santa Catalina Island, Channel Islands, California. SBMNH-AHF Bryozoa Holotype No. 205.

Distribution. British Columbia to the Galapagos Islands and Peru, if all are the same species.

Plate 18. *Copidozoum adamantum*. A. Ancestrula in center, with two small spines remaining of tatiform stage, three small zooids budded distally, followed by larger zooids around proximal end; from James Bay, Galapagos Islands. B-C, from Octavio Rock, Colombia. B. Zooids with one, two and three cryptocysts, suggesting reparative budding. C. Wide crenulate wall, cryptocyst; a multiporous communication plate is at the top interior, uniporous plates to the left and right. D. Zooid with two large multiporous communication plates on left and center body wall, uniporous plates on right interior body wall; from Alijos Rocks, Mexico.


A
B
C

Copidozoum ? protectum (Hincks, 1882)

Plate 19 A-C

Membranipora protecta Hincks, 1882a: 256; 1882b: 468, pl. 19, fig. 3. — C.H. and E. O'Donoghue, 1923: 25.
Amphiblestrum protectum: C.H. and E. O'Donoghue, 1926: 38.
Copidozoum protectum: Osburn, 1950: 73, pl. 7, fig. 5.

Material Examined. AHF and BMNH Collections.

Description. Colonies encrusting. Zooids ovoid, 400-500 μm long, 250-270 μm wide. Cryptocyst a rolled rim, little gymnocyst visible, gymnocystal spines encroaching on cryptocyst. Distal rim adjacent to aperture bearing 4 stout, hollow spines or large sockets as spine scars; on each side proximal to the aperture, an moose antler-like spine showing 3-6 prongs leaning over the opesia, prongs interdigitated like fingers folded over a belly, prongs sometimes fused. Avicularia interzooecial, with a long raised rostral chamber and an elongate, slender, acute mandible with setose tip directed distally, usually parallel to zooids. Ovicell small, a granular, shallow hood, closed by operculum.

Biology. Depths reported from 10 to 50 m, on hard substrates. It may have a deeper distribution in California since it is apparently a temperature tolerant species; also found along the peninsula of Baja California and in the Gulf of California.

Taxonomic Remarks. C.H. and E. O'Donoghue said that their material had longer, more slender avicularia than those illustrated by Hincks, almost vibraculoid, but Hincks described them as long, slender, and setiform, even though the mandibles are not setose in his illustration. It is possible that there is more than one species involved in the extensive distribution, from British Columbia to Colombia, South America, but the characters appear to be consistent.

The generic placement of this species is questionable. It has ovicells and avicularia like those in *Copidozoum*, but the distribution of spines resembles those in *Chaperiopsis*. There are, however, no paired, calcified shelves (*occlusar laminae*) internal to the cryptocyst distolaterally for attachment of occlusor muscles to operate the operculum as there are in most chaperiids. The ovicells are complete hoods in *Copidozoum*, lacking frontal fenestrae or other evidence of an incomplete ectooecium, as in most chaperiids; ovicells in the chaperiid genus *Larnacicus* lack fenestrae (Gordon, 1982). The latter genus has a very extensive cryptocyst, however.

Type Locality and Type Specimens. Virago Sound, Queen Charlotte Islands, British Columbia. BMNH 86.3.6.1, type.

Distribution. Southward from British Columbia waters to Baja California, Mexico and probably to Port Utria, Colombia (AHF bottom sample Station 232), if all are of the same species.

Plate 19. *Copidozoum protectum*. Anacapa Island. A. Zooids irregularly oriented, opercula open, apertures flanked by four stout spines. Proximal pair of spines at midzooid branched, interdigitating, shielding opesia. B. Zooids with spine scars for the two pairs of stout apertural spines and the pair of branched spines. C. Ovicells and two interzooecial avicularia.

Tegella circumclathrata (Hincks, 1881)

Plate 20 A-D

Membranipora circumclathrata Hincks, 1881: 131, pl. 5, fig. 1. — Robertson, 1908: 259. — C.H. and E. O'Donoghue, 1923: 24.
Callopora circumclathrata: C.H. and E. O'Donoghue, 1926: 33. — Osburn, 1950: 65, pl. 8, fig. 2.
Retevirgula circumclathrata: Brown, 1948: 110.

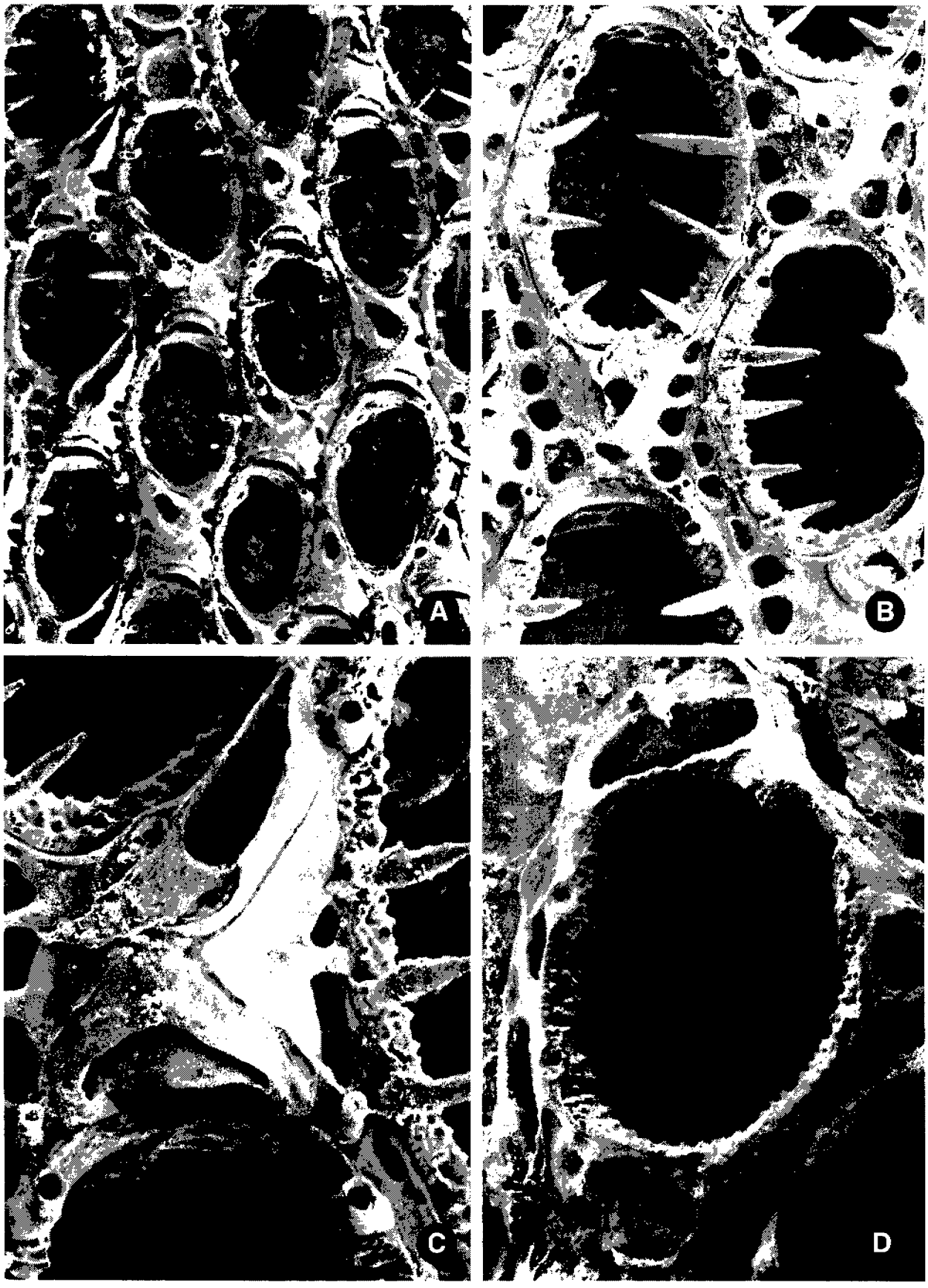
Material Examined. MMS Station: BRA-27. Other collections: AHF and BMNH.

Description. Colonies encrusting. Zooids loosely connected by short tubules, leaving fenestrae between them, 450-500 μm long, 300-320 μm wide, ovoid, with an ovoid opesial area and large dietellae. Two erect, strong distal spines and 3-4 pair of pointed lateral spines curving over the opesia. Avicularium proximal to opesia medium to large, directed proximally resting on gymnocyst; when associated with an ovicell on the proximal zooid, avicularium originating between zooecial transverse walls is larger, with elongate triangular mandible directed distolaterally. Ovicell small, globose with 2 layers incompletely fused, a riblike rim on outer layer. Basal portion of large avicularium often overlapping ovicell.

Biology. Encrusting rock and shells. Depths from shallow water to 100 m reported previously; the MMS depth was 96-126 m.

Taxonomic Remarks. Brown (1948) placed this species in *Retevirgula* because of its tubular connections between zooids. The type of the genus, *R. acuta* (Hincks, 1885), illustrated by Gordon (1986), has a smooth ovicell surmounted, without a marginal line distally, by a small avicularium and the ectooecium is complete, without a lucidum frontal area or a gap between layers. Other species assigned by Osburn (1950) to the genus, *R. tubulata* (Hastings, 1930) and *R. lata* Osburn, 1950 from the Galapagos Islands, have a fenestra or pore distally on the hood, as does *R. sejuncta*, from New Zealand and Australia. *Retevirgula areolata* Canu and Bassler, 1950, from Pleistocene and Recent southern California, and the other *Retevirgula* species with an ovicell pore do not seem to have ovicell avicularia. *Callopora* and *Tegella* species usually have a distinct central, endooecial frontal area (lucidum) gap between the entooecium and ectooecium, but do not have an ovicell pore, except for *Tegella magnipora*, an Alaskan species which lacks avicularia and may not belong in the genus *Tegella*. *Tegella* should be restricted to those species having a large avicularium at the transverse wall between zooids which encroaches on the distal portion of the proximal ovicell, with the ovicell not closed by the zooidal operculum. *Callopora* should be restricted to those in which an avicularium, if present, does not cover the distal portion of the ovicell and the zooidal operculum does close the ovicell opening, as suggested by Dick and Ross (1988). Examination of the developing colony indicates that the large avicularium originates from a space at the basal wall, becoming directed transversely, coming to rest on the proximal gymnocyst. Levinsen (1909) used the presence of single pore plates to distinguish *Callopora* from *Tegella*, the latter being characterized as having multiporous septula, but the difference is not definitive; Dick and Ross found both in some *Tegella* specimens, as have the present authors.

Plate 20. *Tegella circumclathrata*. Anacapa Island. A. Colony showing fenestrae between zooids; all zooids with ovicells have giant avicularia with long, raised rostra, curved tips, directed distolaterally, encroaching from the distal end onto the proximal ovicell. B. Zooids without ovicells showing two pair of distal spines and three to four pair around the opesia; avicularia rest on gymnocyst with short, acute mandibles directed proximally. C. Giant interzooecial avicularium with mandible open encroaching on ovicell. Note space between ectooecium and entooecium. D. Giant avicularium developing from basal wall distally at edge of colony; smaller avicularium developing on proximal gymnocyst; avicularium on right is distal to partial zooid in lower right.


A
B
C
D

Tegella circumclathrata is similar *T. horrida* (Hincks, 1880) except that zooids in the former are separated by large fenestrae whereas those of *T. horrida* are not. Dick and Ross (1988, p. 45) placed the *Tegella robertsonae* of Osburn (1950: 81, pl. 9, fig. 5) in *T. horrida*, but listed the same Osburn figure as *Tegella aquilirostris* (p. 42), a *lapsis*, and both synonymies seem questionable. *Tegella horrida* has 6-8 spines, while *T. robertsonae* has 3-4, only one of which is large; *T. aquilirostris* has four spines, none of which are large and tubular. None of these species has avicularia on the lateral walls, whereas another group of *Tegella* does, including *T. armifera* and *T. larusiensis*, new species. This might indicate a future division of the tegellids. Characters in all the above species are very difficult to see with optical microscopy.

Type Locality and Type Specimens. Santa Cruz, California. BMNH Hincks collections.

Distribution. British Columbia southward to Mexico. The MMS station is northwest of Pt. Buchon.

Tegella armifera (Hincks, 1880)

Plate 21 A-D; Plate 22 D

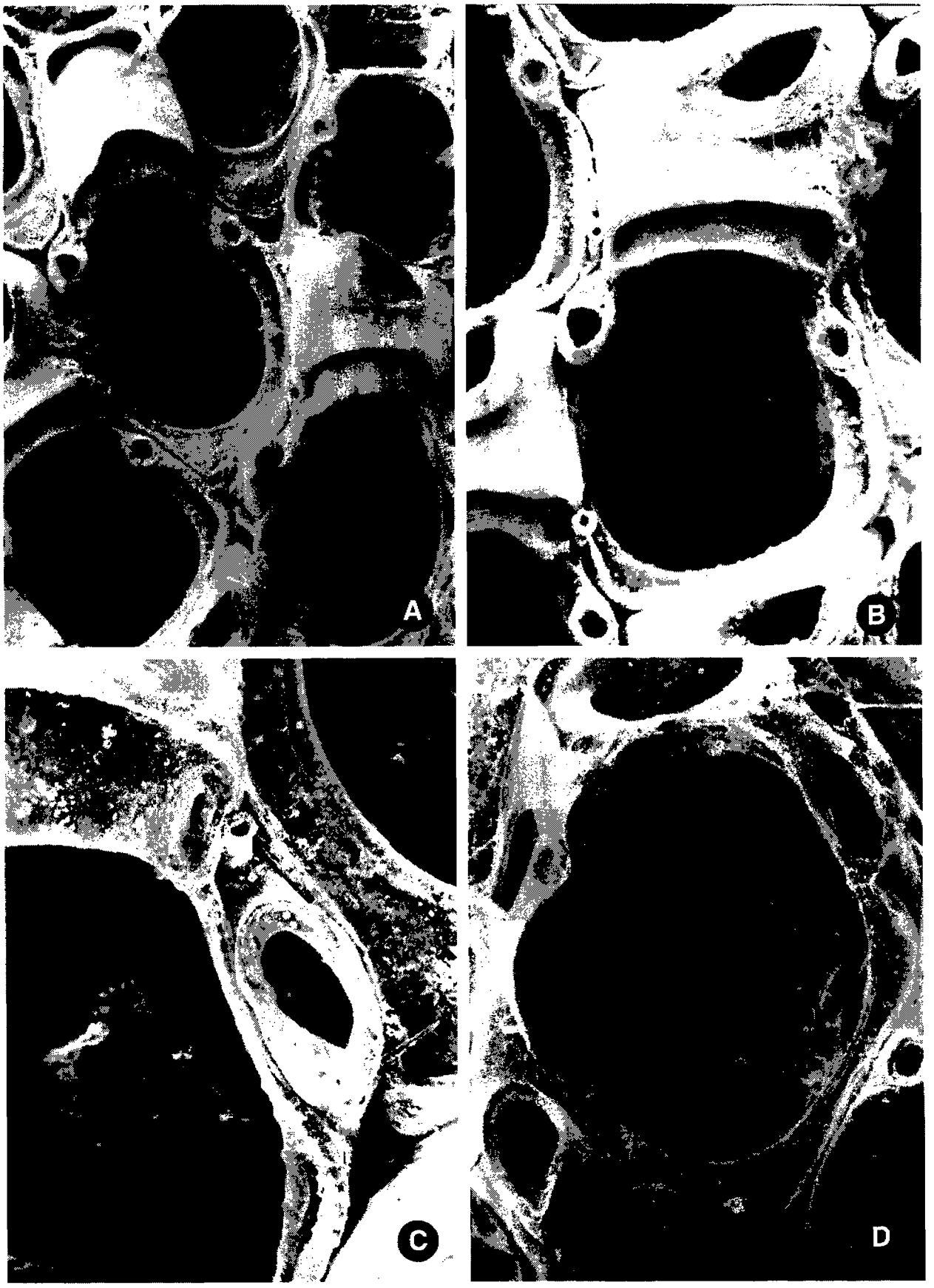
Membranipora armifera Hincks, 1880a: 82, pl. 11, fig. 5; 1892: 155, pl. 8, fig. 4.
Tegella armifera: Osburn, 1950: 79 (in part). — Dick and Ross, 1985: 89; 1988: 44, pl. 3, fig. C.

Material Examined. MMS Station: BRA-14. Other collections: AHF; BMNH: (1911.10.1.599 from the Norman Collection).

Description. Colonies encrusting. Zooids 400-440 μm long, 250-300 μm wide. Opesia oval, cryptocyst narrow, granular, with crenulate inner margin, depressed below rim of zooidal walls; zooids separated by grooves, small cryptic spaces. A small spine at each distal corner in young zooids, sometimes remaining in mature zooids, flanking the ovicell space (lucidum) between ectooecium and entooecium; sometimes a tall stout spine present just proximal to, or in place of, a lateral avicularium; 1 small lateral avicularium, or 1 on each side of the mural rim, with triangular mandible opposite the operculum, directed proximally. A large avicularium with inflated chamber having a straight proximal margin and slanted distal margin originating basally between transverse walls, with triangular mandible directed distolaterally; avicularium distal to ovicell larger, encroaching on ovicell hood. Transverse and lateral walls bearing a mixture of uniporous and multiporous plates. Ovicells globular, prominent, a ridge across the hood rimming an almost straight slit (lucidum) where the 2 ovicell layers do not meet, with a large pore at each end adjacent to the small spines.

Biology. Encrusting rock, shells, worm tubes and algae. Depths from intertidal to 70 m previously reported, although some citations may not be of *T. armata*. The MMS record extends the depth to 105-117 m.

Plate 21. *Tegella armifera*. Canoe Bay, Alaska. A. Growing edge of colony, zooids with pair of tiny spines flanking distal end of zooids, or flanking slitlike ovicell lucidum between ectocyst and entocyst. Single or paired avicularia on distal lateral wall bordering cryptocyst, one sometimes replaced by a stout spine. B. Ovicelled zooid with one small avicularium, one stout spine (scar) on lateral wall, cryptocystal shelf below wall; ovicell flanked by small spines, slitlike space with pore at either end. Giant avicularium between ovicell and transverse wall of next distal zooid, directed distolaterally, not as large as those in *T. cassidata*, Plate 22. C. Avicularium that comes to lie on lateral wall originating between zooids, possibly from basal gymnocyst. D. Interzooecial avicularium developing at colony margin distal to zooid; small lateral avicularium developing on right margin.


A
B
C
D

Taxonomic Remarks. In describing this species, Hincks (1880a) had only a few zooids from a young colony, which he illustrated as having two or three distinctly distal spines and two lateral oral avicularia proximal to the spines, but lacking ovicells; he did not mention a large spine or spine scar on the lateral wall distal of the middle opesia. Hincks (1892) later revised the description and illustrated an ovicell with a large avicularium encroaching on it, although the drawing is sketchy. His 1892 description was used by later authors (e.g., Norman, 1903a; Osburn, 1950; Kluge. 1975; Dick and Ross, 1988), but some of these lacked measurements which might have indicated whether more than one species was present.

Part, if not all, of the California material, which has more than one spine, belongs to *Tegella larusiensis*, new species, discussed below. Comparison of the Hincks type of *T. armifera* with that of *Membranipora cassidata* C.H. and E. O'Donoghue, 1923: 27, pl. 2. fig. 15 (*Tegella cassidata*, C.H. and E. O'Donoghue, 1926: 36) indicated that *T. cassidata* is not a junior synonym for *Tegella armifera*, as indicated by Osburn (1950), but is a consistently larger form with differences in the ovicell. Mawatari and Mawatari (1980) summarized characters of 17 species of *Tegella*, although some synonymies remain questionable due to the disappearance of Robertson's types and the condition of other types.

The developing margin of colonies labeled *T. armifera* by Osburn from Canoe Bay, Alaska, show that the lateral avicularia are of interzooecial origin, arising outside the mural rim from basal gymnocyst; they can appear as if they were on a comparatively long "stalk", which might be considered pedunculate, before forming the rostrum and mandible and coming to lie on the lateral wall, directed proximally. The large avicularia at transverse walls, when young, are erect and directed upward and distally on the ovicells, but older avicularia that have moved onto the ovicell are torqued and directed distolaterally. Those that are between autozooids and not associated with an ovicell are smaller and oriented more transversely. The Canoe Bay material may represent an as yet undescribed species, but the mode of development appears to be similar in the species examined.

Previous authors have attributed the large avicularium lying along the transverse wall to be developed on the frontal gymnocyst proximal to the opesia (e.g., Mawatari and Mawatari,1980, Figure 34F), although Osburn, 1950, indicated that it arises from the "basal gymnocyst". Development indicates that the large avicularia arise interzooecially; SEM examination shows that the chamber retains a connection with the basal wall at one side. Where the avicularium is distal to an autozooid lacking an ovicell, adjacent zooids show complete body walls separating them from the conical chamber, sometimes with areolate spaces that typically occur between zooids.

The frontal portion of the ovicells has an area not covered with the ectooecium; growth progresses from an arched ectooecial margin (bar), flanked or not by tiny spines, to a more closed slit in *T. armifera*, whereas the ovicell in *T. cassidata* has a large lucidum between the rimmed entooecium and the ectooecium, which borders the avicularium.

Specimens with more than one spine proximal to the lateral avicularia probably belong to one or more other species (e.g., Mawatari and Mawatari, 1980, Figure 34). *Tegella larusiensis* new species has two small spines flanking the ovicell opening and three large spines, one of which may appear bifurcate.

There is considerable variation in length of zooids and ovicelled zooids with avicularia recumbent upon them. In the Canoe Bay specimen of *T. armifera*, zooids range from 409 to 501 μm with a mean of 428.6 μm, and zooids with ovicells range from 516 to 694 μm, with a mean of 655 μm. The Nash Harbor specimen, questionably of *T. cassidata*, has a range in zooid length of 540 to 668 μm, with a mean of 597 μm; zooids plus ovicell and avicularia ranged from 658 to 857 μm with a mean of 787.8 μm. The Mist Harbor specimen of *T. cassidata* has similar sized zooids but the zooids plus ovicell and avicularium ranged from 737 to 1,600 μm, with a mean of 1,002μm. Thus there is no overlap in measurements of zooid plus ovicell length, indicating that there may be two or more species involved.

Kluge (1962, translated 1975) described *Tegella armiferoides* with a large avicularium raised in a conical protuberance from the gymnocyst, having two distal spines and two lateral avicularia proximal to the spines but he did not mention or illustrate any large lateral marginal spines such as those in *T. armifera*. Kluge collected his material in the East Siberian Sea north of Novosibirsk Island, at 73-91 m on polychaete tubes.

Type Locality and Type Specimens. Gulf of St Lawrence. BMNH 33.12.116.1, type.

Distribution. Alaska southward to Puget Sound, Washington, possibly in deeper waters off Oregon and California. The MMS record is from west southwest of Purisima Point, but the specimen was too small and battered to determine the species with certainty. It may have been of *T. larusiensis*, new species, instead. *T. armifera* has been reported from Arctic seas and both sides of the North Atlantic, and from the Bering Sea, if all records are valid.

Tegella cassidata (C.H. and E. O'Donoghue, 1923)

Plate 22 A-C; Plate 23 A-D

Membranipora cassidata C.H. and E. O'Donoghue, 1923: 27, pl. 2, fig. 15.
Tegella cassidata: C.H. and E. O'Donoghue, 1926: 36.
Tegella armifera: Osburn, 1950: 79 (in part), pl. 9, fig. 7.

Material examined. AHF and BMNH Collections.

Description. Colonies encrusting. Zooids ovate, ranging in length from 500 to 600 µm; cryptocyst narrow, rolled, granular. Single pore chambers and multiporous chambers in vertical walls. A pair of bulbous avicularia with triangular mandibles flanking aperture, raised on conical chambers originating outside the lateral gymnocyst. A large spine interior of the base of one avicularium and proximal to the rostrum. A large avicularium between zooidal transverse walls, with almost rectangular base, rising to an erect, curved and hooked rostrum, directed distally at first, becoming twisted distolaterally when encroaching on ovicell of proximal zooid. Ovicell with large lucidum between a high, arcuate or bow-shaped ectooecial border and the lower rimmed entooecial hood.

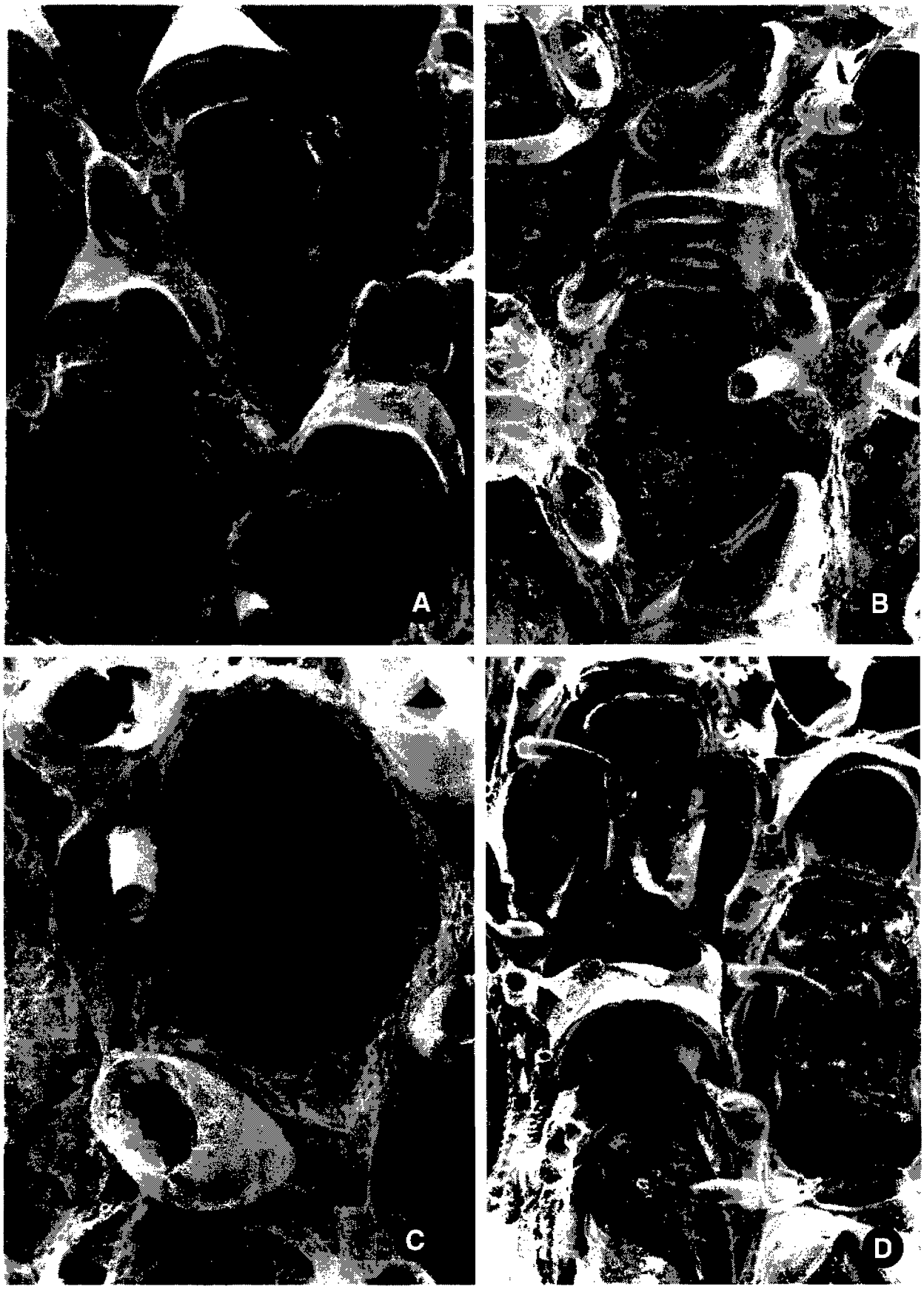
Biology. Encrusting shell, rock. Because of the confusion between species, the maximum depth is not known.

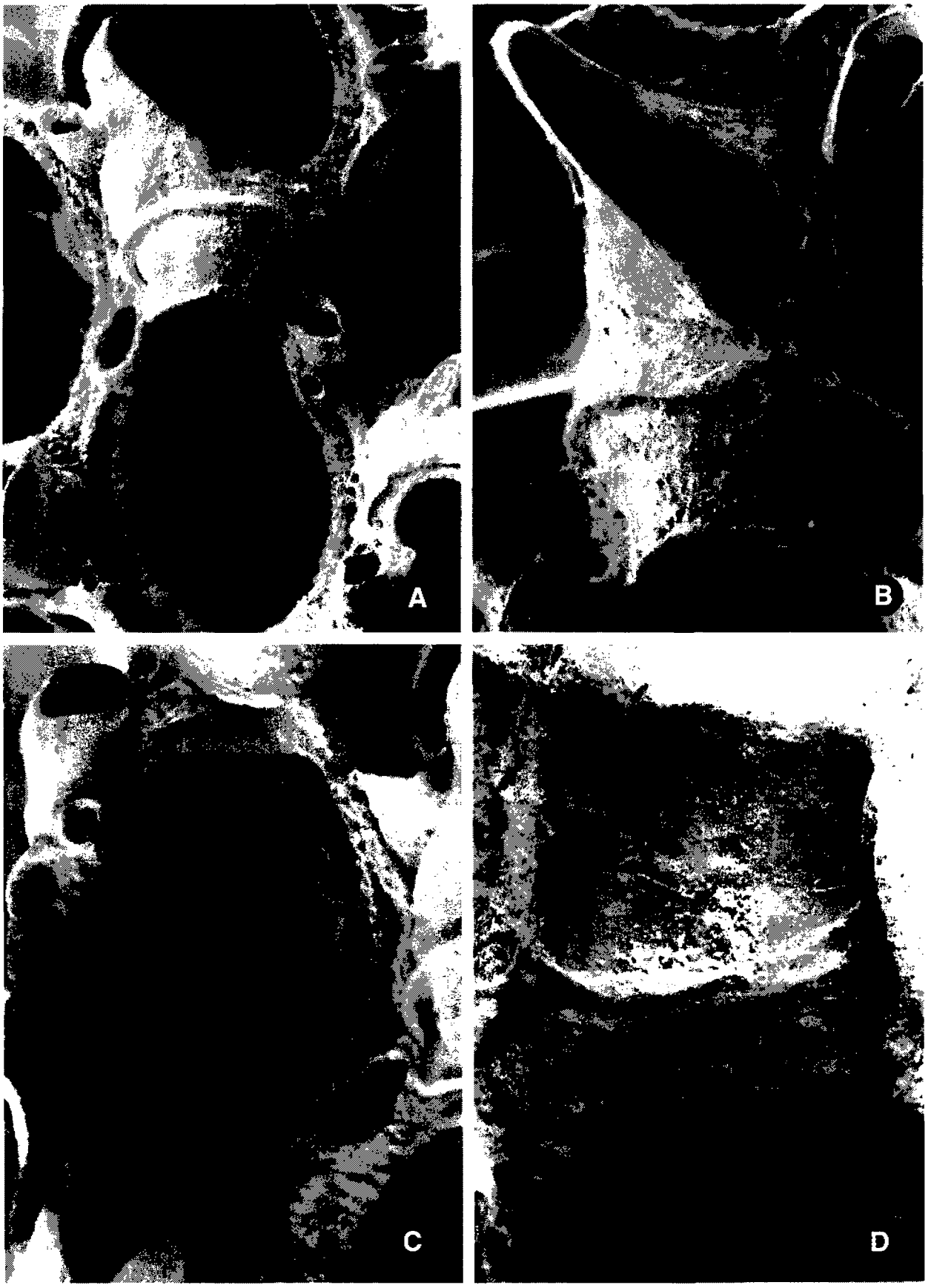
Taxonomic remarks. Osburn (1950) illustrated "*T. armifera*" (Plate 9, Figures 1 and 7) as having avicularia distal to the large spines, while C.H. and E. O'Donoghue specified that the lateral avicularia

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Plate 22. *Tegella cassidata*. [OVER, LEFT] Nash Harbor, Alaska. [A-C] A. Various stages of development in ovicell, with wide lucidum between ectooecium and entooecium, young interzooecial avicularia on ovicells small, directed straight distally. B. Ovicell in same colony has closed layers to slit; large avicularium becoming elongate, raised, directed distolaterally. C. Same colony, lateral avicularia arising between zooids; interzooecial avicularia arising between transverse walls of nonfertile zooids smaller than those associated with fertile zooids. D. *Tegella armifera ?* from Punuk Island, Bering Sea. Smaller ovicells, zooid with intact lateral wall spines.

Plate 23. *Tegella cassidata*. [OVER, RIGHT] Mist Harbor, Alaska. A. Large ovicell with wide lucidum, raised, curved avicularium rostrum; two lateral wall avicularia and a large spine scar proximal to one avicularium. B. Detail of ovicell and interzooecial avicularium, without the large pores at the ends of the lucidum seen in *T. armifera*. C. Interior of zooid showing communication pores with single and multiple pores. Lateral avicularia show pedunculate growth outside lateral wall. D. Growing margin of colony showing basal wall of giant avicularium, with transverse walls separating it from zooids.


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were located distal to small spines, as illustrated by them, although the spine scars seen indicate larger spines in that position; they described the avicularia as pedunculate, as can be seen in marginal zooids. An AHF specimen from Mist Harbor, Nagai Island, Alaska, has the raised, lateral avicularia at the margin of the ovicell, as described by C.H. and E. O'Donoghue, with a stout spine scar proximal to one avicularium and no apparent small spines distal to the avicularia in ovicelled zooids.

Type locality and type specimens. Departure Bay, British Columbia. The O'Donoghue type is in their collection at the BMNH.

Distribution. Probably a cool water species, it is widely distributed in British Columbia but its southern extension is unknown, although it could be expected to occur in deeper water to the south of British Columbia.

Tegella larusiensis, new species

Plate 24 A-D

Tegella armifera: Osburn, 1950: 79 (in part), pl. 9, fig. 1.

Material Examined. AHF and BMNH Collections.

Description. Colony encrusting. Zooids ovoid, 355-511μm long, narrowed at operculum base; 2-3 spines, 1 small spine and 1 larger one, sometimes bifurcate, on one side of aperture, 1 spine on other side; a raised lateral avicularium near middle of opesia on lateral wall, directed distolaterally on some zooids; a larger avicularium between transverse walls with raised, truncate rostrum, mandible directed proximally, curved downward at tip. Ovicell with ectooecial, entooecial layers separated by a rimmed lucidum slit, the large avicularium recumbent on ovicell, mandible triangular, reversed, directed upward and distally, not distolaterally; when not associated with an ovicell, the large avicularium is truncate. Transverse walls with multiporous septula, a few pore plates, lateral walls with septula.

Etymology. *Larus*, Latin for gull; Gull Island is the type locality.

Biology. Encrusts sandy polychaete tubes; collected at 88 m , but probably also occurring in shallower and deeper waters on appropriate substrate.

Taxonomic Remarks. This species was included in *Tegella armifera* by Osburn (1950), with the type specimen of *T. larusiensis* being used to illustrate "*T. armifera*" (Osburn, 1950, Plate 9, Figure 1). *Tegella armifera* citations apparently involve more than one species. *T. larusiensis* differs from *T. armifera* in having two small distal spines that remain flanking the ovicell opening plus three larger spines, two on one side of the aperture, one of which may be bifurcate, and one on the other. The lateral wall avicularium is midway down the opesia in *T. larusiensis* rather than opposite the operculum distal to the spines as is the case in *T. armifera*. The truncate shape of the large avicularium in zooids without an ovicell proximal to it is like that in *Tegella armiferoides* Kluge, 1962 (translated 1975). The zooidal length ranged from 355 to 511 μm with a mean of 428.5 μm, and the zooid plus ovicell and avicularium, measured through the middle without regard to the extension distolaterally of the avicularium, ranged from 530 to 759 with a mean of 643.3 μm. This places it in the size range of the Canoe Bay specimen of *T. armifera*, and smaller than the Nash Harbor "*T. armifera*", but the zooid plus ovicell and avicularium is much longer in *T. cassidata* from Mist Harbor, up to 1,600 μm.

Type Locality and Type Specimens. The type locality is 4 miles NW of Gull Island, off Santa Cruz, California, AHF Bottom Station 1245. SBMNH-AHF Bryozoa Holotype No. 206.

Distribution. Central and southern California sandy bottom areas are the only locations known to date.

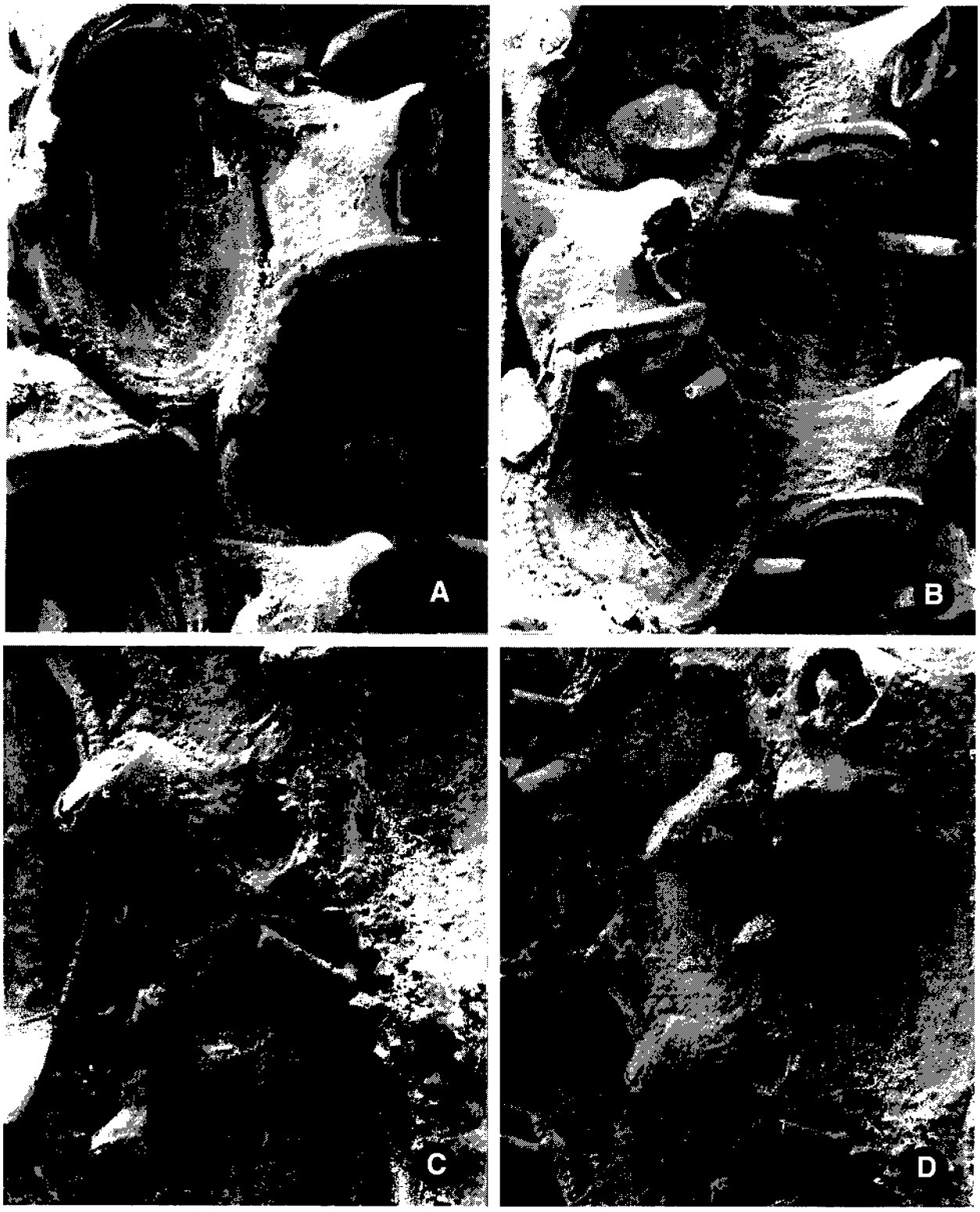
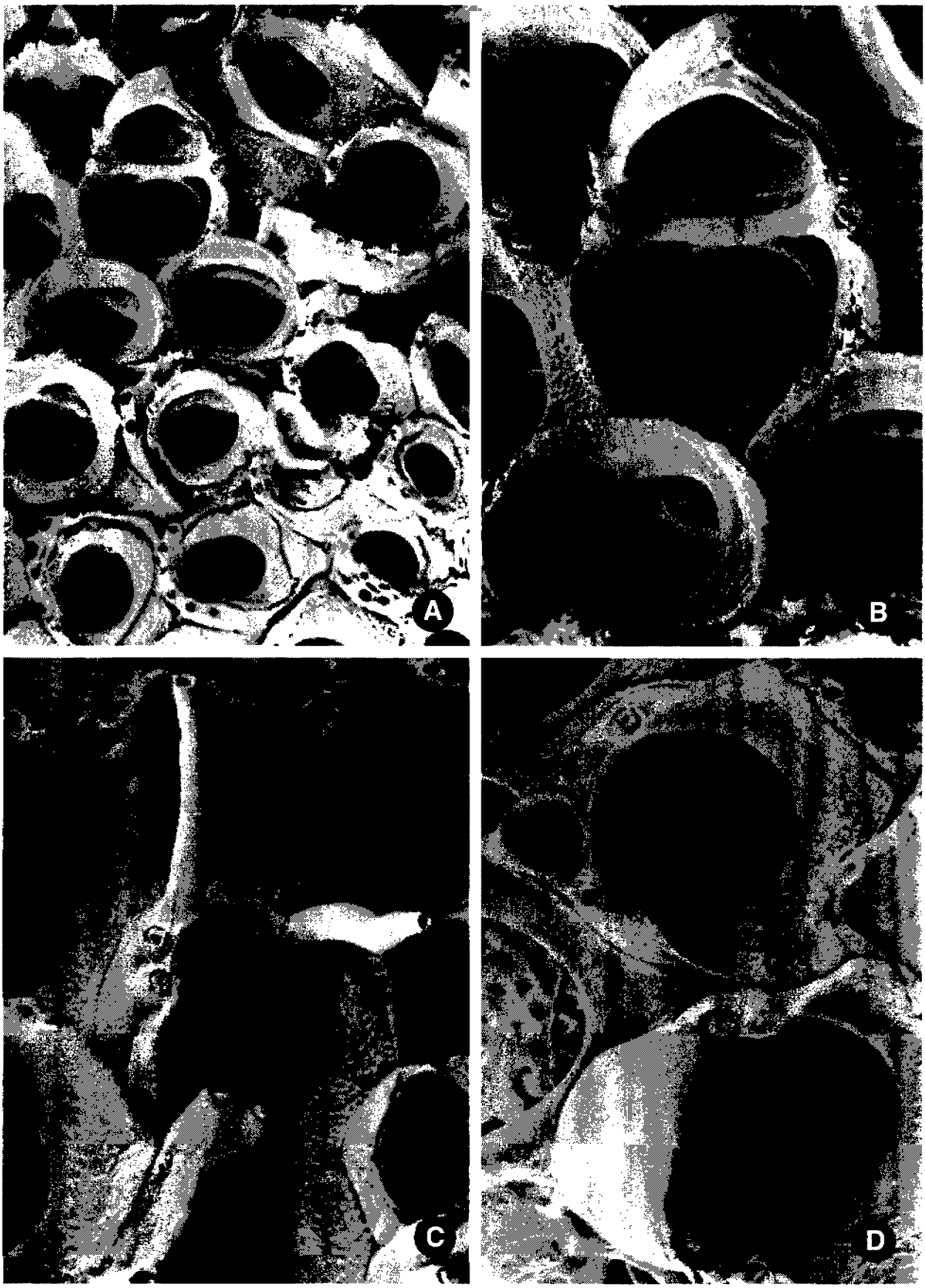


Plate 24. *Tegella larusiensis.* Northwest of Gull Island, off Santa Cruz, California. A-B. Ovicelled zooids with two or three spines flanking aperture; tiny avicularium on one side of lateral wall proximal to middle, or absent; ovicell with layers almost merged into a lip, interzooecial avicularium smaller than in *T. armifera* and *T. cassidata*. C-D. Interzooecial avicularium between non-fertile zooids raised into a truncate pedestal. Sand grains on frontals of some zooids.


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Family Chaperiidae Jullien, 1888

Encrusting or erect colonies. Zooids with moderate to large opesia, cryptocyst narrow to moderately wide, gymnocyst present or absent or obscured by spines. Usually (in *Chaperia* and *Chaperiopsis*), below the cryptocyst and immediately proximal to aperture, a shelf or paired lateral ledges (occlusar laminae) is present for attachment of muscles control the operculum. Spines, avicularia and ovicells present or absent.

Chaperiopsis patula (Hincks, 1881)

Plate 25 A-D

Membranipora patula Hincks, 1881a: 150, pl. 8. fig. 4; 1882: 465. — Robertson, 1908: 263, pl. 25, fig. 10. — C.H. and E. O'Donoghue, 1923: 167.
Chapperia galeata: Canu and Bassler, 1923: 52, pl. 34, figs. 9, 10.
Amphiblestrum patulum: C.H. and E. O'Donoghue, 1925: 97; 1926: 83.
Chapperia patula: Osburn, 1950: 89, pl. 10, fig. 12. — Soule and Duff, 1957: 96. — J. D. Soule, 1959: 20.

Material Examined. MMS Station: BRA-1. Other collections: AHF and BMNH.

Description. Colonies typically forming reddish-purple encrustations attached by rough, irregular protuberances. Zooids 500-850 μm long, 400-425 μm wide, opesiae broader than long, 250-300 μm by 300-350μm; granular cryptocyst with raised mural rim; a shelf in the distal half of the opesia on each side (occlusar laminae), internal to cryptocyst, for attachment of the occlusor muscles of the operculum, sometimes meeting in the middle; rim of distal half, outside of cryptocyst, bearing 4-6 tall, thick, hollow spines, extending upward and outward from basal joints. A small avicularium with curved proximal wall and triangular mandible directed distally on border of distal rim in some zooids but not in ovicelled zooids. Ovicells large, 350 μm wide, hooded, the 2 layers open or fused in 2 ridges, sometimes keeled; ovicell not closed by operculum, closed by a separate membrane.

Biology. Encrusts almost any substrate, including stems. Depths reported from shallow water to 90 m; the MMS station is at 69-73.5 m.

Taxonomic remarks. The type of this species (BMNH 1886.3.6.23) is disintegrating. Specimens from the A.E. Blagg Collection (BMNH 1938.11.30.32) and O'Donoghue Collection (BMNH 1968.1.8.13) on the Pacific coast confirm the characters of the species.

Osburn (1950) described *Chapperia californica*, whose chief differences are smaller zooidal size, with the opesia longer than wide and striate ovicells. It is capable of forming bilaminar colonies, as well as encrusting hydroid stems and worm tubes. Striae on the ovicells were also described, which may be due to aging. According to Osburn, part of "*Chapperia galeata* (Busk)" of Canu and Bassler (1923) is *C. californica*, including Pleistocene specimens.

Plate 25. *Chaperiopsis patula*. Anacapa Passage, off Santa Cruz Island. A. Colony with variably shaped and oriented zooids, 4-6 distal spines or spine scars on each. B. Ovicelled zooid with cryptocyst below lateral walls, and calcified shelf for attachment of opercular retractor muscles below cryptocyst across distal ends; ovicell hood developing, with keeled ectooecium. C. Detail of long, telescoping spines. D. Small avicularium on distal end of infertile zooid (above); ovicell nearly complete with slit between layers (below). Colony margin on left is overgrowing another species with a perforate frontal wall.

There has been confusion over the validity of the name *Chaperia* (see Brown,1952), which was used in a list of Mollusca (Munier-Chalmas, 1873:73) but was a *nomen nudum* because it was not defined by Fischer until 1887 (p. 1059), which was after *Chaperia* was introduced by Jullien in 1881 for a bryozoan. Strand (1928) proposed the name *Chaperiella* for Jullien's genus, having mistaken the date of Jullien's paper as 1888. Willey (1900: 5) made a typographical error, spelling *Chaperia* as *Chapperia*, which Bassler (1935) adopted as an emendation for *Chaperia*, and this was followed by Osburn (1950), while J. D. Soule (1959) used the *Chaperiella* of Strand. The genus *Chaperia* is now restricted to species lacking both ovicells and avicularia; Uttley (1949: 186, 187) placed species with both avicularia and ovicells in a new genus, *Chaperiopsis*. Gordon (1982:1-24) erected several new genera including *Pyrichaperia* for species having ovicells but no avicularia.

Distribution. *Chaperiopsis patula* has been found frequently in British Columbia, ranging southward to Baja California, Mexico, while *C. californica* is said to extend from southern California to Baja California. The MMS station is in the Santa Barbara Channel.

Family Candidae d'Orbigny, 1851

(= Family Cabereidae Busk, 1852; = Scrupocellaridae Levinsen, 1909)

Colonies erect, unilaminar, branching, usually biserial, with or without joints; attached by rhizoids (rootlets) originating in a septulum or a vibracular chamber. Zooids well calcified except for frontal membrane usually bordered by well developed gymnocyst, comparable to opesia. Distal spines usually present, plus a modified spine (scutum) arching over the frontal membrane. Vibracula sometimes on back (ventral) surface. Avicularia sometimes lateral, sometimes frontal on gymnocyst. Ovicells commonly with one or more fenestrae, or imperforate, hyperstomial.

Gordon (1984) placed the Scrupocellariidae (Levinsen, 1909) under the Cabereidae (Busk, 1852), leaving the distinctions between them to the generic level. D'Hondt and Gordon (in press) conclude that Candidae has priority over the other names and can include all the various genera previously associated with either of the other two families.

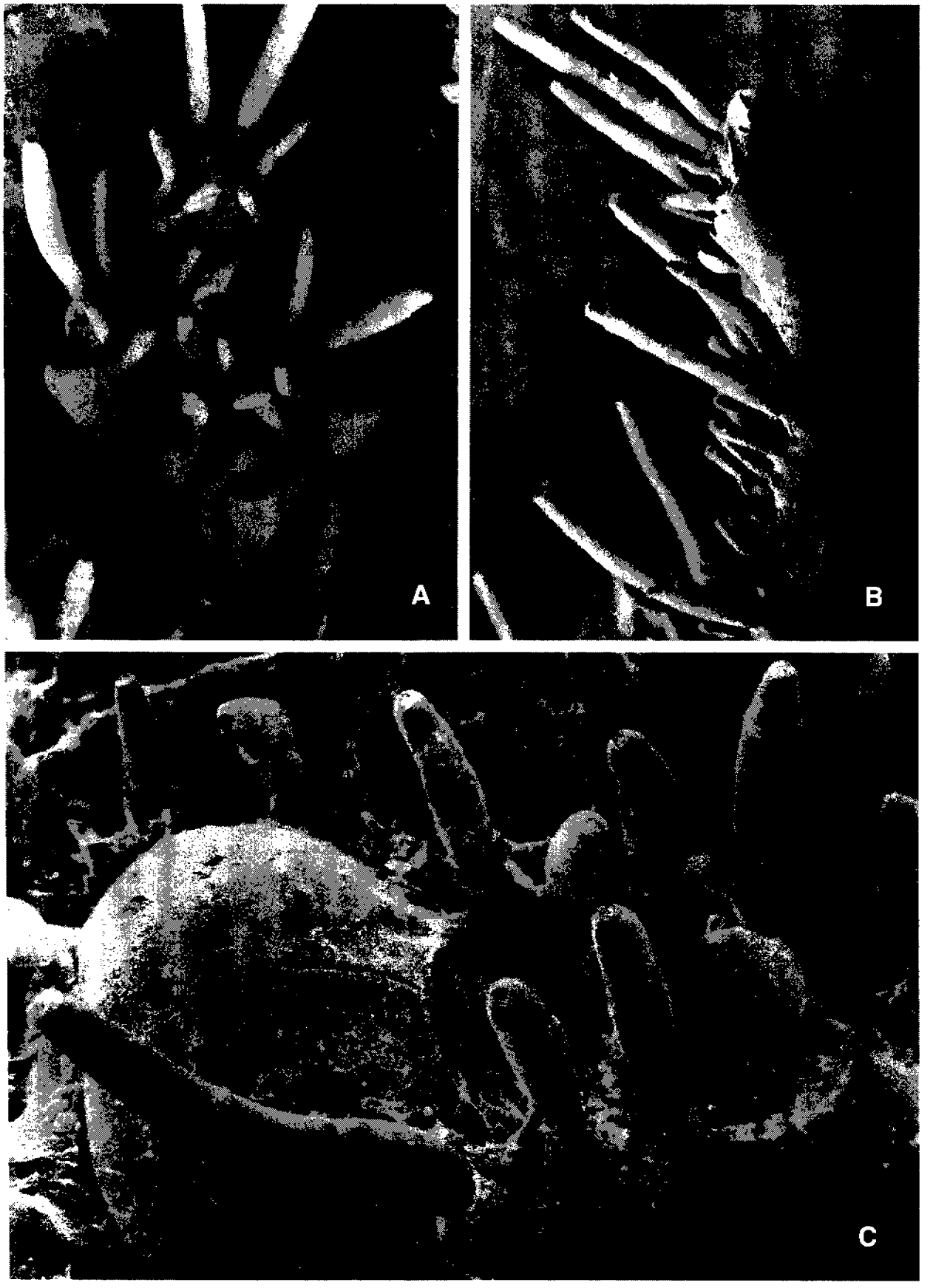
Tricellaria occidentalis (Trask, 1857)

Plate 26 A-C

Menipea occidentalis Trask, 1857: 102, pl. 4. fig. 4. — Robertson, 1905: 254, pl. 6, figs. 22-25. — C.H. and E. O'Donoghue, 1923: 17; 1925: 99.
Menipea compacta form *triplex* Hincks, 1882: 461; 1884a: 208, pl. 9, fig. 8.
Tricellaria occidentalis: Osburn, 1950: 122, pl. 13, figs. 6, 7.

Material Examined. AHF and BMNH Collections.

Plate 26. *Tricellaria occidentalis*. Punta Santa Rosalia, Mexico. A. Terminal end of erect branch with three zooids; two longer, stout spines distally with two pair flanking apertural area, a scutum resembling a distorted spine on proximal mural rim of opesia; zooid narrowing to proximal stalk; avicularium on lateral wall of outer zooids, with hooked rostrum. B. Lateral view of colony tip. C. Ovicell with median suture, external pores; spines with socket bases; scutum near proximal end of opesia leaning over it.


A
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Description. Colonies erect, tuftlike bushy, branches usually consisting of internodes of 3 zooids, sometimes up to as many as 5 or 6. Zooidal frontal membrane oval, occupying almost half of frontal area. Scutum attached in proximal half of frontal membrane, varying from the usual simple spine or bipronged fork, mostly in northern specimens, to an expanded multipronged structure, usually in southern material. Usually 3 smaller spines on inner margin of frontal membrane and 3 larger spines on outer margin, most distal spines largest. Large lateral avicularia with triangular mandibles, hooked at tips. No frontal avicularia. Ovicells globular, prominent, with scattered pores distally, a median suture sometimes visible at margin.

Biology. Depths reported from intertidal to 40 m on algae and hard substrates.

Taxonomic Remarks. It should be noted that the term "opesia" is used by some authors (e.g., Osburn, 1950) for the uncalcified, membranous frontal area in all Anasca, regardless of whether the opening is surrounded by cryptocyst or gymnocyst, whereas other authors (e.g., Ryland and Hayward, 1977; Boardman, *et al.*, 1983) restrict the term to the opening in the cryptocyst and refer to the membranous frontal area without using the special term in those genera and species with little or no cryptocystal development such as the *Tricellaria, Caberea, Scrupocellaria, Dendrobeania, Bugula* and *Caulibugula.* The latter may be technically correct but makes for awkward descriptions in those species in which gymnocyst forms the major portion of the frontal wall surrounding the membrane.

The more southern specimens were given the name *Menipea occidentalis catalinensis* by Robertson (1905) for the forms in which the larger branched scutum prevails. However, the variation sometimes occurs in British Columbia specimens, and it was reported in Japanese waters (e.g., Mawatari, 1951). The species is similar to *Tricellaria circumternata*, described below; *T. occidentalis* has six spines and the ovicell has distinct pores, whereas *T. circumternata* has three to five spines and the ovicell is striate.

Mawatari (1951) illustrated Japanese material and reported internodes numbering up to nine zooids. Gordon (1986) illustrated *Tricellaria occidentalis* from New Zealand with SEM. It is a common fouling organism, occurring in the fouling felt of biota on ships' hulls. However, there are slight differences: the scutum in southern California material (which may be more than one species) is not as large as the paddle shape he illustrated, in spite of the number of prongs on it, which he noted on ovicelled zooids. As illustrated herein, our ovicell has only a thin scutum. Our material usually has three inner spines and three outer spines, although Robertson (1905) indicated variability occasionally of five to seven spines. Gordon's specimens have three outer spines, the most proximal one forked, a median distal spine and a pair of inner distolateral spines. Mawatari also mentioned bifurcate spines. These are small distinctions but may be indicative of a different species, although the fouling nature of the species and the wide range of environmental conditions under which it occurs in the northeastern Pacific suggests that it could survive considerable transport to become a Pacific basin species. So-called variation may result from repeated trans-Pacific reintroductions.

Type Locality and Type Specimens. Trask (1857) listed the species from Cape Flattery, Washington to Santa Barbara, California. No type is known.

Distribution. British Columbia south to Baja California, Mexico. Since the ranges of *T. occidentalis* and *T. circumternata* overlap in California, taxonomic separation depends on the position of the scutum on the opesial margin, the number of spines, and the character of the ovicell.

Tricellaria circumternata, new species

Plate 27 A-C

? *Menipea ternata*: Robertson, 1900: 316. — C.H. and E. O'Donoghue, 1923: 17; 1925: 99; 1926: 42.
Menipea ternata: Robertson, 1905: 251, pl. 5, figs. 12-16, pl. 6, fig. 17.
Tricellaria ternata: Osburn, 1950: 251 (in part), pl. 14, figs. 1, 2.

Material Examined. AHF and BMNH Collections.

Description. Colonies erect, in tufts or flaccid branches, spreading. Zooids usually 3 per internode, occasionally up to 7 zooids, especially when ovicells are present; joints light colored. Zooids measure 400-450 μm long, 200 μm wide at their widest part near distal end, tapering proximally, Frontal membrane oval, 150-200 μm long. Scutum placed distal to middle of membrane. Scuta varied, often in the form of single spine, sometimes wider, spatulate or ovate. Spines 2 or 3 long curved on the outer rim, 1 or 2 on the inner rim around operculum. On some zooids a small frontal avicularium with acute mandible located proximal to frontal membrane, larger lateral avicularia projecting outward from distal ends, with large rostral chamber, hooked upward, directed laterally; sometimes absent. Root chambers arising above avicularia on frontal surface, roots anchoring colony or twining around substrate organisms. Ovicells globular, striate, imperforate.

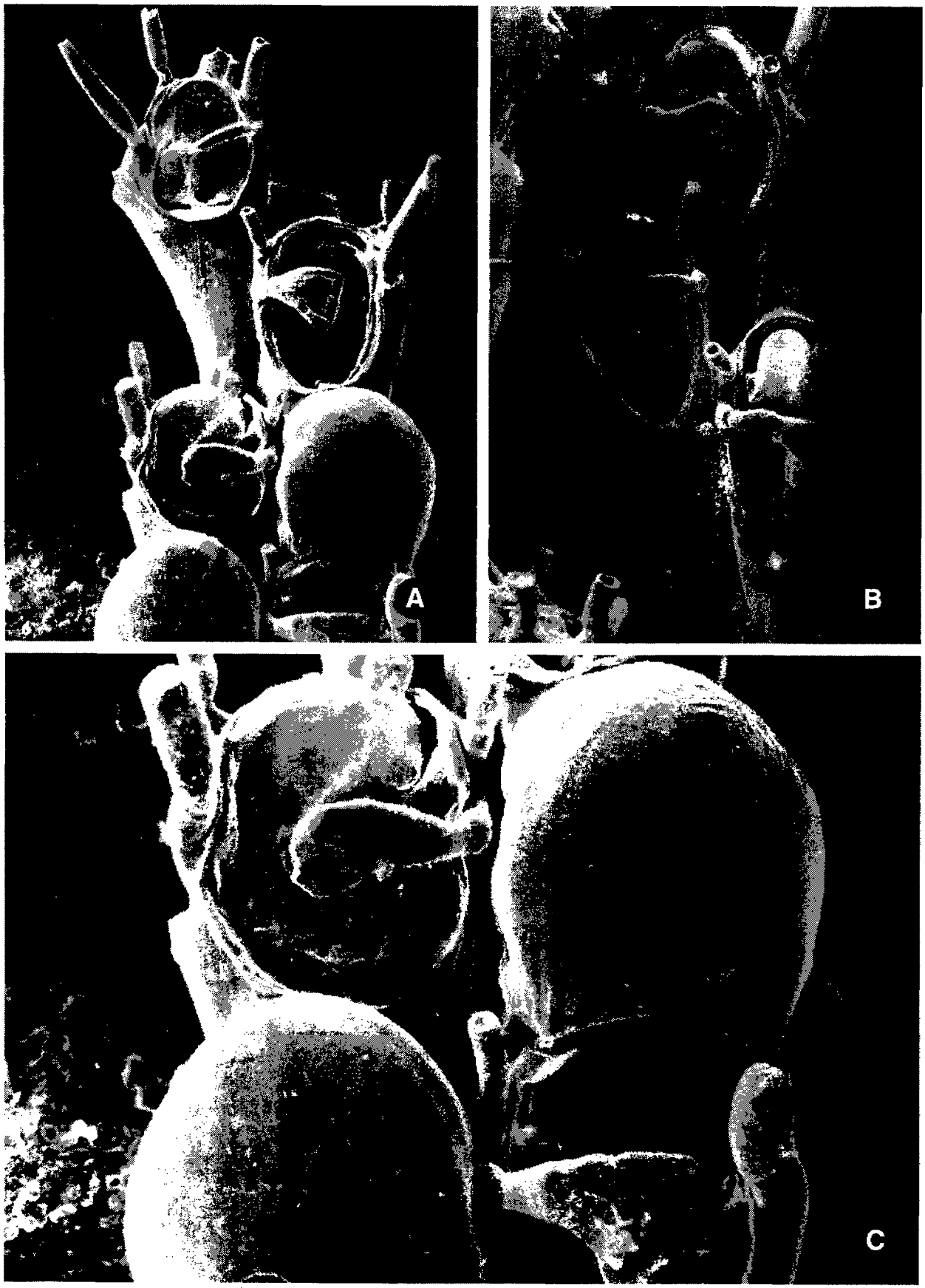
Etymology. Latin *circa*, meaning near, close to *T. ternata*.

Biology. Depths known to 51.2 m. Attached to hydroids, arenaceous worm tubes, and erect bryozoan colonies, seaweeds.

Taxonomic Remarks. The new species was formerly included in *Tricellaria ternata*, originally described by Solander (1786) as collected by Dr. David Skene from Aberdeen, Scotland. Previous citations have listed the authors of the species as Ellis and Solander because the title page of the volume reads "The Natural History of many curious and uncommon Zoophytes collected from various parts of the globe by the late John Ellis ...systematically arranged and described by the late Daniel Solander...." Osburn correctly attributed the species to Solander alone.

Robertson (1905) indicated a more compact colony growth form in California specimens. She gave the length of an internode in Puget Sound as 1,100-1,500 μm, and that of California material as smaller. Osburn (1950) gave zooid length as about 400 μm, which is consistent with our measurements. This is much smaller than the 750 μm or more indicated by Ryland and Hayward (1977) for the boreal and arctic material, and frontal membrane lengths are 150-200 μm in our material while theirs were about 280 μm. This gives a different ratio to length of the frontal membrane to the total zooid, which may be more important than actual length. In Alaskan specimens, Dick and Ross (1988) give a length of 500-1,000 μm, with the frontal membrane about one third of the length, consistent with Ryland and Hayward's measurements, indicating that the Alaskan specimens were of *T. ternata*.

Ryland and Hayward (1977) stated that the ovicell of *T. ternata* has one or more pores, as was also illustrated by Marcus (1940) in the Danish fauna. Ovicells are described as imperforate in all reports from the eastern Pacific, although Kluge's (1962) illustration suggests a single pore. Pores are difficult to see. Material of *T. circumternata* from Big Sur and Dillon Beach, California, did not contain ovicells and Osburn did not illustrate them. The obverse side of the *T. ternata* colony illustrated by Ryland and Hayward (1977: fig. 69A) shows the basic plan of branch bifurcation in *T. ternata*, with 3 segments at the base of the two inner zooids, the segments not quite touching, at an angle on the back of the third zooid, whereas the obverse illustrated by Osburn for eastern Pacific specimens shows only two segments, the more proximal one fused laterally across the third zooid. The lateral avicularia are much larger in the Ryland and Hayward illustration than in the Osburn illustration. These characters help to separate the two species.


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Type Locality and Type Specimens. The type locality of *T. circumternata* is Big Sur, central California. SBMNH-AHF Bryozoa Holotype No. 207. The type locality of *T. ternata* was Aberdeen Scotland; the type was not designated.

Distribution. The distribution of *Tricellaria circumternata* is presently known only from Yakan Pt., British Columbia, and from Dillon Beach and Big Sur, in central California. *Tricellaria ternata* is circumpolar and boreal in distribution, reported in the eastern Atlantic and North Sea, off Greenland, Iceland and Labrador, and in the western Atlantic south to Woods Hole. In the U.K. it occurs in shallow waters.

In the eastern Pacific, *Tricellaria ternata* has been reported in the Bering Sea, Alaska (Kluge, 1962, 1975; Dick and Ross, 1985, 1988), the Queen Charlotte Islands (Hincks, 1880, 1882; O'Donoghue and O'Donoghue, 1923, 1925, 1926), and Puget Sound and California (Robertson, 1900, 1905). Some of the eastern Pacific material is not *T. ternata*, although it is quite similar, and is therefore described as *T. circumternata*; the material is uncommon in California.

Plate 27. *Tricellaria circumternata*. Big Sur, California. A. Growing tip of colony with two spines on outer margin of opesia, one on inner margin, growing new base between; a long thin spine or hollow, paddle shaped scutum arching over opesia. B. Three zooids at branch with distal zooid flanked by chitinous joints for two new branches. C. Enlarged zooid and smooth ovicells; partial ovicell on left has incomplete hood.

Caberea ellisi (Fleming, 1818)

Plate 28 A-E

Flustra ellisii Fleming, 1818: 251, pl. 17, figs. 1-3.
Caberea ellisi: Hincks, 1880c: 59, pl. 8, figs. 6-8. — Robertson, 1905: 263, pl. 8, fig. 40, pl. 9, figs. 45, 46. — C.H. and E.O'Donoghue, 1923: 19; 1925: 98; 1926: 41. — Osburn, 1950: 130, pl. 16, figs. 1, 2. — Kluge, 1962 (translation, 1975): 463, fig. 244.

Material Examined. MMS Station: BRA-27. Other collections: AHF and BMNH.

Description. Colonies coarse, erect, fan shaped, with branches increasing wide from 2 to 4 zooids, flabellate. Zooids of moderate size, 375-400 μm long, 200 μm wide, with 2 outer spines and 1 inner spine, sometimes indicated only by spine scars. Opesial area elliptical, occupying most of frontal; no scutum. Very small scattered avicularia, 50 μm long, with bluntly pointed mandibles, present on the frontal and lateral surfaces. Dorsal vibracular chambers large, oriented diagonally, with prominent, narrow rostra, vibracula lengthy barbed whips; radicles (rootlets) forming longitudinal cordlike ridges medial to vibracula on dorsal surface. Ovicells flattened, shallow, semicircular, imperforate, with incompletely calcified frontal area.

Biology. Encrusting hydroids and bryozoans in beds of stone, sand and silt. Depths previously reported as intertidal to 240 m; the MMS record is from 96-126 m. Kluge (1962, trans. 1975) gave a range of 9-452 m, most common from 75 to 200 m, with a temperature range of 1.23 - 4.95°C and salinity range of 34.5 to 34.79 0/00. However, the distribution to Baja California would include temperatures much higher than those, to around 30°C, if all reports are correct. Such extreme ranges of temperature and depth are most unusual.

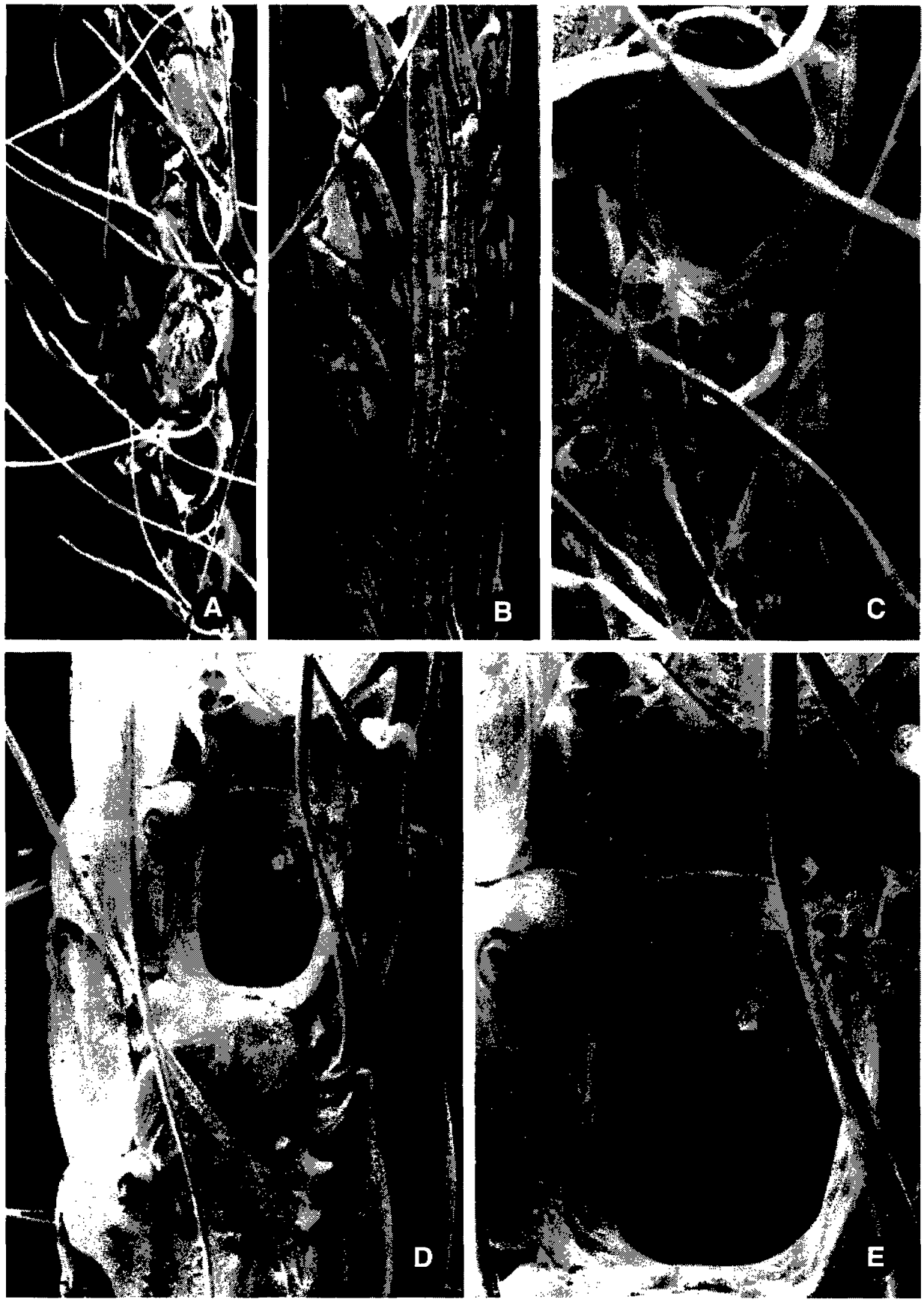
Taxonomic Remarks. BMNH 99.7.1.871 from the Busk Collection is from Puget Sound and was identified by A.B. Hastings as the same as material collected by C.H. and E. O'Donoghue. We have not been able to determine any significant differences between eastern Pacific material and European specimens examined.

Osburn (1950), Kluge (1975), Ryland and Hayward (1977), and others place the genus *Caberea* in the family Scrupocellariidae; Gordon (1984) placed it in Cabereidae, and d'Hondt and Gordon (in press) place it in Candidae.

Type Locality and Type Specimens. Collected originally ..."off cod-lines from 100 fathoms off Stenhouse, in the Parrish of North Mavine, Zetland [Shetland Islands] in July 1808, growing on an aged specimen of *Escara Cervicornis* with *Retepora cellulosa*." Type not designated.

Distribution. *Caberea ellisi* has a prominent Arctic-boreal distribution but has been reported in the eastern Pacific from Alaska southward to Baja California, Mexico. The MMS station is northwest of Point Buchon, off Morro Bay. Common in the Atlantic north of Cape Cod and north from the British Isles.

Plate 28. *Caberea ellisi*. Santa Rosa Island. A. Frontal (ventral) surface of erect colony, with tangle of dorsally originated vibracula tangled around colony and associated other bryozoans and hydroids. B. Obverse (dorsal) side of colony with clamshell-like vibracular chambers angled to sides, cord running lengthwise for strength and flexibility. C. Zooids with membranous area occupying almost the entire frontal, with two outside and one inside distal spines, small acute avicularia with hooked tip on rostrum; vibracula with barbed edges on right. D. Ovicell with ectooecium leaving an uncalcified central portion. E. Communication chambers with pores in lateral walls.


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Scrupocellaria c.f. *californica* Trask, 1857

Plate 29 A-C

Scrupocellaria californica Trask, 1857: 102, pl. 4. fig. 2. — Robertson, 1905: 259, pl. 8, figs. 35-37. — C.H. and E. O'Donoghue, 1923: 18; 1925: 98; 1926: 40. — Osburn, 1950: 135, pl. 16, figs. 6, 7; pl. 20, fig. 5.

? Scrupocellaria brevisetis Hincks, 1882: 462.

Material Examined. MMS Station: BRA-16. Other collections: AHF and BMNH.

Description. Colonies erect, tuftlike. Zooids biserial, alternating, in series of 3 or 4 zooids, sometimes 7-9 zooids per internode; zooids 400-450 μm long, 200-230 μm wide. Frontal membrane (opesial) elliptical, occupying about 2 thirds of frontal length, measuring 400-450 μm long, and 200-220 μm wide. Scutum curving over the frontal small, often paddle-shaped, sometimes reduced, spinelike. Two or 3 outer spines, 1 or 2 inner spines or spine scars. Small frontal avicularia positioned proximolateral to membrane. Lateral avicularia flanking aperture on the outer margin, sometimes replaced by very large avicularia. Dorsal vibraculum chambers laterally placed on basal wall of zooids, with short setae. Ovicells raised, globose, 220-250 μm wide, imperforate with a lightly calcified central area.

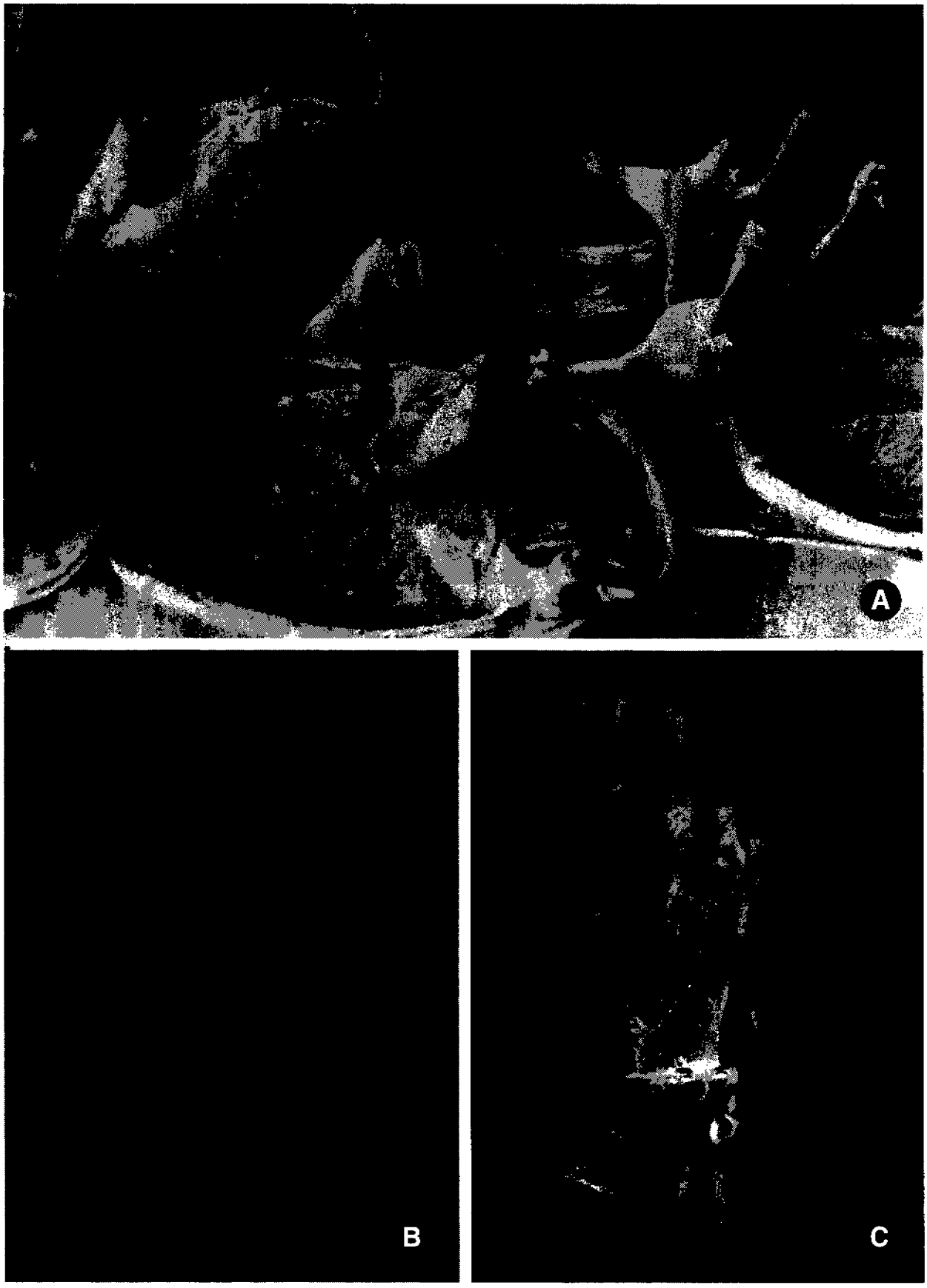
Biology. Depths from shallow waters, where it is common in fouling communities, to 80 m have previously been reported. The MMS record extends that to 91.5-123 m.

Taxonomic Remarks. There are a number of inconsistencies between Trask's original description and that commonly accepted as the *S. californica* of others (e.g., Osburn, 1950). Trask (1857) stated that there were 7-9 zooids to a joint (internode), 1 spine, no avicularia and no vibracula, whereas most other authors have stated that there were two to three outer spines and 1 to two inner ones. Hincks (1882) stated that the frontal membrane of his species *S. brevisetis*, which he described but did not figure, occupied half or less of the total length, whereas Robertson (1905, fig. 36) indicated that it occupied more than half in *S. californica*, and Osburn said it occupied two thirds of the zooid length. Robertson found that vibracula sometimes occur only on the lower portion of the colony, which would account for one of the discrepancies between Trask's description and later ones. Osburn (1950) placed *S. brevisetis* in synonymy, but it is probably a separate species. In our opinion, the commonly accepted form is not Trask's species, but it was not possible to determine whether it is Hincks' species due to the lack of illustration and the condition of reference specimens. The description and illustrations of Robertson (1905) have come to be the form commonly accepted as *S. californica*.

Type Locality and Type Specimens. San Francisco Bay is the type locality for Trask's species but the location of his types is unknown. The type locality for Hincks' species is British Columbia; the Hincks collections are at the BMNH.

Distribution. *Scrupocellaria brevisetis* was recorded by Hincks from Houston-Stewart Ship Channel, British Columbia. *Scrupocellaria californica* was reported by C.H. and E. O'Donoghue from many locations in British Columbia and Puget Sound, and Robertson listed it from San Francisco to Pt. Conception, California. Osburn extended the distribution southward as far as San Benito Island on the west coast of Baja California, Mexico, although it is not common south of Pt. Conception. The MMS record is off of Purisima Point.

Plate 29. *Scrupocellaria* c.f. *californica*. Cape Arago, Oregon. A. Frontal of colony viewed from side, distal end to right, to show variation in scuta; frontal membrane occupying most of zooid, with lateral avicularium directed outward on edge a zooid beyond center scutum; two outer, one interior spine stumps at distal end of zooid. Ovicell, upper left, has membranous frontal area in flattened, imperforate hood. B. Frontal view of joints at base of branch, rootlets in background and small vibraculum on left. C. Dorsal view showing small vibracula chambers, short whips.


A
B
C

Scrupocellaria varians Hincks, 1882

Plate 30 A-D

Scrupocellaria varians Hincks, 1882: 461, pl. 19, figs. 1-1c. — Robertson, 1905: 260, pl. 8, figs. 38, 39; pl. 16, fig. 95. — C.H. and E. O'Donoghue, 1923: 160; 1925: 98; 1926: 87. — Osburn, 1950: 149, pl. 19, fig. 5; pl. 20, fig. 6. — J. D. Soule and Duff, 1957: 103. — J. D. Soule, 1959: 38.

Material Examined. MMS Station: BRA-6. Other collections: AHF and BMNH.

Description. Colonies erect, branching, forming short bushlike tufts; internodes of 4-9 zooids in series. Zooids 350-500 μm long, 120-130 μm wide; the frontal membrane occupying half or more of frontal. Two or 3 spines present on outer rim of frontal membrane, 1 on inner edge of rim; scutum variable, from simple 2 prongs to up to 6 prongs. Frontal avicularia small, located proximal to frontal membrane, with triangular mandibles directed proximolaterally. Lateral avicularia vary from those with triangular mandibles to giant avicularia having an enormous curved, trough-like rostrum with irregularly spiked tips. Northern specimens with many more giant avicularia. Dorsal vibraculum small, subtriangular, with a narrow transverse groove and short seta; rootlet (radicle) originating from pore in vibraculum chamber. Ovicell with ectooecium forming a ridge across upper part of hood leaving a lucidum of lightly calcified entooecium on face above opening.

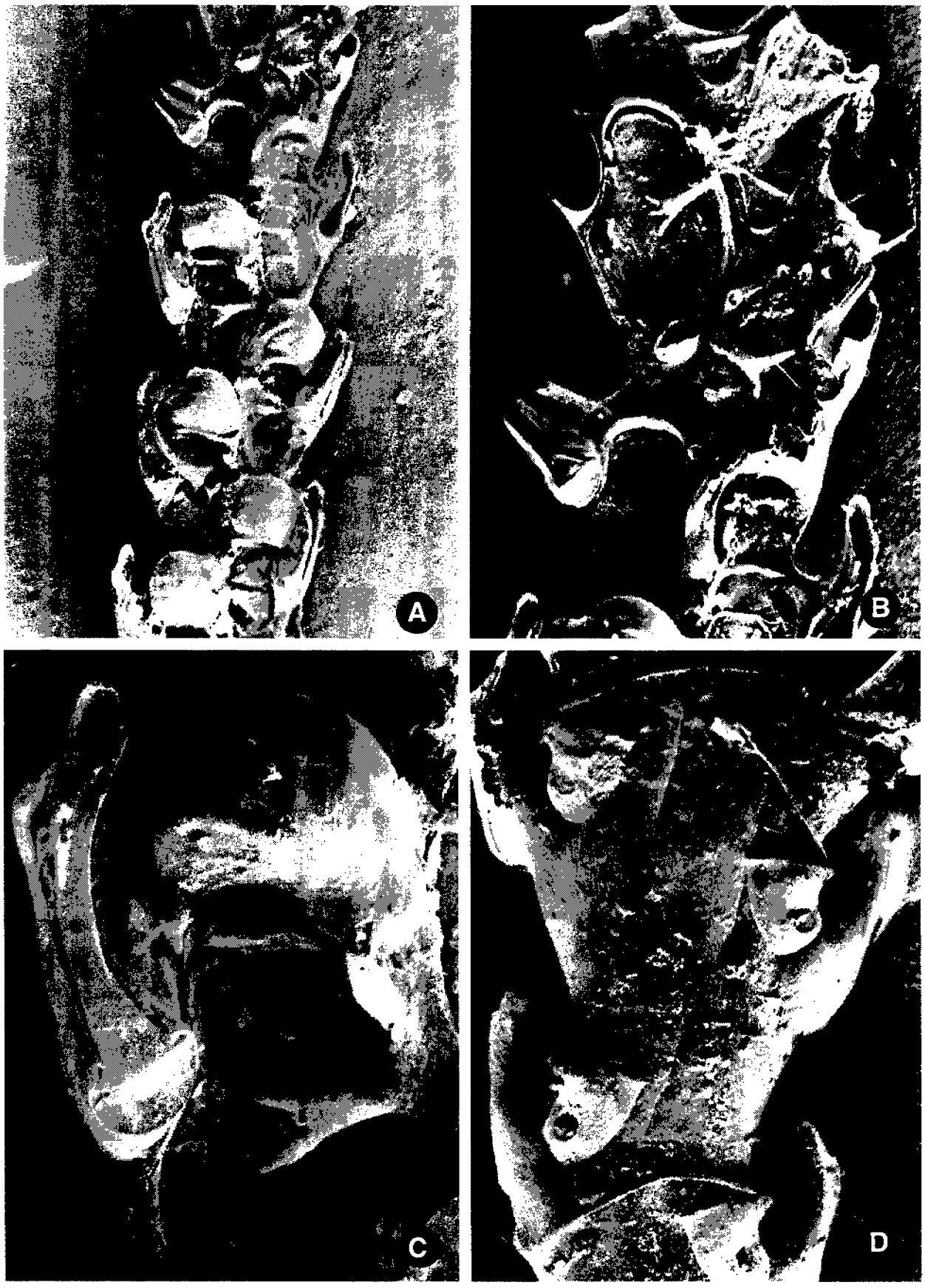
Biology. On hard substrates; depths recorded from shallow waters to the MMS depth of 54-63 m.

Taxonomic Remarks. The distinctive giant lateral avicularia make this species easily distinguishable even though the northern specimens have more numerous giant avicularia than are found in more southern populations.

Type Locality and Type Specimens. Off Cumshewa Harbour, Queen Charlotte Islands. The holotype, BMNH 1886.3.6.12, is a balsam mount which has deteriorated due to the acid in the medium and is unrecognizable.

Distribution. Southward from British Columbia to the Gulf of California, Mexico. The MMS record is from off Pt. Arguello.

Plate 30. *Scrupocellaria varians.* Anacapa Island. A. Colony with very large avicularia along the margins. B. Frontal membrane occupying more than half the ventral surface, with small avicularium below opesia; operculum distinct, flanked by two or more spines; scuta with one, two or three prongs. C. Giant lateral avicularium, forked scutum on zooid; ovicell hood with ectooecial rim across top, thinly calcified area on face down to opening. D. Dorsal surface with small vibracular chambers, short whips, giant avicularia extended laterally.


A
B
C
D


A
B
C

Family Bugulidae Gray, 1848

Colony usually erect, branching, unjointed, unilaminar, attached by rhizoids. Zooids elongate, parallel sided, almost all of the frontal surface membranous; lateral and basal walls lightly calcified, marginal spines usually present. Avicularia usually pedunculate, "bird's heads". Ovicells hyperstomial, independent, with membranous ectooecium.

Gordon (1984) gave an extensive discussion regarding the families Bicellariellidae Levinsen, 1909, and Bugulidae. Osburn (1950) used the family Bicellariellidae for *Beania, Dendrobeania, Caulibugula, Bugula, Sessibugula, Corynoporella* and *Bicellariella*, based on the interpretation of Harmer (1926), although Osburn (1940) followed Canu and Bassler (1927) in the separation of genera into the Bicellariellidae, Bugulidae, and Beaniidae. The Beaniidae remain separate under current classifications, while the other two families are merged, under Bugulidae Gray, 1848, because the name has priority over Bicellariellidae Levinsen, 1909.

Dendrobeania curvirostrata (Robertson, 1905)

Plate 31 A-C

Bugula curvirostrata Robertson, 1905: 272, pl. 11, figs. 56-58. — C.H. and E. O'Donoghue, 1923: 21; 1925: 99; 1926: 45.
Dendrobeania curvirostrata: Osburn, 1950: 166, pl. 25, figs. 7, 8.

Material Examined. MMS Station: BRA-16. AHF Collection.

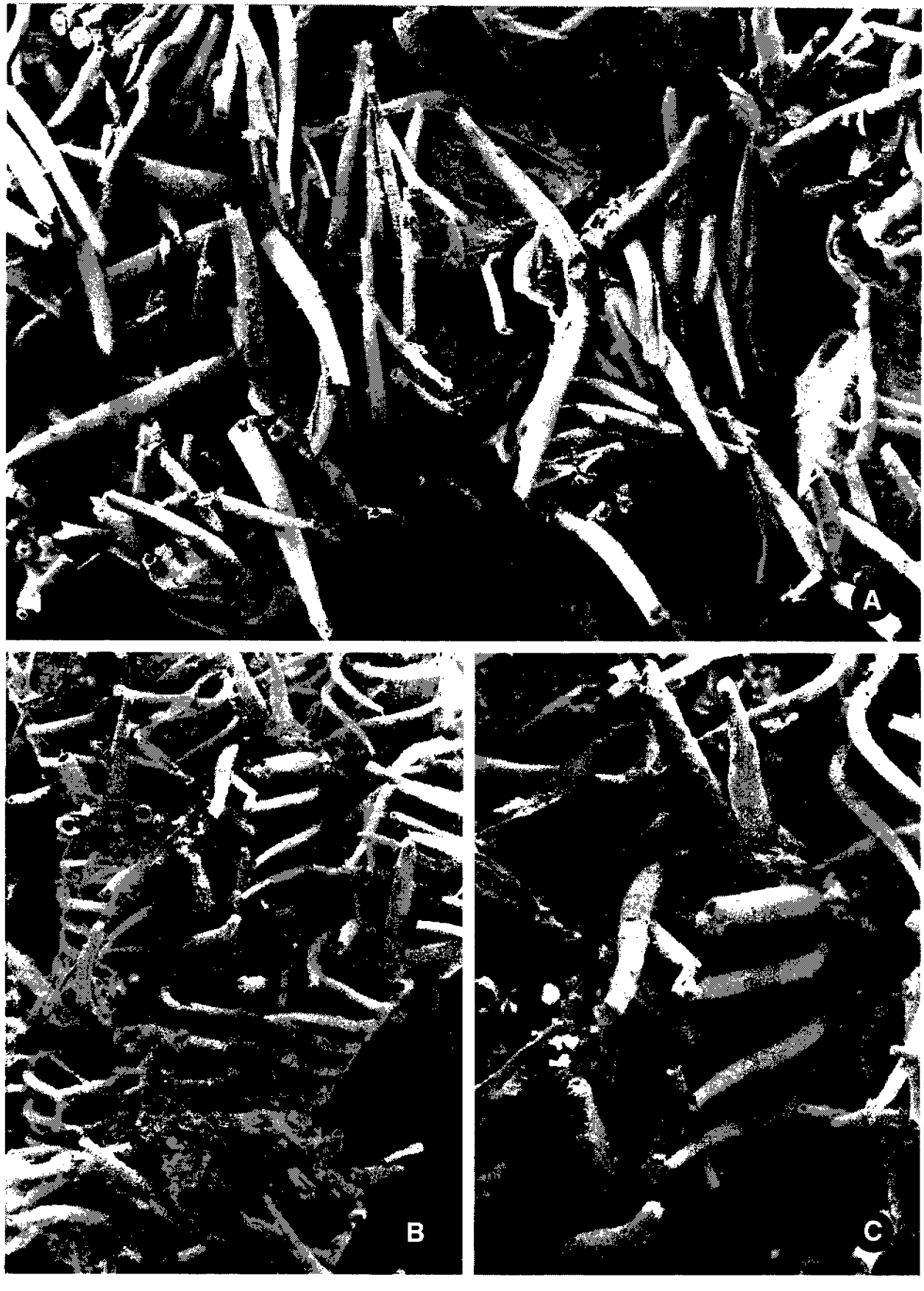
Description. Colonies erect or recumbent, with wide straplike branches composed of 4-8 zooids in series, held to substrate by strong rootlets. Zooids are elongate, 650-700 μm long, 270-320 μm wide; distal corners with a very short inner and outer spine, plus 1-2 tiny spines opposite operculum, not extending over the frontal; operculum distinctly separated from frontal membrane. Very large avicularia at base of outer zooids, 450-500 μm long with sharply curved "beak" and mandible. Inner avicularia similar, raised, but smaller. Obverse smooth, zooids alternating in truncated diamond shape, proximal wall without bifurcate "tails" typical of *Bugula* spp. at corners; large rootlets arising from marginal zooids. Ovicells globose, imperforate, ectooecium only around margin of hood, entooecium "wrinkled" over frontal area giving appearance of irregular pores or stigma beneath; ovicell large, 300-310 μm wide.

Biology. Found on hard substrates; depths previously recorded extend down to 220 m. The MMS record is at 91.5-123 m.

Taxonomic Remarks. This species differs from *D. murrayana* (Johnston, 1847), which is known only from the Bering Sea to Puget Sound, in having spines reduced or absent. *Dendrobeania murrayana* has 4-12 zooids in series, with two distal spines, 2-5 spines curving over the frontal membrane on outer zooids, 1-3 on inner zooids. Osburn (1950) recorded the ovicells of *Dendrobeania* spp. as being striated,

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Plate 31. *Dendrobeanea curvirostris.* British Columbia. A. Zooids with a short spine at each distal corner, one or two thin spines on each side of operculum; pedunculate avicularia with hooked mandibles at base of zooids. Ovicells with wrinkled appearance as if covering thin areas. B. Branch with giant, hooked avicularia on zooids of outer margins. C. Obverse, dorsal side of colony, with straight proximal and distal wall sutures, differing from inverted Y-shape in *Bugula* spp.; a few small rootlet bases,large frontal marginal avicularium visible.


A
B
C

but this may have been due to optics then available as compared to SEM.

Type Locality and Type Specimens. Southern California. No type specimen is known having been apparently mixed with other specimens in the CAS Collections after Robertson's study.

Distribution. Robertson did not find *D. curvirostrata* north of Pacific Grove at the southern end of Monterey Bay, or in the San Francisco Bay area, but C.H. and E. O'Donoghue reported it in British Columbia and Puget Sound, if theirs is the same species. It ranges south to the Channel Islands off southern California. Depths increase with southerly distribution. The MMS station is off Purisima Point.

Dendrobeania longispinosa (Robertson, 1905)

Plate 32 A-C

Beania longispinosa Robertson, 1905: 277, pl. 12, figs. 65, 66.
Dendrobeania longispinosa: Osburn, 1950: 168, pl. 25, figs. 4, 5.

Material Examined. MMS Station: BRA-13. AHF Collections.

Description. Colonies recumbent, branches formed of zooids in series of 6-8 or more rows. Colonies anchored to the substrate by elongate rootlets. Zooids 600 to 800 μm long, 300 to 450 μm wide. No avicularia. Walls at distal ends of zooids thickened, containing a large distal rosette plate and 2 distolateral rosette plates. Spines long, the pair distal to the aperture stout, erect, directed distally, the marginal spines, 5-7 pair, not as stout but strong, curving over frontal membrane, overlapping in a thicket. Numerous radicles (rootlets) originating on obverse side tangled in with spines on frontal; spines encrusted with diatoms, spores. Ovicells globular, 260-300 μm wide.

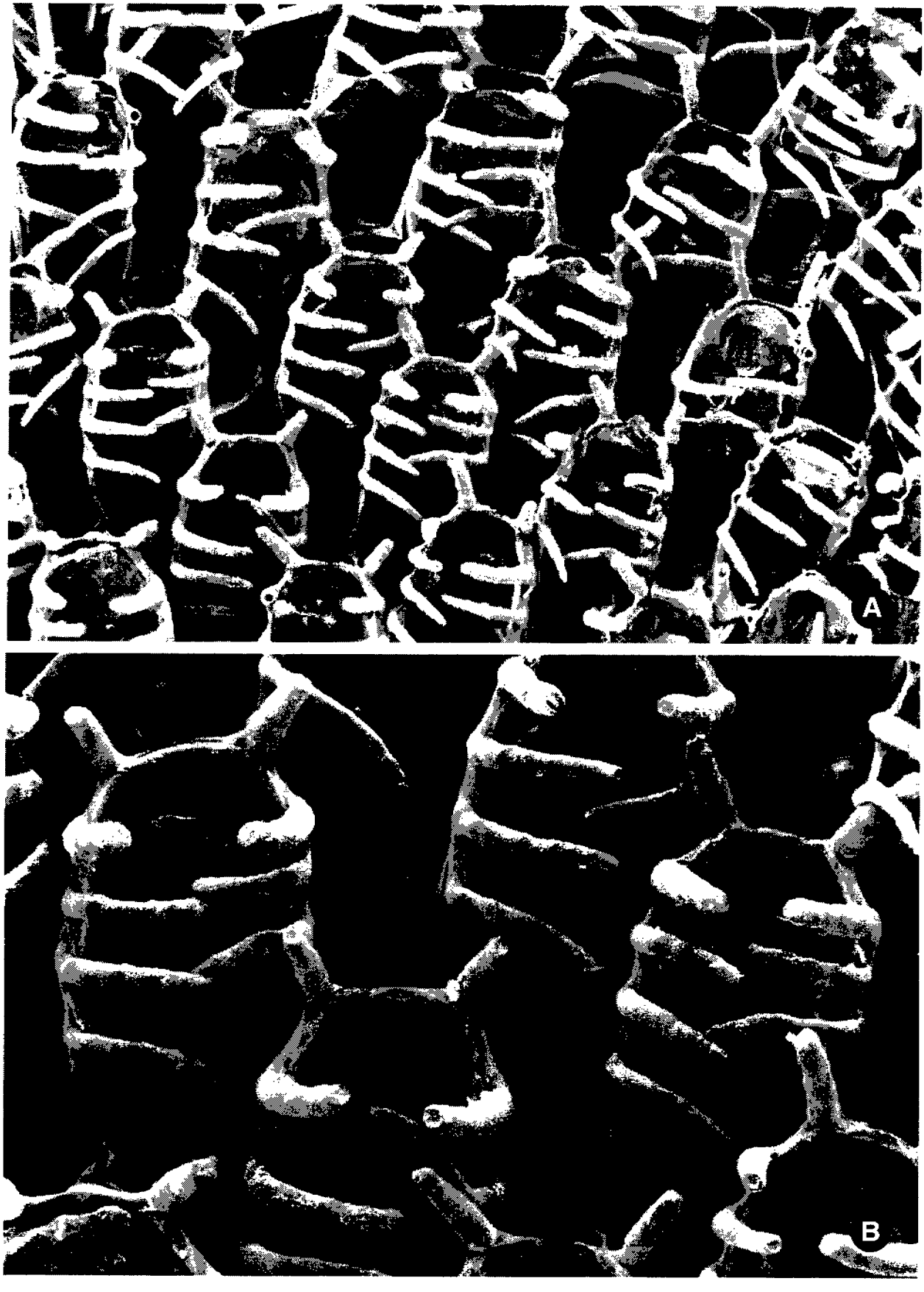
Biology. Found on hard substrates; depths previously recorded from 20 to 150 m. The MMS report is from 92 to 100 m.

Taxonomic Remarks. Although there are sometimes small, irregular fenestrae between zooids, there are no tubules such as would identify it with the lightly encrusting species of *Beania*.

Type Locality and Type Specimens. Off La Jolla, California. No type specimen is known having been apparently mixed with other specimens in the CAS Collections after Robertson's study.

Distribution. Previously known from the Channel Islands of southern California to Ranger Bank off Cedros Island, Baja California, Mexico. The MMS record extends the range northward somewhat, offshore between Point Arguello and Purisima Point. This species seems to have a limited offshore distribution.

Plate 32. *Dendrobeania longispinosa*. Tanner Bank, off Point Loma (San Diego). A. Colony with the appearance of a thicket of stout spines. B. Section of branch widening from three to six zooids; rootlets extending from obverse dorsal side. C. A single zooid in center having two long, erect, stout distal spines, five pair extending over frontal membrane, sometimes overlapping. Ovicells (not present) like those in *D. curvirostrata*.


A
B

Dendrobeania laxa (Robertson, 1905)

Plate 33 A-B

Bugula laxa Robertson, 1905: 275, pl. 12, figs. 61, 62. — C.H. and E. O'Donoghue, 1923: 21; 1925: 99; 1926: 45.
Dendrobeania laxa: Osburn, 1950: 167, pl. 25, figs. 2, 3.

Material Examined. MMS Station: BRA-13. AHF Collections.

Description. Colonies spreading, recumbent, forming fronds in series of 2-3 to 15 or more zooids, attached to substrate by thin rootlets. Zooids about 520-720 μm long, 250-270 μm wide, loosely attached to each other. Spines prominent; 2 erect distal spines, usually 4 pair of lateral spines curving over frontal membrane but with little overlap. No avicularia. Obverse smooth, with small rootlet scars; spaces between zooids visible. Ovicells large, globose, striate, 250-260 μm wide.

Biology. Depths from intertidal to 100 m were previously recorded. The MMS report is 92-100 m. Found on hard substrates.

Taxonomic Remarks. The specimen illustrated was collected at Pescadero Point, Monterey County, California, and none of the zooids measured reached the 900 μm extreme that Osburn noted. However, that may depend on substrate availability. None of our SEM specimens had ovicells but they are reported to be similar to those of *D. curvirostrata*.

Type Locality and Type Specimens. First reported from Puget Sound to Monterey Bay, California. No type specimen is known having been apparently mixed with other specimens in the CAS Collections after Robertson's study.

Distribution. British Columbia south to the California Channel Islands and to San Pedro (Los Angeles), California. The MMS station is offshore between Point Arguello and Purisima Point.

Plate 33. *Dendrobeania laxa*. Pescadero Point, south of San Francisco. A. Colony with fronds from 2-3 to 15 or more zooids in width, attached to substrates by thin rootlets. B. Enlarged view of single zooids with two short distal spines, up to four pair of marginal spines curving over frontal membrane but rarely overlapping as do the spines in *D. longispinosa*. No ovicells were present on our specimens.

Dendrobeania lichenoides (Robertson, 1900)

Plate 34 A-C

Flustra lichenoides Robertson; 1900: 322, pl. 20, figs, 7, 7a, 8. — Robertson, 1905: 291, pl. 15, figs. 91, 92; pl. 16, fig. 105. — C.H. and E. O'Donoghue, 1923: 23; 1925: 100; 1926: 48.

Dendrobeania lichenoides: Osburn, 1950: 167, pl. 25, Fig 6. — McCain and Ross, 1974: 13. — Dick and Ross, 1985: 89; 1988:51, pl. 4, fig. D.

Material Examined. MMS Station: BRA-13. AHF Collections.

Description. Colonies unilaminar, spreading in greenish, foliaceous fronds, reclining, loosely attached to the substrate by tubular radicles (rootlets). Zooids large, 700-900 μm long, 200-300 μm wide, closely connected to each other but with small spaces between some parts of zooids. Frontal membrane with thin, indistinct operculum. A short spine at each distal corner. Lateral spines absent, or 2-3 pair thin, short spines curving over frontal membrane. No avicularia. Obverse (dorsal) surface with straight transverse walls. Ovicells (not present in illustrations) large, globular with longitudinal surface striae.

Biology. On hard substrates; depths from intertidal to 10 m were previously reported. The MMS record extends the depth range to 100 m, a considerable change.

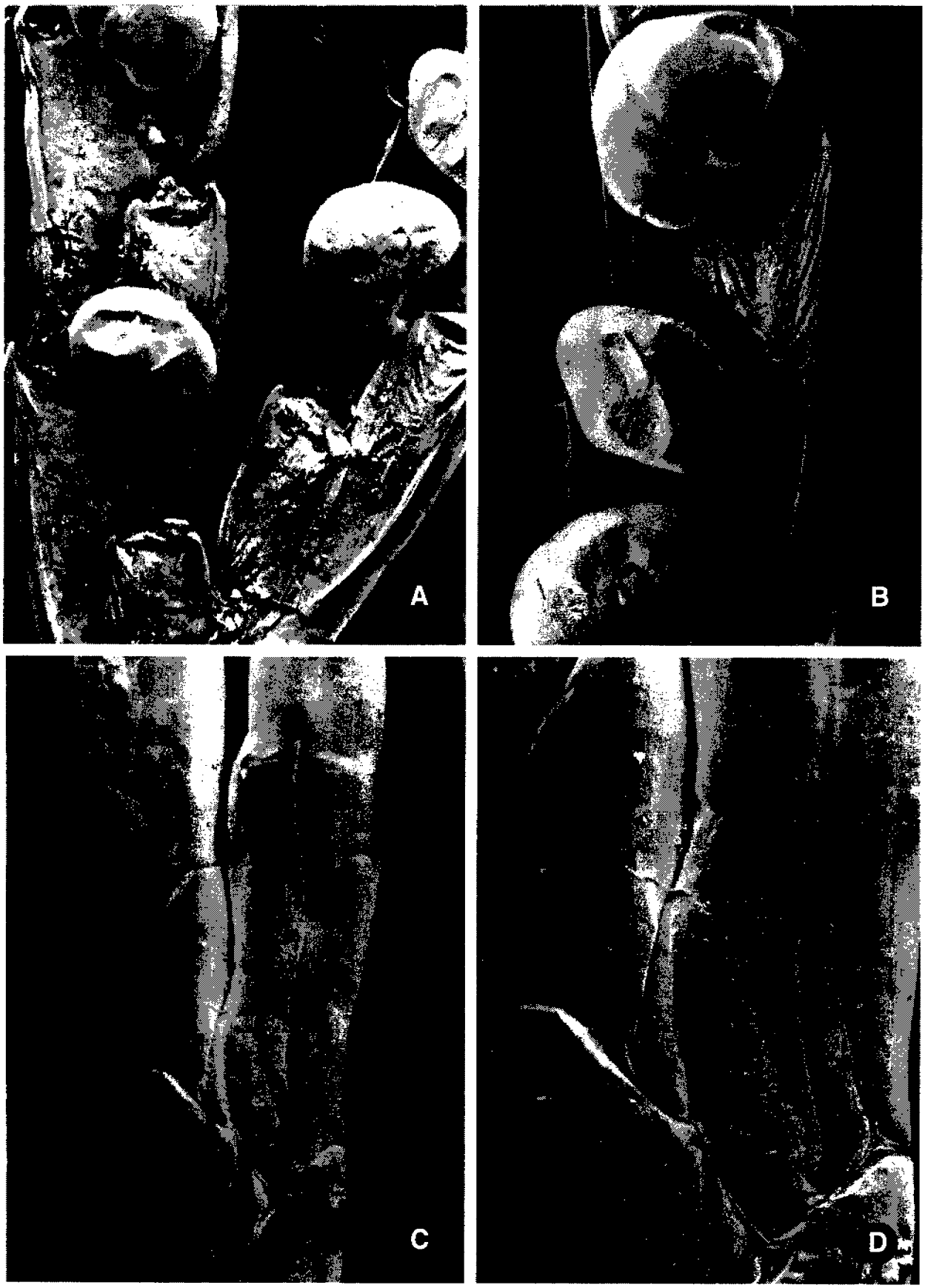
Taxonomic Remarks. This species is much more lightly calcified than other species in the genus. No ovicells were seen on specimens available for SEM. The recumbent, greenish fronds resemble terrestrial lichens. Although the zooids are loosely attached to each other, they are not separate and connected by tubules as are the species of *Beania*.

Type Locality and Type Specimens. Robertson indicated a range from Alaska to San Francisco, California, but did not designate a type locality. No type specimen is known having been apparently mixed with other specimens in the CAS Collections after Robertson's study.

Distribution. Alaska southward to central California; the MMS station is offshore between Point Arguello and Purisima Point. Common at Dillon Beach, California in shallow water.

Plate 34. *Dendrobeania lichenoides*. Puget Sound, Washington. A. Zooids with ovoid shape distally (to right), narrowing proximally; lightly calcified, with a pair of weak distal spines, three pair of small lateral spines. B. Margin of colony; colony is loosely attached to substrate, greenish in color, giving it the appearance of a lichen. C. Obverse side, showing a rootlet (radicle); small spaces between parts of zooids but without connecting tubules as in *Beania* spp; transverse walls straight, not forked as in *Bugula,* spp.


A
B
C


A
B
C
D

Bugula neritina (Linnaeus, 1758)

Plate 35 A-D

Sertularia neritina Linnaeus, 1758: 815.
Bugula neritina: Robertson, 1905: 266, pl. 9, fig. 47, pl. 16, fig. 97. — Hastings, 1930: 704. — Osburn, 1950: 154, pl. 23, fig. 3, pl. 24, fig. 3. — J. D. Soule, 1959: 39.

Material Examined. MMS Station: 28. Other collections: AHF and BMNH.

Description. Colony tuftlike, bushy, typically reddish purple to brown when live, translucent brown when preserved. Zooids in biserial rows, large, 600-800 μm or more long, 200-300 μm wide; lacking spines except for a single pointed tip on outer distal corner. Frontal membrane covering most of zooid. Avicularia absent. Obverse side of zooids in *Bugula* spp. with a forked tail appearance to proximal end; a modified Y-shaped zooid at bifurcation of branches. Ovicells large, prominent, globular, 400-450 μm wide, often numerous, resembling small snail shells attached obliquely at inner distal angle of zooid, ovicell opening beneath frontal curve not readily visible; entooecium calcified, ectooecium membranous, a wrinkled covering.

Biology. Common in temperate to tropical waters in the fouling community; depths from very shallow water to 85 m have been recorded previously. The MMS record extends the depth range to 96-105 m. Reproducing in the warm summer months, the embryo becomes a fuzzy brown larva which is planktonic for a short time and settles to form an erect ancestrula similar to a zooid. The species has been the subject of many developmental studies (see Woollacott and Zimmer, 1977), and is the source of antineoplastic substances, Bryostatin 1, 2, 3, and 4 (e.g., Petit *et al.*, 1984)

Taxonomic Remarks. This species is probably one of the most commonly recognized bryozoans in the world because its large reddish colonies are frequently found as a fouling organisms on boat hulls and docks and in shallow waters, although it can occur in deeper water. Its fouling mode has given it an almost worldwide distribution within its temperature tolerance range.

Type Locality and Type Specimens. None designated.

Distribution. In the eastern Pacific the distribution reported has been from Monterey, California (Robertson, 1905) and the Channel Islands southward to the Galapagos Islands and Panama, and to Angel de la Guarda in the Gulf of California (Osburn, 1950) as cited above. The MMS station is off Morro Bay, central California. *Bugula neritina* has been recorded extensively in the literature, from the Atlantic, Mediterranean, Hawaiian Islands and Japanese waters.

Plate 35. *Bugula neritina.* Santa Catalina Island. A. Biserial row of zooids with pointed tip (reduced spine) at outer distal corner, operculum an extension of frontal membrane. B. Ovicells globular, sometimes striated, attached at corner opposite tip. C-D. Bifurcation of branch, with main zooid having Y-shaped base.

Bugula pacifica Robertson, 1905

Plate 36 A-C

Bugula purpurotincta: Robertson, 1900: 320.
Bugula pacifica Robertson, 1905: 268, pl. 10, fig. 50; pl. 16, fig. 101. — C.H. and E.O'Donoghue, 1923: 20; 1926: 45. — Osburn, 1950: 155, pl. 22, fig. 6, pl. 23, fig. 4.

Material Examined. MMS Station: BRA-16. AHF Collections.

Description. Colonies erect in delicate, pinkish, bushy tufts, zooids biserial. Zooids elongate, 600-700 μm long, ,with gymnocyst curved around frontal membrane, with 3 distinct spines, 1 inner and 2 outer. Avicularia large, pedunculate "bird's head" shape, 200-225 μm long, attached to outer proximal region of zooid, rostrum thick, with beak hooked strongly downward. Ovicell hoodlike small, shallow, incomplete, barely covering egg, not able to cover developing larva. Obverse with 2 zooids budding from single zooid with straight transverse walls at bifurcation without Y-shaped zooid between; transverse walls between zooids slanted.

Biology. Found in the fouling community and on hard substrates; depths from intertidal to 60 m had previously been reported. The MMS record extends the depth to 91.5-123 m.

Taxonomic Remarks. Robertson (1900) originally identified the Pacific coast material as *B. purpurotincta* Norman, a European species but later (1905) recognized it as a new species. *Bugula longirostrata* also has an incomplete ovicell, somewhat larger, but it has longer, more delicate avicularia than those of *B. pacifica*. No ovicells were present on our SEM specimens. The thick bodied avicularia and the obverse configuration of branching zooids help to distinguish this species from other *Bugula* spp.

Type Locality and Type Specimens. Originally reported from the Pribilof Islands, Bering Sea, Puget Sound, San Francisco Bay and Dillon Beach, California, by Robertson, without designating a type locality in her publications. No type specimen is known having been apparently mixed with other specimens in the CAS Collections after Robertson's study.

Distribution. Alaskan waters south to the Channel Islands, Southern California. The MMS station is off Purisima Point.

Plate 36. *Bugula pacifica*. Dillon Beach, California. A. Biserial rows of elongate zooids, shallow hoods for ovicells. B. Detail of zooid with two short outer spines, one short inner spine, distal end raised above base of next distal zooid; semicircular operculum; "bird's head" avicularium attached to outer proximal end of zooid. C. Obverse (dorsal) side showing branching; transverse walls of zooids slanted or forked due to overlap.


A
B
C


A
B
C
D

Bugula longirostrata Robertson, 1905

Plate 37 A-D

Bugula longirostrata Robertson, 1905: 274, pl. 11. figs. 59, 60. — C.H. and E. O'Donoghue, 1923: 163. — Osburn, 1950: 156, pl. 22. fig. 7, pl. 24, fig. 1. — J. D. Soule, 1959: 40.

Material Examined. AHF Collections.

Description. Colonies erect, with elongate, slender branches. Zooids slender, 600-700 μm long, 180-220 μm wide; gymnocyst curving inward at distal tips, more than three fourths of frontal surface covered by membrane. Pedunculate avicularia slender, terete, with hooked rostrum, about 300 μm long, arising from outer wall gymnocyst. Obverse with zooid transverse walls slanted, an inverted U-shape or Y-shape. Ovicells very shallow, small, like overturned bowl.

Biology. Reported by Robertson from shore down to 230 m, deepest of the *Bugula* species in the eastern Pacific.

Taxonomic remarks. The more slender zooids and avicularia help to distinguish *B. longirostrata* from other *Bugula* spp.

Type Locality and Type Specimens. First reported from a submarine canyon off La Jolla, California. No type specimen is known having been apparently mixed with other specimens in the CAS Collections after Robertson's study.

Distribution. Southward from British Columbia to the Pacific coast of Mexico and the Galapagos Islands.

Plate 37. *Bugula longirostrata.* Santa Catalina Island. A. Colony with biserial stems, elongate zooids. B. Zooids with gymnocyst curved inward at tips around frontal membrane; terete avicularia arising on outer margin with hooked beak on rostrum. C-D. Obverse of branching colony, with inverted Y or U-shaped proximal ends of zooids.

Bugula californica Robertson, 1905

Plate 38 A-B

Bugula californica Robertson, 1905: 267, pl. 10, fig.49; pl. 16, fig. 100. — C.H. and E. O'Donoghue, 1923: 162. — C.H. and E. O'Donoghue, 1926: 91. — Osburn, 1950: 156 (in part), pl. 23, fig. 1, pl. 24, fig. 2. — J. D. Soule, 1959: 41.

Material Examined. MMS Station: BRA-6. Other collections: AHF and BMNH.

Description. Colonies whitish, erect, coarse, forming a distinctive turbinate spiral growth pattern, the branches with 2 series of zooids. Zooids 300-500 μm long, 140-250μm wide, with 2-3 stout, blunt outer distal spines, 1 thin, inner spine flanking aperture. Avicularia large, 180-210 μm long, not longer than width of zooid, prominent "bird's heads" attached about midway along the inner or outer zooidal wall. Ovicells on almost every zooid, large, globular with a large, thinly calcified ectooecial area in central portion of hood, like a pea in an open shell.

Biology. Found in the fouling community and on hard substrates; depths previously reported were from shallow waters to over 70 m. The MMS record is from 54 to 63 m.

Taxonomic Remarks. This species has been considered by some to be a junior synonym of *Bugula avicularia* (Linnaeus, 1758), another turbinate species, but there are some differences; *B. avicularia* is orange-brown, its avicularia are longer than the width of the zooid and the spines are longer, thinner and less blunt. According to Ryland and Hayward (1977) the ovicells of *B. avicularia* are globular and smooth. Osburn (1950) stated that there were two sizes of avicularia in *B. californica*, the larger on the outside walls and the smaller on the inside. We have not observed this in our material.

In southern California, *Bugula californica* has apparently been confused with *B. stolonifera* Ryland, 1960, which has tufted colonies rather than spiral growth and is mainly found in warm ports and harbors as a fouling organism. The avicularia are attached to the outer wall only, distal of the midfrontal area. *Bugula stolonifera* was known only from the Atlantic and Mediterranean until found by the present authors to be confused with *B. californica* in southern California. *Bugula californica* commonly occurs from British Columbia south to Monterey Bay; other citations of *B. californica* (e.g., Osburn 1950, part) from south of there in inshore waters may be questioned, although *B. californica* may occur in deeper, cooler waters and the ranges may overlap since both are fouling species.

Type Locality and Type Specimens. First reported by Robertson from Dillon Beach, central California; also from San Francisco Bay and off Pacific Grove. No type specimen is known having been apparently mixed with other specimens in the CAS Collections after Robertson's study.

Distribution. British Columbia south to Monterey, and to the Channel Islands, California; questionably occurring in the Gulf of California, Mexico, the Galapagos Islands and Hawaii. The MMS station is off Point Arguello.

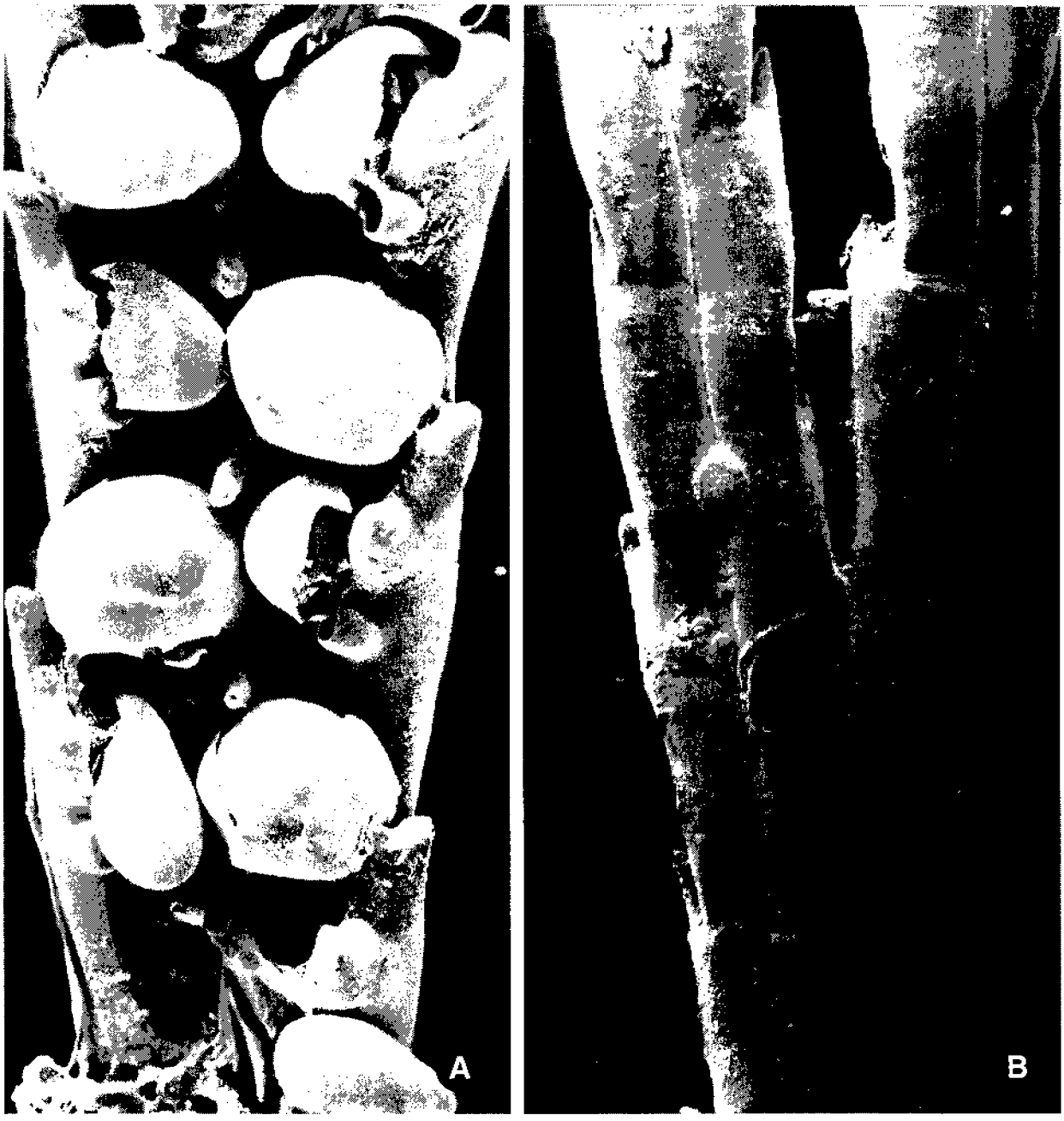


Plate 38. *Bugula californica.* Mussel Pt., central California. A. Biserial branch of turbinate colony with numerous ovicells. B. Detail of zooids with two blunt spines on the outer margins, one thinner spine on the inner margin at the distal end below the ovicell. Ovicell with thin central portion of hood Large bird's head avicularia on outer gymnocystal margins near middle of zooid below blunt spine.


A
B
C

Bugula pugeti Robertson, 1905

Plate 39 A-C

Bugula pugeti Robertson, 1905: 271, pl. 10. figs. 53, 54, pl. 11, fig. 55. — C.H. and E. O'Donoghue, 1923: 21; 1925: 100; 1926: 45. — Osburn, 1950: 158, pl. 23, figs. 7, 8.
Bugula flabellata: Robertson, 1900: 321.

Material Examined. MMS BRA-16. AHF Collections.

Description. Colonies erect, consisting of multiserial branches ranging from 4 to 7 rows wide. Zooids 650-700 μm long, 150-210 μm wide; distal wall rounded. Frontal membrane occupying about 2-thirds of frontal area, with 3 small, blunt spines on the marginal zooids, 2 on the outer wall, 1 on the inner. Large, bulbous, "bird's head" avicularia only on marginal zooids, located midway or more proximally on exterior lateral walls beside frontal membrane. No ovicells known, but distal corners curve inward, almost merging over aperture in possible primitive method of sheltering ova.

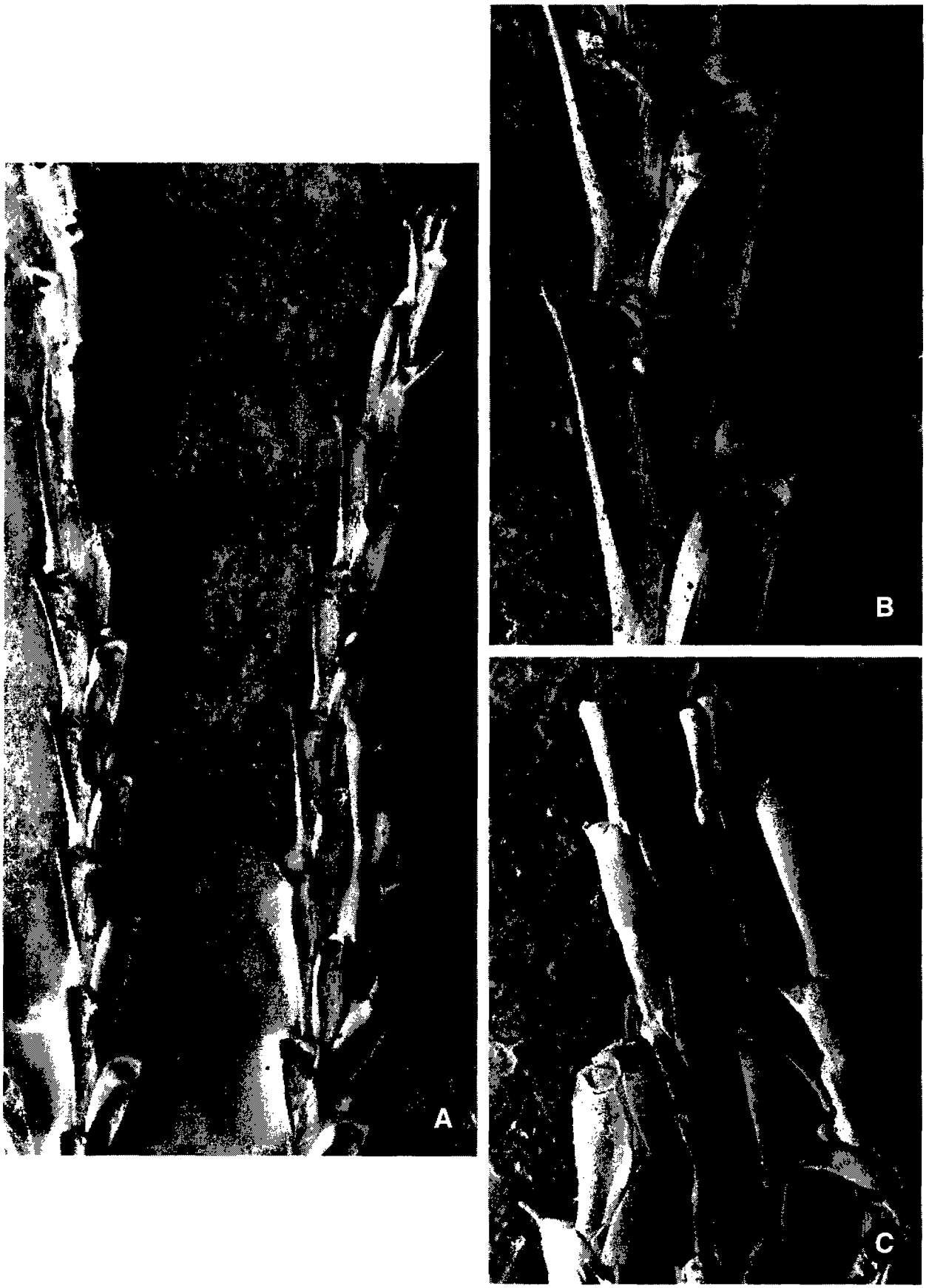
Biology. Found in the fouling community and on hard substrates; depths previously reported were from low tidemark down to 30 m. The MMS record extends the depth to 105-117 m.

Taxonomic Remarks. This species differs from other common *Bugula* species on the Pacific coast in being multiserial rather than biserial. Robertson (1905) and Osburn (1950) mentioned a small knob at the distal end of the zooid which may or may not be present and may be a vestigial ovicell. Osburn (1950:158) stated that avicularia were all one size, but on his Plate 23, figure 7, he illustrated two different sizes, indicating some discrepancy.

Type Locality and Type Specimens. Robertson (1905) originally reported *B. pugeti* from Channel Rocks and San Juan Island, Puget Sound. No type specimen is known having been apparently mixed with other specimens in the CAS Collections after Robertson's study.

Distribution. From Sitka, Alaska, British Columbia waters south to Tomales Bay and San Francisco Bay, California, which was the southernmost record; the MMS report is from offshore of Purisima Point.

Plate 39. *Bugula pugeti.* British Columbia. A. Multiserial branches with bird's head avicularia only on outside zooids, no other avicularia. B. Two short outer distal spines, and one inner spine, avicularia proximal to middle of gymnocystal margin of membranous frontal. No ovicells, but some zooids without spines and tips turned inward may serve as shelter for developing larvae. C. Obverse, bifurcation of branches.


A
B
C

Caulibugula californica (Robertson, 1905)

Plate 40 A-C

Stirparia californica Robertson, 1905: 281, pl. 13, fig. 75, pl. 14. figs. 77-80. — C.H. and E. O'Donoghue, 1923: 23; 1926: 47.
Caulibugula californica: Osburn, 1950: 162, pl. 24, figs. 7, 8.

Material Examined. MMS Station: 2. AHF Collections.

Description. Erect colonies with elongate, jointed stalks composed of kenozooids terminating in palmate, branching tufts of zooids. Zooids *Bugula*-like, narrow, 600-700 µm long, 150-200 µm wide. Apertures slanted, with outer distal corners angled more distally, bearing either a short spine or an elongated spine with a jointed base; inner distal margin with or without a short spine. More than three-fourths of frontal area covered by membrane. Small avicularia, 100-110 µm long attached to proximal gymnocyst. Ovicells small, globose, attached at angle to inner margin of zooid.

Biology. Depths from intertidal in British Columbia to 231 m off La Jolla; the MMS depth was from 110 to 126 m.

Taxonomic Remarks. If only the upper part of the colony, without the stalk (Figure 9), were found, it would immediately be considered a *Bugula* species, but the palmate colony form distinguishes it from these other Pacific species.

Type Locality and Type Specimens. First reported from off La Jolla, California. Robertson's types were mixed in collections at CAS.

Distribution. British Columbia south the Channel Islands, California and to Baja California, Mexico. The MMS station is off Point Conception in the Santa Barbara Channel.

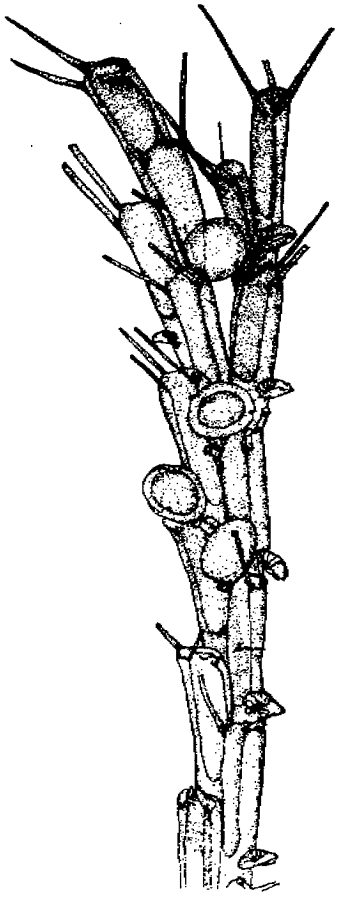


Figure 9. *Stirparia californica*.
From Robertson, 1905, pl. 14, fig. 80.

Plate 40. *Caulibugula californica*. Boiler Bay, Oregon. A. Slim fronds of palmate colony. B. Zooids with slanted apertures, one spine at either distal corner. Frontal membrane covering most of ventral surface, a small pedunculate avicularium on the frontal gymnocyst near the proximal end. Ovicells, not shown, attached at inner margin of distal end. C. Obverse, showing joints at branching; transverse walls angled.

Caulibugula ciliata (Robertson, 1905)

Plate 41 A-C

Stirparia ciliata Robertson, 1905: 279, pl. 12, figs. 67, 68, 69. pl. 13, figs. 70, 71. — C.H. and E. O'Donoghue, 1923: 22. — C.H. and E. O'Donoghue, 1926: 47.
Caulibugula ciliata: Osburn, 1950: 161, pl. 24, figs. 4, 5.

Material Examined. MMS Station: 2. AHF Collections.

Description. Colonies erect, composed of fan-like tufts of zooids supported by stalks of segmented kenozooids or partly modified zooids with a disk at the distal end indicating an aborted zooid at bifurcations; zooids in modified biserial rows, with kenozooids to maintain zooids angling outward (see obverse). Zooids 400-440 μm long, pyriform, rounded distally, tubular proximally. Membrane occupying about half of frontal surface, tilted upward. Stout, elongate, curved spines abundant, 4-6 on the outer margin, 1-2 on inner margin of the membrane. Avicularia few, small, 100-125 μm long, located proximally at base of frontal membrane when present. Ovicells shallow, suspended at side of aperture (pedunculate), 350-370 μm wide.

Biology. Previously reported at depths to 52 m, the MMS record extends the depth range to 110-126 m.

Taxonomic Remarks. Robertson's description and illustrations (Figure 10) are excellent. This species looks less like other buguloid spp. because of its short frontal membrane with more spines. The obverse of *C. ciliata* shows the zooids to be angled strongly outward, with the numerous long spines curving around the frontal, as compared to the parallel, alternating zooidal structure of the obverse in *C. californica*, with its more fragile spines.

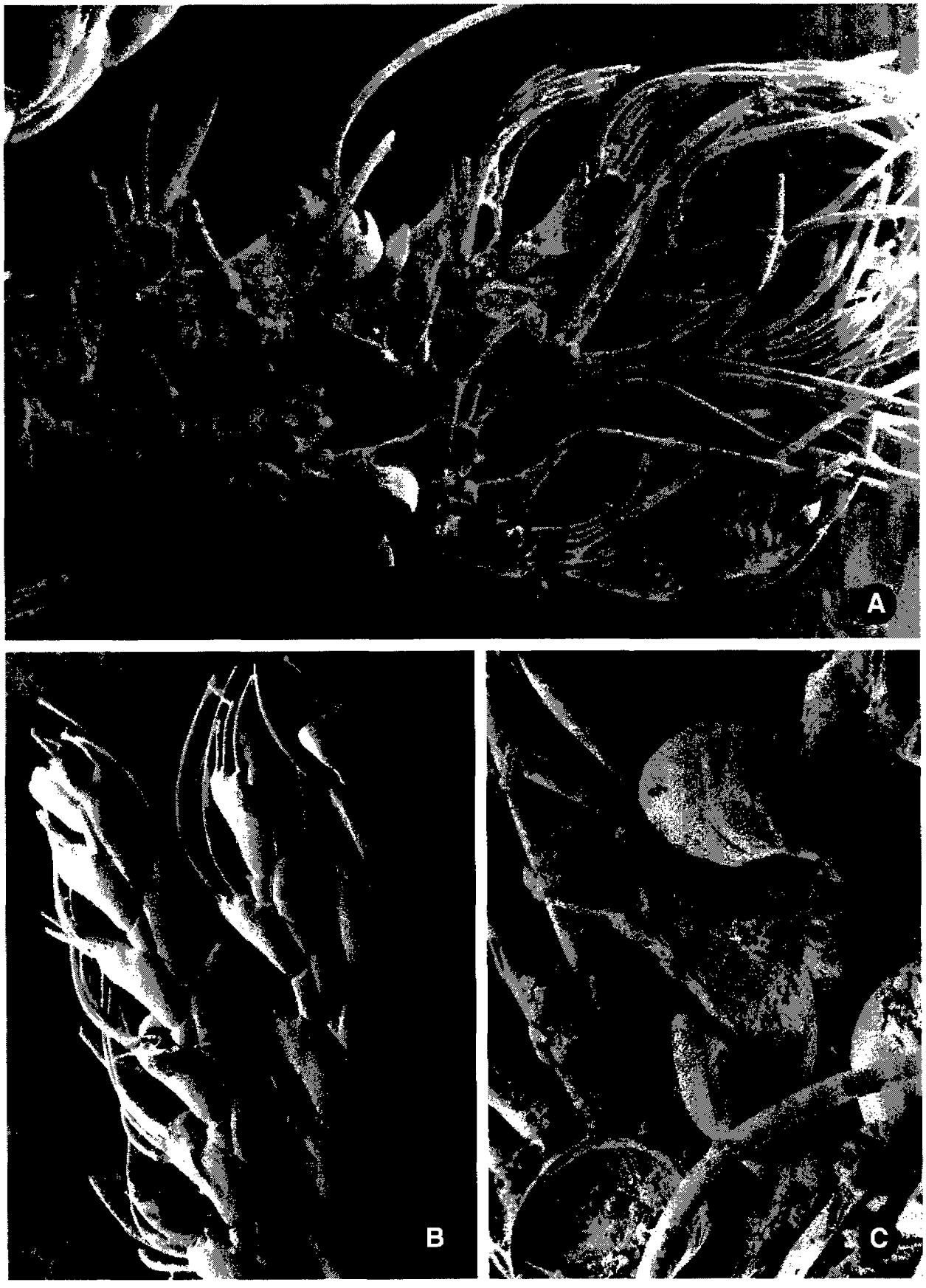
Type Locality and Type Specimens. Originally reported from several locations in San Francisco Bay, off Pacific Grove, Monterey Bay and Dillon Beach, all central California. Robertson's types were mixed with other specimens in collections at CAS.

Distribution. Ranges from British Columbia southward to Santa Rosa Island, Channel Islands, off southern California. The MMS record from off Point Conception in the Santa Barbara Channel seems to be at the southern end of its range.



Figure 10. *Stirparia ciliata.*
From Robertson, 1905, pl 13, fig. 70.

Plate 41. *Caulibugula ciliata.* A. Colony branches with display of zooids with long, curved spines on outer margins, one or two inner distal spines. Frontal membrane area smaller, with more frontal gymnocyst proximally, bearing a small bird's head avicularium. B. Obverse side with kenozooids between zooids at branchings. C. Zooid with ovicell at a slant on inner margin of aperture.


A
B
C

Suborder Cribrimorpha

Family Cribrilinidae Hincks, 1879

The Cribrilinidae differ from the Anasca and Ascophora in having a calcified frontal shield (pericyst) formed from pinnate hollow ribs (costae) which arch over the typically anascan frontal membrane and fuse, leaving intercostal pores between the lateral projections. This allows water to pass between the shield and frontal membrane, enabling the zooid to perform the hydrostatic functions necessary to extrude the tentacles by contracting the frontal membrane. Thus the cribrilinids were placed in the Anasca by various authors (e.g., Harmer; 1926 Osburn, 1950) and in the Ascophora by others (e.g., Hayward and Ryland, 1979). Boardman *et al.* (1983) raised the group to subordinal status. The lacuna proximal to the aperture in Cribrilinidae may act as a primitive ascopore, or opening into the ascus, which is a membranous sac underlying the calcified frontal in some Ascophora, although the ascus may be formed in several different ways.

The terminology for the various pores in cribrilinids has been confused: we refer to the median suboral pore(s) immediately below the proximal rim of the aperture as lacuna(e); the pores between ribs (costae) as intercostal pores, whether regular or not; and to pores in the individual ribs as costal pores (the intracostal lumena of Gordon, 1984, pseudopores of Hayward and Ryland, 1979). The words 'pelma', 'pelmata', and 'pelmatidia' of various authors for intracostal pores seem to us inappropriate because the Greek word *pelma* means sole of the foot, as in footprint, and the diminutives of it would indicate a mark of some sort, not a pore. We usually do not use the word 'pseudopore', for pores filled with tissue, because an opening, or pore, is still present, regardless of whether it completely perforates a structure. Intracostal pores (pseudopores) communicate with the hollow interior coelomic extensions into the costae.

Genera *Cribrilina, Cribrilaria* and *Cribralaria*

The genus *Cribrilina* Gray, 1848, is restricted to those species with punctate ovicells; avicularia, if present, are adventitious, originating from frontal pores borne on individual zooids. *Cribrilina* is not as yet represented in the eastern Pacific collections. The genus *Cribrilaria* Canu and Bassler, 1929, supposedly has imperforate ovicells, and large interzooecial avicularia lie parallel to lateral walls. The genus *Cribralaria* Silén, 1941, has interzooecial avicularia distal to the ovicell and overgrowing it. Unfortunately the genus was created with only a change of one letter from the genus *Cribrilaria*. A previously undescribed species of *Cribralaria* occurs in Baja California (ms in prep.).

Subgenus *Cribrilaria*

Gordon (1984) reduced the genus *Cribrilaria* Canu and Bassler, 1929, to the status of subgenus of the genus *Puellina* because he considered the similarities to be more noteworthy than the differences, including pinnate costae, setiform papillae which protrude through the outermost first intercostal pores in some species, and, often, a suboral lacuna which occupies a position similar to the external ascopore in microporellids. The *Cribrilaria* previously described had a much more extensive costate frontal area than do those previously placed in the *Puellina*. The zooids of the *Cribrilaria* are generally small, <600 μm in length.

Genus *Puellina*

Bishop and Household (1987) revised the description of the genus *Puellina* to incorporate a wider range of characters than had previously been assigned to it, typically the characters now assigned to the subgenus *Puellina*. The genus is now characterized as having zooids with a pericystal frontal shield composed of fused ribs (fused spines, costae) in a pinnate or radiate pattern; each costa has one or more intracostal pores, and intercostal pores present are not elongate or slitlike. Non-calcified papilla, presumably evaginations from the frontal membrane, protrude from pores lying between the bases of the costae at the gymnocyst. Apertures are D-shaped with a straight proximal margin. Ovicells are hyperstomial, with scattered pores or imperforate.

Subgenus *Puellina*

Bishop and Household (1987) created the subgenus *Puellina* Jullien, 1886, under the genus *Puellina*. Harmelin and Aristegui (1988) followed the approach, but questioned it because recent research has indicated that there are gradations among species as to the amount of gymnocyst showing on the frontal surface, which is limited in *Cribrilaria*, spp. and extensive in *Puellina*, spp., with a concomitant reduction in the costate shield. Ovicell pores are supposed to be absent in *Cribrilaria*, and large recumbent interzooecial avicularia present, whereas the ovicells are usually finely perforate and interzooecial avicularia absent in subgenus *Puellina*. As will be seen below, this division is not necessarily adequate or all encompassing, because we found pores in the ovicell of the new species *Puellina (Cribrilaria?) perplexa*, and interzooecial avicularia are present. In *Puellina*, the distal and apertural rims are gymnocystal, originating from the distal end of the zooid.

Genus *Puellina*, Subgenus *Glabrilaria*

The subgenus *Glabrilaria* Bishop and Household, 1987, was established by them to accommodate species with imperforate ovicells and pedunculate avicularia budded from a single lateral wall pore, which gives them an interzooecial appearance. This subgenus has not yet been found in Pacific collections.

Genus *Reginella*

In the genera created by Jullien (1886), *Reginella, Lyrula* and *Figularia*, the proximal apertural rim is formed of modified costae, fused at the midline. It is our opinion that this distinction should be recognized in a parallel to Gordon's (1984) work by retaining the genus *Reginella* Jullien (1886:605) as a genus having page priority over *Lyrula* Jullien (1886:606; preoccupied, now *Jullienula* Bassler, 1953) and *Figularia* Jullien (1886:608), with the latter two becoming subgenera, which we feel is necessary if the system of Gordon (1984) and Bishop and Household (1987) is to be followed.

The subgenera of *Cribrilaria* all have in common several features: the presence of chitinous papillae that protrude through the marginal intercostal pores; suboral lacuna(e) that simulate an external ascopore; distal apertural spines; and pinnate costae. They differ in a number of features: the gymnocyst is present in gradations, because it is not visible in *Cribrilaria*, is relatively narrow in *Glabrilaria*, and is extensive in *Puellina* to the point of reducing the frontal shield or pericyst; interzooecial avicularia are present in *Cribrilaria* and *Glabrilaria*, but are absent in *Puellina*. Ovicells vary also: they are without pores in *Cribrilaria* and *Glabrilaria*, and are finely punctate in *Puellina*. Bishop and Household (1987) classified ovicells as types A, B, and C, based, respectively, on whether it is budded from the proximal end of

the zooid distal to the maternal zooid, budded from a kenozooid between the maternal zooid and the next distal zooid, or whether it is a distal component of the maternal zooid. These are not consistent within the subgenera; *Cribrilaria* have types A and B; *Grabrilaria* has type B or C, and *Puellina* has type C ovicells. Thus, these characters are not mutually exclusive and presumably justify the creation of subgenera in the genus *Cribrilaria*.

In similar fashion, the subgenera proposed to be included in the genus *Reginella* have in common several features: absence of chitinous marginal papillae; absence of suboral lacuna(e); and absence of distal apertural spines, for comparison with *Cribrilaria*. Costae are pinnate, numerous, only in the subgenus *Reginella*; they are reduced in number in *Jullienula*, and further reduced in *Figularia*. Where the number of costae are decreased, the gymnocyst, which forms the distal component of the aperture, is more prominent proximally and laterally. *Reginella furcata*, the type species, appears to have type A ovicells with many or few small pores, while *R. nitida* may have type B ovicells, although that is not as clear. Both *Jullienula hippocrepis* and *Figularia hilli* appear to have type B ovicells, with large fenestrae in the ectooecium that correspond to costal pores, and to be more uniform in this character than are ovicells in *Cribrilaria*.

The genus *Reginella* has the following characters: colonies encrusting, multiserial; zooids mostly large, 600-1,000 μm long; aperture bell shaped or more curved proximally; the distal apertural rim is formed from distal gymnocystal wall, ending at condyles; the proximal apertural rim is formed by fusion of modified costae, sometimes turning distally at outer ends, forming prongs; other apertural spines are absent, or unknown; and there are no suboral lacunae. Avicularia, if present, are interzooecial. Ovicells, if present, formed from modified costae, with numerous small pores or large openings formed from modified costal pores. The type species is *Cribrilina furcata* Hincks 1882, from the Queen Charlotte Islands, British Columbia, described and discussed below as *Reginella*.

Subgenus *Reginella*

The subgenus *Reginella* Jullien, 1886, has the following characters: zooids mostly large (> 600 μm), with many costae; most distal costae straight, proximal costae directed toward center; many large intercostal pores are present; aperture with a gymnocystal curved distal rim, with no distal spines, and the proximal rim is a shallow curve formed by modified costae, with no suboral lacunae. There are no avicularia. Ovicells are hyperstomial, blending with the next distal zooid; there are numerous small pores present, and sometimes a small median keel.

Genus *Reginella*, Subgenus *Jullienula*
(= Subgenus *Lyrula*)

The subgenus *Jullienula* Bassler, 1953 (replacing the preoccupied *Lyrula* Jullien, 1886) includes *Reginella* with many costae, costal and intercostal pores; large spatulate interzooecial avicularia almost the same size as autozooecia lie parallel to them. Ovicells, if present, are type B, kenozooidal, composed of modified costae with 2 large intracostal pores, 1 intercostal pore covered by ectooecium. The type species is *Cribrilina hippocrepis* Hincks, 1882, from the Queen Charlotte Islands, described below.

Genus *Reginella*, Subgenus *Figularia*

The subgenus *Figularia* Jullien, 1886, includes *Reginella* with larger zooids, up to 1,000 µm, with an extensive gymnocyst, and with frontal shield raised; shield is composed of 7 - 14 wide costae tapering to the center, with intercostal pores or horizontal slits, and with 1 large pore on each costa. Interzooecial avicularia, if present, are about half the length of the autozooecia, with spatulate mandibles. Ovicells are type B, kenozooidal, composed of 2 modified costae with 2 large intracostal pores covered by the ectooecium. The type species is *Lepralia figularis* Johnston, 1847, from Britain.

Genus ***Reginelloides*, new genus**

Description. Colony encrusting, uniserial; zooids pyriform or elongate; budding from distolateral wall; 6-15 pairs of costae, without costal pores, mostly straight across, raised in the midline; the proximal and distal apertural rims modified with spinous processes; intercostal pores appearing as longitudinal slits; lateral suboral adventitious avicularia present or not. Ovicells with ectooecial slit or slits. The five distal spines in *R. stolonifera* are petallike, corresponding to the positions of five distal apertural spines in *Cribrilaria*.

Taxonomic Remarks. *Cribrilina vas* Brown, 1954, was transferred to *Reginella* by Gordon (1984) when he described *Reginella stolonifera*. These two species appear to us to differ sufficiently to warrant a new genus, based on the presence of highly modified apertural spines on the distal apertural rim, on the modified suboral costae, and on the structure of the intercostal pores. Both species are uniserial, although uniseriality is not sufficient by itself to justify separation (e.g., *Thalamoporella linearis* Canu and Bassler, 1929, figured by D.F. and J.D. Soule and H. Chaney, 1992).

We propose the name *Reginelloides* for the new genus, and select *Reginella stolonifera* Gordon, 1984, as the type species, since it is well described and well illustrated. The type is No. H319, New Zealand Oceanographic Institute, Wellington. *Reginella vas* is tentatively placed in the new genus, although it may warrant a separate genus after further study. *Cribrilina uniserialis* Harmelin, 1976, may belong to the new genus as well, although it has no spines or intercostal pores, perhaps due to its deepwater habitat, over 800 m, in the Azores.

Type Species and Type Locality. *Reginella stolonifera* Gordon, 1984, New Zealand Oceanographic Institute type nimber H-319, from Kermadec Islands, New Zealand, 270 and 350 m.

***Reginella (Reginella) furcata* (Hincks, 1882)**

Plate 42 A-C

Cribrilina furcata Hincks, 1882: 250, 470, pl. 20, fig. 5. — C.H. and E. O'Donoghue, 1923: 172.
Reginella furcata: C.H. and E. O'Donoghue 1925: 101. — C.H. and E. O'Donoghue, 1926: 98. — Osburn. 1950: 179, pl. 28, fig.3.

Material Examined. MMS Station: BRA-27. Other collections: AHF; BMNH: Hincks Coll. specimens 1886.3.6.17, 1886.3.6.18, part of type, and O'Donoghue Collection 1921.11.17.12 from Departure Bay, Vancouver.

Description. Colonies encrusting. Zooids in alternating series, 680-760 µm long, 370-450 µm wide. Frontal wall elevated, composed of 6-8 pairs of ribs (costae), fused into reticular pattern with a row

of 4-6 pores between costae; each costa also usually bearing 2 small infundibular surface pores. Aperture bell shaped, 180-220 μm at widest point, 100-120 μm high; on each side of aperture, a short broad flange or spine present, tending to be weakly bifurcate as if composed of 2 fused spines. No avicularia, no other spines. Ovicell globular, 380 μm wide, sometimes raised centrally to a faint keel, with scattered pores, the larger ones along the periphery, blending into next distal zooid. Ancestrula with entirely membranous frontal wall, low gymnocystal body wall with 2 long, slender distal spines and 11 small, thin, erect spines surrounding frontal membrane. First generation budded (primary zone of astogenic change) has 2 distal spines, normal fused pinnate costae.

Biology. On hard substrates; previously reported in depths from shallow waters to over 160 m.

Taxonomic Remarks. *Reginella furcata* is the type species of the genus *Reginella*. *Reginella nitida* Osburn (Figure 11) is very similar to *R. furcata*, but it has three infundibular pores on the first pair of costae and four on each of the other costae. Osburn's illustration of *R. furcata* (Figure 12) suggests that costae extend straight across, although this is somewhat exaggerated as compared to the illustration by Hincks (1882). The distal costae are directed toward the midline and the proximal costae are directed toward the center, which is similar to that in *R. nitida*. *Reginella nitida* has slightly larger zooids and spines are absent, which may be a factor of age rather than a difference in species, since the characters overlap. *Reginella furcata* has only two costal pores while *R. nitida* has three or four. Osburn compared differences of *R. nitida* to those of *R. mucronata* rather than to *R. furcata*.

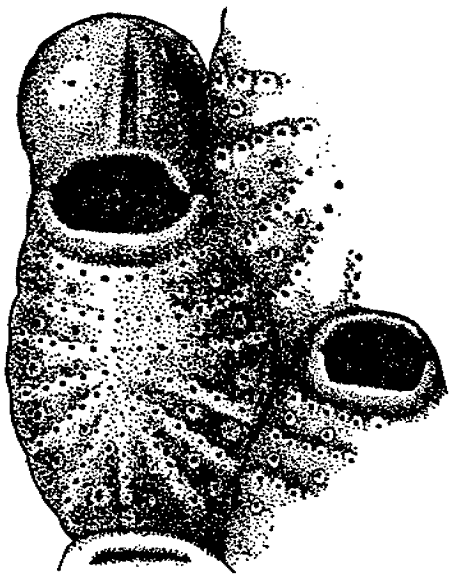


Figure 11. *Reginella nitida*.
From Osburn, 1950, pl. 28, fig. 1.

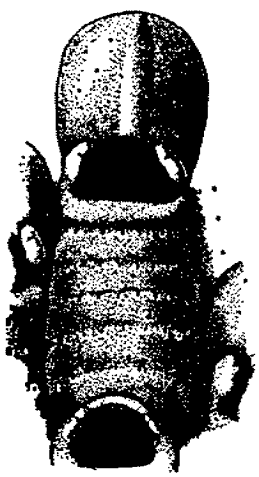
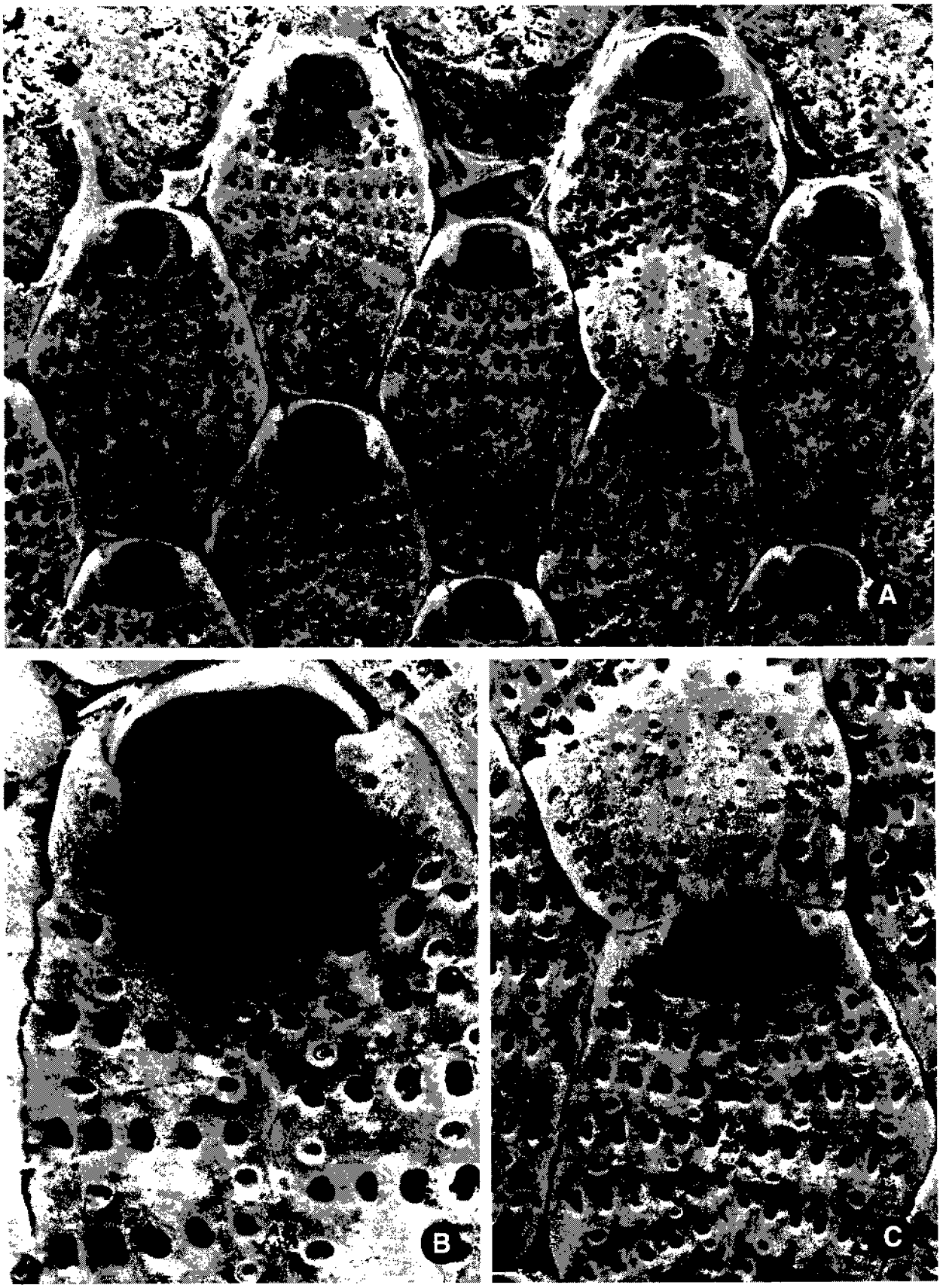


Figure 12. *Reginella furcata*.
From Osburn 1950, pl. 28, fig. 3.

Type Locality and Type Specimens. Described from Cumshewa and Houston-Stewart Channel, Queen Charlotte Islands, British Columbia; BMNH 1886.3.6.18 is part of the type material.

Distribution. The MMS station is north of Point Buchon, at the south end of Morro Bay. The species ranges from British Columbia southward to the San Benito Islands off Baja California, Mexico, although some of the records may have been confused with those of *R. nitida*, which was described by Osburn (1950) as ranging from Puget Sound to the San Benito Islands.

Plate 42. *Reginella (Reginella) furcata*. A. Growing margin of colony from off Santa Cruz Island, California, with lateral oral flange or spine, weakly bifurcate. B. Autozooid showing lateral oral flanges appearing as short fused spines, ribs (costae) bearing costal pores (lumena), intercostal pores. C. Ovicelled zooid.


A
B
C

Reginella (Reginella) nitida Osburn, 1950

Plate 43 A-C

Reginella nitida Osburn, 1950: 181, pl. 28, Fig 1.

Material Examined. MMS Station: BRA-17. AHF Collections.

Description. Colonies encrusting. Zooids large, distinct, 600-780 μm long, 430-470 μm wide. Frontal low, with 5-8 pairs of flattened ribs (costae), sometimes with median rib at the proximal end directed distally. Intercostal grooves well defined, with 5-7 intercostal pores; 3 yellowish infundibuliform intracostal pores on each of first pair of costae, 4 on other costae. The proximal apertural rim in older zooids thickened, forming a low median umbo. Sometimes a small raised projection supposedly not bifurcate, beside aperture. No avicularia. Ovicell large, 330-350 μm wide, 300-380 μm high, with random pores often occluded in older zooids, a hint of a keellike central suture; ovicells somewhat elevated.

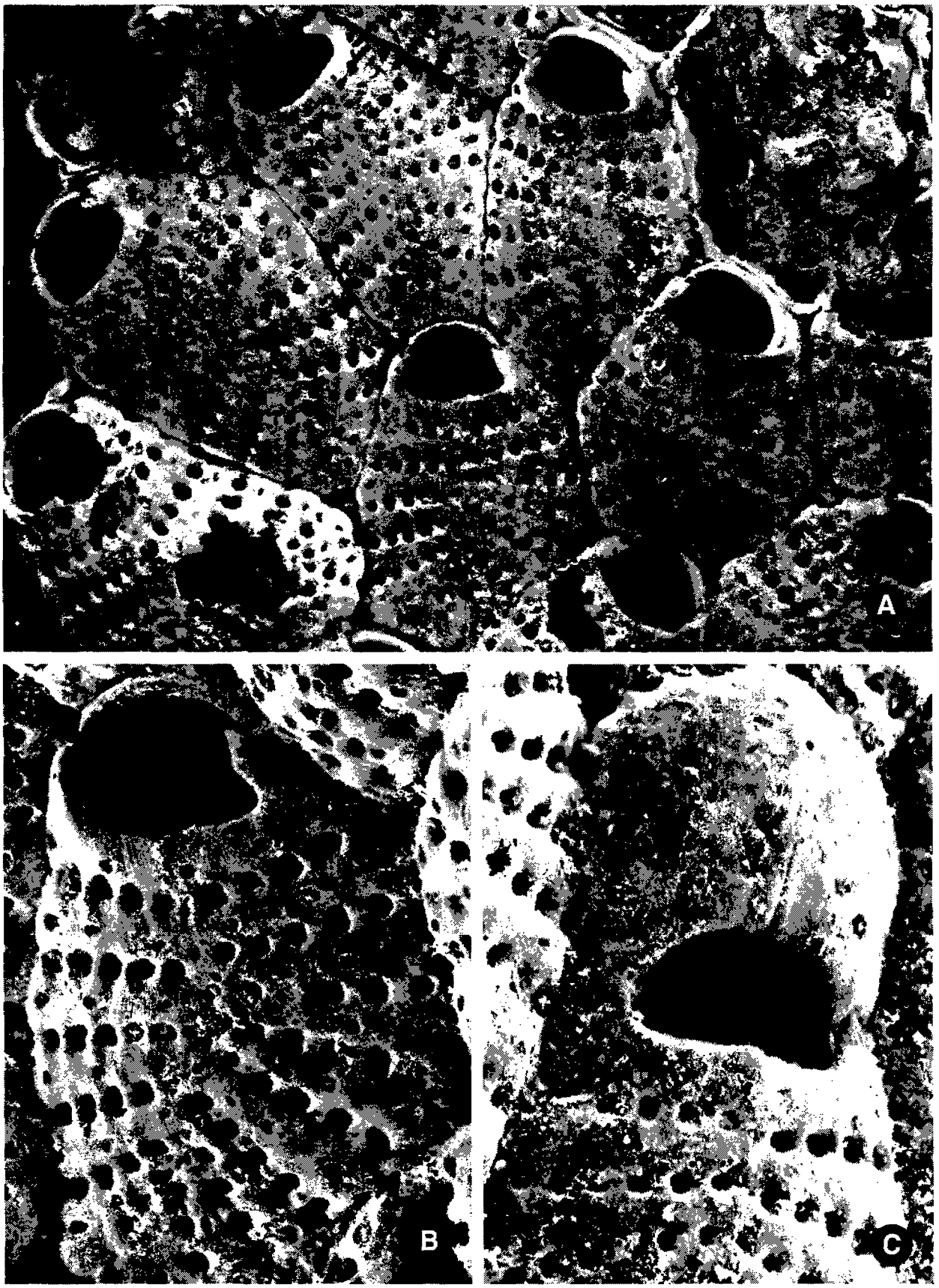
Biology. Reported previously to depths of 127 m; the MMS record extends this to 168 m.

Taxonomic Remarks. The overlap with *R. furcata* in characteristics such as size, number of costae and number of pores suggests that the distribution of the two species has been confused. *Reginella furcata* may be a northern species, but it may occur in the central California area, and the reported occurrence of *R. nitida* in Puget Sound may be questionable. *Reginella furcata* seems consistently to have two intracostal pores (lumen of Osburn) and *R. nitida* to have three or four obscured pores. Ovicells in *R. nitida* are somewhat taller and more raised above the distal zooid than those in *R. furcata*. It is difficult to distinguish *R. furcata* from *R. nitida.*

Type Locality and Type Specimens. Type locality is AHF station 1180-40, off Howlands Landing, Santa Catalina Island, southern California. SBMNH-AHF Bryozoa Holotype No. 45.

Distribution. The MMS station is offshore between Purisima Point and Point Sal, California. The species was reported by Osburn (1950) from Puget Sound, Washington southward to the San Benito Islands off Baja California, and in the Gulf of California, Mexico.

Plate 43. *Reginella (Reginella) nitida.* A. Growing margin of MMS station 017 colony from off Pt. Purisima and Pt. Sal, zooids curving in shell substrate. B. Zooid from off Howlands Landing, Santa Catalina Island, California, with proximal lip curved upward at ends, pores in hood. C. Ovicelled zooid with median suture, scattered pores obscured.


A
B
C

Reginella (Jullienula) hippocrepis (Hincks, 1882)

Plate 44 A-C

Cribrilina hippocrepis Hincks, 1882b: 470, pl. 20, fig. 6, 6a. — C.H. and E. O'Donoghue, 1923: 172.
Cribrilina annulata: Robertson, 1900: 326.
? Cribrilina hippocrepis: Robertson, 1908: 280, pl. 18, fig. 31.
Lepralia regularis C.H. and E. O'Donoghue, 1923: 182, pl. 3, fig. 27.
Lyrula hippocrepis: C.H. and E. O'Donoghue, 1926: 98. — Osburn, 1950: 184, pl. 27, fig. 7, 8.

Material Examined. AHF and BMNH Collections.

Description. Colonies encrusting, sometimes raised, bilaminate. Zooids 550-750 μm long, 325-400 μm wide; zooids arranged in alternating series. Frontal shield somewhat raised, composed of 4-6 pairs of costae separated by 3-4 irregular, dumbbell shaped intercostal pores; each costa with a large intracostal pore at its outer end. Aperture raised distally, formed by distal gymnocyst. Modified costae form a narrow, incomplete proximal rim, with the next pair of modified costae forming a wide proximal apertural bar, curving distally at the outer ends. A few very large interzooecial avicularia inserted into zooidal rows, with a spatulate mandible directed distally, a larger opesia proximally. Ovicell small, apparently formed of modified costae, indistinct, immersed in next distal zooid, curving around distal rim of aperture, with 2 costal pores, a median intercostal pore. Hincks described the ancestrula as having numerous slender marginal spines and a pair of distal ones, according to Harmer, 1926.

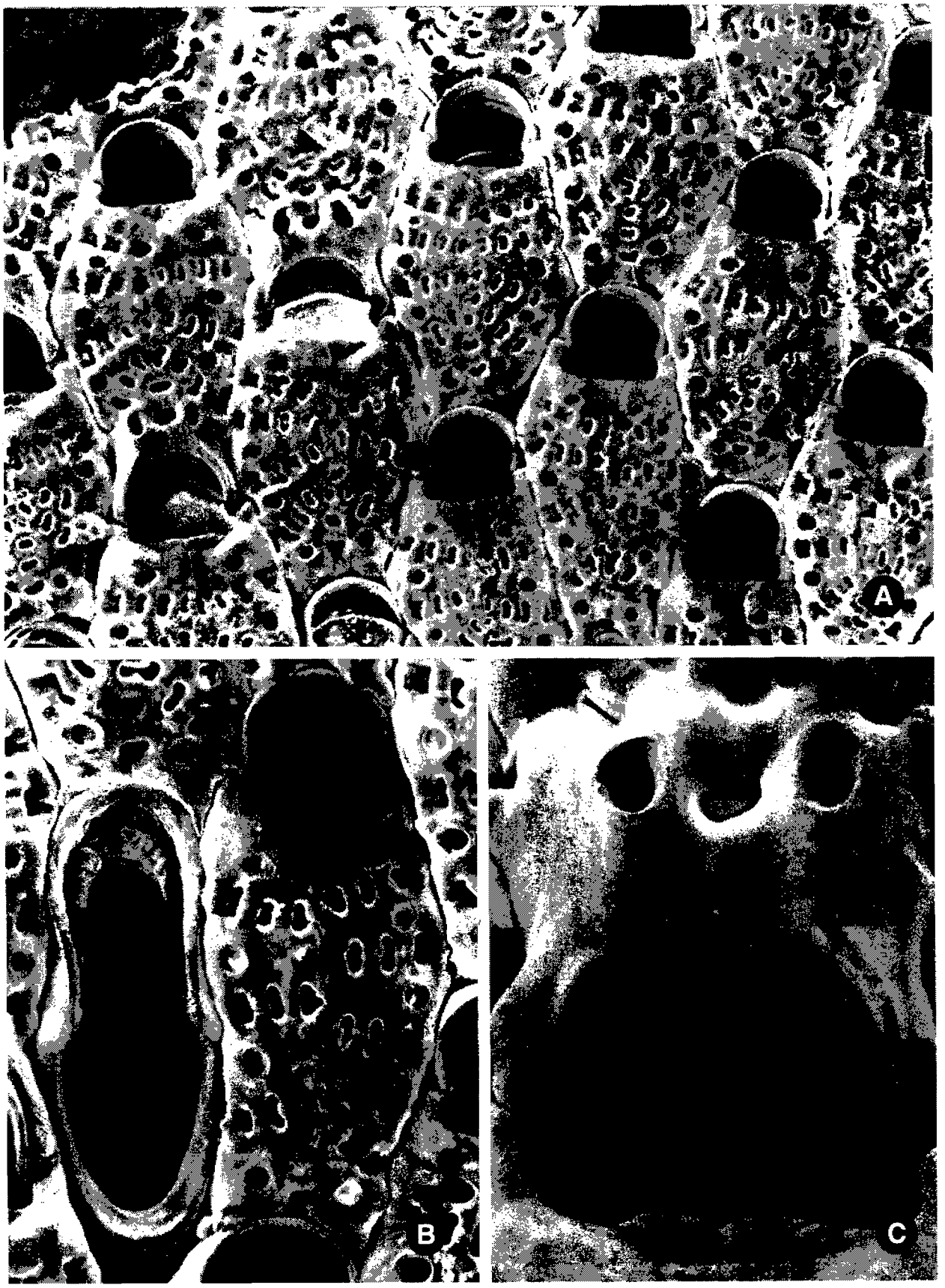
Biology. Colonies encrust stone, shells, worm tubes, other firm substrates. Depths reported from shallow waters down to 160 m.

Taxonomic Remarks. Osburn (1950) did not find ovicells and mentioned that Hincks (1882) did not observe them either. The genus *Lyrula*, as defined by Jullien (1886), lacked ovicells. We have amended the description of the subgenus *Jullienula* to include them. The ovicells of subgenus *Figularia* are similar in structure but the two pores are much larger, the median intercostal pore is absent and the ovicells are more obvious due to the greater gymnocystal area on the next distal zooid and its radiate pattern of intercostal pores. The structures we interpret as ovicells are very hard to locate except by SEM because they are small, immersed, blending into the costal pattern of the next distal zooid. Robertson (1908) probably did not have *L. hippocrepis* since she illustrated a raised ovicell with uniform pores, which is not characteristic, and did not show the large single costal pore at the outer end of each costa.

Type Locality and Type Specimens. BMNH 86.3.6.19, 20. 21. part of type. Queen Charlotte Islands, British Columbia.

Distribution. From Alaskan waters south to southern California.

Plate 44. *Reginella (Jullienula) hippocrepis*. Santa Cruz Island, California. A. Colony with ovicell marked by two large pores left of center; zooids showing large costal pore at end of each costa, dumbbell shaped intercostal pores, beginning of ovicell top left. B. Giant interzooecial avicularium directed distally, with distal cryptocystal palate, large proximal opesia. C. Ovicell with two costal pores, one intercostal pore.


A
B
C

Reginella (Figularia) hilli (Osburn, 1950)

Plate 45 A-B

Figularia hilli Osburn, 1950: 190, pl. 28, fig. 8. — J. Soule, 1959: 49.

Material Examined. MMS Station: BRA-20. AHF collections.

Description. Colonies encrusting; zooids 600-900 μm long and 400-420 μm wide. Gymnocyst extensive, without pores, bordering a reduced, raised frontal shield composed of 5-7 wide, partially fused costae (2-3 pairs and 1 median proximal costae), with 1-2 small slits or pores between costae. Each costa with a very large pyriform pore narrowed toward the median line of fusion. Aperture 200-240 μm wide, 220-240 μm, high, nearly semicircular distally, with small distinct gymnocystal condyles (cardelles), proximal lip curved, formed by first pair of costae. No spines or avicularia. Ovicells inconspicuous, slightly raised, probably a kenozooid formed by 2 pairs of costae with 2 large intracostal pores (fenestrae of some authors); a prominent median suture present, furrows above pores, like wrinkles above eye sockets; aperture of ovicelled zooid flanked by a pair of small costae; aperture 260 μm wide, 240 μm high.

Biology. Encrusting stones, shells, occasionally algae. Depths from intertidal to 100 m were previously recorded. The MMS record extends the range to 130.5 m.

Taxonomic Remarks. The type species of the genus *Figularia*, *F. figularis* (Johnston, 1847), is a warm temperate species widespread in the Mediterranean, extending north in the Atlantic to the southern and western coasts of the United Kingdom (Hayward and Ryland, 1979). According to them, that species has a larger frontal shield and reduced gymnocyst, more costae, 5-7 pairs, with 6-8 intercostal pores across the zooid and a costal pore the outer end of each costa. It also has rare interzooecial (vicarious) avicularia with a complete hinge bar and with spoon shaped mandibles. An SEM of the type, Plate 45 C, courtesy of Dr. Dennis Gordon, shows 4 pairs of costae and a median distal costa, and 6-10 intercostal pores across the zooid. The type has a much larger, raised ovicell with two large lucida (fenestrae) and faint sutural markings.

The ovicell of *R. (F.) hilli* is more easily located than that in *R. (L.) hippocrepis* because the fewer number of costal pores forms a more discrete pattern set off by the larger gymnocyst area. Osburn (1950) indicated that in some specimens there might be only three or four costae but we have not located such specimens. It may represent a different species.

Type Locality and Type Specimens. AHF Station 1130-40, off Laguna Beach, California. SBMNH-AHF Bryozoa Holotype No. 48.

Distribution. The MMS station is off Purisima Point. The known range is from Monterey Bay, California southward to the Channel Islands off southern California, and to Baja California.

Plate 45. *Reginella (Figularia) hilli.* A-B. Del Monte, California (Monterey Bay). A. Autozooids with reduced frontal shield, 5-7 large costae, each with large costal pore; five ovicells with two large costal pores. B. Enlarged zooid with ovicell showing tiny condyles at apertural rim tips. C. *Figularia figularis.* English Channel. Type specimen. Ovicell composed of two pairs of large costae, two small ones flanking aperture.


A
B
C

Puellina (Cribrilaria?) perplexa, new species

Plate 46 A-C

Not *Lepralia innominata* Couch, 1844: 114, pl. 22, fig. 4.
Colletosia radiata form *innominata*: Osburn, 1950: 187, pl. 29, fig. 2,2a.

Material Examined. AHF and BMNH Collections.

Description. Colonies encrusting. Zooids distinct, oval, small, up to about 440-550 μm long, 250-280 μm wide. Gymnocyst hardly visible. Frontal shield (pericyst) composed of 15-17 costae (ribs) directed to center, with knobs at outer ends, costae not buttressed by portion rising at angle from gymnocyst area; 1 costal pore near knob. Intercostal pores small, on each side three proximal to first ribs, 5 between others, totaling 6-10 pores in row; outermost pore larger, may be bordered by gymnocyst and surround tissue papilla. Aperture semicircular, with straight proximal rim. Five hollow spines: 3 smaller distal spines, 2 thicker lateral oral spines. Ovicells with 1-2 pair of lateral oral spines. A large circular, elliptical or heart shaped lacuna between the proximal apertural rim and bar of smaller modified costae and the first pair of costae, sometimes flanked by 2 smaller pores, sometimes all three pores merged; shelf formed by first costae and lacunal area may be raised, but not extended into large umbo. Avicularia interzooecial, lying parallel to zooids along distolateral or proximolateral walls, with elongate triangular mandible 250-300 μm long, palate and opesial area length 200-270 μm. Ovicell globular, partly immersed in next distal zooid, with large pores, sometimes obscured by advanced calcification, with irregular longitudinal ridge sometimes umbonate (probably Type B of Bishop and Household, 1987).

Etymology. Latin *perplexus*, named for the confusion over identity of cribrilinid species.

Biology. Encrusts rock and shell. Osburn reported *C. radiata* form *innominata* from shallow waters down to 175-200 m, but the cribrilinid species have been so confused in the eastern Pacific that the depth and distribution of the species cannot easily be determined.

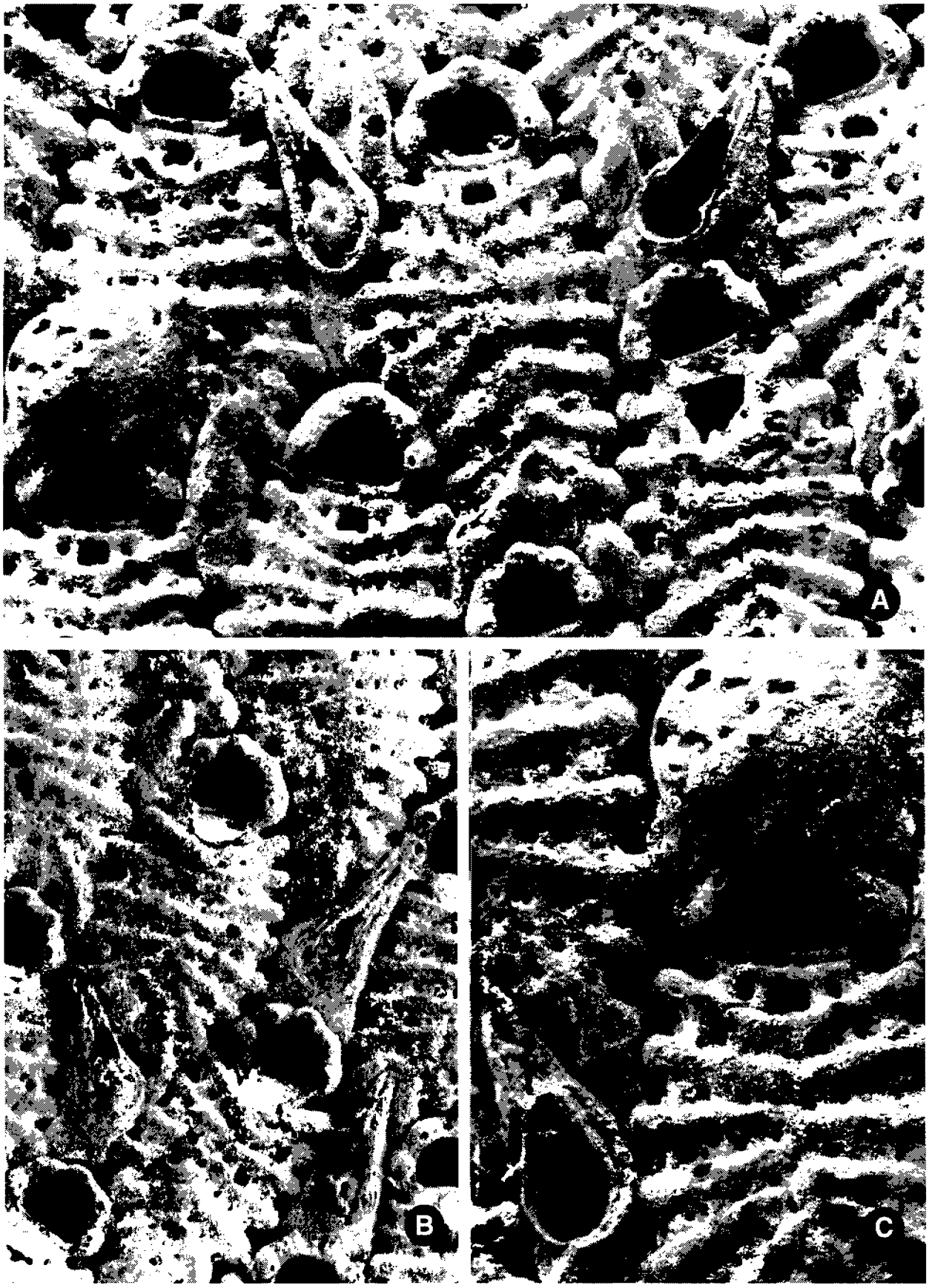
Taxonomic Remarks. This species is being described as new, in spite of the few specimens available and their poor condition for examination, because of the confusion about the identity of eastern Pacific coast Cribrilinidae. The species have very small, glistening zooids that are difficult to observe in light microscopy. *Puellina (C.) perplexa* greatly resembles *P. (C.) innominata*, first described by Couch, 1844, from off Cornwall, England. The type of *P. (C.) innominata* was lost, but the species has been cited from numerous Atlantic and Mediterranean locations. Bishop (1986) designated a neotype for *C. innominata*, BMNH 1847.9.16.32, and redescribed it as *Puellina (Cribrilaria) innominata*, greatly limiting the variations previously included and the resultant distribution.

The new species differs from *P. (C.) innominata* in having pores in the ovicell, in having 15-17 costae rather than 9-14, in usually having 10 intercostal pores per regular transverse row as compared to 8, and in lacking the slanting buttress portion of the costae. The length of the mandible and open opesial area of the avicularia is 300-370 μm in the new species as compared to 170 μm in *P. (C.) innominata*.

A problem of the genus in which to place the species arises due to the restructuring of classification mentioned earlier. Gordon (1984) reclassified *Cribrilaria* as a subgenus under the genus *Puellina*, a system followed by Bishop and Household (1987). Under this system, the new species would belong in the genus *Puellina*, but the subgenus *Puellina* as defined by Gordon, does not have interzooecial avicularia, although

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Plate 46. *Puellina (Cribrilaria?) perplexa.* Port Hueneme, California. A. Autozooids usually with one large suboral lacuna flanked by two small lacunae; large interzooecial avicularium. B. Zooids with five spines; varied interzooecial avicularia. C. Detail of ovicell with pores, 1-2 lateral oral spines on each side of aperture, costae with knobs at outer ends.


A
B
C

it has finely punctate (perforate) ovicells. The frontal costal shield is reduced, with a larger gymnocystal area, especially proximally. The subgenus *Cribrilaria*, as defined by Gordon, has interzooecial avicularia and a costal area covering the entire frontal with a consequent reduction of the gymnocyst. It has imperforate ovicells. The subgenus *Glabrilaria* of Bishop and Household has pedunculate adventitious avicularia (borne on the margin of the zooid), and has imperforate ovicells.

We have adopted the system of subgenera herein reluctantly due to the conflict of subgeneric characters; it could perhaps require yet another subgenus to accommodate the new species with its large ovicell pores, and remove it further from *P. innominata*, which it otherwise closely resembles. Harmelin and Aristegui (1988) stated that they followed the unifying approach of Bishop and Household (1987) with some reservations, considering the wide range of morphological types in the species gathered in *Puellina*. They considered that the genus *Puellina* is a continuum, with the many new species being described from various parts of the world showing three 'nodes' [represented by the subgeneric descriptions], progressing from simple to complex, with gradual variations in the three characters, oral spines, ovicells and avicularia.

There is extensive confusion in the literature over the assignment of species to the two genera *Puellina* and *Cribrilaria*. We would have preferred to see them retained at generic level and the new subgenus *Glabrilaria* Bishop and Household (1987) elevated to generic status. *Puellina (Cribrilaria) radiata*, a very similar species, was placed in *Colletosia* Jullien (1886: 610) by Osburn (1950), a genus resurrected by Harmer (1926). Lagaaij (1963) stated that *Colletosia* is a junior synonym of *Umbonula* Hincks, 1880, which is not a Cribrilinidae.

The *Puellina (Cribrilaria) innominata* of Gordon (1984) from Kermadec Ridge off New Zealand resembles the new species in having 15-17 costae, but differs in having an imperforate ovicell, a bifid umbo formed by the first pair of costae, and in having spinous projections developed on the costae. This differs from the subsequent redescription of *P. (C.) innominata* and designation from around the world. Gordon's species also has five intercostal pores per costa (10 across) in the midsection, according to Gordon's excellent figures (1984: 64, pl. 21, figs. B,C).

Cribrilinid specimens may vary from descriptions due to the ability to regenerate frontal shields in old zooids, to form kenozooids where crowding or irregular substrates occur, and also to bifurcate partially at the proximal end under such circumstances; Bishop (1986) reviewed the literature on such bifurcations.

Type Locality and Type Specimens. AHF Station 1274-41, 3.5 miles south of Port Hueneme, southern California, 29 fms (53 m). AHF Holotype No. 208.

Distribution. Presently known from southern California; further research will be needed to determine whether the distribution extends northward to British Columbia and southward to the Galapagos and Peru, as indicated by Osburn (1950), or whether other species are involved, as we suspect.

Puellina (Cribrilaria) californiensis, new species

Plate 47 A-D

Puellina setosa: Osburn, 1950: 186 (in part).
Colletosia radiata form *innominata*: Osburn, 1950: 187 (in part).
Colletosia radiata: J. Soule, 1959: 49.

Material Examined. AHF and BMNH Collections.

Description. Colony encrusting, shiny, translucent. Zooids ovoid, small, 380-570 μm long, 280-350 μm wide. Frontal shield (pericyst) composed of 13-16 costae in radiate pattern, costae with knobs at periphery, meeting buttress portion slanting upward from gymnocyst; gymnocyst wide in young colonies, giving traditional "puellinid" appearance. Aperture curved distally, straight proximally, 5 distal spines, long, telescoped, arising from basal joints; 1 suboral lacuna between apertural bar and modified short costate bars bounding lacuna proximally, bars sometimes projecting outward; apertural bar sometimes incomplete, with space below proximal apertural rim merging with lacuna; 5 intercostal pores between first true costa and second (10 across), 5-7 intercostal pores on each side at widest part (10-14 across). Peripheral pores larger, with papillae, first papillae sometimes long, setose. Avicularia interzooecial, acute, sometimes almost setose, placed distolateral to zooids, 250-280 μm long, with rostral and opesial areas 150-250 μm long. Ovicells imperforate, irregular, with 4 lateral oral spines. First generation zooids around ancestrula smaller than normal.

Etymology. Named for the known distribution in California waters.

Biology. Found on rock, shell, in sandy and muddy bottom to depths of over 180 m.

Taxonomic Remarks. There has been so much confusion in the literature as to what constitutes the species *"Puellina setosa"* and *"Colletosia radiata"* that it is not surprising that identifications of these small species have remained unclear. It seems apparent that the concept originated by Gordon (1984) of using the genus *Puellina* to include both the traditional *Puellina* species with reduced frontal shield and the *Cribrilaria* species with complete frontal shield will be used for the present (e.g., Bishop, 1986; Bishop and Household, 1987; and Harmelin and Aristegui, 1988). Bishop and Household (1987) selected a lectotype for *Puellina setosa* (Waters, 1899), Manchester Museum MM1173, and limited the distribution to the Mediterranean, Madeira and the Canary Islands. That species has no avicularia.

The Pacific material, while having a somewhat wider gymnocyst than most, does not have as reduced a frontal shield as the Mediterranean species, and possesses interzooecial avicularia, which are absent in *Puellina* but present in *Cribrilaria* (note Figure 13). Harmelin (1970) established a neotype for *Cribrilaria radiata* which indicated that it too is a Mediterranean species that does not occur in the Pacific. Hayward and Ryland (1979) figured both species. The material available for SEM examination is limited, and it is possible one or more other new species may remain undescribed among specimens labeled by Osburn as one or the other of the aforementioned species.

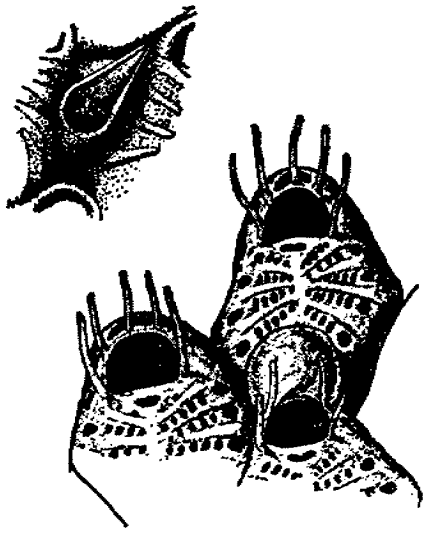


Figure 13. *Collestosia radiata* form *innominata*, top view of interzooecial avicularium. From Osburn, 1950, pl. 29, figs. 2-2a.

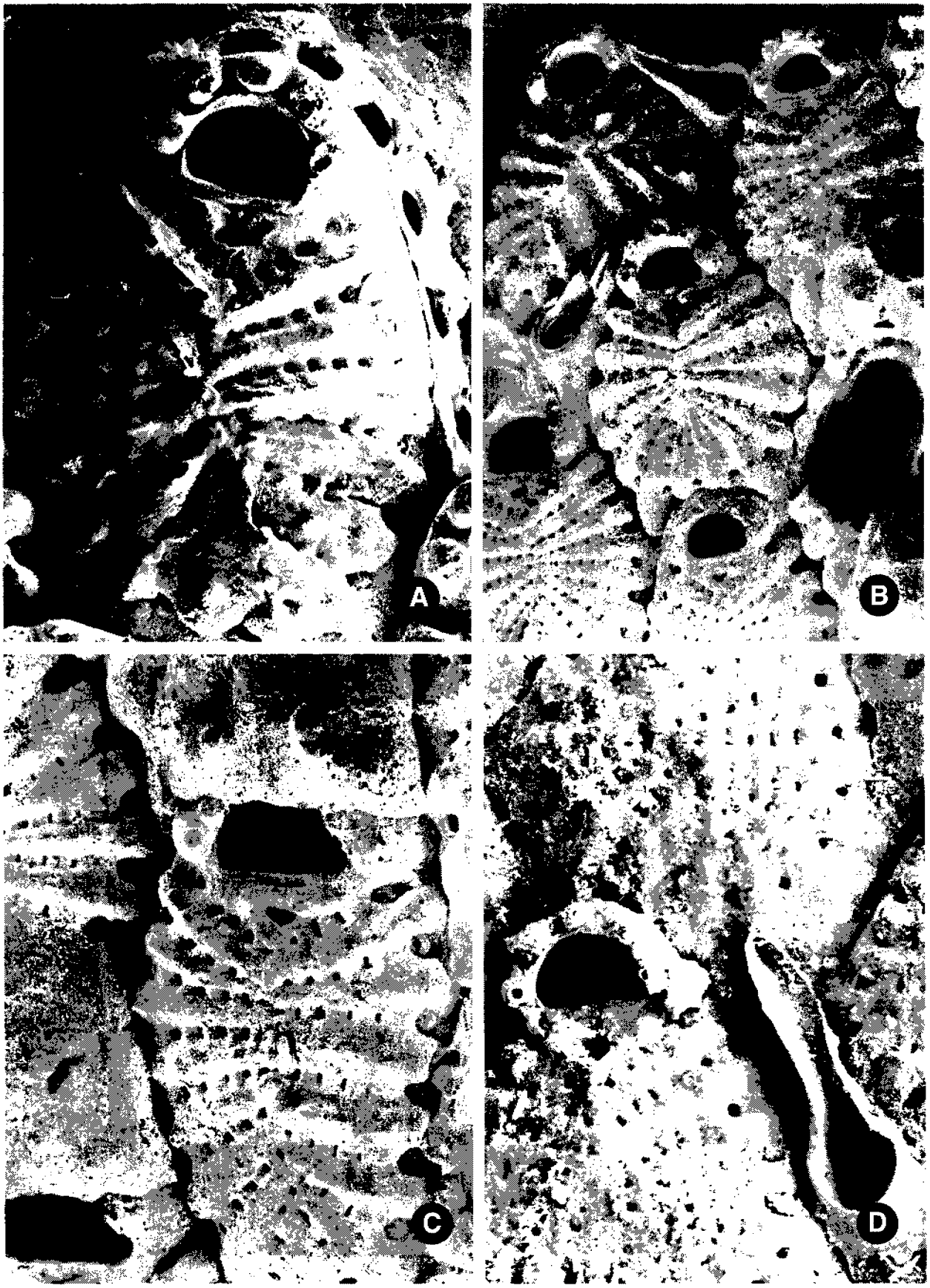
The new species differs from *Cribrilaria radiata (sensu* Harmelin, 1970); the latter has 16-29 costae, 2-3 suboral lacunae sometimes confluent, four distal spines (occasionally five, *fide* Hayward and Ryland, 1979), and its dimensions are generally larger. The avicularia range from 230 to 420 μm in length, and zooid length ranges up to 600 μm, although the lower end of the range overlaps that of the new species. Osburn interpreted the long papillae as avicularia.

Further research is needed to determine whether this is a complex of species, but it is clear, from the various reviews using SEM, that California material is not synonymous with the eastern Atlantic and Mediterranean species.

Type Locality and Type Specimens. AHF Station 1176-40 west of Santa Barbara Island, Channel Islands, California, depth 100 fms (183 m), bottom gray sand. SBMNH-SBMNH-AHF Bryozoa Holotype No. 209.

Distribution. Known from the California Channel Islands, possibly extending to the Gulf of California.

Plate 47. *Puellina (Cribrilaria) californiensis.* Santa Barbara Island, California. A. Zooid at growing margin, showing more gymnocyst proximally, papillae growing from peripheral intercostal pores. B. Interzooecial avicularia at growing margin, aborted ovicelled zooid to right center, completed ovicell below. C. Detail of imperforate ovicell. D. Another shape of avicularium rostrum.


A
B
C
D

Suborder Ascophora

Family Microporellidae Hincks, 1879

The Family Microporellidae is characterized by the presence of an opening (ascopore) for the ascus (compensation sac or asc) in the frontal wall proximal to the aperture, instead of opening internally below the proximal apertural rim, as it does in most ascophorans. The genera *Microporella* and *Diporula* have no frontal pores between the ascopore and aperture, whereas the *Fenestrulina* and *Fenestruloides* (new genus) have stellate or cribrate pores in that space. *Microporella* spp. generally have avicularia while *Fenestrulina* spp. do not, but one has been found in *Fenestruloides*. Frontal wall pores in all but three species in this study, *M. catalinensis, M. umboniformis* and *M. vibraculifera*, have stellate rims or cribrate plates, suggesting a difference in evolutionary approach to protecting the underlying ascus roof. Pore spicules, when present, are much more symmetrical in *Microporella spp.* than in the *Fenestrulina* and *Fenestruloides* spp. examined.

The type species of the Family Microporellidae and the genus *Microporella* is *Eschara ciliata* Pallas, 1766. That species and a number of varieties, have been reported from many localities, from most seas, and from the Miocene to present. Other species described have been synonymized with *M. ciliata* by various authors to such an extent that the original concept of the species has become obscured. Although it has been reported in the eastern Pacific by Hincks (1880c, 1883), C.H. and E. O'Donoghue (1923, 1926), Hastings (1930), Osburn (1952), Soule and Duff (1957), and Soule (1961), we are now of the opinion that the species has been confused with several others as descriptions were modified to include the many "variations" encountered. Hayward and Ryland (1979) consider it to be a temperate-boreal species in the Atlantic, and Kluge (1975) reported it from the Barents Sea.

Two slides collected by Raymond C. Osburn at the Clapp Laboratory at Tiverton, Rhode Island, have zooids averaging 414 µm in length and 360 µm in width, smaller than those described by Hayward and Ryland (1979) from England. Colonies on algae too fragile for SEM have tiny frontal wall pores and granular ovicells but contain very few avicularia, making the identification questionable. This is probably the form on which the illustration by Osburn (Figure 14, at right) was based.

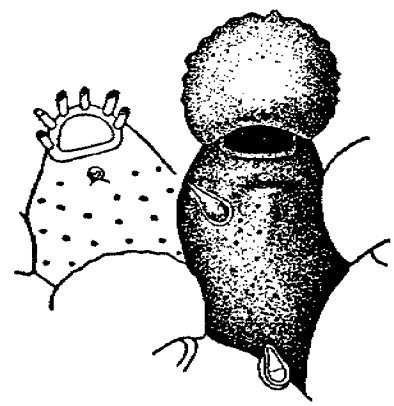


Figure 14. *Microporella ciliata.* From Osburn, 1952, pl. 44, fig.1.

Hayward and Ryland's (1979) description and illustrations of *M. ciliata, sensu stricto*, include the following characters:

"Colony encrusting, often extensive, silvery or vitreous. Zooids oval to hexagonal, convex, separated by deep grooves; 0.45-0.54 X 0.3-0.4 mm. Frontal wall thick, coarse grained and vitreous, perforated by numerous minute pores. Primary orifice semicircular, with a straight proximal border; six erect, pointed spines disposed around the distal and lateral borders, often missing in older zooids. Ascopore large, crescentic; situated on the distal face of a small umbo. Avicularium single, on lateral frontal wall proximal to the ascopore; rostrum short, triangular... supporting a short setiform mandible... directed laterally or disto-laterally... . Ovicell prominent, more or less spherical, but slightly flattened frontally; surface uniformly granular, often with a small umbo apically... . Ancestrula tatiform, gymnocyst smooth, with about nine spines around the extensive frontal membrane."

The single avicularium placed more proximally and the granular ovicell help to distinguish this species from the eastern Pacific species. The AHF eastern Pacific specimens labeled *M. ciliata* by Osburn differ in several ways from specimens of *M. ciliata* in the BMNH collections (e.g., Busk's BMNH

99.7.1.2633, from the Persian Gulf and BMNH 99.7.1.2626 from Suez). Osburn had a mixture of several species, and enlarged the description to include forms with five to seven spines and two avicularia.

M. ciliata stellata (Verrill, 1875), with a stellate (denticulate) ascopore, was reported from Maine (Verrill), Massachusetts (Osburn), British Columbia (C.H. and E. O'Donoghue) and from central California (Osburn). An ascopore of this type is also typical of the British *M. ciliata* (Hayward and Ryland, 1979) and most Microporellidae we examined, based on SEM observations. The "Mediterranean" is considered to be the vague type locality of *M. ciliata*; according to Brown (1952), the type material may be in Berlin. The British/boreal form is different from the Mediterranean type, but further comparison has not been feasible for the present work.

Microporella californica (Busk, 1856)

Plate 48 A-C

Lepralia californica Busk, 1856: 310, pl. 11, figs. 6,7.
? *Microporella ciliata* form *californica*: Hincks, 1883:444, pl. 17, fig. 3.
? *Microporella californica*: Canu and Bassler, 1923: 123, pl. 36, fig. 10. — C.H. and E. O'Donoghue, 1923: 174; 1926: 111.
Microporella californica: Osburn, 1952: 381 (in part), pl. 44, fig. 2. — Dick and Ross, 1986 (in part); 1988, pl. 9, fig. C.

Material Examined. MMS Station: BRA-2. Other collections: AHF and BMNH.

Description. Colonies encrusting. Zooids 600-750 μm long, 400-500 μm wide, ovoid in outline, separated by grooves, an inflated frontal wall marked with numerous coarse pores 20-30 μm in diameter, with deeply set spicules projecting from margins or fused into a spokelike cribrate plate; marginal pores larger, giving a reticulate appearance. Aperture 160-180 μm wide, 120-140 μm high, rounded distally, curving in to a straight proximal border limited by small condyles (cardelles) which appear to be part of a thin proximal apertural (dental) ledge. Usually 4 apertural spines with dark bases. Ascopore immediately below apertural rim, opening 40-50 μm wide by 25-36 μm high, surrounded by narrow collar, with a flat median distal projection directed proximally, with dentate margins on both. Sometimes with small umbo below the ascopore. Avicularia usually paired, 1 on each side of the ascopore, extending distally beside the aperture, each with a moderately long, triangular mandible with a setose tip. Ovicells globular, immersed, perforate to reticulate.

Biology. Colonies are found on shell, rock and algae. Depths from intertidal to 150 m have been reported previously, although several species may have been involved; the MMS record is 110-126 m.

Taxonomic Remarks. The original illustration of Busk's species (1856) added a row of pores between the aperture and ascopore which are not present in the type specimen, and are indicative of the genus *Fenestrulina*, which does not have avicularia. Robertson's (1908) description is primarily of the form later described as *M. cribrosa* Osburn, 1952, with an ascopore having a cribrate sieve plate. Dick and Ross (1988) reported *M. californica* from Alaska with a larger zooid length range of 550 to 820 μm than that found in California specimens.

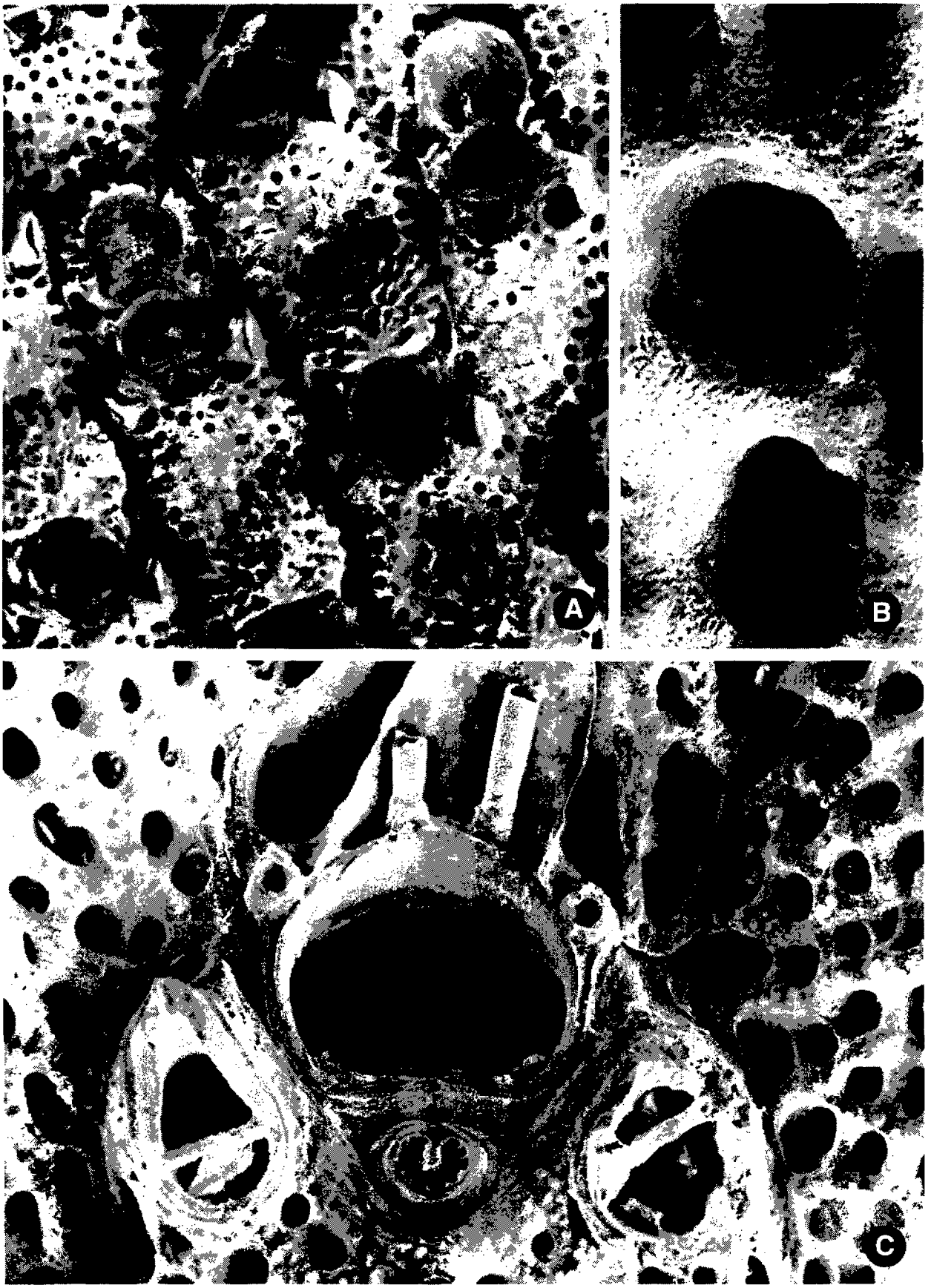
Described by Busk (1856) from "California", the distribution was extended by Osburn (1952) to the Galapagos Islands, by enlarging the range of variation. Busk described four apertural spines, Hincks illustrated six spines, Osburn listed five to seven, while Dick and Ross gave three to five but illustrated four spines. Part of the material from California and from Baja California is now included in other species. The specimen of *M. californica* from Tomales Bay, central California seems to be similar to the original form, and we have limited the species description to four apertural spines.

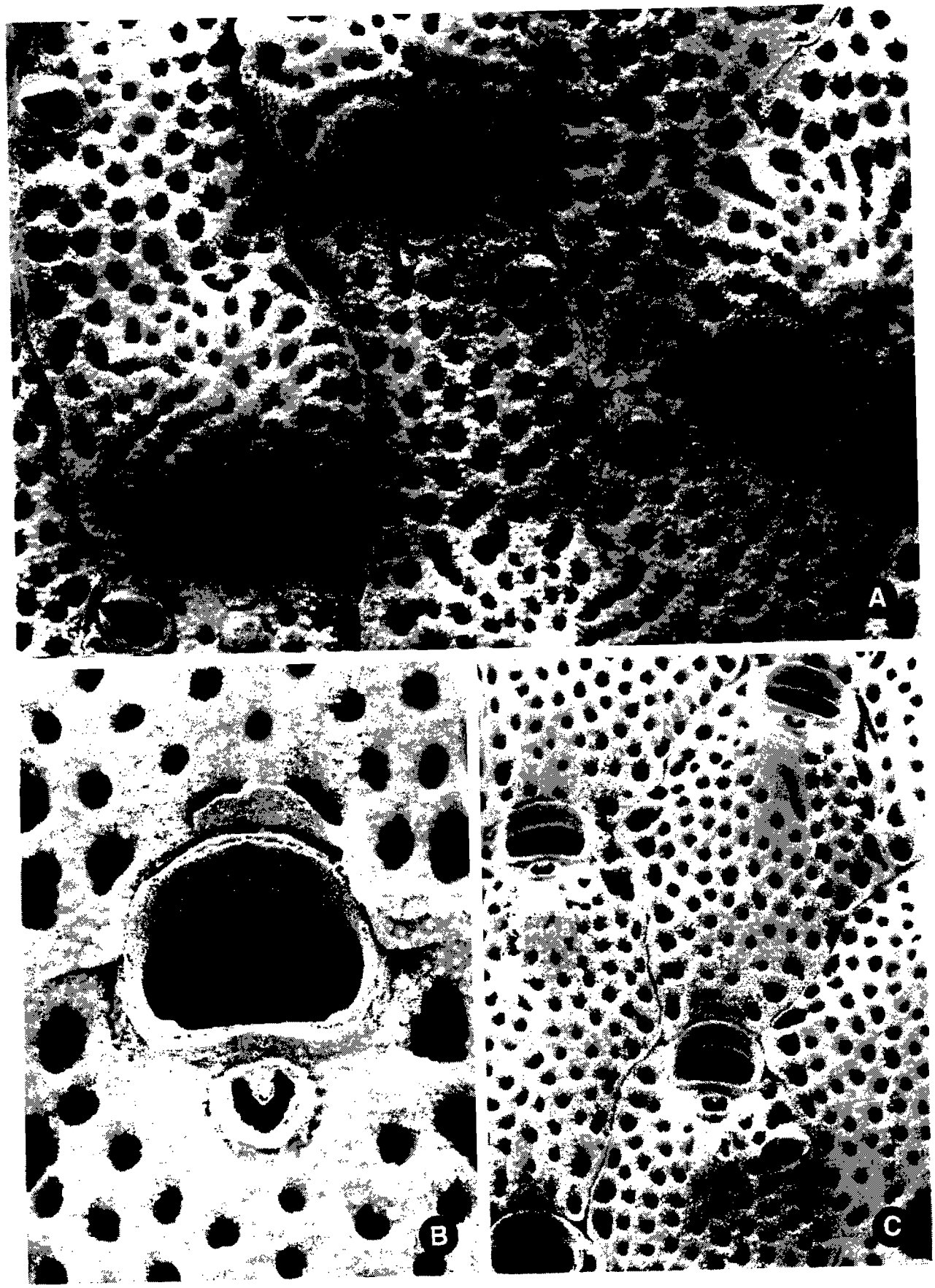
Osburn (1952) placed specimens with five to seven apertural spines with dark bases from the Galapagos Islands under *Microporella marsupiata* Busk, which was originally described from Madiera. In *M. marsupiata*, the first pair of spines is forked, a condition not seen in eastern Pacific material, although both forms have a spout-like umbo partially surrounding the ascopore proximally. Specimens form Mazatlán, Mexico in the Gulf of California, similar to the Galapagos *"marsupiata"* are being described as a new species in a manuscript in preparation on the Gulf of California.

Type Locality and Type Specimens. Locality given as "California"; BMNH slide 1899.7.1.1399 marked "type".

Distribution. The MMS site is in the Santa Barbara Channel off Point Conception. Previously reported from Alaska, British Columbia southward to central and southern California, if all records are to be believed.

Plate 48. *Microporella californica*. A. Colony, from Tomales Bay, California, with numerous developing ovicells, zooids with four spines, paired avicularia. B. Detail of frontal pore plates. C. Aperture with paired avicularia, ascopore with tiny pore at top of hollow median projection.


A
B
C


A
B
C

Microporella catalinensis, new species

Plate 49 A-C

Microporella ciliata (Pallas): Osburn, 1952: 377 (in part).

Material Examined. AHF and BMNH Collections.

Diagnosis/Description. Colonies encrusting; covered with yellowish ectocyst. Zooids ellipsoid, irregular, 480-730 μm long, zooid plus ovicell 548-770 long; frontal wall granular, with pores 18-20 μm in diameter, but sometimes merging into longer slits, becoming reticulate, pores without any deeply set spicules or pore plates, with large areolae; zooids separated by distinct lateral wall lines. Aperture wider than high, about 130 μm wide, 100 μm high, with curved distal rim, no spines or spine scars seen, proximal rim almost straight, with tiny condyles at end. Ascopore close to proximal rim, lunate, opening about 30 μm wide, 20 μm high, with small median distal projection, ascopore rim and projection finely denticulate; an umbo may develop proximal to ascopore, sometimes becoming large on zooids along exposed margins. One avicularium on frontal wall proximal to ascopore beside umbo, sometimes none; avicularium oval to round with bluntly acute rostrum, mandible unseen. Ovicell with radiate rows of costae and pores, sometimes with hood incomplete, central portion becoming umbonate, distal area immersed in next distal frontal.

Etymology. Named for Santa Catalina Island, the type locality.

Biology. Encrusting shell, algae at 27 m depth.

Taxonomic Remarks. This new species was one of the variations included in the *Microporella ciliata* of Osburn (1952), although *M. ciliata* was characterized as being much smaller (450 to 500 μm long, 300 μm wide), with very small frontal wall pores and granular ovicells. Denticulations on the ascopore rim may not be visible with a dissecting microscope.

Other eastern Pacific species with a single or no avicularium include *M. gibbosula* Canu and Bassler, 1930, which has five spines and a frontal wall and ovicell with tiny pores; its only known distribution is the Galapagos Islands. *Microporella pontifica* Osburn, 1952 is similar but a peristomal ridge forms a bridge between the ovicell and the aperture and may surround the ascopore; it is also from the Galapagos Islands but its distribution extends northward to Baja California and southward to Colombia. Neither species has yet been found in California.

Microporella catalinensis is one of three species in this study in which no spicules or spokelike pore plates were seen protecting the bottom of the pores; instead the calcified surface granules (secondary or surficial calcification) narrow the openings and extend down into the sides of the pores; *M. umbonata* and *M. vibraculifera* are the others. The latter two species have very small pores, 10-15 μm in diameter, rimmed with granules and protecting the tissue beneath. In comparison, the obverse side of the frontal wall in *M. cribrosa* indicates that the projections are formed in the primary calcified layer, which may continue to grow until it closes the pores.

The Channel Islands seem to be very hospitable habitats for *Microporella* spp. They host both species with northern ranges and species with predominantly southern ranges, indicating that species from both ranges can occur off central California.

Type Locality and Type Specimens. Collected from White's Cove, Santa Catalina Island, southern California Channel Islands, at 27 m depth, AHF Station 1650-48. SBMNH-AHF Bryozoa Holotype No. 210.

Distribution. Also found at AHF 1238-41, off Wilson Cove, San Clemente Island, Channel Islands, southern California.

Plate 49. *Microporella catalinensis*. Santa Catalina Island. A. Ovicells with tiny ascopore, a single avicularium, small umbo proximal to ascopore, reticular frontal wall and margins of pores covered with granules. B. Detail of aperture, ascopore on zooid without avicularium. C. Zooids with various umbones, avicularium present or absent.

Microporella cribrosa Osburn, 1952

Plate 50 A-C

Microporella californica: Robertson: 281, pl. 18, figs. 32-34 (in part).

Microporella cribrosa Osburn, 1952: 380, pl. 44, fig. 3. — J. D. Soule, 1961: 27.

Material Examined. MMS Station: BRA-2. AHF Collections.

Description. Colonies encrusting. Zooids irregularly ovoid, small, 430-450 μm long, 300-320 μm wide; frontal wall somewhat inflated, with numerous pores 12-20 μm in diameter, with stellate or cribrate plates at the bottom of pores, surface openings of pores sometimes merging to give reticulate appearance. Aperture 120-140 μm wide by 100 μm high, rounded distally, curving inward to an almost straight border, condyles present or worn away; distal rim bearing 5 or 6 sturdy, erect spines with jointed bases. Ascopore opening large, 40-60 μm wide by 30-40 μm high, a narrow median projection developing into a perforate sieve plate with wide rim, located between straight proximal apertural rim and a low umbo, ascopore not on umbo. Avicularia single or paired, flanking ascopore, rostrum triangular with grooved tip, mandible elongate, setose, directed distolaterally. Ovicells prominent, globose, with a rib on hood margin, flanked by 2 apertural spines; hood perforate, reticulate, or with ribs converging at smooth apical area, sometimes topped by a knob or umbo, marginal pores at base of ovicell distinctly rimmed by encroaching frontal wall. Ancestrula almost round, tatiform, with 9 spines.

Biology. Encrusting algae, shell and rock. Depths reported from shallow water (dock pilings) down to 100 m; the MMS record extends the depth to 126 m.

Taxonomic Remarks. The distinguishing characteristic of the ascopore sieve plate is one that develops with maturing zooids, so that a colony may show various stages of formation, from an ascopore with the usual median distal projection and denticulate rim to the fully closed plate with round pores in it. It is necessary to have more than a small fragment to distinguish this species. The sieve plate may be broken out in worn specimens or dissolved in old balsam mounts.

Microporella neocribroides Dick and Ross, 1988, is a similar species, but it lacks spines and has a single avicularium that is variably placed. *Microporella discors* Uttley and Bullivant, 1972, from New Zealand waters, as illustrated by Gordon (1984) has a narrowly crescentic cribrate plate.

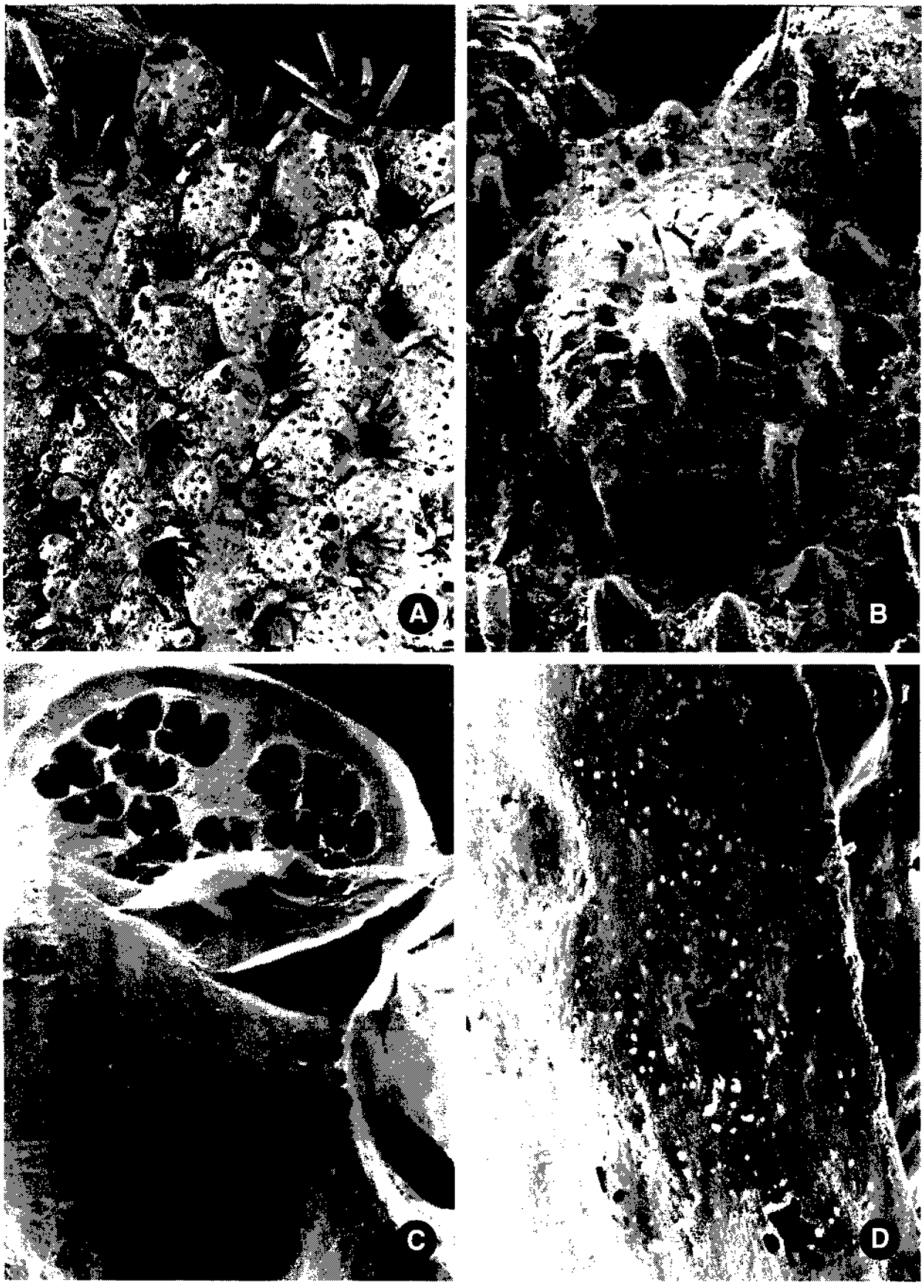
Other than the cribrate ascopore plate in *M. cribrosa*, all Pacific species examined except *M. setiformis* have a denticulate ascopore. The variety *Microporella ciliata stellata* Osburn, 1912, based on the species *Porella stellata* Verrill, 1875, from New England, and reported by C.H. and E. O'Donoghue (1923) from British Columbia, was characterized by having a denticulate ascopore without a median projection; it may be similar to the early stages of formation of the cribrate plate in *M. cribrosa.*

Many *Microporella* spp. have an umbo proximal to the ascopore produced where the ascopore rim may push upward to resist encroachment of secondary frontal calcification. Umbones also are more pronounced on zooids on exposed margins, apparently to protect colonies from sediment deposition and abrasion as the shell fragment substrates are moved about on unconsolidated sediments.

Type Locality and Type Specimens. Corona del Mar, Newport Harbor, southern California; AHF Bryozoa Type No. 80.

Distribution. Known from Mussel Point, central California, to the Gulf of California; the MMS station is in the Santa Barbara Channel off Point Conception.

Plate 50. *Microporella cribrosa.* San Pedro Bay. A. Tatiform ancestrula with nine spines. other zooids with six. B. Detail of cribrate ascopore, cribrate spicules at base of frontal pore. C. Ovicell with paired avicularia, two spines, erect umbo.


A
B
C
D

Microporella infundibulipora, new species

Plate 51 A-D

Microporella californica: Osburn, 1952: 381 (in part). — J. D. Soule and M.M. Duff, 1957: 116 (in part).

Material Examined. AHF and BMNH Collections.

Diagnosis/Description. Colony encrusting shell fragments. Zooids ovoid, with deep separating grooves, zooids 550-800 μm long, irregular, frontal walls thick, heavily calcified, with large, reticulate, infundibular pores. Aperture arched distally, 160-180 μm wide, 140 μm high, with traces of 5 spines, proximal rim straight, with tiny condyles or worn mounds; ascopore close to proximal rim, ovoid, large, crescentic, opening 56 μm wide, 42 μm high, with small median distal projection, both with small denticulations. Frontal pores 20 μm in diameter, deeply sunk, with pore plate like a spoked wheel with tiny center pore; whorled, secondarily calcified linings of pores sometimes rising to form cuplike margins. Umbo directly proximal to ascopore, elevated above it, small near center of colony, very large along margins of shell fragments, where it grows on both sides of substrate, reticulate to tip of umbo. Avicularia paired, on raised rostra, bluntly acute with setose mandibles, rostral walls becoming encased in secondarily calcified exterior layer. Ovicell reticulate like frontal, flanked by 2 spines, sometimes with an umbo on the central portion of the hood, becoming merged into the next distal frontal wall.

Etymology. Latin, *infundibulum*, funnel; named for the unusual structure of the frontal pores.

Biology. This species is apparently well adapted to life on loose shell fragments wich are shifted about on sandy bottoms. It becomes multilaminar, colonizing both sides of its substrate.

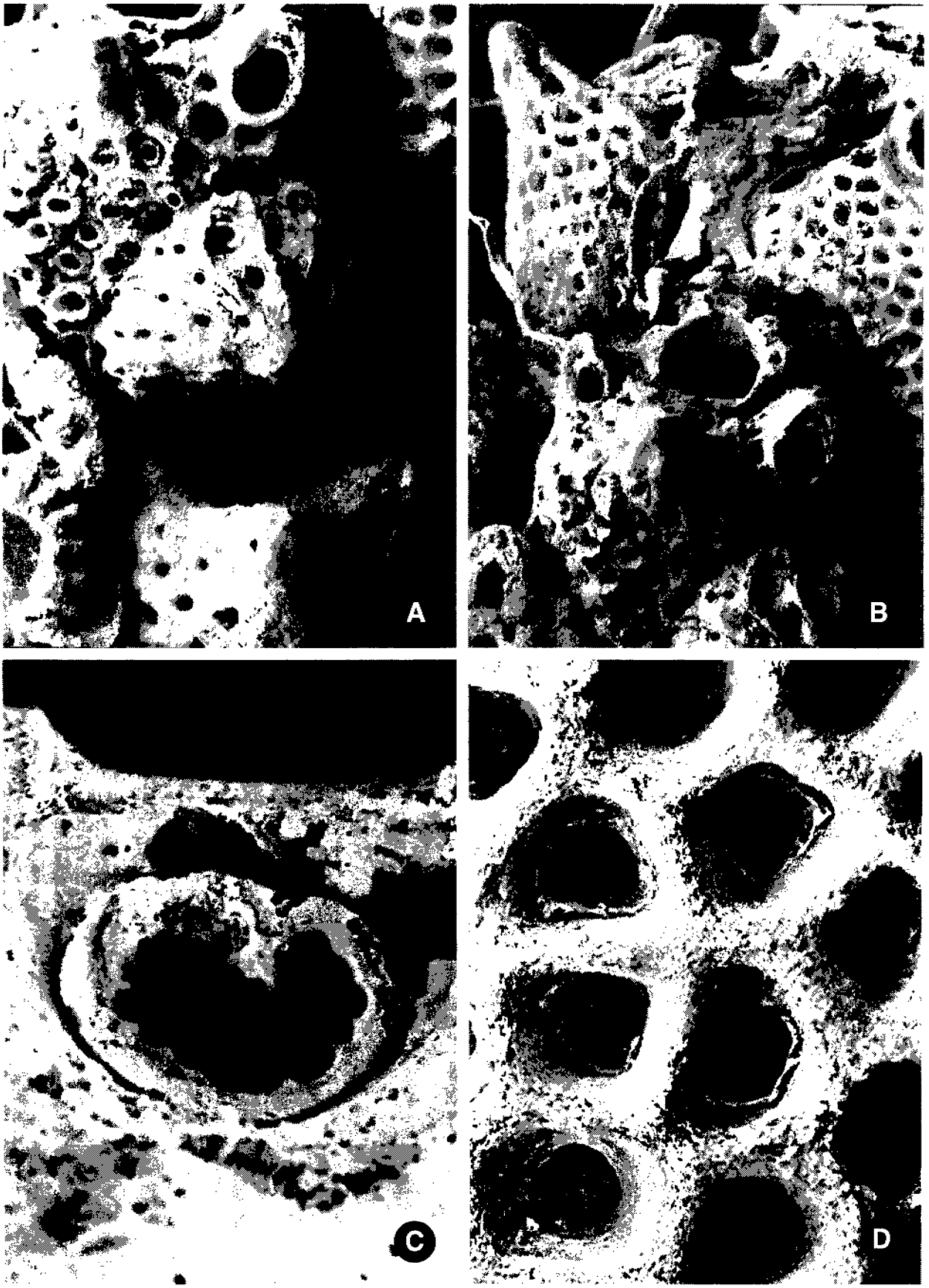
Taxonomic Remarks. There are a number of *Microporella* spp., with similar basic body plans; five spines, paired avicularia, and an umbo. The funnel-shaped pore rims are perhaps an adaptation to combat overgrowth by the encroaching secondary calcification of the frontal wall while protecting the pores from silt. The pattern in pore plates, with their spoked wheel structure, differs from the two tiers of pores in *Microporella setiformis*, while *M. planata*, n. sp., has fewer, more irregular spokes. The spicules on pores of *Fenestrulina* and *Fenestruloides* are much more irregular in form and fusion. Also distinctive in *M. infundibulipora* are the reticulate umbones on the margins, which act almost as stilts when their substrate shells roll over. Other species may have large umbones along exposed margins but the umbones are all imperforate, except possibly at their bases.

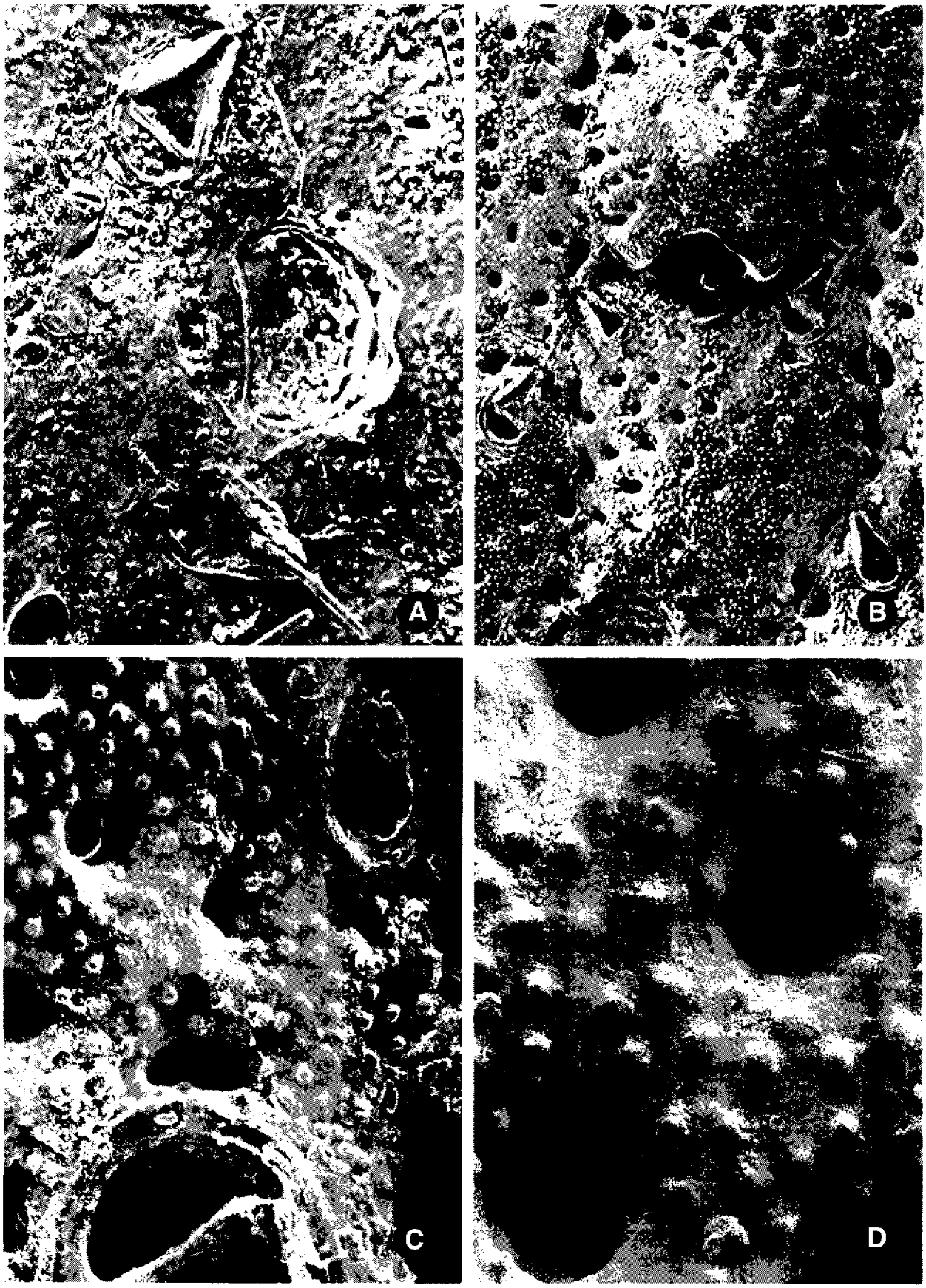
Microporella alaskana Dick and Ross, 1988, is similar, but with smaller dimensions, and the umbones are not very large or reticulate. It is possible that their species may represent the *M. californica* of Hincks, 1883, from the Queen Charlotte Islands, which has six apertural spines.

Type Locality and Type Specimens. Described from off Anacapa Island, AHF Station 1267-41, Channel Islands, southern California. AHF. Bryozoa Holotype No. 211.

Distribution. California Channel Islands. The Channel Islands appear to host species with both primarily northern and primarily southern distribution, suggesting the variability in microniches and the variation in the extent of cool and warm water flow from season to season and between years. Also found in Pleistocene material from Second Street and Pacific Avenue, San Pedro (Los Angeles), California (now the site of a fast-food restaurant parking lot).

Plate 51. *Microporella infundibulipora*. Anacapa Island. A. Ovicell with one avicularium, frontal walls with infundibular pores, small umbones. B. Margin of colony with very large umbones. C. Detail of ascopore, with small denticulation. D. Infundibular pores with secondary walls, wagon wheel spokes in basal plate.


A
B
C
D


A
B
C
D

Microporella planata, new species

Plate 52 A-D

Microporella ciliata: Osburn, 1952: 377 (in part).

Material Examined. AHF and BMNH Collections.

Diagnosis/Description. Colonies fragile, thin, flattened, encrusting shell, covered with thick, yellowish ectocyst in turn heavily encrusted with diatoms. Zooids varied in length, 480-730 μm long, frontal wall with small pores, larger marginal areolar pores; aperture shallow, curved distally, bearing 4 evanescent spines, proximal rim slightly arched, aperture 125 μm wide, 75 μm high; suboral ascopore small, with rim and central projection denticulate, opening 33 μm wide, 18 μm high. Paired triangular avicularia beside or slightly proximal to ascopore, with complete hinge bar, bearing narrow, setose mandibles. Ovicell perforate, ribbed near margin, central portion of hood flattened, not perforate, margin of opening curved away from frontal wall at transverse wall.

Etymology. Latin, *planus*, flat; named for the flattened appearance of the colony.

Biology. Encrusting shell and shell fragments, at depths to 66 m.

Taxonomic Remarks. This inconspicuous species has in common with *Microporella californica* the presence of four spines and two avicularia. *Microporella planata* is smaller, flattened, with smaller frontal wall pores and with areolae, a shallower aperture and smaller ascopore. Its dimensions are slightly larger than those of *M. ciliata*, which has five to seven spines, one, sometimes two, avicularia, a median umbo, and an imperforate ovicell; we believe the latter does not normally occur in the eastern Pacific.

Other species in the northeastern Pacific with five to seven spines and generally with two avicularia include *Microporella cribrosa* and *Microporella tractabilis* Canu and Bassler, 1930 which has paired setose avicularia flanking the aperture and directed straight distally; the latter species is limited so far as is known to the area of Panama, Colombia, and the type locality in the Galapagos Islands.

Type Locality and Type Specimens. Off Santa Catalina Island, 1.25 nautical miles east of White Cove, Channel Islands, California, AHF Station 1234-48, at 65.84 m. SBMNH-AHF Bryozoa Holotype No. 212.

Plate 52. *Microporella planata*. Santa Catalina Island. A. Aperture (distal end to right) with four spines bases, two avicularia, with heavy ectocyst still intact. B. Zooid with small frontal pores, marginal areolae; ovicell with flattened, imperforate central area, ribs around edges, some tiny pores between ribs, large areolae. C. Small ascopore upper right, frontal pores and avicularium; an areolar pore lower right. D. Cribrate plates in frontal wall pores.

Microporella setiformis C.H. and E. O'Donoghue, 1923

Plate 53 A-D

Microporella setiformis C.H. and E. O'Donoghue, 1923: 174, pl. 3, fig. 21; 1926: 111.

Material Examined. BMNH slide 1968.1.18.266, O'Donoghue Collection. AHF Collections.

Description. Colonies encrusting. Zooids ovoid, measuring 600-650 μm long, 400-420 μm wide. Frontal wall inflated, with numerous small pores 8-13 μm in diameter, sometimes closed by secondary calcification; cribrate plates deeply set in frontal pores, bearing about 13 smaller openings: 9 large ones peripherally and 4 smaller ones centrally. Aperture rounded distally, curving inward to straight proximal rim with small or no condyles; young zooids with 5 thin spines. Ascopore close to aperture, small, opening about 16-20 μm wide, 10-14 μm high, rounded, with reduced median projection like a tiny condyle, surrounded by a flat collar, with a slightly raised rim, lacking any denticulation. Avicularia paired, flanking or slightly proximal to ascopore, bases small, rostra raised distally with short triangular palate, complete hinge bar, with short setose mandibles directed distolaterally. Ovicells prominent at first, globose, sitting above narrowed part of zooid, 300μm wide, with small pores, surface becoming ribbed, pores closed, partly immersed distally.

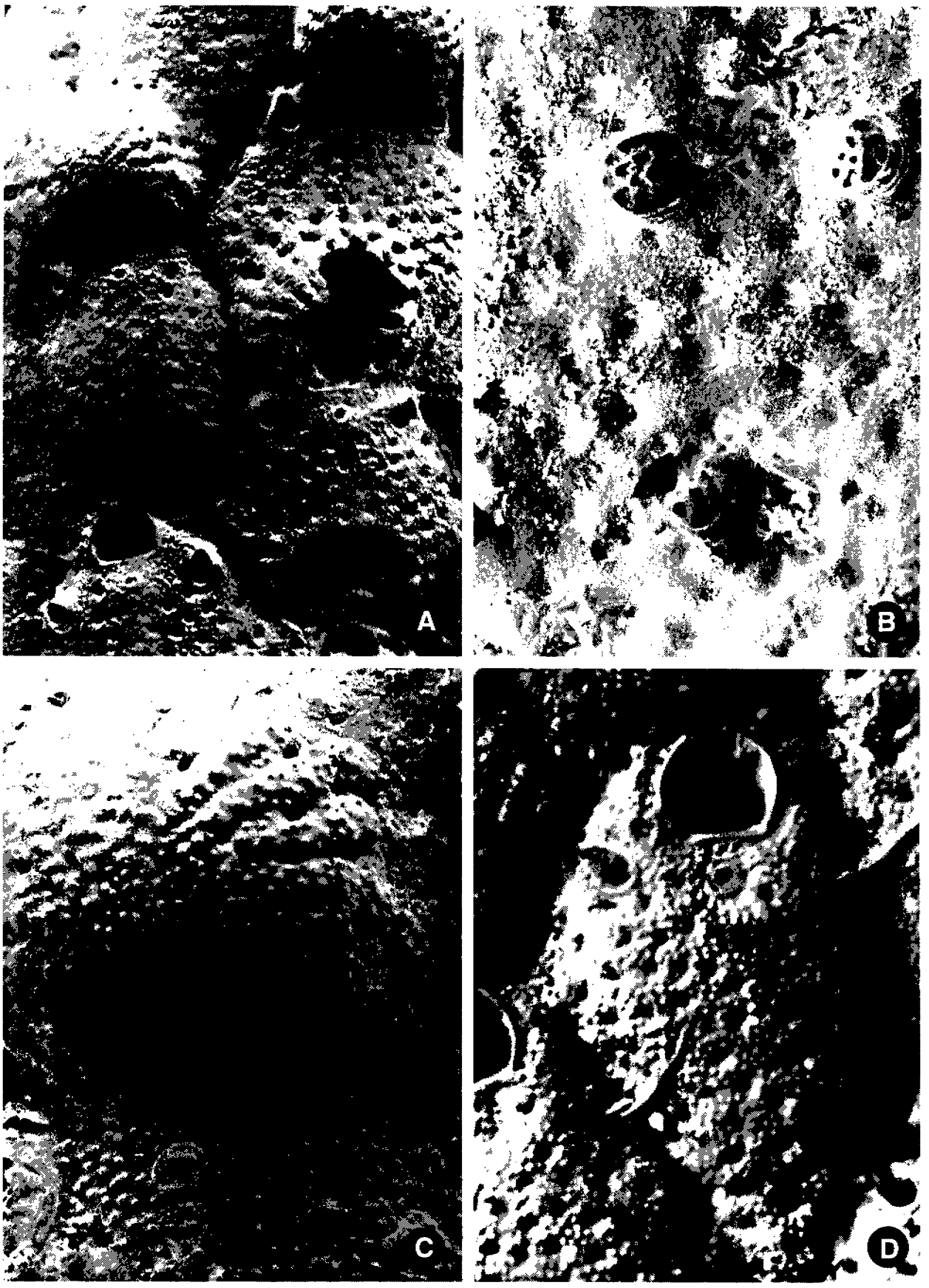
Biology. Encrusts rock, shell and other firm substrates. Depths recorded from shallow waters to over 100 m.

Taxonomic Remarks. Examination of the O'Donoghue Collection at the BMNH shows the setose mandibles surprisingly well preserved, with the median projection on the ascopore is only a tiny bump. The very small size of the ascopore, with its round, flat collar lacking any denticulation, makes this species distinctive from most Pacific species. *Microporella arctica* (Norman, 1903b) has a similar small non-denticulate ascopore, but differs in having a single avicularium and larger zooids (Osburn, 1953:779). *Microporella planata* resembles *M. setiformis* in location and shape of avicularia but the ascopore in *M. planata* has a denticulate projection and rim. The flattened zooids are also distinctive.

Type Locality and Type Specimens. Described from waters between Round and Mudge Islands, Northumberland Channel, British Columbia; the BMNH slide, figured, from the O'Donoghue Collection, is considered to be the type, or part of the type.

Distribution. Reported from the San Juan Islands, British Columbia, and Puget Sound southward to the southern California Channel Islands.

Plate 53. *Microporella setiformis*. A. Colony from off Santa Rosa Island, California, on fragile shell fragment, showing single or paired avicularia. B. Cribrate frontal pores. C. Ovicell, untreated, showing ribs and pores, typical round, suboral nondenticulate ascopore. D. BMNH specimen, part of type, showing setiform avicularia, nondenticulate ascopore.


A
B
C
D

Microporella umboniformis, new species

Plate 54 A-D

? *Microporella umbonata*: Canu and Bassler, 1923: 123, pl.36, figs. 6,7.
Microporella unbonata: Osburn, 1952:378, pl.44, fig. 4.

Material Examined. AHF; BMNH, Hincks and O'Donoghue Collections.

Diagnosis/Description. Colony encrusting. Zooids irregularly oval, 646-801 μm long; ovicelled zooids 745-994 μm long; frontal wall inflated, finely granular, with tiny pores 10 μm in diameter or less, appearing denticulate due to tiny granulations. Aperture almost circular, 110-120 μm wide, 95-110 μm high, with narrower proximal lip, 2 condyles at ends; distal rim bearing 5-6 spines in young, transverse wall intersecting apertural rim between first and second pair of spines, first pair larger, becoming encrusted, umbonate. Ascopore small, crescentic, 28 μm wide, 24 μm high, with treelike distal projection having a hollow central tubule, projection becoming wider, ascopore and projection denticulate; ascopore becoming tilted upward proximally by growth of umbo. One, 2 or no avicularia; avicularium beside or proximal to median suboral umbo, with small base, becoming umbonate, chamber with complete hinge bar, narrowing to spoutlike tip, mandible base triangular, with setose tip 200 μm long. Ovicell distal to lateral oral umbones, incised at transverse walls, with tips on rim of opening; with fine granules, and with small pores radiating from umbo on central top obscuring pores; becoming immersed in next distal zooid.

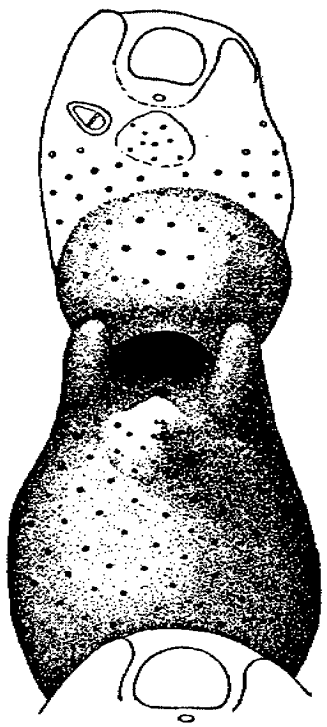


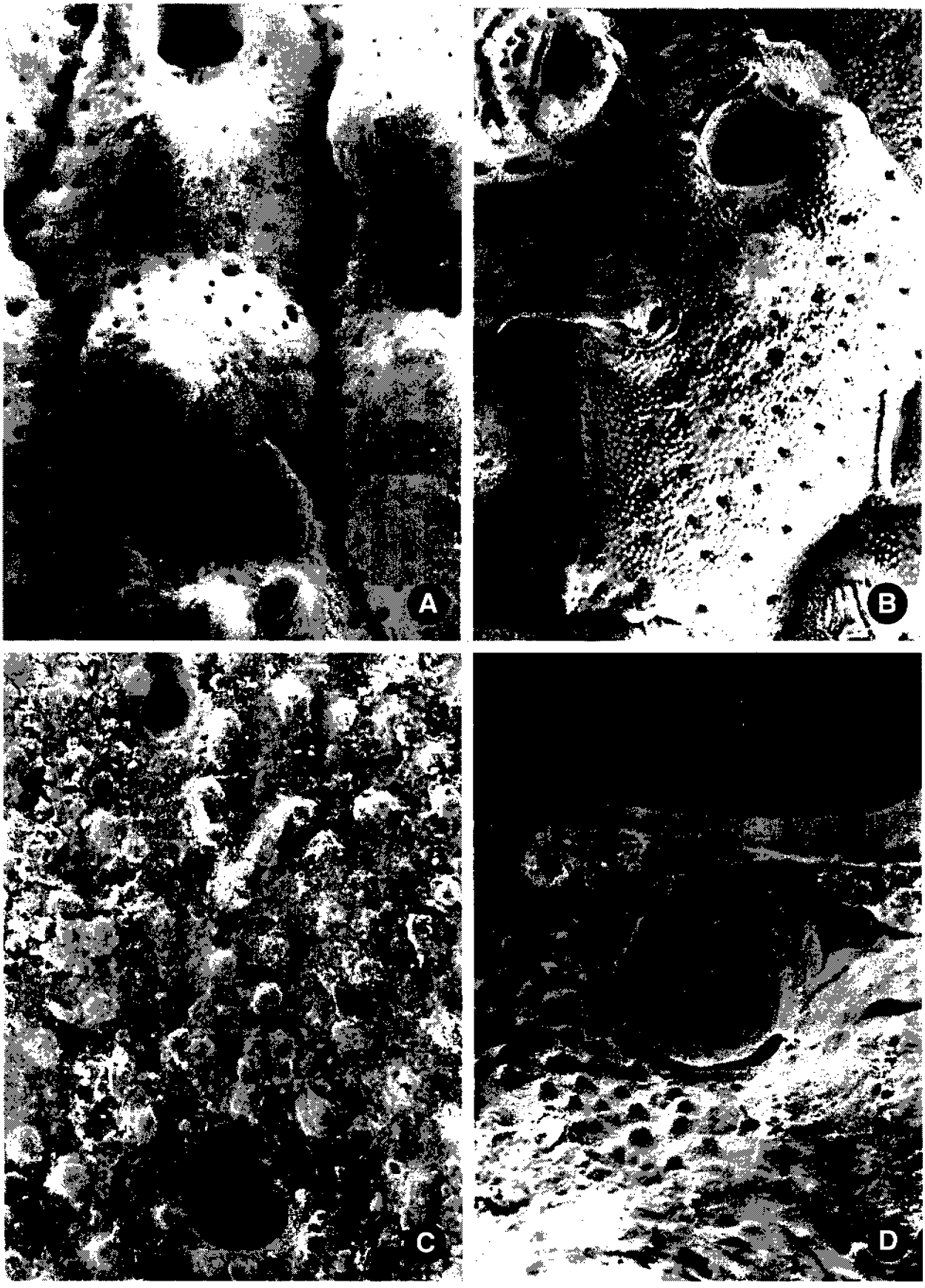
Figure 15. *Microporella umbonata*. From Osburn, 1952, pl. 44, fig. 4.

Etymology. Named for its resemblance to the northern species *Microporella umbonata*, which also has three large umbones but differs in other respects.

Biology. Encrusts worm tubes. Found in bottom samples and dredge hauls at about 14 m, possibly to 102 m (as *M. umbonata*).

Taxonomic Remarks. The new species is probably closely related to *M. umbonata*, but that species was described by Hincks (1884) and redescribed by Osburn (1952) as having numerous large frontal pores (tremopores), as confirmed by AHF specimens from Puget Sound. However, Osburn's illustration (Figure 15) clearly shows the very small pores and granular frontal wall of the new species from southern California. The tiny pores are not the result of advanced calcification but are seen in young zooids. Hincks illustrated a single small avicularium placed distal to the umbo beside the ascopore or beside the umbo, but did not mention it in his text. Osburn stated that there was a single avicularium, often wanting, whereas the new species usually has one or two avicularia, placed beside the

Plate 54. *Microporella umboniformis*. A. From San Pedro Bay, colony zooids with median umbo, two lateral oral spines becoming umbonate; ovicells also umbonate. B. Colony from off Santa Barbara Island, showing spine scars, single midfrontal avicularium with setose mandible directed laterally or distolaterally (cribrilinid, upper left overgrowing colony). C. Tiny frontal pores without denticulation. D. Small, denticulate ascopore showing treelike, hollow median projection.


A
B
C
D

median umbo or proximal to it, although they are sometimes absent. The umbonate lateral oral spines in *M. umbonata* lean over the aperture, almost occluding it.

The *M. umbonata* of Canu and Bassler (1923), from the Pleistocene of Santa Barbara, Santa Monica and San Pedro, California, has only one umbo placed medially and a single avicularium, rarely two, plus a costate ovicell. This appears not to be the *Microporella ciliata* form *umbonata* of Hincks (1883), which has three umbones, two flanking the aperture and leaning over it. Many of the *Microporella* spp. examined have umbones of various sorts.

Type Locality and Type Specimens. Described from AHF Bottom Station 1064, off Santa Barbara Island, Channel Islands, southern California. SBMNH-AHF Bryozoa Holotype No. 213.

Distribution. Known also from AHF 1232-41, 5 nautical miles south 150° off San Pedro Harbor, Los Angeles. Osburn reported "*M. umbonata*", probably the new species, from off Santa Cruz Island and from Dillon Beach, California. The distribution of the two species may overlap in California.

Microporella vibraculifera Hincks, 1883

Plate 55 A-C

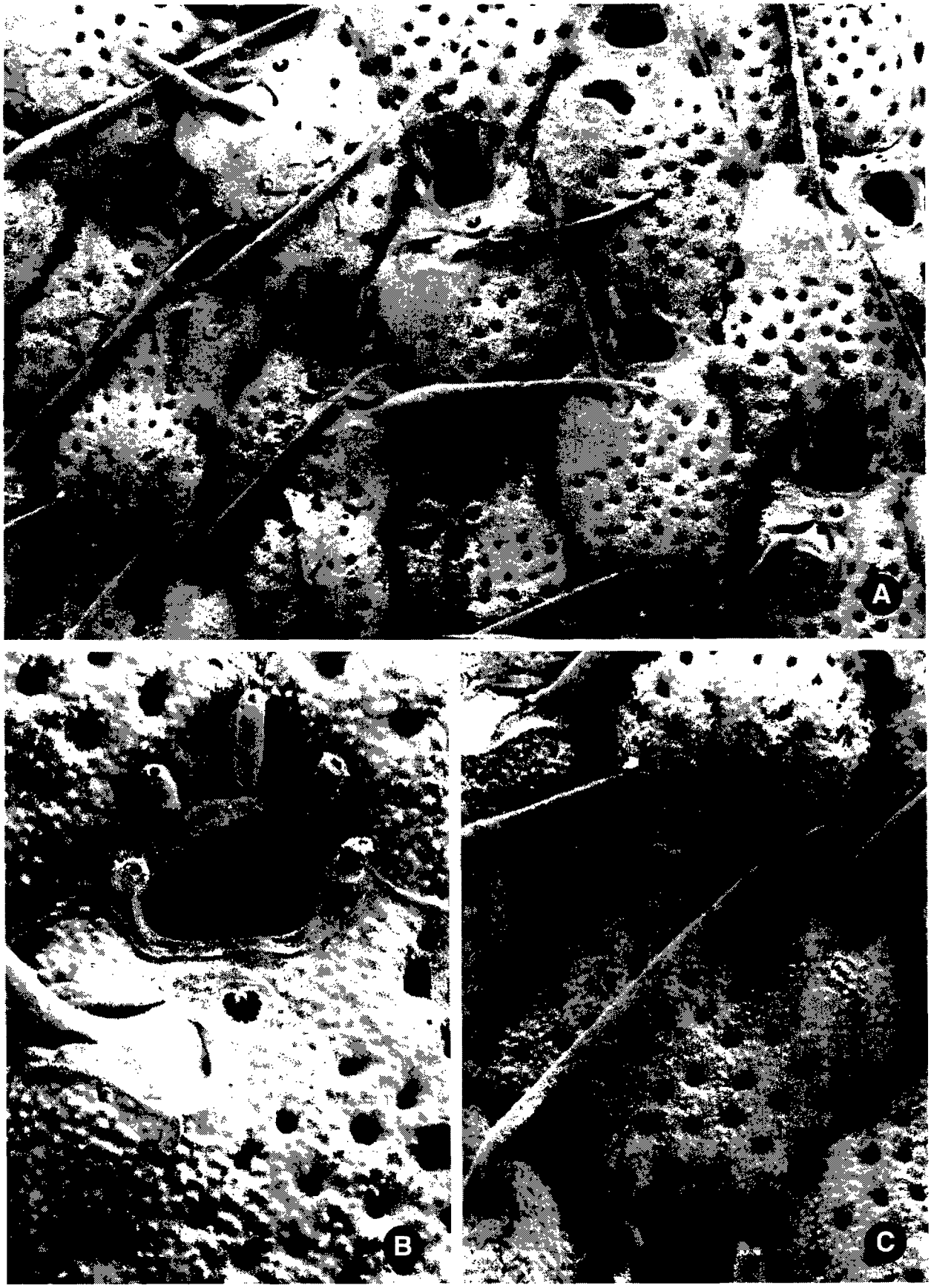
Microporella ciliata form *vibraculifera* Hincks, 1883: 443, pl. 17, fig. 2.
Microporella ciliata var. *vibraculifera* C.H. and E. O'Donoghue, 1923: 173.
Microporella vibraculifera: Canu and Bassler, 1923: 124, pl. 36, figs. 11,12. — C.H. and E. O'Donoghue, 1926: 110. — Osburn, 1952: 379, pl. 44, fig. 7.

Material Examined. MMS Station: BRA-2. Other collections: AHF and BMNH.

Description. Colonies encrusting. Zooids 510-620 μm long, 320-450 μm wide, irregularly hexagonal, elongate with a weakly elevated frontal wall bearing small pores 10-15 μm in diameter, without interior spicules. Aperture about 120 μm wide by 100 μm high, with a low, thin rim, curved distally, bearing 5-7 hollow spines, proximal rim almost straight. Median suboral ascopore semilunar, opening about 16-20 μm high, 20-24 μm wide, with a small, rounded, median distal projection extending into the ascopore; ascopore inner margin and projection denticulate, with a rolled, raised outer rim. A single avicularium chamber proximolateral to and abutting the ascopore, large, bulbous, rostrum with a heavy hinge bar, with raised, spout-like margins. Mandible long (1.0 mm or more) extended to form a vibraculum (whip), grooved beneath, with 2 projections near base that rest on the spout-like tip of the rostrum; vibracula capable of sweeping colony surface. Ovicell raised, recumbent upon next distal zooid, many small pores, becoming obscured by mineralization, with small rim around opening; ovicelled zooids larger, up to 682 μm long.

Biology. *Microporella vibraculifera* occurs at depths of about 5 m to more than 125 m. It appears to tolerate fine sediments by use of the vibracula to keep the aperture and frontal wall clear; the vibracula seem to be coordinated so that they can overlap in sweeping across the colony. Found encrusting shell, rock and algae.

Plate 55. *Microporella vibraculifera.* A. MMS specimen from the Santa Barbara Channel showing zooids and ovicells with large chamber for long vibraculum on each frontal wall, small frontal pores. B. Enlarged view of vibracular base with whip lowered. C. Ovicell with vibraculum overlapped by adjacent vibracula.


A
B
C

Taxonomic Remarks. *M. vibraculifera* was originally described as a form of *M. ciliata*, which has six spines and small acute avicularia in the position occupied by the whiplike vibracula in *M. vibraculifera*; the latter has five to seven spines. The vibraculum rostral chamber is so large that it spreads over much of the frontal wall and is imperforate. The Canu and Bassler (1923) records from the Pleistocene of southern California appear to be valid due to the very large single avicularium chamber, although the illustrations have been liberally retouched.

The Hincks type is covered with a thick, dark ectocyst but some areas are sufficiently clean to see the large pores in the frontal walls and ovicells, numerous long vibracula, and the denticles on the ascopore projection and inner rim. There were seven spine bases visible on one zooid, whereas our specimen had only five, but it is otherwise identical.

Type Locality and Type Specimen. Originally described from the Queen Charlotte Islands, British Columbia. The Hincks type is BMNH 99.5.1.1184.

Distribution. Recorded from British Columbia and Puget Sound, Washington south to the Pacific coast of Baja California (Osburn, 1952). Canu and Bassler (1923) reported it from the Pleistocene in Santa Barbara, Rustic Canyon in Santa Monica, and Dead Man's Island in San Pedro, California. The MMS station is in the Santa Barbara Channel off Point Conception.

The *Fenestrulina malusi* Species Complex

Fenestrulina malusii (Savigny and Audouin, 1826), the type of the genus, has been recorded as present in numerous localities around the world, often without recourse to the original illustration, and the original specimens have been lost. J.C. Savigny illustrated specimens collected by the French Army in Egypt in a series of imperial folios, with the Bryozoa section published about 1817. He did not complete his work due to ill health and political reasons, but his illustrations were used by later authors as types. Audouin (1826) merely named Savigny's 1817 illustrations after various friends or well known scientists, without any scientific descriptions whatever, but later authors have generally credited him with authoring the species.

An original imperial folio illustration of *Cellepora malusii* in Savigny (1817) in the Allan Hancock Foundation Library shows a colony with zooids well separated, having a wide gymnocystal border, much like that in some cribrilinids, which encroaches on the frontal wall; the largely imperforate frontal wall has only three pores at lateral margins distal to the medial area only, and with four or five pores in a single row between the proximal apertural rim and the large ascopore. The ovicell is imperforate except at the margin, where there is a rim and a row of pores, as is typical of the genus.

A specimen collected at Naples by Osburn in 1910, has three lateral marginal pores, but has two rows of tiny pores between the aperture and the ascopore; it is otherwise very similar to the Savigny illustration. Osburn's specimen has three to four apertural spines, and the tatiform ancestrula has 11 spines. Cook, 1985:191, fig. 49, gives a clear illustration of a form of *Fenestrulina malusii* from off Ghana, western Africa, that is very similar to the original Savigny illustration, having pores restricted to the marginal and suboral area only.

More than 20 *Fenestrulina* species have been described worldwide which show lateral pores that are more or less limited to a row of areolar pores only.

Based on these factors, we have concluded that the very common material in the eastern Pacific is not *Fenestrulina malusii*, but a complex of at least two genera and several species in which the frontal wall shows numerous pores not limited to the marginal areolar pores. At least 18 species have been described around the world with this characteristic. Some eastern Pacific citations had no descriptions or lacked illustrations, but the various forms were indicated in the following citations:

Cellepora californiensis Gabb and Horn, 1862: p. 130, pl. 19, fig. 12. The illustration is of a frontal wall covered with pores and an umbo, but the description included forms with only a single row of marginal pores as well. Gabb and Horn's material was fossil, probably Pleistocene, from Santa Barbara.

Microporella Malusii: Hincks, 1883: 444. Hincks did not describe or illustrate the species but remarked that it was one of the commonest species in the Queen Charlotte Islands collections, British Columbia. A specimen in the BMNH Hincks Collection, 1899.5.1.1202, figured by him was from Jersey, the British Island off the coast of France. The specimen shows zooids with two to three rows of pores between the proximal apertural rim and the ascopore, plus one to three rows of pores along the narrow lateral gymnocystal wall. The ascopore is raised on the apex of the inflated frontal wall and pores may be lacking on the proximal side of the raised area. There are three spines on the shallow aperture, which is about 180 μm wide and 80 μm high. The ovicell contains a few central pores, plus the usual fenestrulinid marginal rim of pores separated by narrow ribs. This is probably the form described and illustrated by Hayward and Ryland (1979: 225, fig.96). Hincks had earlier illustrated (1880c: 211, pl. 28, Figs. 9-11, but not pl.29. fig. 12) the form in his volumes, *British Marine Polyzoa*. We consider that this is not the true *F. malusii*.

Microporella Malusii: Hincks, 1884a: 57. A reprint of the above citation (1880c) from Britain without description or illustration.

Microporella malusi (Audouin) Hincks: Robertson, 1908: 282, pl. 18, figs. 35, 36. A form with four or five spines; placed tentatively herein in *Fenestrulina farnsworthi*; the ancestrula with 10 spines.

Fenestrulina malusi Savigny-Audouin, 1826: Canu and Bassler, 1923: 114, pl. 36, fig. 2, 3. A form with four spines, pores except on an umbo and immediately proximal to it.

Fenestrulina porosa Canu and Bassler, 1923: 117, pl. 37, fig. 4. Pores all over frontal wall, no umbo, no spines or avicularia known; it most resembles the type of the new genus *Fenestruloides, F. morrisae*, from the Gulf of California and the Revillagegedos Islands.

Microporella malusii: C.H. and E. O'Donoghue, 1923: 174. The O'Donoghues did not figure either of two forms: *Microporella malusii* var. *typica*, based in part on Hincks' British material, above; and *M. malusii* var. *glabra*, in which the frontal wall is smooth and shiny, pores are smaller and confined to the margins, with a single row of pores below the aperture and on the margins. The single row of marginal pores is similar to those in true *Fenestrulina*, such as *F. malusii* from the Mediterranean and *F. farnsworthi*, from southern California.

Fenestrulina malusii var. *umbonata*: C.H. and E. O'Donoghue, 1925: 103 (list only).

Fenestrulina malusii (Savigny-Audouin, 1826): C.H. and E. O'Donoghue, 1926: 109, and *Fenestrulina malusii* (Savigny-Audouin, 1826) var. *umbonata* var. nov. C. H. and E. O'Donoghue, 1926: 109, pl. 5, fig. 45. Although the ascopore is on a raised prominence in *Fenestruloides morrisae*, there is also a distinct form, *Fenestruloides umbonata*, that often has an umbo. The ascopore remains level with the frontal wall, with the small umbo rising proximal to it; the remainder of the frontal bears large pores containing irregular denticles. There are three spines in *F. umbonata*, and a single row of marginal pores distal to the aperture.

Fenestrulina malusi: Osburn, 1952: 387, pl. 45, fig. 3. This figure is not *F. malusii* because it shows tiny pores on the entire frontal wall and on the ovicell, as in *Fenestruloides*, but the locality of the figured specimen is unknown. It may be a composite figure, which Osburn sometimes had prepared to

illustrate a range of variation without so noting.

Fenestrulina malusi: J. D. Soule and Duff, 1957: 117. The fossil material is possibly *Fenestrulina farnsworthi.*

Fenestrulina malusi: J. D. Soule, 1961: 28. A species of *Fenestruloides*, as yet undescribed, with numerous stellate pores.

Fenestrulina malusii: Viviani, 1969: 133. Moyano (1991: 120) demonstrated that *F. cornuta* (d'Orbigny, 1847) is a valid species, common to Valparaiso, Chile. *F. thyreophora* (Busk, 1857): 172, is also not a subspecies of *F. malusii* as was indicated by MacGillivray (1889: 275) and Gordon (1984: 107), but was corrected by Gordon (1989: 64). It also occurs in central Chile.

Microporella malusii: Kluge, 1975: 633. There are 3-4 rows of stellate pores between the aperture and the ascopore; not *F. malusii.*

Fenestrulina malusii: Dick and Ross, 1986: 89.

Fenestrulina malusii: Dick and Ross, 1988: 77, pl. 9, fig. F. One row of marginal pores, two rows between aperture and ascopore, plus extras; 3 spines, 2 on ovicell, ovicell striate. Not *F. malusii, sensu stricto.*

Fenestrulina porosa: Dick and Ross, 1988: 78, pl. 9, fig. E. Pores all over except on umbo proximal to ascopore, 2 spines; referable to *Fenestruloides.*

Fenestrulina farnsworthi, new species

Plate 56 A-D

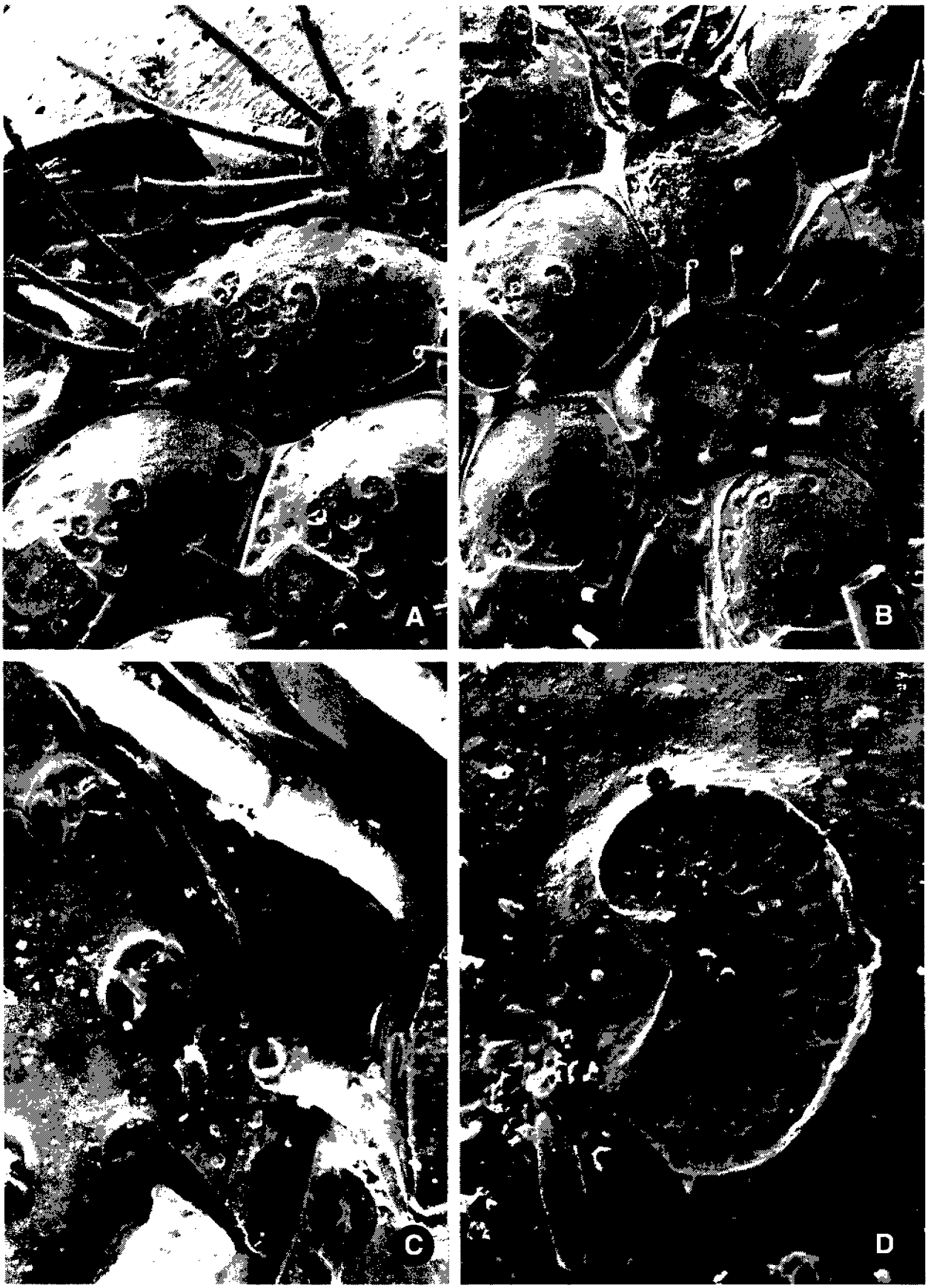
? *Cellepora californiensis* Gabb and Horn, 1862: 130 (in part).
? *Microporella malusi*: Robertson, 1908: 282, pl. 18, figs. 35, 36.
Fenestrulina malusi: Osburn, 1952: 387 (in part).

Material Examined. MMS Station: BRA-21. Other collections: AHF and BMNH.

Diagnosis/Description. Colonies encrusting. Zooids small, 320-380 μm long, ovate to hexagonal, separated, with a gymnocystal fold or extension of the lateral wall bordering each zooid, a single row of marginal pores interior to the fold, single row distal to aperture, 1 or 2 rows of pores between proximal rim of aperture and ascopore, frontal wall otherwise smooth, with scattered occasional extra pores, pores with irregularly merged spicules bridging the openings (so-called stellate pores). Aperture a high arch, 100-110 μm high, 100-110 μm wide, with 5 to 7 long, telescoped spines distally in young zooids, proximal rim slightly arched or straight. Frontal wall sloped upward to ascopore measuring 50-60 μm at widest part of opening, 33 μm high through median projection; median projection wide, with pore at distal rim of ascopore, with branched denticles on projection and ascopore margin. No ovicell found. Ancestrula tatiform, surrounded by 12 spines, 275 μm long. No avicularia.

Etymology. Named for Farnsworth Bank, the type locality.

Plate 56. *Fenestrulina farnsworthi.* A. Lateral view of growing margin of colony with long spines. B. Tatiform ancestrula with 12 spines, first zooids with six spines, one row of suboral and marginal pores. C. Merging spicules in frontal pores, telescoped spines. D. Lateral view of ascopore with branched denticles, pore at top of median projection.


A
B
C
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Biology. The type was dredged encrusted on a cyclostome bryozoan colony, probably *Diaperoecia* (= *Diaperoforma*) *californica*, in waters 20 to 44 m deep. Robertson reported her material from La Jolla, California growing on the roots of kelp (perhaps 15-20 m), and also dredged between 20 and 30 fms (36.5-54.9 m). The MMS station depth is from 75 to 90 m. Also found on shell rubble.

Taxonomic Remarks. This species most resembles the original *Fenestrulina malusii* as illustrated by Savigny, but differs in the number of marginal and suboral pores. It is much smaller than the other local material formerly placed in *Fenestrulina malusi* by Osburn (1952). Robertson's collections have been lost at the California Academy of Sciences by mixing of specimens, but her illustration is somewhat similar, although her ancestrula has only 10 spines and the mature zooids have four spines. Gabb and Horn (1862) described, as a single species, specimens that had only a single row of marginal pores and others with pores over the entire frontal and with an umbo (pl. 19, fig. 12).

Type Locality and Type Species. Farnsworth Bank, off Los Angeles California; no other data, collected by the California Department of Fish and Game. SBMNH-AHF Bryozoa Holotype No. 214.

Distribution. Santa Catalina Island on algae and on the Federal (middle) Breakwater of Los Angeles-Long Beach Harbor on shell rubble; the distribution probably extends to La Jolla (Robertson's site), in southern California. The fossil deposits cited by Gabb and Horn (1862) in Santa Barbara, California were thought by them to be Miocene but were probably Pleistocene (e.g., Canu and Bassler, 1923; Soule and Duff, 1957). The MMS station is off Purisima Point, as *F. malusii*.

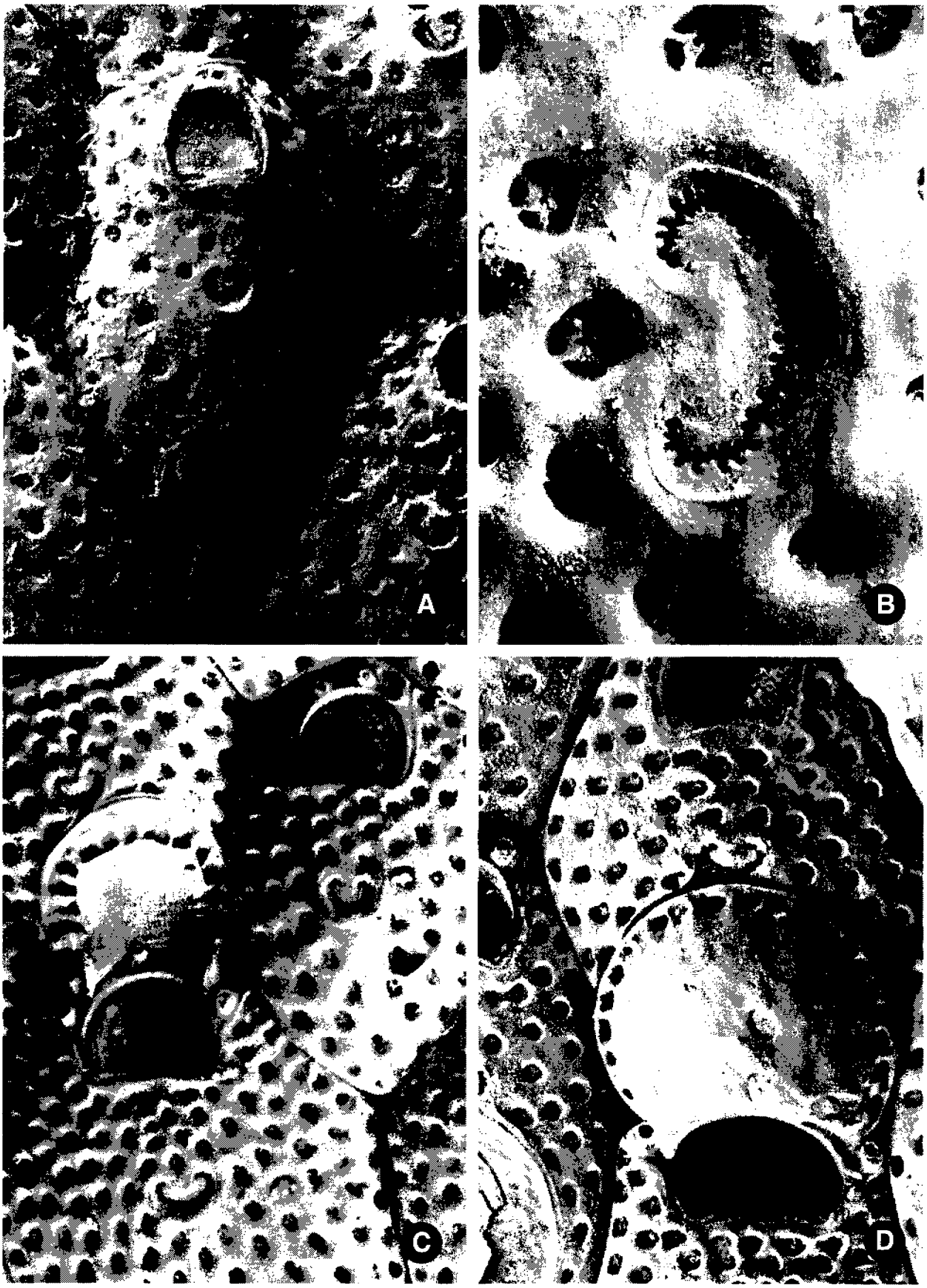
Fenestruloides, new genus

Description. Colony encrusting. Zooids hexagonal, ovate, separated by distinct lateral walls but with narrow or no raised marginal gymnocystal borders; in mature zooids, frontal wall inflated, with pores covering most of frontal wall, 2 rows or more between aperture and ascopore, 1 row distal to aperture, young zooids with fewer pores; pores with irregular spinous processes merging in center. Aperture arched distally, bearing spines. Ascopore large, 50-60 μm wide, median projection wide, both extensively denticulate. Rarely, a small, acute avicularium present on the proximal frontal wall, probably of interzooecial origin. Ovicell an imperforate globe, or with 1-2 pores, smooth or rugose, bordered by distal rim with single row of pores separated by ribs; sometimes a ridge across rim of opening appearing as two thick spines fused to hood. Two kinds of presumed ancestrulae seen; one a small zooid with single row of pores, the other tatiform with 10 spines, sometimes a porous frontal wall overgrowing it without an aperture.

Taxonomic Remarks. There is a clear difference in the distribution and number of frontal wall pores between the many species described from the northwestern Atlantic, the Mediterranean, and from off Ghana, and those found with the type species of *Fenestrulina, F. malusii, sensu stricto,* which has a single row of peripheral pores only proximal to the ascopore. Horowitz (1993, electronic media) lists nearly 50 named species, many of which have been transferred to other genera or placed in synonymy. However only about 20 of these show the central area of the frontal wall as imperforate, with pores confined to the margins. The new genus seems to show this characteristic in some ancestrulae or in the zone of astogenetic change, but beyond that zone the pores develop until they cover the entire frontal wall, except for an umbo, where present. The ovicells in *Fenestruloides* are imperforate, or with one or two closed pores, except for a distinct row of marginal pores at the distal marginal band. A single frontal avicularium on the holotype of *Fenestruloides morrisae* is unique in the two genera and is the first time we have seen this structure among the hundreds of fenestrulinids we have examined over many years. Obviously it may be difficult to find this structure in any other specimens, but it cannot be ignored. Zooids of *Fenestruloides* spp. seem to be generally larger than those of *Fenestrulina* spp.

Based on the character of the frontal wall pores, *Fenestrulina catasticos* Gordon, 1984, *F. multicava* Gordon, 1989, *F. harmeri* Winston and Heimberg, 1986, and *F. caseola* Hayward, 1988 may to belong to the new genus. Almost all Indian Ocean-western Pacific species lack spines, while all the northeastern Pacific species and only one western Pacific species, *F. multicava*, have spines. Spines are rare in *Fenestrulina microstoma* Moyano, 1983, from Chile and unlike the northeastern Pacific species, it lacks denticulate ascopores, but has a small central area without pores, similar to the umbonate area of *Fenestruloides eopacifica* and *F. blaggae*, new species. *F. vivianii* Moyano, 1991, would appear to be *Fenestruloides* and has typical pores, two spines and denticulate aperture. *Fenestrulina fritilla* Hayward and Ryland, 1990, from South Georgia, has no oral spines and appears to lack a denticulate ascopore, while *F. antarctica* Hayward and Thorpe, 1989, lacks spines but had a finely denticulate ascopore. Because many genera include species with or without spines, and with and without avicularia and ovicells, these cannot be used as criteria for creating mutually exclusive taxa. *Fenestrulina threophora* (Busk), figured by Gordon (1989) and by Moyano (1991) has greater development of the pores distal to the aperture, which may form a basis for a future division of the genus after further study.

Type Species. *Fenestruloides morrisae*, new species.


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B
C
D

Fenestruloides morrisae, new species

Plate 57 A-D

? *Microporella Malusii*: Hincks, 1884: 57.
? *Fenestrulina porosa* Canu and Bassler, 1923: 117, pl. 37, fig. 4.
Fenestrulina malusi: Osburn, 1952: 387 (in part).

Material Examined. MMS Station: BRA-21. Other collections: AHF and BMNH.

Diagnosis/Description. Colonies encrusting. Zooids hexagonal to ovate, 620-740 µm long, variably sized, frontal wall inflated, without marginal wall gymnocystal borders encroaching on frontal wall; numerous stellate pores 20-25 µm in diameter. Aperture arched distally with 3-4 spines, straight proximally, 120-140 µm wide, 120-130 µm high, with 1 row having 2 larger pores distal to aperture. Ascopore large, opening 60-80 µm wide, 50 µm high at center, with wide distal medial projection, denticles almost meeting those of ascopore rim, rim raised around pore at apex of frontal wall. Ovicell flattened, imperforate except for a few large medial pores calcified over; a single row of small marginal pores with raised rim separating ovicell from next distal zooid. One small, acute, interzooecial avicularium seen on holotype at proximal end of zooid, raised, directed distally. Ancestrula either tatiform with 10 spines, sometimes becoming overgrown with porous frontal wall without aperture, or a small zooid with imperforate frontal wall, a single row of marginal and suboral pores.

Etymology. Named for Dr. Penny Morris Smith, who first called this form to our attention as possibly belonging to an undescribed genus after much collecting in southern California and Baja California, and examination of *Fenestrulina* collections at the Allan Hancock Foundation and The Natural History Museum, London. The BMNH also holds Canu and Bassler "plesiotypes" from the Smithsonian Institution, and the O'Donoghue collections from Pacific Grove, California.

Biology. Encrusts shells, stone. Depths from shallow waters to about 100 m.

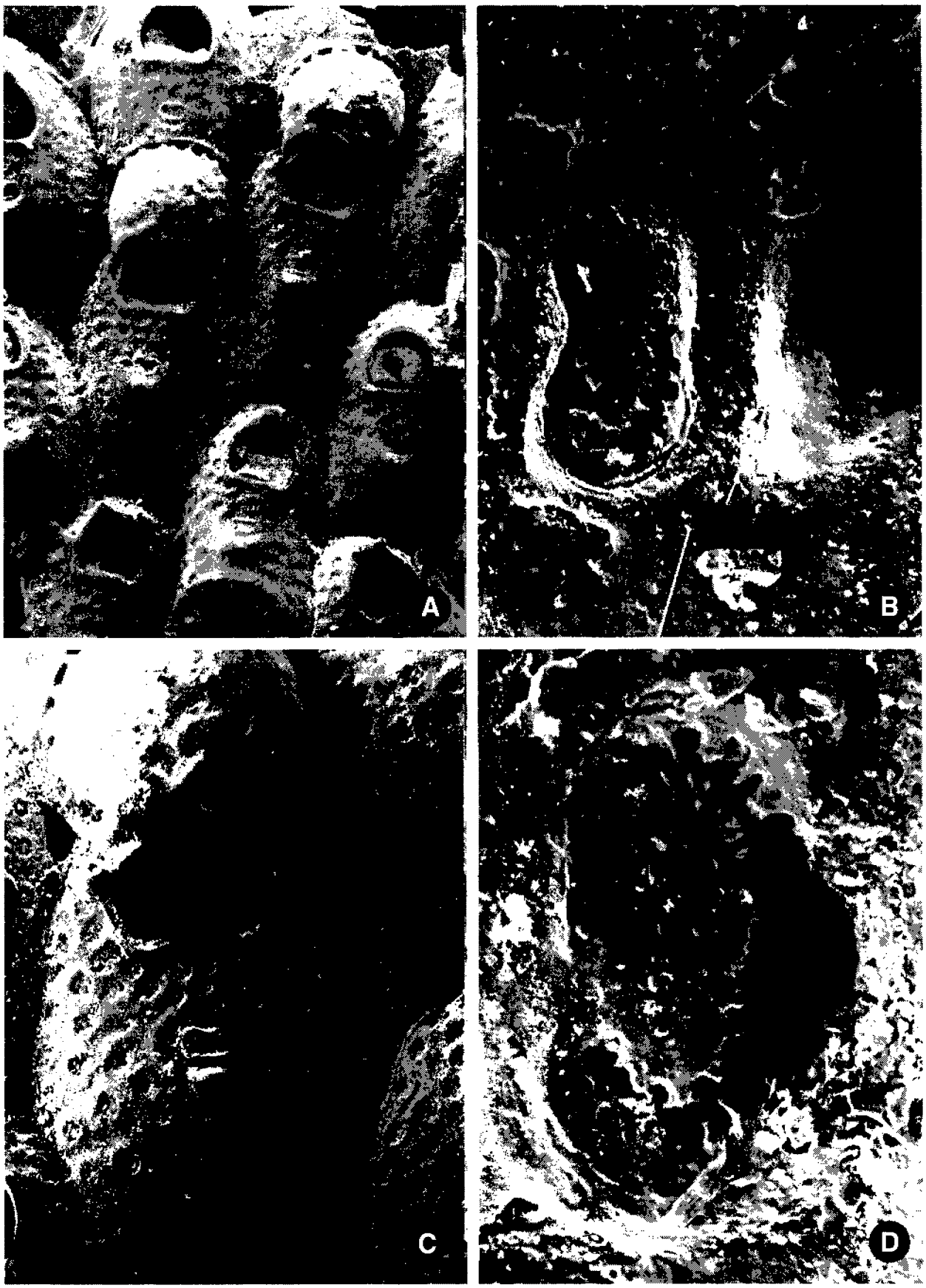
Taxonomic Remarks. The genus *Fenestrulina* is defined as lacking the avicularia possessed by species of the genera *Microporella* and *Diporula*, the latter an erect genus. *Microporella* avicularia are often paired, flanking the ascopore or umbo. Canu and Bassler's fossil species has pores all over the frontal wall and lacks an umbo, but no spines or avicularium were described or figured in that species.

The Chilean species *Fenestrulina viviani* Moyano, 1991, would belong in *Fenestruloides*; it is very similar to *F. morrisae*, but has only two spines; although it lacks avicularia, so do most of the California specimens.

Type Locality and Type Specimens. Albatross Station 2994, off the Revillagigedo Islands, Mexico, collected 6 March 1889. SBMNH-AHF Bryozoa Holotype No. 215.

Distribution. The MMS station is off Purisima Point; previously known from AHF 1271-41, 0.75 nautical miles southeast of Cat Rock, Anacapa Island, Channel Islands, southern California; AHF 1190-40, Anacapa Passage; common at HEP Station H2, Federal breakwater, Los Angeles-Long Beach Harbor, California, shallow water, 6-8 m; southeast of the Cortes Bank buoy 4.75 nautical miles, near the California, Baja California line, bottom sample BS 1190, in sand on shell; Carmen Island, Gulf of California, Puritan-American Museum Station P132; Tiburon Island, Gulf of California. P161. Only the holotype had an avicularium.

Plate 57. *Fenestruloides morrisae*. A. Holotype from ***Albatross*** collection off Revillagigedos Islands, showing unique avicularium. B. Lateral view of denticulate ascopore, frontal pores on colony from Tiburon Island, Gulf of California. C. Tiburon colony with developing ovicell, three spines. D. Mature ovicell with two closed pores in hood frontal, marginal pores, from Anacapa Island passage, California.


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B
C
D

Fenestruloides umbonata (C.H. and E. O'Donoghue, 1926)

Plate 58 A-D

Fenestrulina malusii var. umbonata C.H. and E. O'Donoghue, 1926: 109, pl. 5, fig. 45.

Material Examined. AHF and BMNH Collections.

Description. Colonies encrusting. Zooids hexagonal, length 674-697 μm, with little or no gymnocyst visible; frontal wall inflated, with numerous stellate pores 20-25 μm in diameter except on umbo; aperture large, 180-210 μm wide, 150 μm high, curved distally, with 1 or 2 distal spines, proximal rim straight. Three or more rows of pores between proximal rim and ascopore; ascopore large, 60-70 μm wide, 30-40 μm high, with wide, denticulate median distal projection, almost meeting denticulations of ascopore rim; a small umbonate process immediately proximal to ascopore. Ovicell large, zooid plus ovicell more than 1 mm long, hood rugose, sometimes with ribbed margin like 2 spines fused across front at opening, flanked by 2 small spines, rimmed distally by gymnocyst, bordered by 1 row of pores.

Biology. Encrusting hard substrates. Depths known to 108 m; apparently a cool water species.

Taxonomic Remarks. Hincks (1884b: 31) mentioned this form: "A variety of this species [*F. malusii*] occurs, in which there is a prominent umbo below the pore." The O'Donoghues named this form as *F. malusii*, var. *umbonata* var. nov. We find it sufficiently different from the form in which the entire ascopore is elevated on an inflated frontal wall to give it species rank, in spite of the variability within and between colonies.

Type Locality and Type Specimens. Hincks did not propose the varietal name formally, in Latin, nor did he designate a type or type locality; however, he found the form in the Queen Charlotte Islands. The O'Donoghues listed it as being common in the San Juan Islands, Puget Sound. A type specimen has not yet been found in the O'Donoghue Collection at the BMNH.

Distribution. Found from British Columbia south to Santa Catalina Island, Channel Islands, southern California.

Plate 58. *Fenestruloides umbonata.* Santa Catalina Island, California. A. Uncleaned specimen with umbones raised proximal to ascopore. B. Lateral view of ascopore compressed distally and proximally, not included on umbo, to right. C. Ovicell, with bars across margin of hood, two spine bases. D. Lateral view, variation of ascopore not depressed distally (to left).

Fenestruloides eopacifica, new species

Plate 59 A-D

? *Microporella Malusii*: Hincks, 1883: 444; 1884: 57.
? *Microporella malusii* var. *typica* C.H. and E. O'Donoghue, 1923;174.
Fenestrulina malusi: Osburn, 1952: 387 (in part).

Material Examined. BMNH and AHF Collections.

Diagnosis/Description. Colonies encrusting. Zooids with inflated frontal walls, crowded, with grooves between zooids, with small gymnocystal rim on proximal edge of frontal wall; zooid lengths 340-600 μm long, 340-540 μm wide, except where widely distorted by crowding; many kenozooecia in areas of overgrowth competition. Aperture arched distally, with 1 - 3 spines or spine scars, straight proximally, 140-150 μm wide, 90-110 μm high; ascopore mounted atop frontal apex, 50-60 μm wide, 30-40 μm high, with wide median projection; both ascopore and projection irregularly denticulate. Ovicell flanked by 2 spines, imperforate, smooth, with small areolar pores, a distal rim around the margin separating it from the next distal zooid; a small hood bordering the opening, enclosed at the ends to meet the distal end of the zooid. Ancestrula a small zooid, with 1 row of marginal pores, 1 - 2 rows between aperture and ascopore, more pores being added in next astogenetic rows, finally in mature zooids pores covering all of frontal wall except, sometimes, the proximal slope of the apex.

Etymology. Greek, *eos*, east and Pacific, for its distribution in eastern Pacific coastal waters.

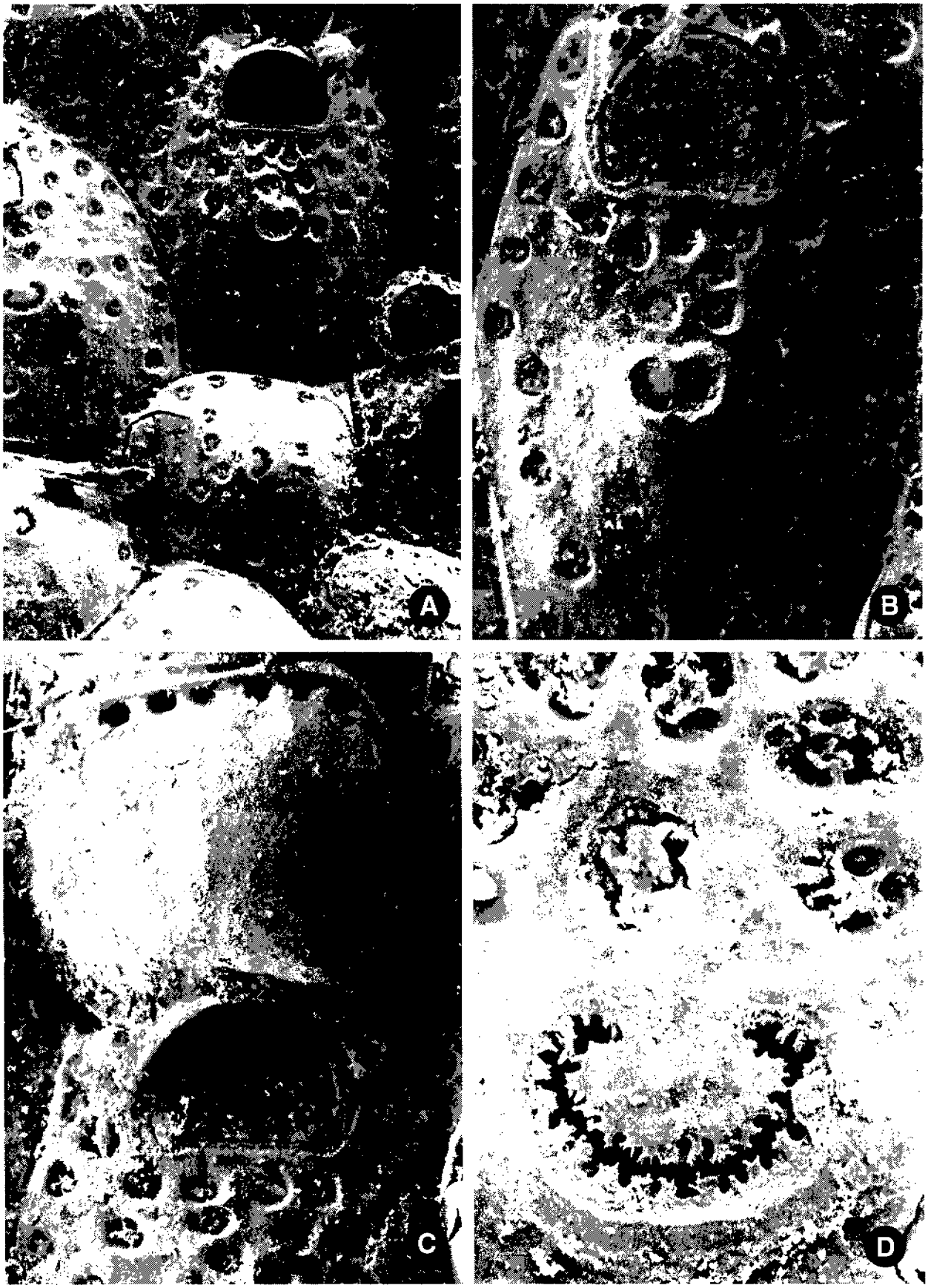
Biology. On shell fragments at 18 m. Larvae apparently settle adjacent to the ovicell, producing a small zooid that buds over existing zooids. This may be an adaptation to the problems of small substrates, shell fragments that roll about on the bottom.

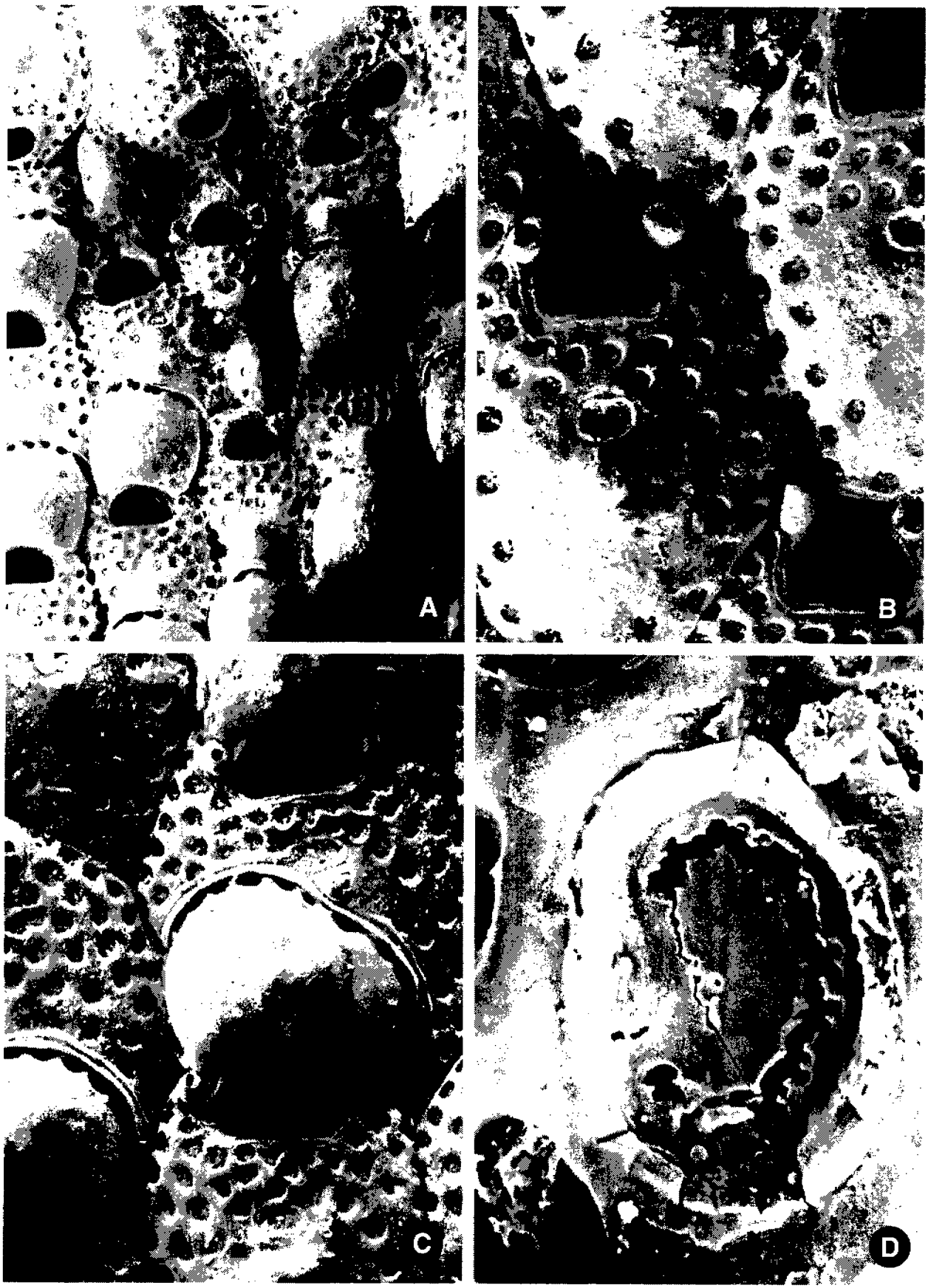
Taxonomic Remarks. One of the several forms included by Osburn (1952) in *F. malusii*, the presumed ancestrula, which resembles a small zooid of a true *Fenestrulina*, develops more frontal wall pores in succeeding astogenetic generations until the entire frontal wall is perforate except for the apex bearing the ascopore. This may, in fact, be identical to *F. morrisae* in a mature colony, although it is much smaller and it seems better at this time to accord it separate species status. This species most resembles the British form identified by Hincks as *F. malusii*, but Hincks' specimen (illustrated herein, Plate 61) has longer zooids, 524-874 μm long, and the aperture is wider, about 160 μm, than in *F. pacifica*.

Type Locality and Type Specimens. "Barn Kelp", off San Onofre, California. SBMNH-AHF Bryozoa Holotype No. 216.

Distribution. No other locality known at present.

Plate 59. *Fenestruloides eopacifica*. San Onofre, California. A. Ancestrula center, like a small zooid, zooids increasing in size and in number of frontal wall pores. B. Detail of young zooid with three spine scars. C. Imperforate ovicell with flanged lip, numerous frontal pores. D. Detail of ascopore, frontal pores.


A
B
C
D


A
B
C
D

Fenestruloides blaggae, new species

Plate 60 A-D.

Fenestrulina malusi: Osburn, 1952: 387 (in part).

Material Examined. AHF and BMNH Collections.

Description. Colonies encrusting. Zooids porcellanous, very irregular in size, shape, normal zooids 400-600 μm long, with ovicell, about 700 μm long; younger zooids with single row of marginal pores, 2 rows between aperture and ascopore, pores filled with irregular spiculate projections; pores becoming numerous except on frontal wall proximal to umbo; other irregular humps and bumps on proximal frontal, usually bearing 1 or more pores. Aperture a shallow arch distally with 1 to 2 spines or spine scars distally, proximal border almost straight, 150μm wide, 90 μm high. Ascopore crescentic, 50-60 μm wide, 30-40 μm high, with wide distal projection almost filling space; both ascopore and projection denticulate. Umbo proximal to ascopore but independent of it. Ovicell porcellanous, lumpy or umbonate, with single row of small areolar pores and a pronounced marginal rim distally, 2 spines flanking hood.

Etymology. Named for Alice E. Blagg, who collected extensively in the Carmel, California area, but also in many locations around the world. She gave tentative identifications and deposited collections in a number of museums including the CAS, AHF, the Smithsonian Institution, and the British Museum, but never published on any of them. Her training and history are otherwise unknown to us.

Biology. Collected on settling racks. Normal depth range unknown.

Taxonomic Remarks. This species is somewhat larger than *Fenestrulina pacifica* but smaller than the "*F. malusii*" of Hincks. It resembles *F. umbonata*, but that species has much larger zooids and also much larger apertures; the ascopores are about the same size as those in both *F. eopacifica* and *F. blaggae*. *Fenestruloides. blaggae* also has some peculiar extra umbones near the proximal end of the zooids, possibly stimulated by some type of predator activity.

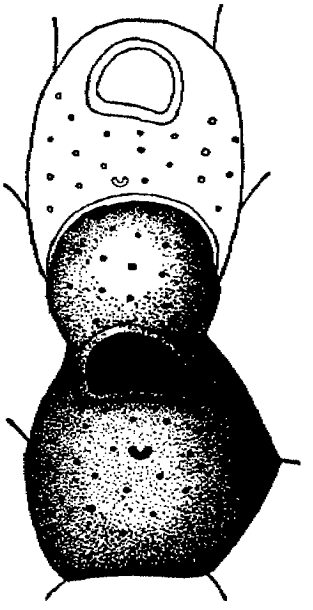


Figure 16. (right) *Fenestrulina malusi*.
From Osburn, 1952, pl. 45, fig. 3.
Note remarks on pages 156-158.

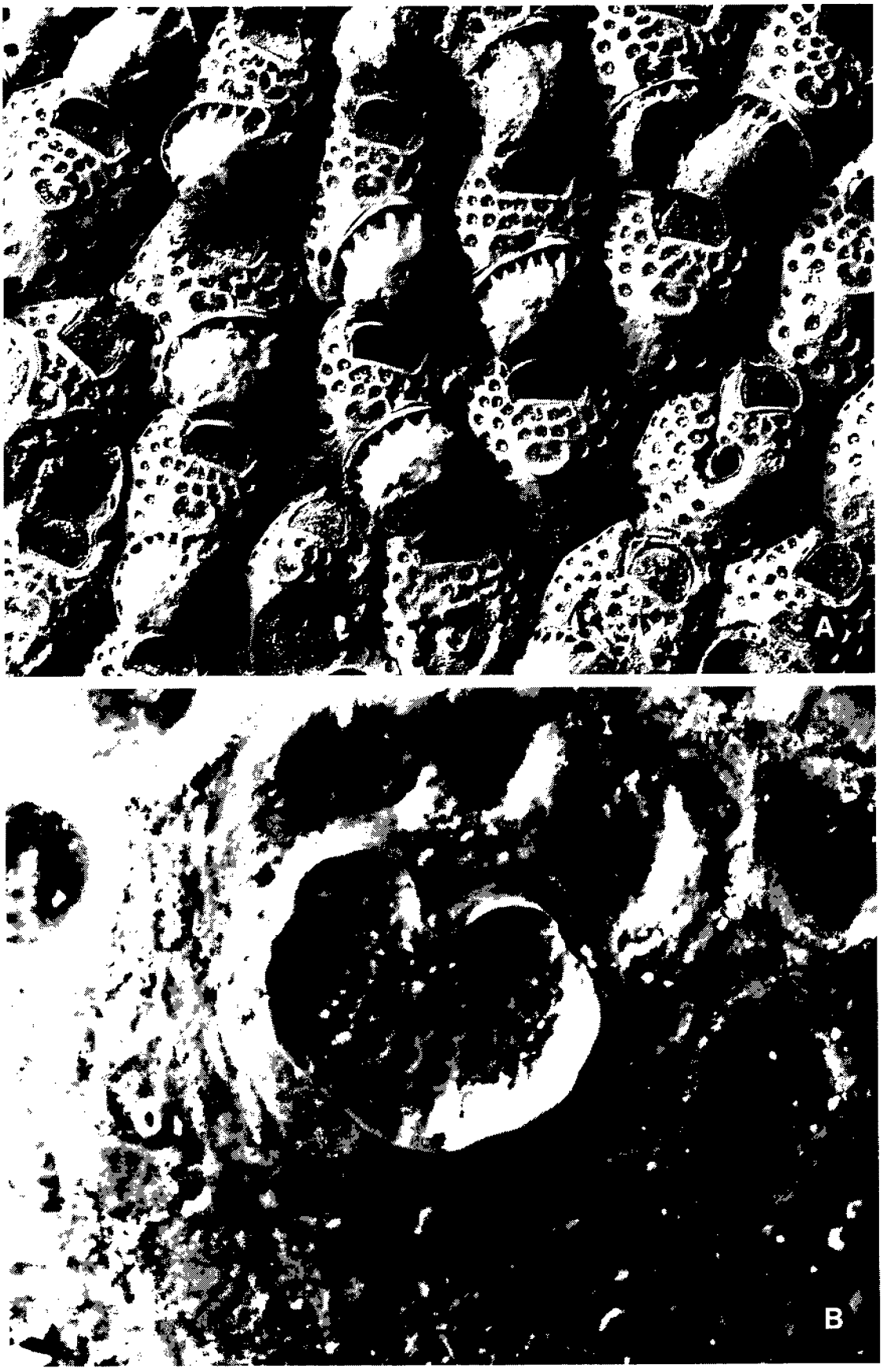
Plate 60. *Fenestruloides blaggae*. Carmel, California. A. Zooids with low umbo, two large spine scars, two or three rows of frontal pores, imperforate ovicells, frontal nodules on hood; note kenozooids where competing colonies met at top. B. Zooid with two large spine bases, ascopore, small umbo. C. Detail of ovicells with nodular texture, frontal pores except on umbo. D. Lateral view of ascopore with flaring rim, frontal pores very denticulate.

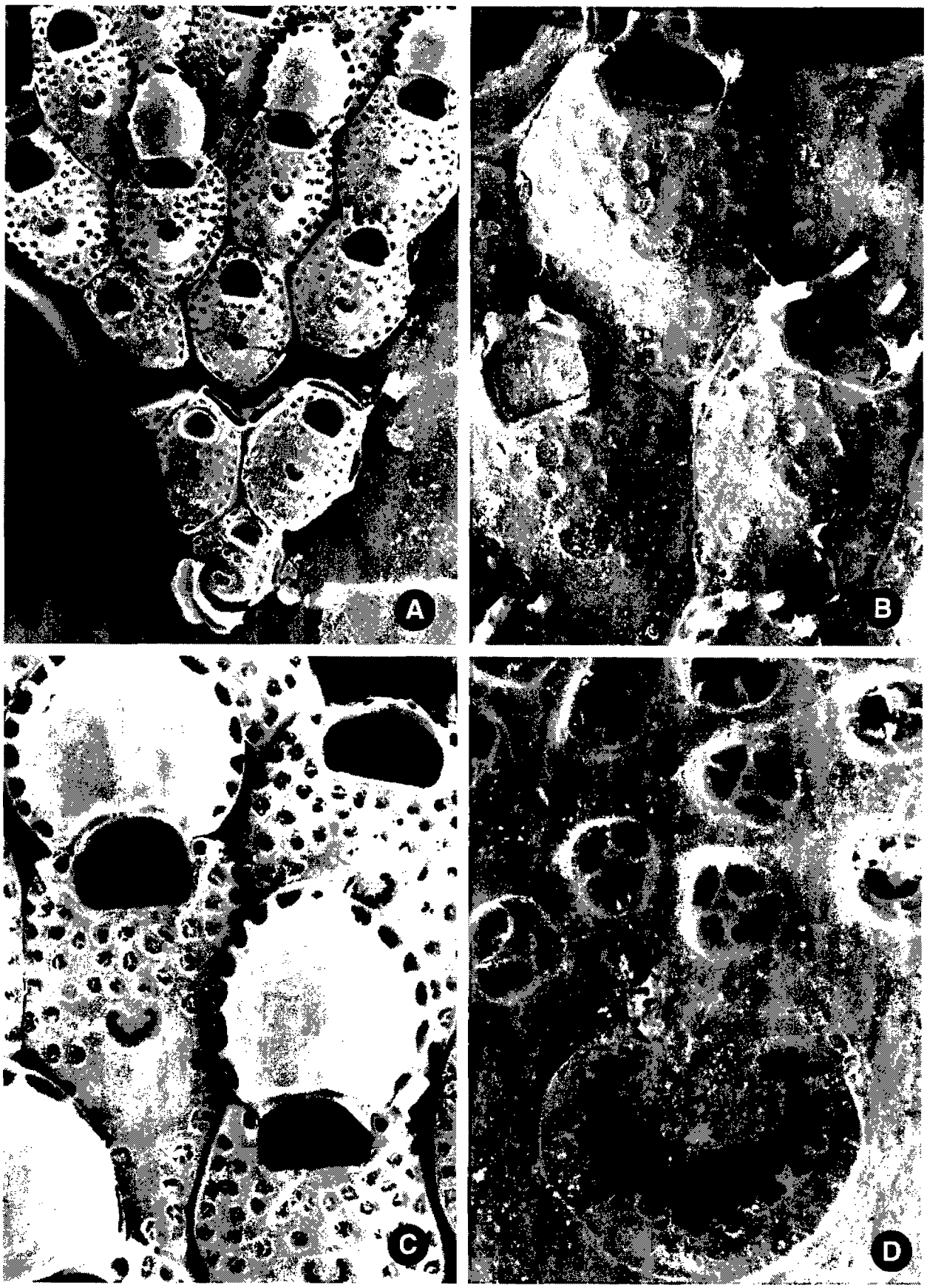
Plate 61 A-B are SEMs, courtesy of Dr. Paul Taylor, of the figured specimen illustrated by Hincks, from Jersey, of "*Microporella Malusii*" (Hincks, 1884a: 57); it is not the same as *F. blaggae*. Hincks illustrated the Jersey specimen in his 1880c publication and said the British Columbia specimens were the same. It is a *Fenestruloides* with three spines, no umbo but with a raised ascopore, and the ascopore has a distinctive raised rim around it. The marginal denticles are elaborately spined as is the medial projection, although it generally has a narrower stem than the Pacific species illustrated, widening out until its denticles almost touch those of the rim. Like *F. blaggae*, the zooids are very irregular in competing for space, with many misshapen zooids with extra humps and bumps. Zooids are generally larger than those of *F. blaggae*, 500 to 874 μm long; the zooid plus ovicell is up to 1 mm long, more the size range of ovicelled zooids in *F. morrisae*. Hincks' Jersey form should undoubtedly be renamed for it is certainly not *Fenestrulina malusii*.

Type Locality and Type Species. Carmel, California is the type locality for *Fenestruloides blaggae*. SBMNH-AHF Bryozoa Holotype No. 217.

Distribution. No other distribution is known for *F. blaggae*, but this could conceivably be widely distributed in central California, probably on shell substrates.

Plate 61. *"Fenestrulina malusii"*; *sensu* Hincks collection. A. BMNH specimen 1899.5.1.1202, illustrated by Hincks, from Jersey is an undescribed *Fenestruloides*, not *F. malusii*, with numerous frontal pores, three spines, flaring ascopores, imperforate ovicells with strong distal rims. B. Detail of raised ascopore, with branching denticles.


A
B


A
B
C
D

Fenestruloides miramara, new species

Plate 62 A-D

Material Examined. BMNH and AHF Collections

Diagnosis/Description. Colonies encrusting seaweeds. Zooids small, 380-550 μm long, 200-380 μm wide, oval to hexagonal, separated by grooves, small spaces, with lateral gymnocystal walls showing; frontal pores numerous, covering frontal wall except proximal to ascopore, with irregular denticles meeting in center. Aperture semicircular, with 2 large lateral spines, 2 or 3 small or large distal spines, straight proximally, 150-160 μm wide, 100-110 μm high; ascopore separated from aperture by 2-3 rows of pores, mounted on frontal apex, not umbonate in autozooids, ascopore with flaring rim, opening crescentic, 75-80 μm wide, 48-50 μm high, median projection wide, both rim and projection irregularly denticulate. Ovicelled zooids large, 750-800 μm long, with solid hood, an indented ledge across edge of hood between 2 flanking large spines, large pores around distal rim of hood; ascopore more raised than in autozooids, sometimes umbonate. Ancestrula a small zooid with 1 row of marginal pores, 1 row between aperture and ascopore, next 2 zooids in zone of astogenetic change larger with increasing pores, followed by 3 zooids, all with 4 spines; fourth row of zooids normal size, with 5 spines, some ovicelled zooids.

Etymology. Named for Miramar Beach, where the species was collected on drift algae.

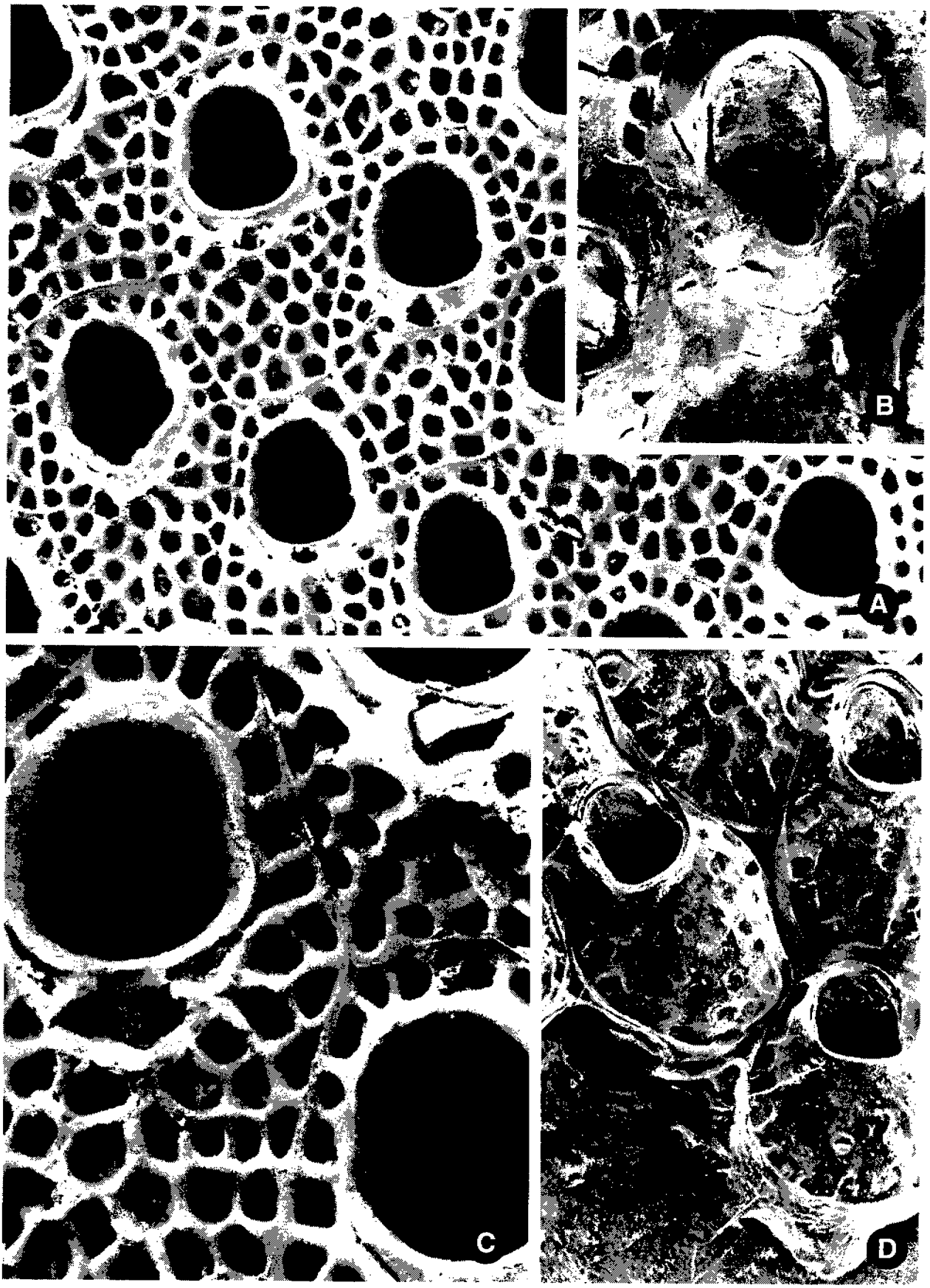
Biology. Actual depth of algal substrate is unknown.

Taxonomic Remarks. *Fenestruloides miramara* somewhat resembles *F. blaggae*, except that *F. miramara* has somewhat smaller autozooids but larger ovicelled zooids and has five spines instead of one or two spines. Ovicells of *F. blaggae* are lumpy, as are the frontal walls, and the frontal pores are almost filled with irregularly branched spicules. *Fenestruloides eopacifica* has three spines; both *F. eopacifica* and *F. blaggae* have a wider ascopore projection nearly filling the opening. The three species named as new might be considered as variations of a single species, but it seems better to give them species status until more is known of their distribution and variability.

Type Locality and Type Species. Miramar Beach is in Montecito (Santa Barbara), California. SBMNH-AHF Bryozoa Holotype No. 218.

Distribution. No other known at present.

Plate 62. *Fenestruloides miramara*. Miramar Beach, Santa Barbara, California. A. Ancestrula a miniature zooid, with one row of suboral and marginal pores; number of frontal pores increasing to cover all but umbones. B. Zooids at growing edge with five spines, not cleaned. C. Ovicells imperforate with marginal pores, two spines showing. D. Detail of ascopore, frontal pore spicules.


B
A
C
D

Family Cryptosulidae Vigneaux, 1949

Cryptosula pallasiana (Moll, 1803)

Plate 63 A-B.

Eschara pallasiana Moll, 1803: 64, pl. 3, fig. 13.
Lepralia pallasiana: C.H. and E. O'Donoghue, 1925: 19.
Cryptosula pallasiana: Osburn, 1952: 470, pl. 57, fig. 4,5. — Hayward and Ryland, 1979: 9, fig. 30. — Dick and Ross, 1985: 89.

Material Examined. BMNH and AHF Collections.

Description. Colonies encrusting a wide variety of substrates. Zooids of northeastern Pacific specimens moderately large, 540-700 μm long, 350-450 μm wide, their boundaries obscure. Frontal wall with large, irregular, reticulate pores, extending distally around aperture. No spines. Apertures large, 230-250 μm high, 190-210 μm wide, bell shaped, borders thick, fairly straight laterally, proximal rim arcuate, wider than the distal arch, condyles very small; operculum dark brown; a small sulcus below the proximal lip, sometimes containing avicularium. Avicularia few, scattered on colonies; when present, small, median, oval with a semicircular mandible, 90 μm long, 80 μm wide. An umbo sometimes in that location. No evidence of ovicells; embryos pink, white or orange, visible brooding in body cavity. Ancestrula a small zooid with fewer pores and erect oral lappets; next 2 zooid buds showing much lateral wall with spaces between zooid margins.

Biology. Depths reported as intertidal to 60 m. This species is one of the most competitive fouling organisms in ports and harbors, where it can cover several centimeters in a few days. It is also able to colonize kelp holdfasts, shell and rock in deeper water where it is less well known.

Taxonomic Remarks. Only a few of the numerous citations of this species have been included above for reference. Osburn (1952) placed the species in the Cheiloporinidae, a grouping of many genera in which the only common feature is endozooecial ovicells or no ovicells. BMNH Busk specimens from Guernsey have no large umbones and few avicularia (BMNH 99.7.1.1464, 1465). Specimen 99.7.1.1704 from Devon has a few umbones and avicularia. Pacific coast material has more umbones and avicularia, but is included in the range of variation by Hayward and Ryland (1979), although Atlantic material is much longer, 600-1,000 μm, than the eastern Pacific material.

Specimens from Port Phillips Head, Australia (BMNH 97.5.1.820, J.Bracebridge Wilson Collection, and 97.5.1.821 collected by MacGillivray in J.B.W. Collection), have a raised peristomal rim and few avicularia. The latter specimen is foliate, with large, plain zooids back to back. BMNH 1890.8.23.6 from Vineyard Sound, Massachusetts has no umbones or avicularia, and apertures are narrower, more bell shaped. Winston's (1982) specimens from Indian River, Florida have a high, thin peristomal rim and lack avicularia. Hayward and Ryland (1979) reported flaring peristomes in some colonies, which we have not seen in our material. Occupinti-Ambrogi (1980) reported that colonies in Italian lagunal brackish waters bore occasional small avicularia; the species is not generally tolerant to oxygen depletion. The general lack of distinctive features in *C. pallasiana* make separation of species difficult. It did not appear in early eastern Pacific records until it was listed by C.H. and E. O'Donoghue in 1925, so it may be an introduced fouling species.

Type Locality and Type Specimens. Unknown.

Distribution. Found from Alaska to Oaxaca, Mexico and Chile; reported in the western Atlantic, from Nova Scotia to Florida, and in Europe, from Norway to the Black and Red Seas.

Plate 63. *Cryptosula pallasiana*. A. Colony from Mussel Point (Monterey Bay), California. B. Uncleaned colony showing avicularium and semicircular mandible. C. Bell shaped apertures, avicularia on left zooid. D. Early astogeny showing ancestrula.

Family Hippoporinidae Bassler, 1935

Bitectiporidae MacGillivray, 1895, senior subjective synonym *fide* Gordon, 1994

(= Hippoporinidae Brown, 1952; not Hippoporinidae Osburn, 1952)

There is much disagreement about the placement of genera and species in some of the ascophoran families, with decisions based on a number of criteria including shape of aperture, the nature of the frontal wall (perforate or imperforate) and on the nature of the ovicell.

The definition of the family Hippoporinidae according to Hayward and Ryland (1979) is as follows: "Frontal wall cryptocystidean, uniformly porous. Aperture broadly horseshoe-shaped, with prominent lateral condyles. Ovicell hyperstomial."

The type species of the genus *Hippoporina* Neviani, 1895: 109, is *Cellepora pertusa* Esper, 1796, the first species listed by Neviani under the new genus, although he did not designate it as the type species, which was designated by Waters (1918). Hayward and Ryland (1979) described the genus as having a frontal wall closely and regularly perforated, with the ovicell also perforated and closed by the zooidal operculum, with avicularia present or absent and spines only on the ancestrula.

However, Canu (1917) and Bassler (1935), created a subfamily of the Schizoporellidae, the Hippoporininae, and named as the type for *Hippoporina* the imperforate species *H. integra*, another Neviani species published later in 1895, not a valid procedure (see Harmer, 1957: 977).

Osburn (20 March 1952) created a family Hippoporinidae Osburn, apparently based on the subfamily Hippoporininae of Bassler (1935), although it seems unusual for the name not to be credited to the original author when raising the status to that of a family (ICZN, 1985: Art. 11 f). Osburn's definition was limited to species with imperforate frontal walls or those with marginal rows of pores. Osburn did not include *C. pertusa* Esper in the genus *Hippoporina*, but placed it in the Schizoporellidae, in the genus *Hippodiplosia* Canu, 1916, which has as its type *Hippodiplosia verrucosa* Canu, 1916. In the same year Brown (10 March 1952) created a Family Hippoporinidae Brown, with a porous frontal wall. Lagaaij (1952) used Brown's citation as being in press.

Bassler meanwhile (1953) corrected his 1935 error, changing the type species to the perforate *C. pertusa* (see Gordon, 1984: 75), which Hayward and Ryland (1979) followed in referring to family Hippoporinidae Bassler, 1935.

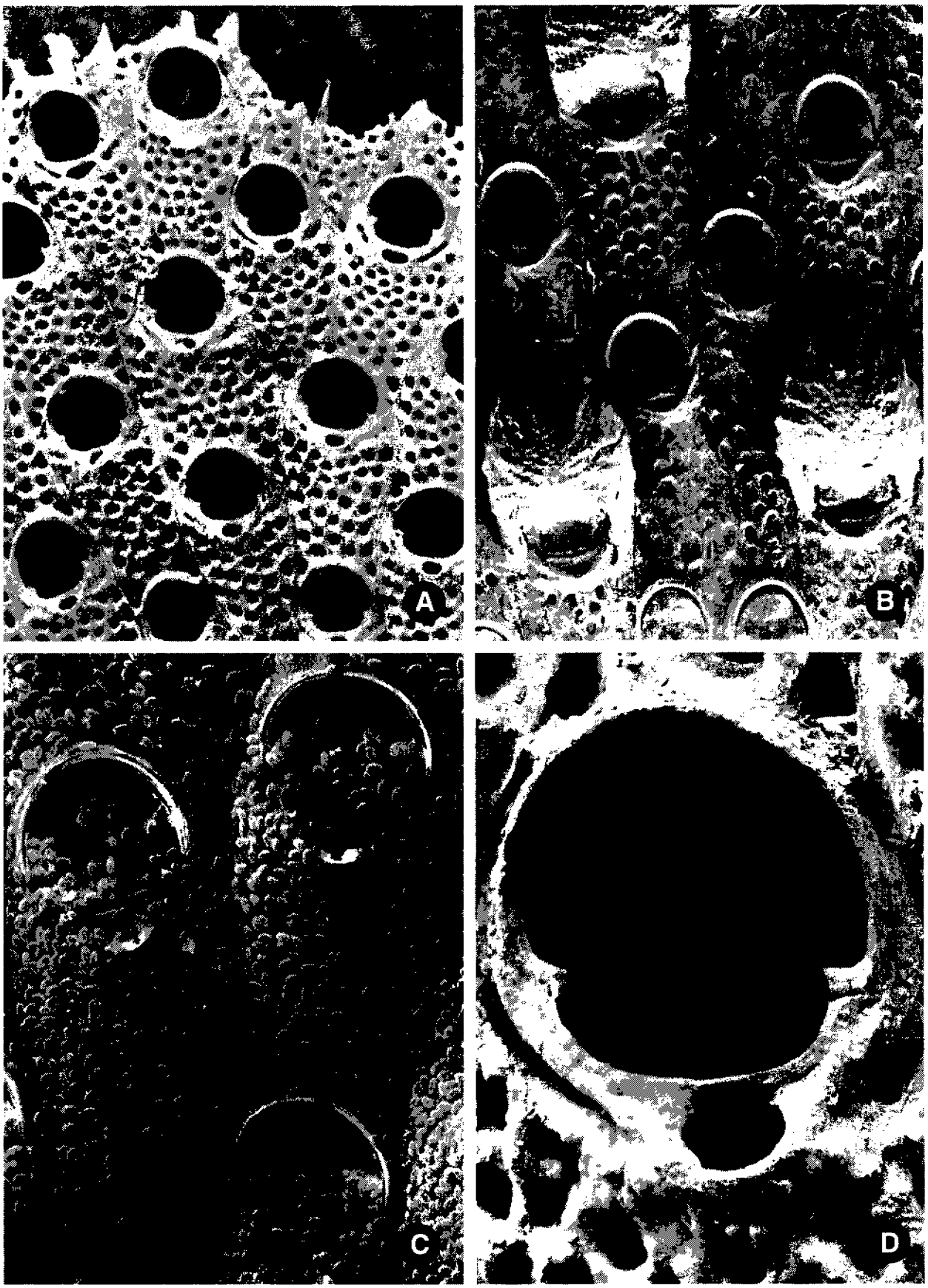
Many of the species with imperforate frontal walls were placed in a new genus *Cleidochasma* by Harmer (1957), for which Cheetham and Sandburg (1964) created the family Cleidochasmatidae. Soule *et al.* (1991) demonstrated that the genus *Cleidochasma* in fact contained species with widely different apertures and ovicells from the type species, *C. protrusum*, and created several new genera to accommodate them. Gordon (1993) concluded that some of the new genera described by Soule *et al.* (1991) do not belong in the Cleidochasmatidae, a conclusion we have not been able to study sufficiently as yet to adopt.

Gordon (1984) used the family Hippopodinidae Levinsen, 1909, for the "*Hippoporina*" species with perforate frontal walls and perforate ovicells closed by the operculum, although Levinsen, in describing the genus *Hippopodina*, with the type species *Hippopodina feegeensis* (Busk, 1884), thought the ovicells were endozooecial, which they are not, as pointed out by Osburn (1952). The type also has very distinctive lateral oral avicularia that are directed distally around the distal aperture, sometimes meeting in the center. Osburn placed *Hippopodina* in the family Petraliidae, in which he placed a variety of genera, most of which we consider misplaced. Thus we indicate the confusion in the placement of genera and the lack of consistency in the literature. We use the family Hippoporinidae as described by Hayward and Ryland (1979) for forms with perforate frontal walls and perforate ovicells, which leaves some genera in *incertae sedis* at this time.

Gordon (1994), in a paper received after completion of research for this manuscript, reported on the examination of a Tertiary fossil species, *Bitectipora lineata* MacGillivray, 1895, a monotypic species placed in the family Bitectiporidae MacGillivray, 1895. Gordon concluded that Bitectiporidae should be considered a senior subjective synonym of Hippoporinidae Brown, 1952, although the species and family name had not been used in 99 years. The ICZN Article 79(c) can be petitioned for rejection of a name not used in the preceding fifty years. Gordon makes a case for resurrection of the name to avoid the conflicting Hippoporinidae interpretations, discussed above, and it is beneficial to develop continuity between fossil and Recent genera and species to better reveal the evolutionary history. Gordon describes *B. lineata* as encrusting colonies having irregularly oriented zooids with perforate frontal walls and a median or eccentric suboral avicularium directed proximally forming a mucro. The aperture has a proximal sinus and paired condyles somewhat concealed by a secondary peristome merging with the avicularian mucro. The ovicell is perforate like the frontal wall.

Osburn (1952) included *Cellepora pertusa* in the genus *Hippodiplosia*, in the Schizoporellidae. *Hippodiplosia pertusa* lacks the pore and suboral rib but has a small, cruciform umbo below the aperture, differing from *H. insculpta* and *H. mexicana*, both of which have a suboral, riblike projection with a pore or avicularium inside it similar to that in *Cryptosula pallasiana*. Hastings and Ryland (1968) illustrated the type species of *Hippodiplosia*, *H. verrucosa*, and demonstrated that the genus is very different from those species assigned to it by Osburn. He included *H. reticulato-punctata* (Hincks, 1877), which has a reticulate frontal wall and medium large suboral avicularium, and *H. americana* (Verrill, 1875), which has an avicularium off to the side of a small suboral umbo, in the genus. *Hippodiplosia insculpta* and *H. mexicana* might better be included in the Cryptosulidae even though they have ovicells, which would necessitate a modification of the description of the Cryptosulidae; the more fragile, reticulate frontal wall is also more like that of *Cryptosula*.

Hippoporina insculpta has heretofore been the only strictly eastern Pacific species. "*Hippodiplosia pertusa*" of Osburn (1952) is apparently not that species, *H. reticulato-punctata* is an Arctic-North Atlantic species, and *H. americana* is an north and south American Atlantic species. Ovicells are perforate with an encroaching rim in *H. pertusa* and *H. americana*, but are imperforate, ribbed and bordered by pores distally in *H. insculpta*, and nodular and imperforate with a distal border of areolar pores in *H. mexicana*. The last two species, illustrated herein, perhaps do not belong to the *Hippoporina* or Hippoporinidae, but we are unwilling to create a new genus and different familial assignment for them at present.


A
B
C
D

Hippoporina insculpta (Hincks, 1882)

Plate 64 A-D.

Schizoporella insculpta Hincks, 1882: 251. — Hincks, 1883: 447, pl. 17, figs. 5, 5a. — Robertson, 1900: 326; 1908: 290, pl. 20, figs. 46,47. — C.H. and E. O'Donoghue, 1923: 178; 1925: 102; 1926: 103.
Hippodiplosia insculpta: Osburn, 1952: 341 (in part), pl. 40, fig. 1. — Soule and Duff: 1957: 111.

Material Examined. AHF and BMNH Collections.

Description. Colonies encrusting, sometimes rising into fan shapes and yellowish frills, orange during reproduction. Zooids irregularly rectangular to hexagonal, flattened, basal walls thin, 500-700 μm long, 300-350 μm wide. Frontal wall with many coarse pores; aperture curved distally, with a thin, low rim, ending laterally at downcurved condyles, at tips of the shallow arcuate proximal lip. Peristome low, forming a liplike, projecting arch or umbo proximally with a large pore between the primary aperture and the arch, covered by a thin flap of membrane, sometimes replaced by a tiny avicularium. Fertile zooids with an arched distal tip; ovicells globose, prominent, 400-500 μm wide, with radiating ribs, possibly with few small pores closed by advanced calcification.

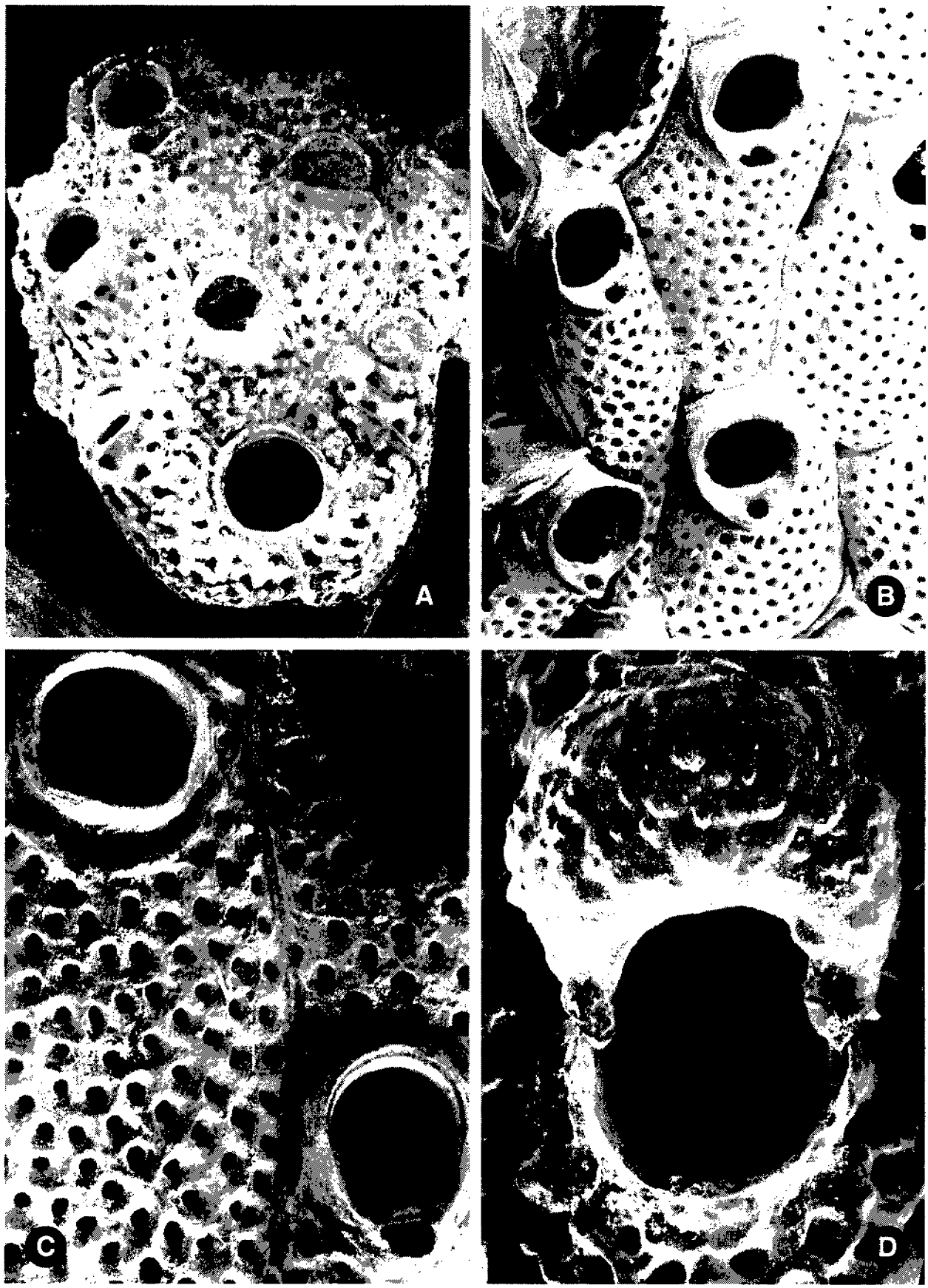
Biology. Encrusts a wide variety of substrates including rock, shell, bryozoans, hydroids and algae. Depths reported from shallow waters to 240 m but especially common in shallow water.

Taxonomic Remarks. The northern form of *H. insculpta*, found from Alaska to California, differs from the southern form, found from southern California to Mazatlán, Mexico and to Costa Rica. The differences are subtle; Osburn considered that *H. insculpta* became gradually smaller in its more southern distribution until south of southern California only the small form that is 60 to 75 percent the size of the northern material occurred. This difference is not definitive, because there is considerable size overlap. However, other differences, such as the presence of a higher peristome, condyles located higher on the lateral apertural rim, and an elevation in the middle of the primary proximal lip, lead us to describe *H. mexicana* as a new species, below.

Type Locality and Type Specimens. Virago Sound or Cumshewa Harbor, Queen Charlotte Islands, British Columbia. BMNH 1886.3.6.15, slide labeled "part of type".

Distribution. *H. insculpta* ranges southward from Sitka, Alaska to California.

Plate 64. *Hippoporina insculpta*. A. Colony from Departure Bay, British Columbia, with sulcus or tiny avicularium below aperture, enclosed by suboral peristomal arch. B-D. Colony from Corona del Mar, California. B. With ribbed, imperforate ovicells bordered by marginal pores. C. Uncleaned frontal membrane colonized by diatoms. D. Enlarged, hoof shaped aperture with small condyles, tiny suboral avicularium.


A
B
C
D

Hippoporina mexicana, new species

Plate 65 A-D.

Hippodiplosia insculpta: Osburn, 1952: 341 (in part). — J. D. Soule, 1961: 17.

Material Examined. AHF and BMNH Collections

Diagnosis/Description. Colonies encrusting. Zooids hexagonal, 461-679 μm long, separated by deep grooves, frontal walls inflated, with small pores. Primary aperture a high arch distally with small condyles about two-thirds of the way down the lateral rim, continuing downward to proximal rim, straight or arched distally in the middle; peristome raised into a collar except in fertile zooids, forming a secondary aperture with pointed lip proximally, projecting outward, bearing a large pore developed below a sulcus, covered by small flap of frontal membrane, sometimes with a hinge bar forming a thin, blunt avicularium directed proximally. Ovicells large, 580 μm wide, raised, imperforate with nodular surface, widely open, with flaps at the corners, proximal lip pore inside peristome.

Biology. Encrusting shells, stones, in shallow waters to unknown depths due to confusion of records with *H. insculpta*.

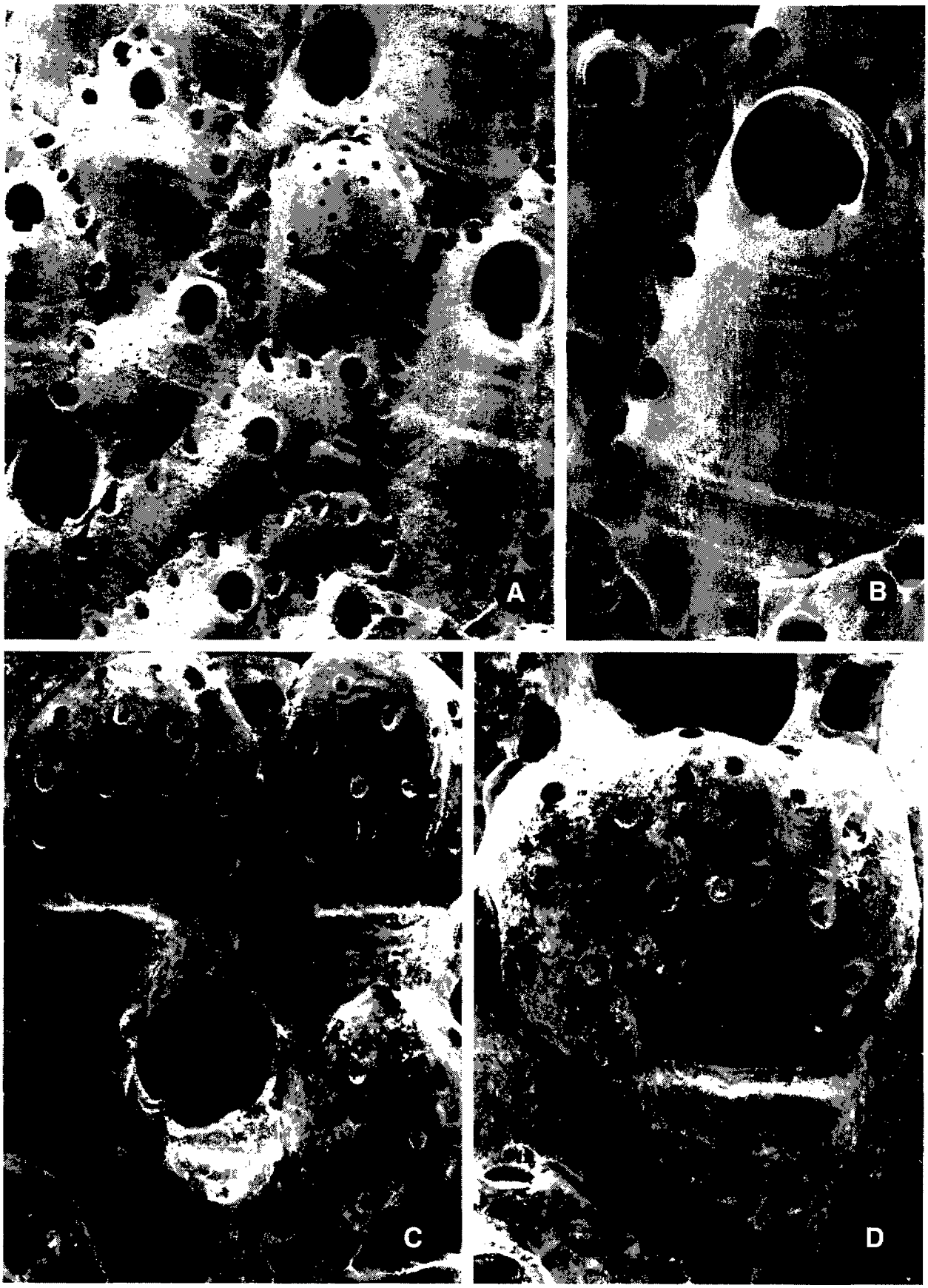
Taxonomic Remarks. Although Osburn (1952) noted that the smaller sized "*H. insculpta*" was the only form found south of California, he did not see differences which are particularly noticeable in SEM photos. The northern *H. insculpta* has flattened zooids with thin basal walls, a low, thin apertural rim with proximal condyles setting off a large, arcuate proximal rim and the secondary rim enclosing a suboral pore, or a small weak avicularium. The new species has a raised peristome, condyles located more distally and an almost straight proximal lip, arched slightly distally in the center.

Ancestrulae were found on sea grass. The ancestrula is round, apparently without spines, with a large, round frontal membrane, giving rise to two large zooids that surround the ancestrula distally and laterally, with their proximal transverse walls fused, and distal to them a single small, wide hexagonal zooid whose proximolateral walls abut the distolateral walls of the two larger zooids. The frontal projection is large, developing as suboral avicularia do, from a suboral sulcus between two pores that originate at the level of the condyles beneath the proximal lip.

Type Locality and Type Specimens. Mazatlan, Mexico, HEP Station 21. SBMNH-AHF Bryozoa Holotype No. 218.

Distribution. Juvenile colonies were found on sea grass in West Cove, San Clemente Island, southern California; distribution extends to the Gulf of California and south to Cocos Island off Costa Rica.

Plate 65. *Hippoporina mexicana*. A. Ancestrula with large twin zooids curved around it, one medial distal zooid, on seagrass, from West Cove, San Clemente Island. B-D. Colony from Mazatlán, Mexico. B. Growing margin of colony, showing cryptocystidial frontal formation, and large lateral pore; raised peristome surrounding suboral pore. C. Detail of suboral sulcus, left, suboral avicularium, right. D. Imperforate ovicell with lateral oral flanges; suboral pore is hidden inside peristome.


A
B
C
D

Family Hippothoidae Levinsen, 1909

Colonies mostly encrusting, or erect, zooids uniserial or contiguous; frontal wall a thin gymnocyst, with fine perforations, or imperforate, sometimes with transverse or longitudinal striations. Aperture with a proximal sinus; without apertural spines. Occasional interzooecial avicularia. Ovicells prominent, with or without pores; some species with miniature male zooids, larger female zooids.

Celleporella hyalina (Linné, 1767)

Plate 66 A-D.

Cellepora hyalina Linné, 1767: 1286.
Schizoporella hyalina: Hincks, 1883: 445. — Robertson, 1900: 326; 1908: 289, pl. 19, figs. 43-45. — C.H. and E. O'Donoghue, 1923: 177.
Hippothoa hyalina: Canu and Bassler, 1923: 92, pl. 35, fig. 4. — C.H. and E. O'Donoghue, 1926: 100. — Hastings, 1930: 720. — Osburn, 1952: 277 (in part), pl. 30, fig. 1-3 — J. D. Soule and Duff, 1957: 106. — J. D. Soule, 1961: 2. — D.F. and J.D. Soule, 1964: 13. — Morris, 1976: 11-43, fig. 1.
Hippothoa hyalina var. *rugosa* Canu and Bassler, 1923: 94, pl. 35, fig. 9.
Celleporella hyalina: Hayward and Ryland, 1979: 251, fig. 109.

Material Examined. MMS Station: BRA-20. AHF Collections.

Description. Colonies encrusting, often glistening; multilaminar. Three kinds of zooids: autozooids, female zooids and dwarf male zooids. Autozooids tapered distally and proximally (terete), with large, flaring marginal fenestrulae separating the zooids; zooids measuring 375-500 µm long, 200-250 µm wide; frontal walls inflated, with transverse striations, imperforate; aperture nearly circular, with a wide shallow proximal sinus, small lateral oral condyles. Male zooids small, 180-200 µm long, with smaller apertures like autozooids. Female zooids shortened proximally, 260-350 µm long, with a wide shallow aperture with thick condyles, prominent, globose ovicells, 180-200 µm wide, with many large pores. Small funnel shaped tubules, presumed buds, originating in fenestrulae.

Biology. Encrusting algae, rock and shell. Depths from intertidal to 90-130.5 m.

Taxonomic Remarks.. This species has been placed in several genera and there is still some disagreement. Ryland and Gordon (1977) and Hastings (1979) placed this species in the *Celleporella* based on the crustose colony and contiguous zooids, while species with the zooids in branching, uniserial colonies are placed in the genus *Hippothoa*. The characters of *C. hyalina, sensu lato* have been so confused that the seemingly widespread distribution may not be valid. There are several eastern Pacific species with differences in apertural sinus shape and in pattern of perforation or lack of pores in ovicells (Morris, 1976). The *C. cornuta* autozooid has a suboral umbo, an imperforate ovicell, and notches on either side of a U-shaped sinus, while *Celleporella santacruzana* has a narrow, V-shaped sinus and ovicells without pores. *Celleporella cornuta* occurs from Bodega Bay, California, to Mazatlan, Mexico, as well as in the Pliocene (Etchegoin Formation of California), and *C. santacruzana* is known from San Francisco to Santa Barbara, the Channel Islands and in the Pliocene Fernando and Pico Formations of California (Morris, 1976; 1980).

Plate 66. *Celleporella hyalina*. A. Colony from Canoe Bay, Alaska, with large female zooids, smaller male zooids and dwarf zooids; flaring fenestrae between zooids. B-D. Lighthouse Point, Monterey Bay, California. B. Large autozooid, smaller male zooid to left. C. Ovicells with wider shallower sinus than in autozooid in center. D. Detail of ovicell encroaching on distal autozooid.

Type Locality and Type Specimens. BMNH neotype designated.

Distribution. *Celleporella hyalina* ranges from Alaska south to California, and possibly to the Galapagos Islands, but distribution has been confused with other species. The MMS station is off Purisima Point, north of Point Arguello. *Celleporella hyalina* apparently occurs in the western Atlantic from Canada to Massachusetts, and in the eastern Atlantic from the Arctic to the Bay of Biscay (Hayward and Ryland, 1979). It is also found in the fossil record from the Miocene, Yakataga Formation, Alaska Morris, 1980:103).

Trypostega claviculata (Hincks, 1884)

Plate 67 A-C.

Lepralia claviculata Hincks, 1884a: 50, pl. 3, fig. 2.
Trypostega claviculata: Levinsen, 1909: 281. — Osburn, 1952: 281, pl. 30, fig. 11.

Material Examined. MMS Station: BRA-27. Other collections: AHF; BMNH 1886.3.6.35.

Description. Colonies encrusting shells and rock. Three kinds of zooids: autozooids, female zooids with large ovicells, and smaller zooids. Autozooids 510 μm to 570 μm long, 280-310 μm wide, irregularly ovoid, frontal wall moderately inflated with many large pores; aperture a wide arch distally ending in strong condyles, a wide, curved proximal sinus not as wide as distal arch; a row of pores distal to aperture. Avicularia (zooeciules of some authors) 200-210 μm long located at distal ends of some zooids, with a single row of small pores, and a spatulate mandible. Small zooids (perhaps males) lie next to ovicelled zooids; ovicells large, 380-410 μm wide, globose, porous and weakly carinate (keeled).

Biology. Encrusts shells and rocks. Depths reported from shallow to 180 m. The MMS depth was 96-126 m.

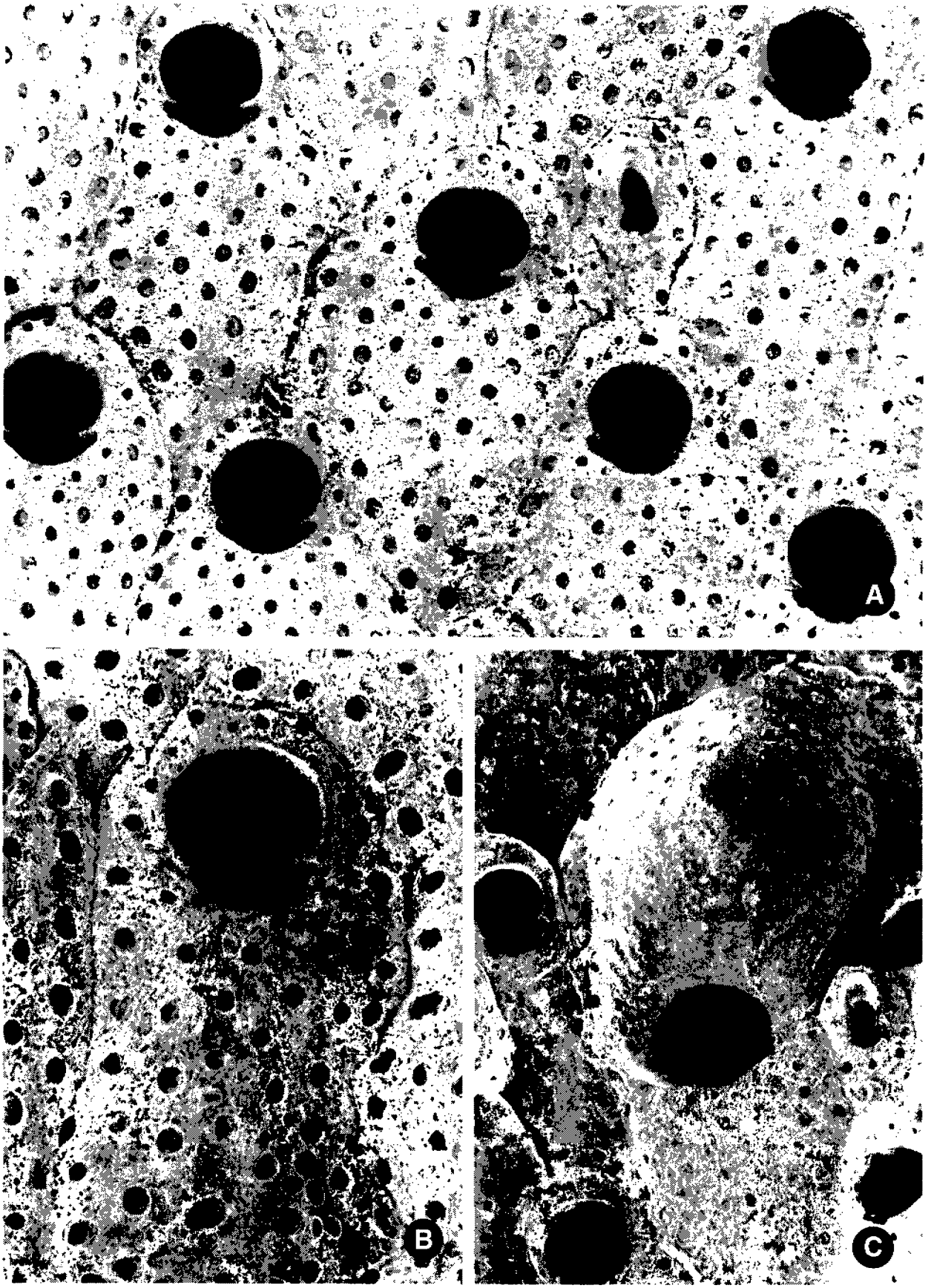
Taxonomic Remarks. The genus *Trypostega* is placed in the Hippothoidae strictly on the basis of the three kinds of zooids and otherwise does not fit there because of the transversely striated frontal walls in *Hippothoa, Celleporella*, and the other genera associated with the family. The genus *Trypostega* as described by Levinsen (1909), with *T. venusta* (Norman, 1864) as the type, had no avicularia but he indicated that the genus might be altered to accommodate *T. claviculata*, with its avicularia. The latter also has a much wider, shallower sinus than the narrow, V-shaped sinus of *T. venusta*. Harmer (1957:953) considered that if *T. claviculata* had avicularia it belonged in the genus *Chorizopora*, a form with imperforate frontal walls and marginal pores, a conclusion not followed by others.

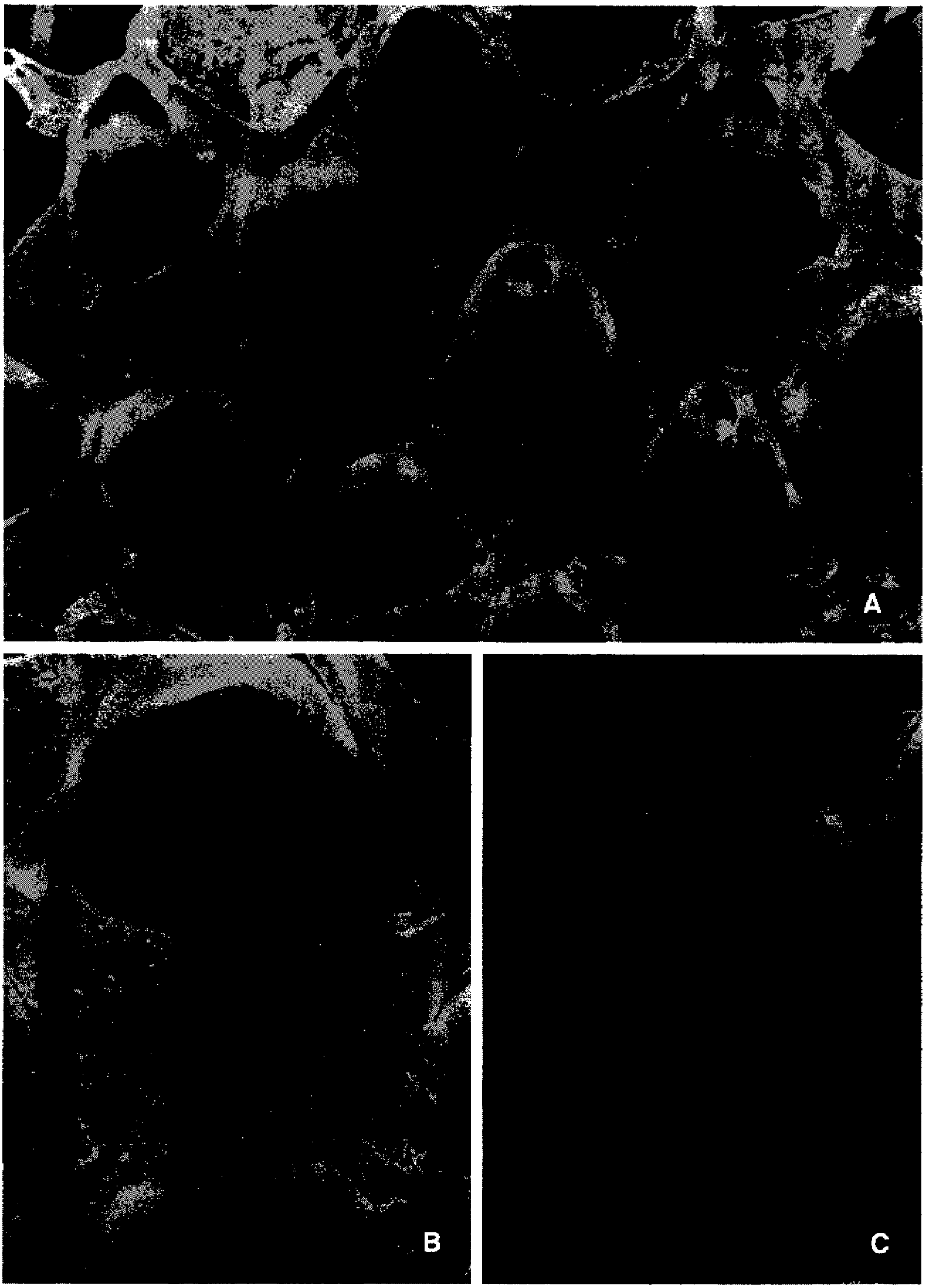
The smaller zooids in *T. claviculata* appear more likely to be autozooids suppressed because of the very large ovicell than to serve as the male miniature zooids in *Celleporella hyalina*, which involve frontal budding.

Type Locality and Type Specimens. Houston-Stewart Channel, Queen Charlotte Islands. BMNH 1886.3.6.35 is part of the type material (no holotype designated).

Distribution. South from British Columbia to the waters off southern California; the MMS station is off Morro Bay, central California. Gautier (1962) reported finding *T. claviculata* off Tunisia, but did not illustrate it, quoting Osburn's (1952) description. It seems a doubtful distribution pattern.

Plate 67. *Trypostega claviculata*. Santa Cruz Island. A. Colony with large female zooids, smaller (male?) zooids, interzooecial keyhole shaped avicularia (zooeciules). B. Autozooid with row of pores distal to aperture, thin condyles, curved proximal border; frontal wall with widely spaced pores, areolae. C. Ovicell with wider aperture, with small (male?) on left, avicularium on right.


A
B
C


A
B
C

Family Eurystomellidae Levinsen, 1909

The Eurystomellidae is a small family that has traditionally been placed in the Ascophora (e.g., Osburn, 1952; Cook and Chimonides, 1981). Gordon (1985, 1989) placed it in the Cribriomorpha (= Cribrimorpha) based on characters of the type species, *Lepralia foraminigera* Hincks, 1883. Gordon characterizes the family as having zooids with a gymnocystal frontal wall, smooth or with a few conspicuous pores. The aperture is wider than long, with a narrow proximal rim. No spines or avicularia. Ovicells subimmersed or recumbent. The type species differs greatly from the eastern Pacific *Eurystomella bilabiata* in having two to four large open foramina in the frontal wall, giving it somewhat the appearance of the figulariid cribrimorphs.

Eurystomella bilabiata (Hincks, 1884)

Plate 68 A-C.

Lepralia bilabiata Hincks, 1884: 49, pl. 3, fig. 1, 1a. — Robertson, 1908: 298, pl. 21, fig. 61-64.
Eurystomella bilabiata: Canu and Bassler, 1923: 142, pl. 37, fig. 6. — C.H. and E. O'Donoghue, 1925: 104;1926: 111. — Osburn, 1952: 389, pl. 58, fig. 5. — Soule and Duff, 1957: 118.

Material Examined. MMS Station: BRA-4. Other collections: BMNH 1897.5.1.809, J. Bracebridge Wilson Collection; AHF.

Description. Colonies encrusting, red, pink or reddish brown in color. Zooids moderately large, 600-650 μm long, 500-550 μm wide, rounded distally and narrowed proximally. Frontal wall imperforate, sometimes with umbo. Aperture distinctive, 240-260 μm long, 300-320 μm wide, with a shallow rounded border proximally with a large rounded notch at each end for opercular muscles to pass through, narrowed distally with a wide, flat border; aperture in cleaned colonies resembling silhouette of a derby hat. Operculum dark brown, with shape of aperture. Developing zooids diamond shaped, with V-shaped margin in calcified frontal wall, rounded distally with little transverse wall; numerous septula in lower lateral walls. When complete, frontal wall may have markings like a small rib or tail extending from distal rim of zooid up the frontal wall of next distal zooid to the umbo, markings not seen in older zooids. Obverse (dorsal) side with basal window, narrow proximal portion extending farther proximal compared to portion showing on ventral side as if zooids overlap at extremities. Colony ventrally may conform to irregular surface with nodular growths (kenozooids ?). Disk-shaped colony may have modified zooids, possibly excurrent zooids, in center. No spines or avicularia. Ovicell formed as a slit bordering subtriangular distal margin of fertile aperture, becoming immersed, a small, shallow subtriangular hood, thickened, imperforate except for a large pore in center distally corresponding to extent of transverse wall. Apertures of fertile zooids sometimes wider, more triangular than in autozooids. No kenozooid occurring distal to ovicell. Ancestrula resembles adult zooid but with cuticular frontal wall.

Biology. Encrusts shells, stones and ship hulls. The reddish color in *E. bilabiata* is a carotinoid, hopkinsiaxanthin, that is passed directly to the predator nudibranch species, *Hopkinsia rosacea*. Previously recorded from intertidal depths to over 186 m; the MMS record extends the depth to 168-237 m.

Plate 68. *Eurystomella bilabiata*. Lighthouse Point, California. A. Autozooid apertures resembling derby hats; colony margin with developing ovicells (wider distal rim with central pore). B. Detail of aperture, with openings for opercular muscles at margins. C. Detail of ovicell.

Taxonomic Remarks. *Eurystomella bilabiata* is a commonly recognized southern California species but it differs greatly from the type species, *Eurystomella foraminigera*. In having a smooth frontal wall, *E. bilabiata* does not show the evidence of frontal formation by fusion of broad costae with the presence of two large "intercostal" pores as seen in the type species, and the notches for the occlusor muscles are much more pronounced in *E. bilabiata*. The ovicell is almost triangular in *E. bilabiata* as compared to a more rounded structure in *E. foraminigera*, with a suggestion of formation by fusion of lateral processes (Gordon, 1989. plate 4, figure A). It is possible that *E. bilabiata* should be placed in a separate genus, as has been suggested by Levinsen (1909) and other authors since. Gordon (1984) described *Eurystomella crystallina*, with a uniserial or biserial colony and a thick lower lip on the aperture with a median suture, and very small occlusor notches. The ovicell contains the typical large eurystomellid pore plus two small lateral ovicell pores. It too might well be considered a separate genus.

Cook and Chimonides (1981) studied the structure of some species with rooted colonies as compared with similar non-rooted *Eurystomella* species, and the modified apical zooids seen by us in one discoidal colony may be modified for excurrent circulation. They also noted that Japanese reports of *E. bilabiata* show forms with furrows extending farther proximally from the occlusor notches than is generally the case in the eastern Pacific form, although that character is somewhat variable.

Type Locality and Type Specimens. Queen Charlotte Islands, British Columbia. BMNH 1897.5.1.809 labeled part of type.

Distribution. The range extends southward from Nootka Island, Alaska through British Columbia to southern California and to Navidad Head, Tenacatita, Mexico, which might be an area subject to cool water upwelling. The MMS station is west of Pt. Conception. BMNH 1885.8.29.1 from the Gulf of Tartary, Sea of Japan, appears to be the same under light microscopy examination. The species, or a very similar undescribed one, also occurs in the Pacific Islands collections of the authors.

"Dakaria" : Osburn, 1952; *incertae sedis*

Osburn (1952) and others placed a number of species in the genus *Dakaria* Jullien, 1903, in the family Schizoporellidae, although the species reported by him differ from the type of *Dakaria* and most Schizoporellidae. Jullien (1903), as translated by Osburn (1952), indicated that "...the orifice in young zooids with two lips juxtaposed at the extremities, the extremities of the anter enclosing between them those of the poster". Osburn interpreted this as meaning that the anter (distal rim) was longer than the poster (proximal rim), which it is, in the species attributed to the genus by Osburn. Unfortunately, the type of the genus, *D. chevreuxi*, as illustrated by Jullien (1903: 90, plate 10, figure 6), is identical to that of *Watersipora* Neviani, 1895, *Lepralia cucullata* Busk, 1854 (see Bassler, 1953 for copies of both types). Harmer (1957) concluded that the reverse was true, erroneously placing *Watersipora* in synonymy under *Dakaria*, perhaps a bit of biopolitics, since he was not an admirer of Arthur W. Waters. Both species lack spines, avicularia and ovicells.

Canu and Bassler (1920) placed three fossil and three Recent species in *Dakaria*, in another strange taxonomic decision. In the French scientist Canu's prose, translated by his American collaborator Bassler, they say: "All the species of this genus have not the special form of apertura mentioned by Jullien for *Dakaria chevreuxi*. But as this species must enter normally into the new genus we have adopted Jullien's name so as not to encumber the literature with a new term."

Canu and Bassler (1920) placed *Schizoporella condylata* and *D. magniporata*, both of Nordgaard (1906), in *Dakaria*, illustrating a perforate ovicell in the former species with frontal lines, perhaps sutural. Canu and Bassler also described as new two species, one with a perforate ovicell and one with an imperforate

ovicell. C.H. and E. O'Donoghue (1926) followed Canu and Bassler's lead in moving their *Schizoporella ordinata* and *S. pristina* Hincks into *Dakaria*, and later Osburn (1952) transferred *S. dawsoni* Hincks and several other species, some with spines, to the genus. *Schizoporella condylata* may belong in *Calyptotheca* Harmer (1957) which has a wide shallow apertural sinus, although most *Calyptotheca* have avicularia.

The quote in Osburn from Jullien concerning the way in which the distal and proximal rims meet applies better to the species discussed below under *"Dakaria"* and *Neodakaria*. The lateral portions of the distal transverse wall join the aperture as much as half way down the sides of the aperture, forming a high arch distally which encroaches well into the frontal wall of the next distal zooid, while the proximal rim turns downward and then forms an almost straight line or shallow curve for the proximal lip. This is especially evident in the ovicelled zooids. The operculum closes the ovicell.

Dakaria were defined as lacking avicularia, as is the case in the eastern Pacific species. Rogick (1962), however, described *Dakaria dabrowni*, which has spatulate frontal avicularia, and Canu and Bassler (1923) claimed that *D. chevreuxi*, the type species, has minute frontal avicularia, which are not evident in Jullien's illustration or description. Vigneaux (1949) erected the fossil genus *Stephanotrema*, which Bassler described as being like *Dakaria* with avicularia. Moyano (1965) proposed the genus *Dakariella*, with *D. dabrowni* as the type for those with avicularia, instead of using *Stephanotrema*, but added the further qualifications that the ovicell is not closed by the operculum and the sinus is wide and shallow. Hayward (pers. comm.) indicates that *Dakariella*, an endemic Antarctic genus, is systematically remote from the southern California *"Dakaria"* species.

The lack of a well defined sinus with a proximal dental ledge, narrow or wide, the position of the transverse wall, and the nature of the ovicells, which have a perforate entooecium partially covered by ectooecium or have large central pores, indicate that the *"Dakaria"* are not appropriate for inclusion in the *Schizoporella*, in which most had originally been placed. The question is, where do they belong, and we have discussed the options for each species included herein.

"Dakaria" dawsoni (Hincks, 1883)

Plate 69 A-B

Schizoporella dawsoni Hincks, 1883:449; 1884b:41. — C.H. and E. O'Donoghue, 1926: 102, pl. 4, fig. 39.
Schizoporella torquata Hincks, 1884b:41 (not *E. torquata* d'Orbigny).
Dakaria dawsoni: Osburn, 1952: 326, pl. 39, fig. 1, 2.

Material Examined. MMS Station: BRA-20. Other collections: AHF bottom sample 1190, Puget Sound; BMNH 1968.1.18.56 (O'Donoghue Collection).

Description. Colonies encrusting, with distinct lateral and transverse walls; transverse walls meeting aperture at sides; zooids irregularly rectangular, 550-750 μm long, 350-500 μm wide; frontal wall raised, coarsely porous; marginal pores slightly larger areolae. Aperture rounded, 180-200 μm wide, 140-160 μm high, with proximal lip straight or slightly curved, without a sinus, with frontal wall encroaching on lip giving a beaded appearance to rim; no condyles seen. No avicularia. Ovicells globular, partially immersed, with a large, irregular pore or scattering of large pores, indistinct distal margin; ovicell closed by the operculum.

Biology. Encrusting rock and shell; depths from shallow waters down to 50 m have been reported previously; the MMS records extend the depth range to 130.5 m.

Taxonomic Remarks. *"Dakaria" dawsoni* differs from other northeastern Pacific "*Dakaria*" species in having a large single pore or a few large, irregular pores in the frontal area of the ovicell hood separated from the proximal rim of the hood and covered distally by imperforate secondary calcification with irregular suture lines. The SEMs in Plate 69 of an O'Donoghue specimen indicate the irregular nature of the ovicell frontal pores, whereas Osburn's illustration (Figure 16) indicates more symmetry than is actually present in AHF and BMNH specimens.

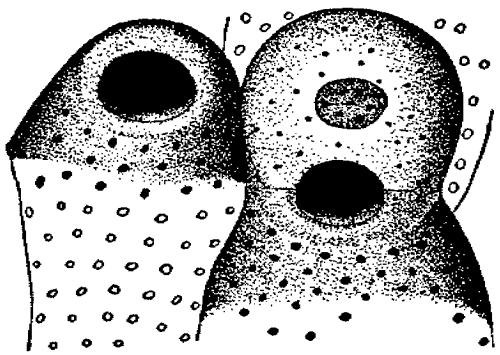


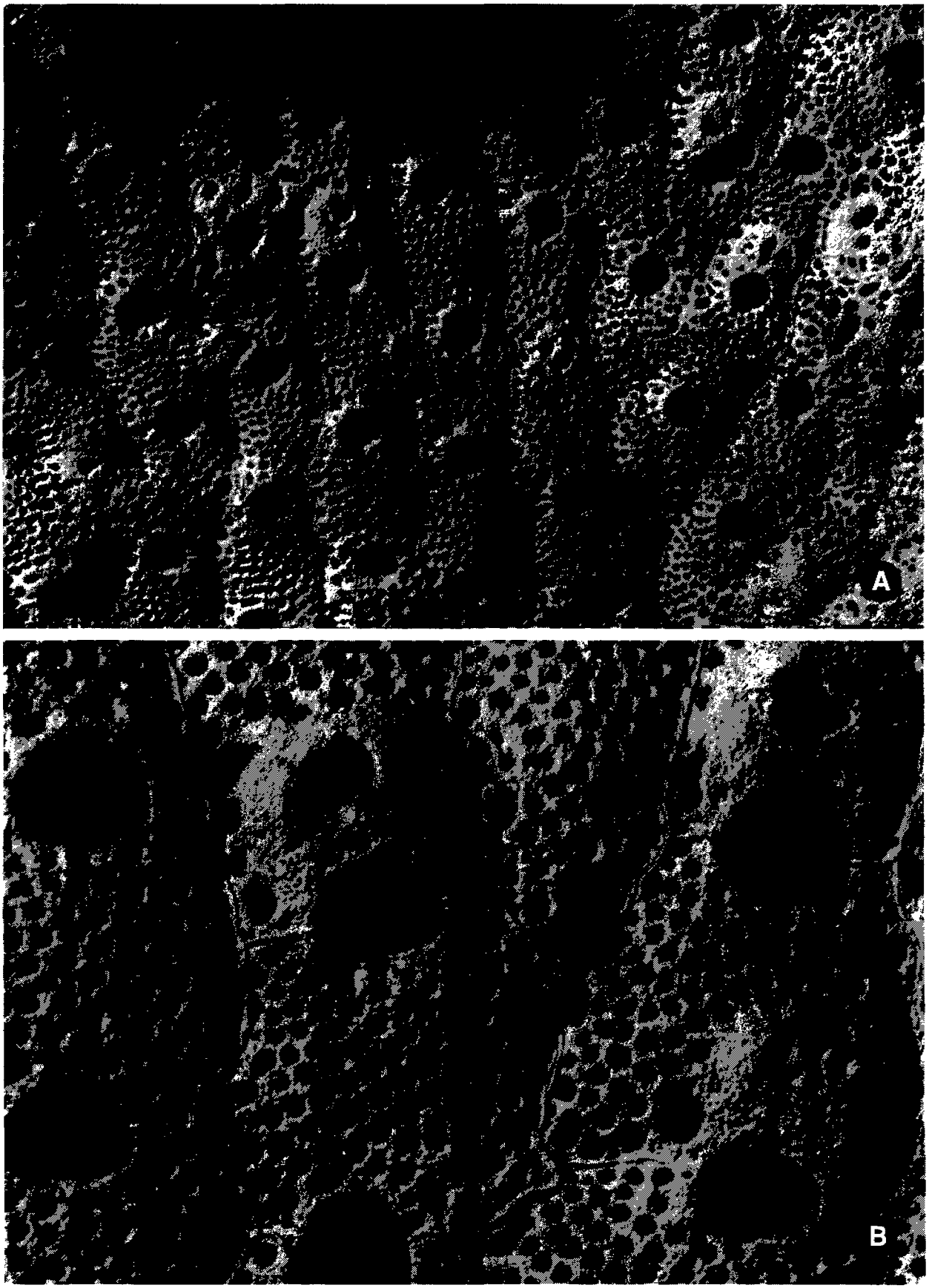
Figure 16. *Dakaria dawsoni*. From Osburn, 1952, pl. 39, fig. 1.

"Dakaria" dawsoni could be placed in *Stomachetosella* under the concept of the genus as used over the last 50 years, based on the appearance of the frontal wall with numerous pores and the ovicell with numerous irregular pores. *Stomachetosella sinuosa*, with a single ovicell pore, was illustrated by Osburn (1952) and Kluge (1975). However, it and other species placed in the genus have the typically oval primary aperture with a secondary aperture that has a clear proximal sinus (pseudosinus). The type species, *Stomachetosella crassicollis*, is a Tertiary fossil which was either erect or encrusting a branched substrate. We have not seen the type, but Canu's original illustration (1917:45, plate 4, figure 7) indicates that a peristomal collar surrounds both the aperture and the ovicell opening, and the sinus is marked by a small avicularium. *"Dakaria" dawsoni* lacks these features. The genus *Stephanotrema* Vigneaux (1949) was described from a Miocene fossil species, *Dakaria stricta*: Bassler (1953) described it as being like *Dakaria* with avicularia, which would still require the presence of a secondary proximal sinus. *Cigclisula*, another stomatochetocellid genus, has very large interzooecial avicularia not seen in *"D." dawsoni*. *"Dakaria" dawsoni* also resembles superficially our new species, *Dengordonia uniporosa*, except for the pronounced median denticle and avicularium which place the latter in the Smittinidae.

Type Locality and Type Specimens. First reported from Virago Sound, Queen Charlotte Islands, British Columbia; Hincks' specimen is in the BMNH but no type has been designated.

Distribution. From British Columbia to California; the MMS station is off Purisima Point, north of Pt. Arguello. O'Donoghues' specimen BMNH 1968.1.18.56, photographed by the BMNH, is from Pacific Grove, Monterey Bay, California.

Plate 69. *"Dakaria" dawsoni*. BMNH 1968.1.18.56, from the Queen Charlotte Islands. A. Colony reticulate, pores with granules, oval to D-shaped aperture; ovicells with varied large pores. B. Enlarged, ovicells with large, single pore or irregular pores; note transverse wall juncture at mid-lateral side of aperture.


A
B

Neodakaria, new genus, *incertae sedis*

Diagnosis. Colonies encrusting. Zooids rectangular or subrectangular, frontal walls reticulate, with large pores. Apertures with wide or narrow primary proximal sinus, arched distally; large or medium large, blunt condyles present. No spines, no avicularia. Ovicells with triangular or rounded frontal area of large irregular pores, not separated from margin of hood opening, remainder of hood covered by imperforate ectooecium, sometimes marked with transverse lines from distal or adjacent zooids; distal wall on either side of aperture of fertile zooid visible, incised at ovicell base.

Type Species and Type Locality. *Neodakaria islandica*, new species, SBMNH-AHF Bryozoa Holotype No. 220, from AHF Station 1123-40, off San Nicolas Island,

Taxonomic Remarks. This genus encompasses three species that had been considered part of *Dakaria ordinata* C.H. and E. O'Donoghue: Osburn, 1952, and *D. pristina* Hincks; the type and specimens of the latter are lost. The above species cannot remain in *Dakaria*, which has been placed in synonymy with *Watersipora*, and that genus lacks ovicells. The genus *Dakaria* as used by Canu and Bassler (1920, 1923), C.H. and E. O'Donoghue (1925, 1926), and Osburn (1952), included species with various types of ovicells and apertures. They do not appear to us to belong in Schizoporellidae, *sensu stricto*, based on the configuration of the ovicells and apertures, but we remain undecided as to the family in which they might best be accommodated.

Neodakaria ordinata (C.H. and E. O'Donoghue, 1923)

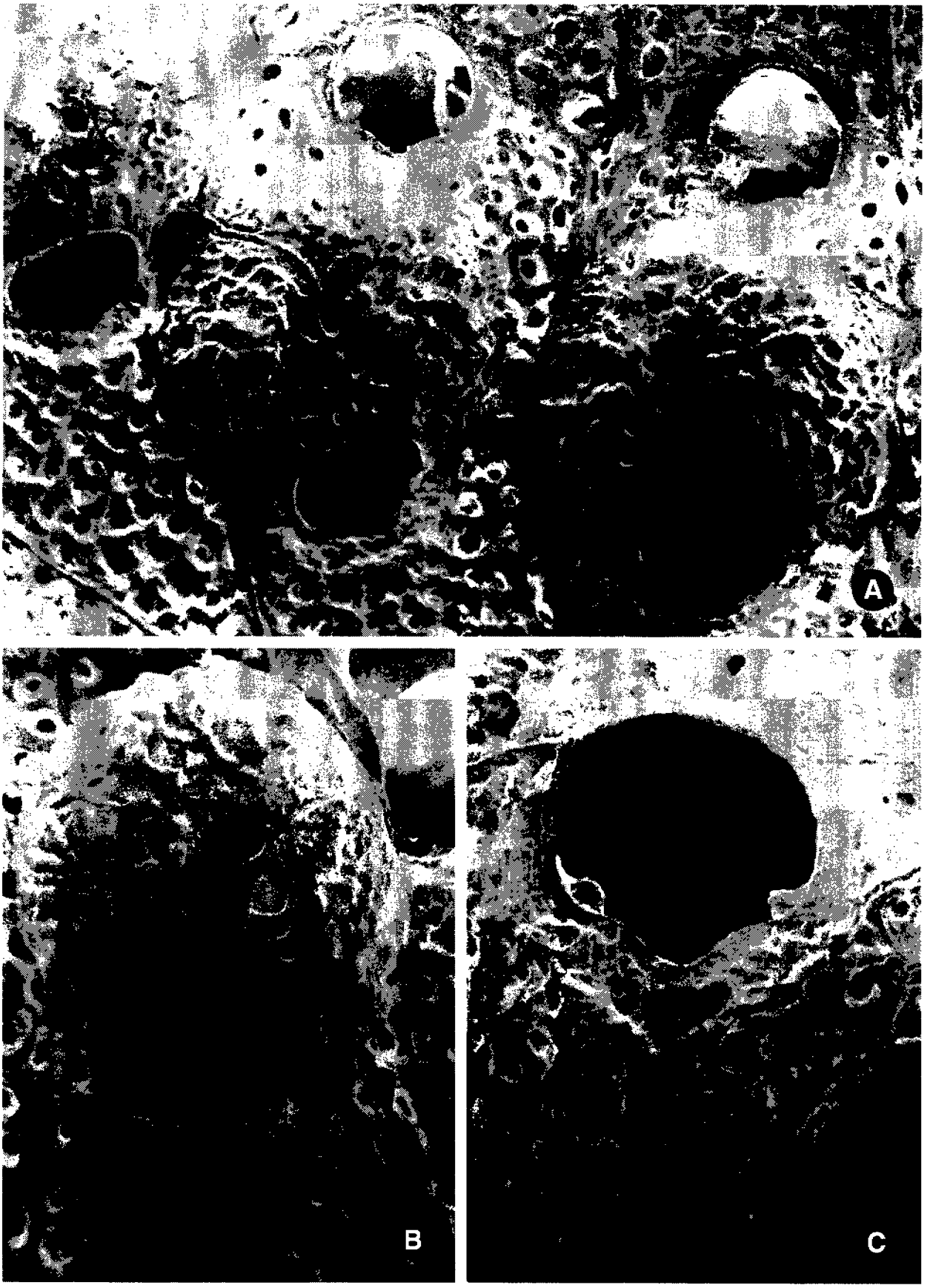
Plate 70 A-C

? *Schizoporella pristina* Hincks, 1883: 448, pl.17, fig. 6.
Schizoporella ordinata C.H. and E. O'Donoghue, 1923: 180, pl. 3, fig. 25.
Dakaria ordinata: C.H. and E. O'Donoghue, 1925: 103; 1926: 107.
? *Dakaria ordinata*: Osburn, 1952: 327, pl. 57, fig. 10-11 (in part). — J. D. Soule, 1961: 13.

Material Examined. AHF; BMNH: Collections of Hincks and C.H. and E. O'Donoghue; BMNH 1964.1.2.12 of *D. ordinata* identified by C.H. and E. O'Donoghue.

Description. Colonies encrusting. Zooids in rows unless crowded, large, about 600 to 800 μm long, 400 to 500 μm wide; frontal wall with large pores, with reticulate appearance. In older colonies frontal walls quite rugose, with roughened, imperforate suboral area; larger areolae at corners of zooids. Aperture arched distally, with transverse wall forming a shallow curve, lateral rims curving inward to large, blunt condyles, proximal rim continuing as a wide V-shaped curve with a depressed area below it, then a raised ridge; aperture about 210 μm wide, about 185 μm high. No spines or avicularia. Ovicell large, 450-475 μm wide, 350 μm high, covering much of next distal zooid frontal wall, a fan shaped, subtriangular frontal area above rim of hood with more or less regular arcuate group of pores in the entooecium; imperforate ectooecium covers rest of the ovicell, sometimes marked by transverse wall line from next distal zooid.

Plate 70. *Neodakaria ordinata*. BMNH 1964.1.2.12, selected holotype, marked "Pacific Coast of N. America" (C.H. and E. O'Donoghue, 1923, listed the species distribution as British Columbia and Puget Sound). A. Colony with three ovicells showing subtriangular frontal porous area similar to that in *D. pristina* Hincks, 1883, which has a circular aperture. B. Developing ovicell and apertures showing widely V-shaped sinus and blunt, triangular condyles. C. Detail of aperture, with depressed suboral area, secondary frontal wall calcification raised proximal to that.


A
B
C

Biology. Encrusting rock, shell and possibly algal stems, from intertidal to 70 m.

Taxonomic Remarks. Osburn (1952) gave the zooid length range for *D. ordinata* as 500 to 700 μm, with an aperture 150-180 μm wide and 130-150 μm high, whereas he gave *Dakaria pristina* as being 600-800 μm long, 400-500 μm wide, with a round aperture about 200 μm in diameter. Hincks (1883) did not observe ovicells in *D. pristina*.

SEMs of the O'Donoghue type of *D. ordinata* show a triangular ovicell frontal area that supposedly typifies Hincks' *D. pristina*, as illustrated by Osburn (Figure 18), which may be common to both species. The aperture in the type of *D. ordinata* has a more pronounced V-shape sinus, not the wide arc of Osburn's *D. pristina*. The latter aperture is typical of specimens identified by Osburn as *D. ordinata* from San Nicolas Island (AHF 1123-40), named herein as *N. islandica*. It has an aperture like that illustrated by Osburn (Figure 19), but a more triangular ovicell frontal area rather than the round, perforate area in the ovicell as illustrated.

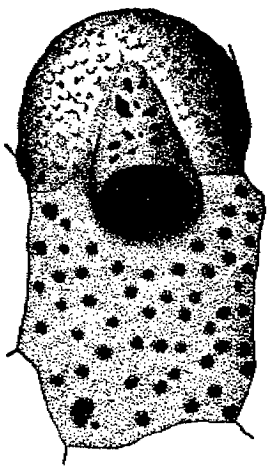


Figure 18.
Dakaria pristina.
From Osburn, 1952, pl. 39, fig. 3.

Schizoporella pristina was described by Hincks (1883) from Dolomite Narrows. We were unable to find the Hincks type BMNH 1968.1.18.57 or any other BMNH specimen to compare with *N. ordinata*. It is possible that the *N. ordinata* is a junior synonym of *N. pristina*, but there is no way of confirming that. However, Hincks (1883) emphasized that the aperture appeared round, and that a sinus was rudimentary, the operculum not incised at the condyles, while *N. ordinata* has a distinct V-shaped sinus, indicating that they are not synonymous. That might place it in a different genus if specimens could be located, but otherwise the species name should not be used.

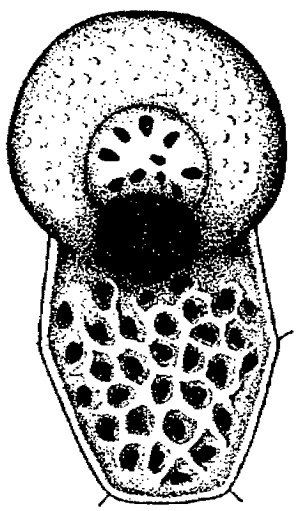


Figure 19.
Dakaria ordinata.
From Osburn, 1952, pl. 57, fig. 10.

Another form, found in Departure Bay, British Columbia and in the Channel Islands of California, has a more open, rounded ovicell with a porous frontal area and a large suboral umbo; we name it *N. umbonata* herein. At the time of Osburn's research, none of the BMNH O'Donoghue types had been located.

Type Locality and Type Specimens. *Dakaria ordinata* was reported by C. H. and E. O'Donoghue from Gabriola Pass, British Columbia and San Juan Island, Puget Sound. BMNH 1964.1.2.12 is hereby designated the holotype, although the specimen itself is labelled "from the Pacific coast of N. America.".

Distribution. The O'Donoghues also recorded *D. ordinata* from off Round Island, British Columbia. Although Osburn (1952) recorded it from Monterey Bay to Tanner Bank, some of these specimens would be included in *N. umbonata* and some in *N. islandica*. C.H. and E. O'Donoghue reported *D. pristina* from Gabriola Pass and off Round Island, British Columbia. Osburn extended the range to Dillon Beach, California, perhaps erroneously.

Neodakaria islandica, new species

Plate 71 A-C

Dakaria ordinata: Osburn, 1952: 327 (in part).

Material Examined. AHF and BMNH Collections.

Description. Colonies encrusting. Zooids irregularly rectangular, measuring 480-630 μm long, 350-450 μm wide. Frontal wall coarsely perforate, with larger pores at corners and with marginal slits. Aperture wider than high, 180-200 μm wide and 160-170 μm high. Lateral condyles prominent, thick knobs extending outward, curved downward, proximal lip with a wide, very shallow sinus, with a flat, roughened, imperforate suboral area. No spines. Ovicells prominent, hood 420 μm wide, 340 μm high, globular, with a central, arched, subtriangular or oval area having large, irregular pores above the aperture, the remainder of hood with an imperforate covering, incised at the base by transverse walls; ovicelled zooids about 765 μm long, closed by operculum.

Etymology. Named for its distribution in the Channel Islands.

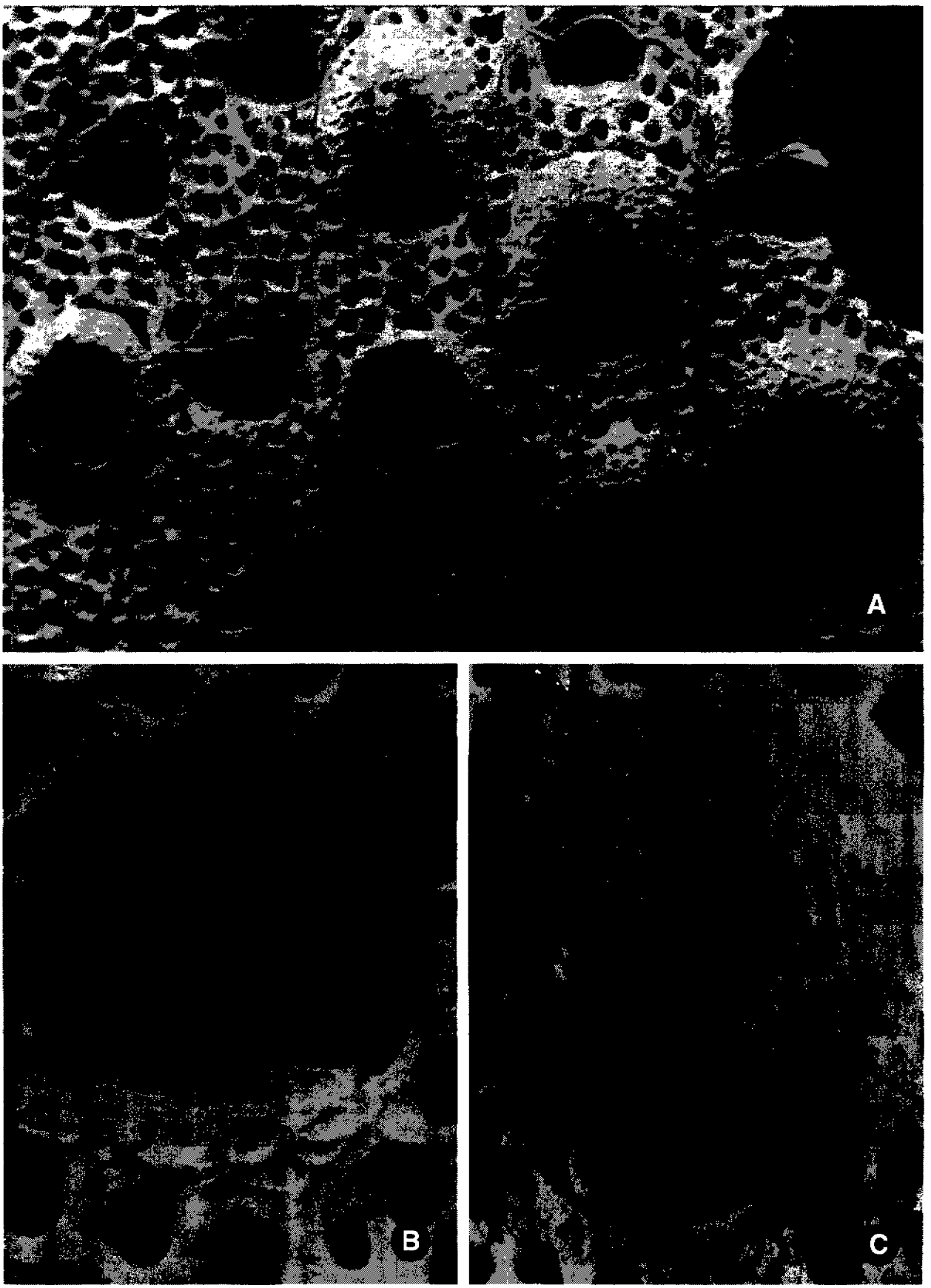
Biology. Encrusts shells, rock and possibly algae. Depths reported to 50 m.

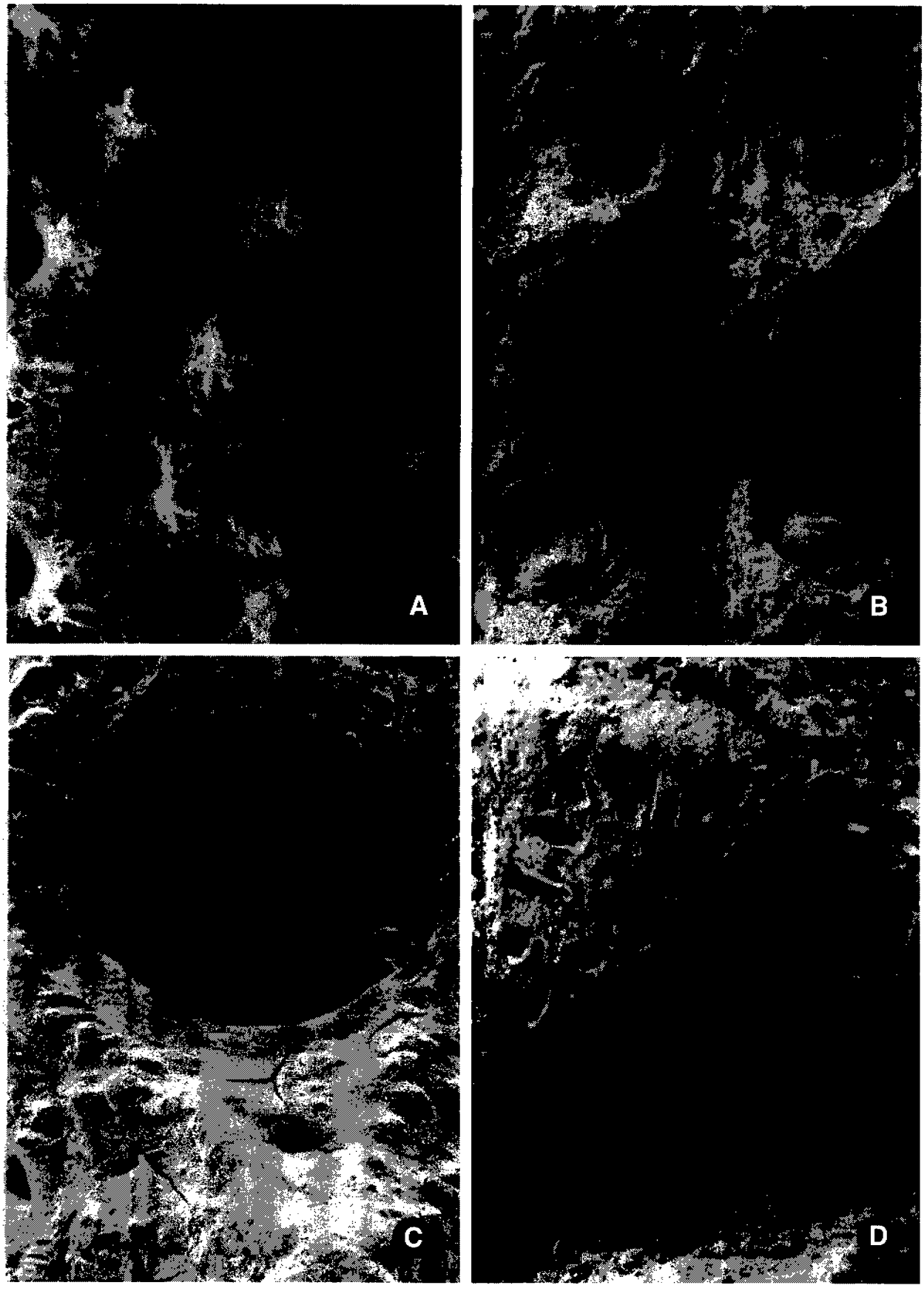
Taxonomic Remarks. In the absence of ovicells, the *Neodakaria* species may easily be confused without careful examination of the aperture shape; *"Dakaria" dawsoni* has an almost straight proximal lip, *N. ordinata* has a widely V-shaped sinus, and *N. islandica* has a more shallow arc for a sinus. *Neodakaria umbonata* has a more shallow sinus, really just a wide curve; the species is very similar to *N. ordinata* and was included in it by Osburn (1952), but it lacks the widely V-shaped sinus and the triangular appearance to the ovicell frontal porous area. The knoblike condyles are hooked downward as in *N. islandica*, rather than being the blunt, subtriangular denticles seen in the *N. ordinata* type. Without SEM, these differences would not be apparent.

Type Locality and Type Specimens. AHF Station 1123-40, off San Nicolas Island; SBMNH-AHF Bryozoa Holotype No. 220.

Distribution. Southern California Channel Islands, and 5 nautical miles south of San Pedro Bay; this species may be a southern species, extending to Baja California.

Plate 71. *Neodakaria islandica*. [OVER, LEFT] San Nicolas Island, California. A. Colony view; ovicells with curved, subtriangular porous area. B. Details of aperture, wider than high, with thick, hooked condyles, knob-like, shallow sinus, depressed area below it. C. Details of ovicell, with oblate pores at periphery of subtriangular area, irregular central pores; aperture shallower, with large condyles, shallow sinus, depressed area below it.


A
B
C


A
B
C
D

Neodakaria umbonata, new species

Plate 72 A-D

Dakaria ordinata: Osburn, 1952: 327, 328 (in part).

Material Examined. BMNH and AHF collections.

Description. Colony encrusting. Zooids subrectangular in young colonies, with large frontal wall pores, larger marginal areolae, 550-640 μm long, 320-400 μm wide, dominated by large suboral umbo, height up to 280 μm, with pores mostly calcified over. Aperture oval, arched distally, sides almost parallel, ending in large condyles, proximal rim with wide, slightly curved sinus; 160-200 μm wide, 140-180 μm high. Ovicells large, hood 400-550 μm wide, 340-350 μm high, raised on curved margins, becoming immersed; frontal area curved, large, with large pores, little encroaching imperforate area distally.

Etymology. Named for the pronounced suboral umbo.

Biology. Encrusts gravel, pebbles in sandy bottoms; depth records between 31 and 51.2 m.

Taxonomic Remarks. As discussed under *N. ordinata*, the AHF records of Osburn contain at least two other forms, one with very pronounced umbones. It is possible that production of umbones is associated with the unstable substrates such as shell and rock fragments which tumble about in the turbulent channel waters, with the umbones protecting the apertures from erosion. Several other species with umbones, quite unrelated to *Neodakaria, spp.*, have been found in the islands.

The aperture of *N. ordinata* has a relatively deep, V-shaped sinus; *N. islandica* has a wide, shallow sinus, while *N. umbonata* has almost no sinus, just a curved proximal rim. The ovicells are larger, with a larger frontal area and larger pores in *N. umbonata*, and the frontal wall is strongly umbonate.

Type Locality and Type Specimens. Off Santa Rosa Island, 2.25 nautical miles east of South Point; sand and gravel bottom; depth 28 fms (51.2 m). SBMNH-AHF Bryozoa Holotype No. 221.

Distribution. Southern California Channel Islands, south to San Pedro Bay, 5 nautical miles off San Pedro (Los Angeles) breakwater, and north to Monterey Bay, off Del Monte, California.

Plate 72. *Neodakaria umbonata.* [PREVIOUS, RIGHT] (A, C from Santa Rosa Island; B, D from San Pedro Bay, California.) A. Colony encrusting pebble, with large umbones; apertures wider than high. B. Zooids with opercula in place, muddy surface. C. Detail of aperture with knob-like condyles, umbo below. D. Detail of ovicell with larger, more rounded porous area.

Family Schizoporellidae Jullien, 1903

The family Schizoporellidae has been the recipient of almost any species with a porous frontal wall (tremocyst) and with a sinus in the proximal lip, the latter has been interpreted as almost any curve, however slight, in the proximal wall, up to and including a V-shaped or U-shaped sinus. Even though the definition has been restricted by various authors, the family is still quite broadly defined. The ovicell is closed by the operculum in most genera included in the family by Osburn (1952), except for *Schizoporella* itself and *Arthropoma*. We have included only species with a perforate frontal wall, although Hayward and Ryland (1979) included other genera with imperforate frontal walls and areolae, if a sinus is present. Avicularia are present or absent. The following two species are questionably placed in *Schizoporella*, under current concepts of the genus.

Schizoporella ? cornuta (Gabb and Horn, 1862)

Plate 73 A-D

Reptescharellina cornuta Gabb and Horn, 1862: 147. pl. 20, fig. 31.

Schizoporella biaperta: Hincks, 1883: 445; 1884a: 57; 211. — Robertson, 1908: 287 (in part), pl. 19, fig. 47. — C.H. and E. O'Donoghue, 1923: 177.

Stephanosella biaperta: Canu and Bassler, 1923: 99 (in part), pl. 99, figs. 4-9. — C.H. and E. O'Donoghue, 1925: 102; 1926: 104. — Hastings, 1930: 721.

Schizoporella cornuta: Osburn, 1952: 320, pl. 37, figs. 9-11. — J. D. Soule and M. Duff, 1957: 109. — J. D. Soule, 1961: 11. — D.F. and J.D. Soule, 1964: 15.

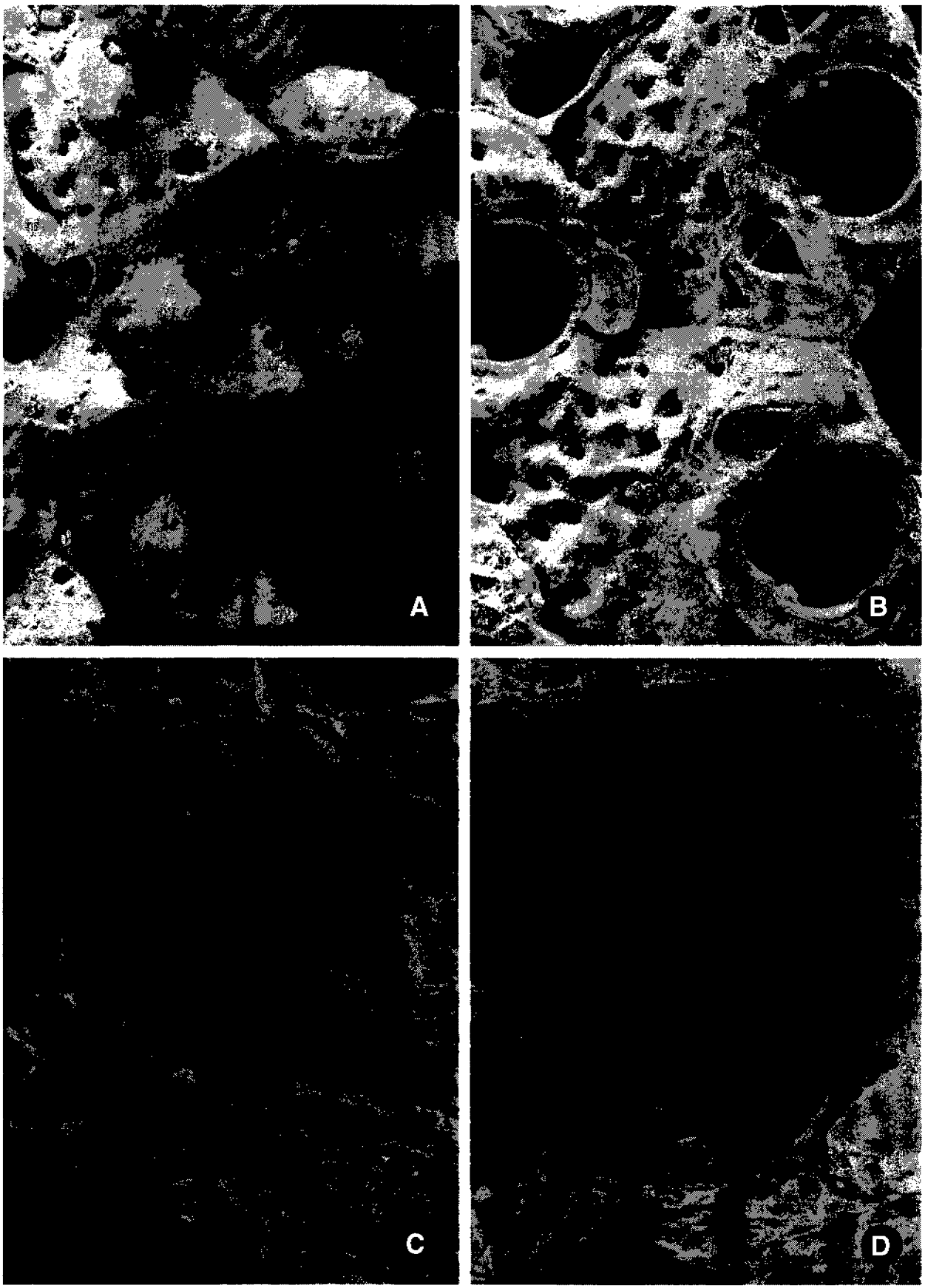
Material Examined. BMNH and AHF Collections.

Description. Colonies encrusting, thick, nodular. Zooids 400-450 µm long, 350 µm wide, irregularly quadrangular, their outlines obscure in older colonies. Frontal wall moderately inflated, with small pores in depressions, becoming occluded. Primary aperture 105-110 µm wide, 120 µm high, rounded distally, with prominent lateral condyles and a well defined U-shaped sinus proximal to narrow dental ledge; becoming surrounded by a low, rounded, secondarily calcified collar bordering thin peristome. Avicularia single, paired, or absent; if present, placed adjacent to aperture, originating from large areolae at distal corners, mandibles triangular, directed distolaterally. Ovicells globose, 200-250 µm wide, imperforate, with sunken circular frontal area of thick, rugose entooecium with radiating striae that may be obscured by secondary calcification, ectooecium forming a thick border around frontal area, with bar across rim; aperture flanked by bluntly acute avicularia on raised nodules; ovicell not closed by operculum.

Biology. Encrusts rock, shell and other firm substrates. Shallow waters down to more than 200 m.

Taxonomic Remarks. This species was confused with *Stephanosella biaperta* (Hincks, 1883), which has an imperforate frontal wall and large interzooecial avicularia; it is an Atlantic-Mediterranean species, if all reports are correct. We suspect that more than one species is involved in "*S. cornuta*" in the eastern Pacific, based on the location and size of the avicularium and on the bar across the front of the ovicell, or lack of it, as is shown in Osburn's illustration (1952: pl. 37, fig. 9).

Plate 73. *Schizoporella cornuta*. [OVER] Diablo Pt., Santa Cruz California. A. Colony with raised, paired avicularia. B. Zooids at growing margin with one or two avicularia; apertures with deep, widely U-shaped sinus, thick peristomal rim developing, frontal wall with numerous pores. C. Ovicell with paired, ovate avicularia; frontal area with roughly calcified central portion surrounded by thick ectocyst, bar across hood margin. Note thick apertural rim, heavily calcified frontal wall in zooid below. D. Detail of primary aperture.


A
B
C
D

Under the above concept of *Schizoporella, sensu stricto*, *S. cornuta* would not be included, based on the ovicell with large, imperforate entooecial area surrounded by imperforate ectooecium. Also, the frontal wall perforations are scattered rather than the uniform, reticulate character of the other species such as *S. unicornis*, for example. The pores in *S. cornuta* penetrate the frontal wall completely (visible from the inside). The ovicell of *S. cornuta* somewhat resembles that in *Buffonellaria* (see Plate 105), which has a larger entooecial area, with an ectooecial area surrounding it distally, with or without an ectooecial bar across the rim of the hood. *Buffonellaria* has an imperforate frontal wall, sometimes with a few scattered pores that do not penetrate the frontal wall completely. Nevertheless, Hayward (pers. comm.) suggests *Buffonellaria* for this species.

Type Locality and Type Specimens. Pleistocene, Santa Barbara, California. Location or existence of type material unknown.

Distribution. From Southern Alaska and British Columbia waters southward to Panama and the Galapagos Islands, if all citations are correct, which is doubtful.

Schizoporella ? inarmata (Hincks, 1884)

Plate 74 A-C

Schizoporella linearis Hassall, form *inarmata* Hincks, 1884a: 212.
Schizoporella linearis subsp. *inarmata*: Robertson, 1908: 291, pl. 20, fig. 48.
Schizoporella linearis var. *inarmata:* C.H. and E. O'Donoghue, 1923: 178; 1926: 104. — Osburn, 1952: 319, pl. 37, figs. 4, 5.
Schizoporella linearis inarmata: J. D. Soule and M. Duff, 1957: 110.
Schizoporella inarmata: J. D. Soule, 1961: 10.

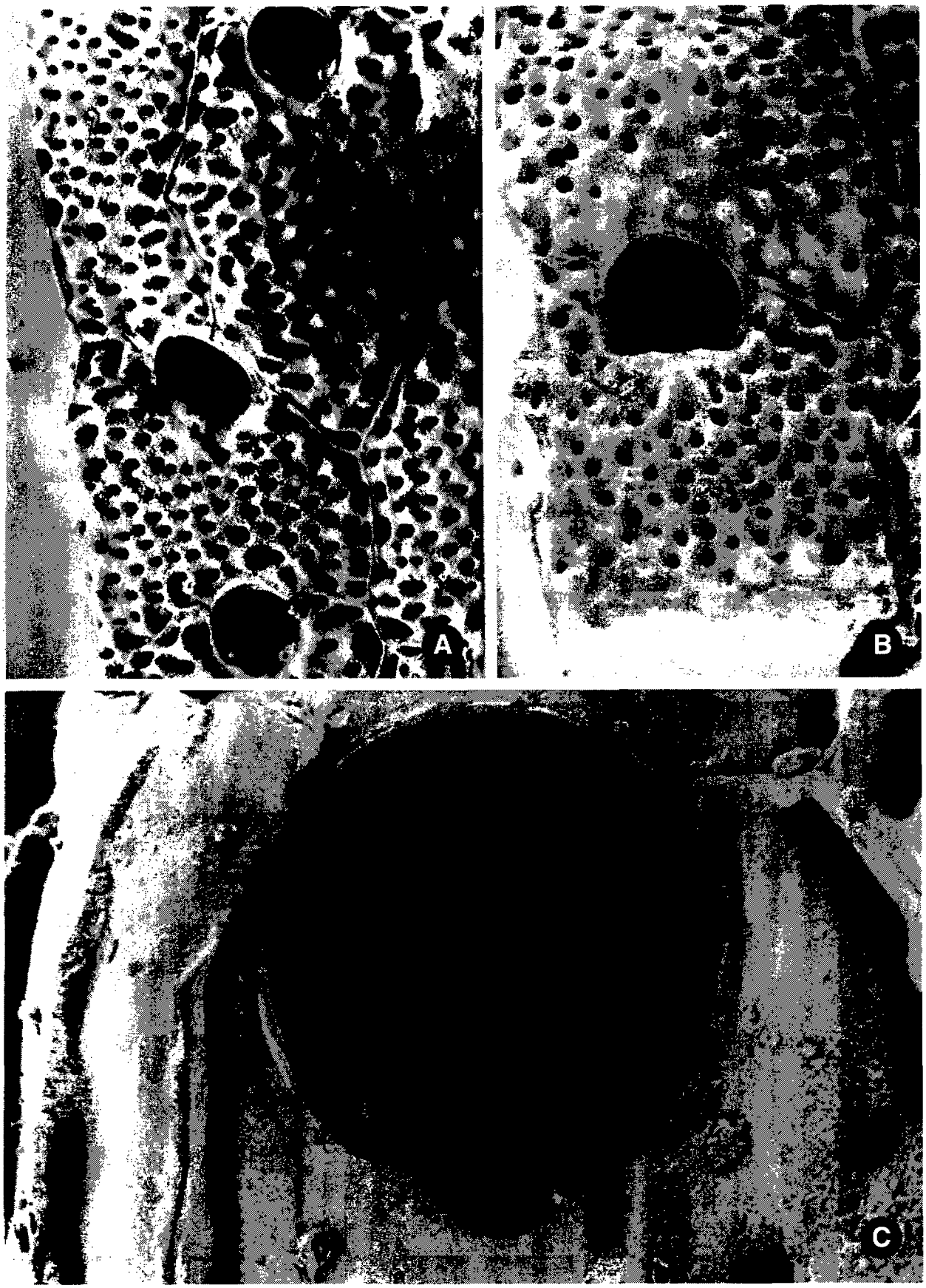
Material Examined. MMS Stations: BRC-1, BRC-2. Other collections: AHF and BMNH.

Description. Colonies encrusting, thin, unilaminar, glistening. Zooids irregular, ovoid to rectangular, 400-500 μm long, 300-450 μm wide; frontal wall perforated by many small pores, bordered by larger areolar pores along distinct lateral walls in young colonies. Aperture about 120 μm wide, 130 μm high including sinus, rounded distally, with distal rim arching above transverse wall; with a wide, U-shaped sinus proximally, with large burred condyles, directed downward. Some zooids (fertile?) lacking sinus. On older zooids a small umbo sometimes proximal to aperture. No spines, no avicularia. Ovicells globular, 300-310 μm wide, aperture wider than in autozooids; ovicell porous like frontal wall, becoming immersed, calcified over, indistinct.

Biology. Encrusting rock and shells. Depths from 3-4 m to 120 m were previously reported; the MMS records extending range to 126 m.

Taxonomic Remarks. Hincks listed the species as a form of *Schizoporella linearis*, now *Schizomavella linearis*, a common northeast Atlantic species. That species has spines and frontal avicularia directed variously, with few frontal pores, and the ovicell has a perforate frontal area bordered laterally and distally with imperforate ectooecium. There is no reason to consider *S. inarmata* a subspecies of *S. linearis*.

An as-yet unnamed species of *Schizoporella* from American Samoa also lacks spines and avicularia, but the aperture differs from that of *S. inarmata*, and the colony rapidly becomes multilaminar, throwing vertical walls upward while ovicells are still developing.


A
B
C

The present species is not characteristic of *Schizoporella* in that it lacks avicularia and apertural spines, and has immersed ovicells crossed by sutural lines from adjacent zooids. Gordon (pers. comm.) suggests that this species belongs in the genus *Calyptotheca* Harmer, 1957, a genus not previously recognized in the northeastern Pacific. We have examined many specimens of *Calyptotheca* in our own and BMNH Pacific Island material. Only one of those species, *Calyptotheca suluensis*, lacks avicularia, and its ovicells seem more apparent than those in *S. inarmata*. Harmer (1957) placed *Calyptotheca* in the family Schizoporellidae, based on the sinusoid aperture and perforate frontal wall, but Gordon (pers. comm.) suggests placement in the Lancioporidae Harmer, 1957, a family previously characterized by bilaminar, erect colonies, with lanceolate or lobate, sometimes keeled branches. Ovicells in some *Lanciopora* species are immersed and crossed by so-called sutural lines, as they are in some *Calyptotheca* species. None of the *Lanciopora* illustrated by Harmer (1957) have the large burred condyles so evident in *S. inarmata*, *Schizomavella acuta* (Osburn), *S. robertsoniae* new species, and in *C. janua* and *C. immersa*, illustrated by Gordon (1989), each with differing apertures, ovicells and placement of avicularia. A number of species, not related to *Calyptotheca*, which have rapid frontal budding show the so-called sutural lines across zooids and ovicells; the lines must be examined carefully to determine whether they are truly sutural for layers on the same plane as the zooids or are precursors of a new colony layer. Some smittinids and schizoporellids create multilayered, sometimes erect, colonies which begin with such lines.

Type Locality and Type Specimens. Queen Charlotte Islands, British Columbia, type material at the BMNH.

Distribution. From British Columbia to the California Channel Islands, the Gulf of California, and Costa Rica. The MMS stations are in the Santa Barbara Channel, off Capitan, and off Pt. Conception, north of Santa Rosa and San Miguel Islands, respectively.

Plate 74. *Schizoporella inarmata.* MMS 002-BRC, from the Santa Barbara Channel. A. Colony margin with large, sunken pores, distinct vertical walls, terminal apertures. B. Older area of colony with zooids becoming hypercalcified, ovicells submerged. C. Detail of aperture.

Schizoporella unicornis (Johnston, *in* Wood, 1844)

Plate 75 A-F

Lepralia unicornis Johnston, *in* Wood, 1844: 19.
Lepralia unicornis: Johnston, 1847: 329, pl. 57, fig. 1.
Schizoporella unicornis: Lagaaij, 1952: 65-66. — Osburn, 1952: 317 (in part), pl. 37, figs. 1, 2. — D.F. and J.D. Soule, 1964: 14. — Hayward and Ryland, 1979: 18-169, fig. 67.

Material Examined. MMS Station: BRA-6.

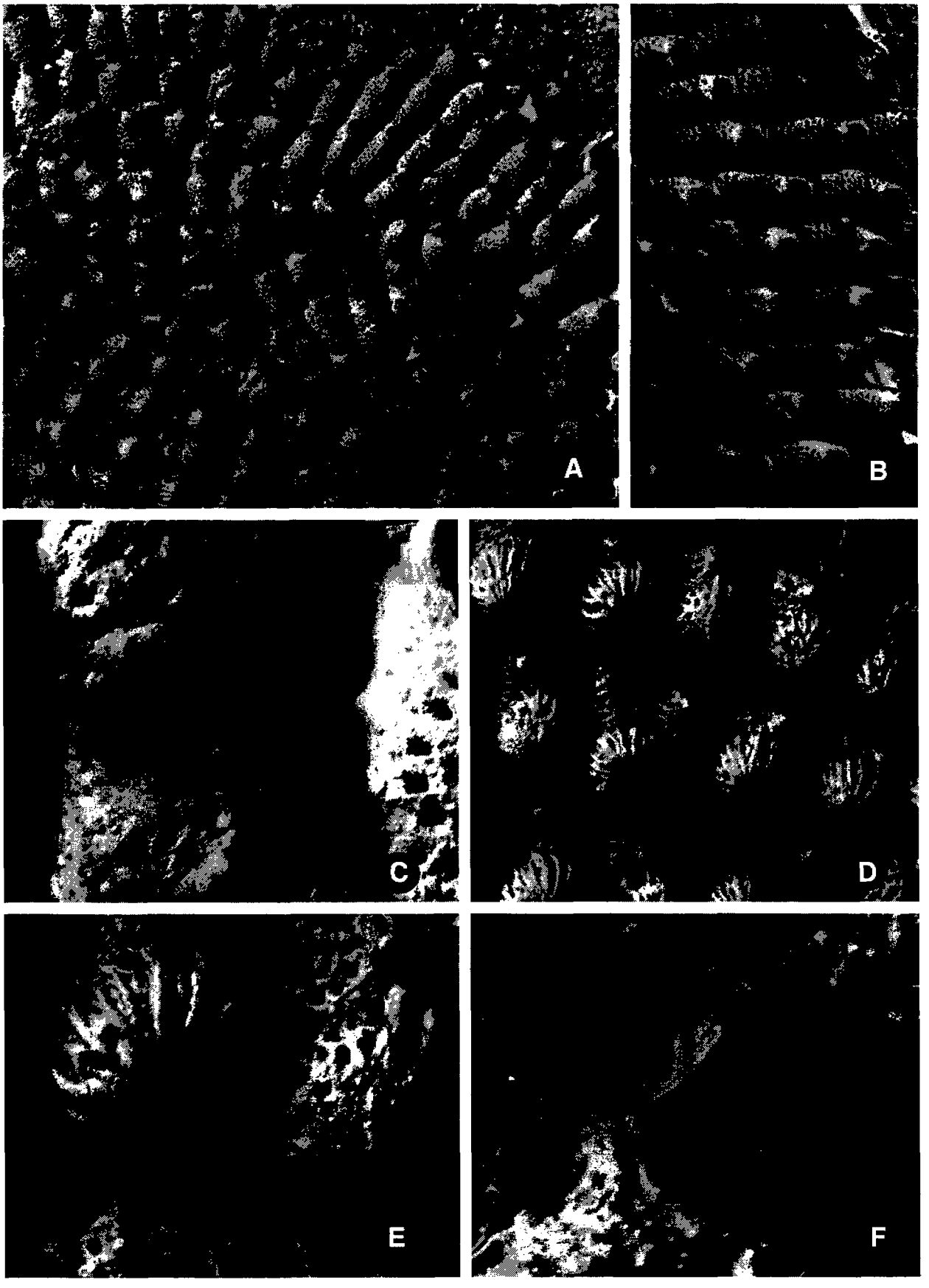
Description. Colonies encrusting, spreading in circular patches where possible, often multilaminar. Zooids 600-760 μm long, 300-500 μm wide, rectangular to hexagonal, sometimes in alternating rows (quincuncial). Frontal wall with many large and small pores, larger marginal pores. Aperture 165-175 μm wide, 150-180 μm high, almost round or wider than high; primary aperture rim somewhat sunken, rounded distally, no spine scars; proximal rim with dental ledge bearing shallow sinus, wider in some zooids than others, depending on zooid width, between blunt condyles; sometimes a small suboral umbo. Avicularia paired, single or absent, flanking aperture or lower, flanking umbo; rostrum small, or sometimes bulbous, acute mandibles directed distolaterally. Ovicells raised, globular, porous, with radiating ribs, sometimes with an umbo.

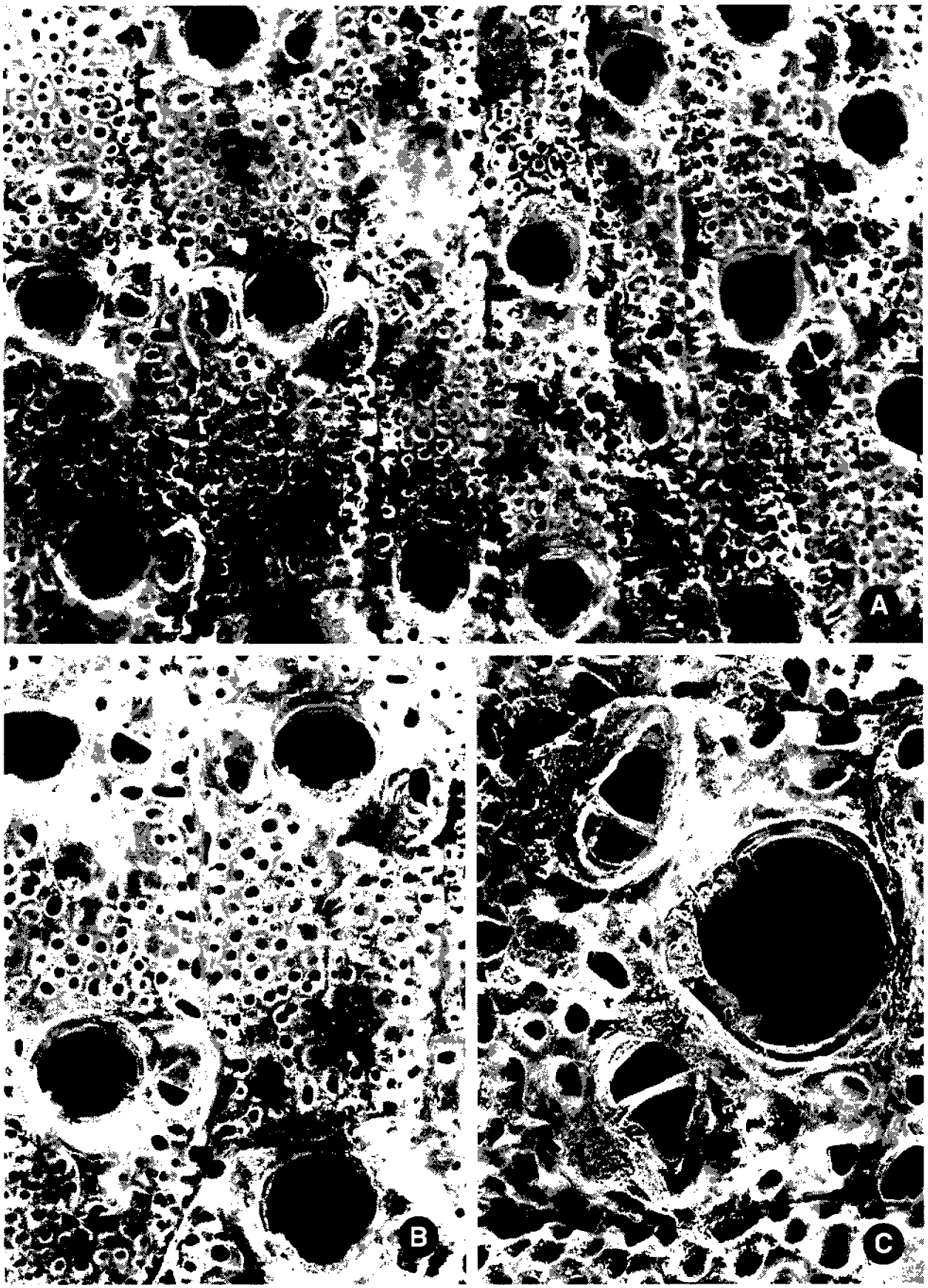
Biology. Yellowish colonies encrusting shells, rock and especially ship's hulls. Depths from shallow intertidal to over 60 m had been recorded, if all citations were of the same species; MMS record extends the depth to 63 m. Colonies with embryos in the ovicells show pink through the translucent hoods. Hayward and Ryland (1979) describe the ancestrula as a small, imperforate zooid with a semicircular aperture bearing eight spines on the distal margin, giving rise to two zooids with perforate frontal walls and sinusoid apertures.

Taxonomic Remarks. Johnston's 1844 manuscript was in C.V. Wood's *Descriptive Catalogue of the Zoophytes from the Crag*. Although the species was recorded from that Plio-Pleistocene fauna, and later from the Recent in Britain, *S. unicornis* did not occur in published records in the eastern Pacific until that of Osburn (1952), who hypothesized that it was introduced on Atlantic oysters brought in for mariculture. It appeared in G.E. MacGinitie's collections of Elkhorn Slough, a wetlands entering the south side of Monterey Bay, California, six years after seed from Japan of *Crassostrea gigas* oysters was introduced in Morro Bay, south of Monterey Bay in central California. According to Powell (1970), *C. gigas* was also introduced into the Strait of Georgia, British Columbia, in the 1930s, while *S. errata* (Waters, 1878) was introduced in southern California on *Crassostrea virginica* oysters imported from the Atlantic to central California. Ross and McCain (1976) indicated that imports of *C. gigas* began as early as 1907, with many shipments in subsequent years, but *S. unicornis* was not reported in the surveys of Robertson (1905) nor of C.H, and E. O'Donoghue (1923, 1925, 1926). The species may be periodically reintroduced on ship's hulls or on new oyster seed.

According to Hayward and Ryland (1979) *S. unicornis* is a cool temperate Atlantic species, although it has been reported from the Indian Ocean, the western Pacific and Hawaii. There have been extensive discussions that there is a single species in the eastern Pacific, which has been identified by some as *Schizoporella errata*, a warm temperate Atlantic and Mediterranean-Atlantic species. There are problems with this either-or philosophy, because we have found both *S. unicornis* and *S. pseudoerrata, n. sp.,* in

Plate 75. *Schizoporella unicornis.* Lectotype BMNH 47.9.16.174, marked "Recent, Britain". A. Growing margin of colony, with one, two or no avicularia on zooids; ovicells developing lower right. B. Detail of margin. C. Aperture with wide sinus, small, flat condyles. D. Ovicells with umbones, ridged and perforate hoods. E. Detail of ovicell with narrower sinus. F. Detail of lateral oral avicularium.


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E
F


A
B
C

Elkhorn Slough collections, but not what we consider to be true *S. errata*. As discussed in the Introduction, California has periods of warm water flow from the south and cold water flow from the north, plus upwelling along coastal promontories, and power plant effluents which warm waters near Elkhorn Slough. There is no question but they occurred in the same locality, but the microhabitats may have differed.

There are some small differences between the lectotype of *S. unicornis* and the California specimens, but we hesitate to describe these as species level differences, given the range of variation possible. Through the kindness of Dr. Paul Taylor, we have examined SEMs of the lectotype designated by Lagaaij of *S. unicornis*, BMNH 47.9.16.174, marked "Recent, Britain", and another specimen, BMNH 42.12.19.5, collected by Johnston, marked "British coast". In the California specimens, the dental ledge bearing the sinus is a wider, curved arc, below blunt condyles, whereas the lectotype shows a narrower U-shape incised in the ledge and smaller, flattened condyles. In the latter, large areas of the growing margin of the colony have no avicularia and, where present, they are small and not much inflated; umbones are small but erect.

An undescribed form with large, paired, bulbous avicularia occurs in Newport Bay, south of Los Angeles to the Galapagos Islands. The large, paired, bulbous avicularia with setose mandibles generally associated with the species were not seen in central California specimens, being found only in southern California and Baja California, and in the Galapagos Islands. If *S. errata* has only one avicularium consistently, these colonies cannot be that species, because they may have one, two or no avicularia, and sometimes have large, secondarily budded avicularia above old zooids. The paired avicularia are somewhat similar to those in *Schizoporella occidentalia* D.F. and J. D. Soule, 1964 described from Scammon's Lagoon (Ojo de Liebre), Baja California, but it is a much smaller species, with a narrower sinus. *S. occidentalia* also has two distal spines on young marginal zooids, and one avicularium is sometimes modified to a rodlike spine in place of a mandible.

Type Locality and Type Specimens. BMNH lectotype 47.9.16.174, designated by Lagaaij (1952), Recent, Britain. Lagaaij (1952) lists the original species as *Lepralia unicornis* (Wood *ex* Johnston MS), rather than Johnston *in* Wood, as we have, since Johnston was the actual describer.

Distribution. Distributed from Monterey Bay southward to the Channel Islands in California; the MMS station is off Point Arguello. Hayward and Ryland (1979) give a distribution from the Faroe Islands and western Norway, south to northwest Africa and the western Mediterranean, and north of Cape Cod, in the western Atlantic.

Schizoporella pseudoerrata, new species

Plate 76 A-D

Not *Lepralia errata* Waters, 1878: 11, pl. 1, fig. 9.
Schizoporella unicornis: Osburn, 1952: 317 (in part).
Not *Schizoporella errata*: Ryland, 1965: 64; 1968: 534. — Hayward and Ryland, 1979: 170-171, fig. 68.

Material Examined. BMNH and AHF Collections.

Diagnosis/Description. Colonies encrusting, regularly oriented in first layer, becoming heaped by frontal wall budding. Zooids subhexagonal, 540-750 μm long, 350-50 μm wide, margins indistinct; without pores distal to the aperture, pores irregular, becoming sunken over rest of frontal wall, none on avicularium rostrum; aperture wider than high, curved distally above thin, semierect condyles, proximally margin with

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Plate 76. *Schizoporella pseudoerrata*. Elkhorn Slough, California. A. Colony with one, two or no avicularia. B. Zooid with two avicularia, shallow sinus with slim, erect condyles. C. Lateral view, detail of aperture with erect, acute condyles.

a wide, curved, shallow sinus within dental ledge, aperture 160-189 μm wide, 140-180 μm high, including sinus. One, 2 or no avicularia beside aperture or proximolateral to it, with rostra directed distolaterally where present, sometimes flanking a small umbo; no avicularia with longer, setose mandible. Ovicell hood porous, sometimes with ribs, becoming immersed.

Biology. Encrusting shells, rock, ship's hulls, pier pilings. Usually found in shallow, intertidal or subtidal waters, but in deeper water on shell fragments; the depth range is uncertain due to the confusion with other species, especially *S. unicornis* and *S. errata*.

Taxonomic Remarks. Osburn (1952) included a wide range of variation in his description of *"S. unicornis"*, which would include the warm temperate and tropical forms of *S. errata, S. mazatlanica* (Busk, 1856), and *S. occidentalia*. The dimensions of *S. errata* given by Hayward and Ryland, 1979 are similar to those of the new species, but no larger avicularia with setose mandibles have been seen in material from the AHF Collections except in that from the Gulf of California.

We have not found the erect, cylindrical, branched or foliaceous growths associated with *S. errata*, according to Hayward and Ryland (1979), although colonies of many species growing outside their optimal ecological range do not produce more than encrusting colonial growth. There is a power plant nearby at Elkhorn Slough that warms waters in the area somewhat. We have assembled material of *S. errata* from North Carolina and the Gulf of Mexico that also have the characteristic avicularia and a narrower, U-shaped sinus that we consider to be *S. errata*. In some of the Gulf of California specimens, however, two avicularia are present, one of which may appear to have been frontally budded secondarily.

Schizoporella mazatlanica from the Gulf of California is another species with, apparently, a single avicularium, and a somewhat thickened apertural rim. The type specimen is battered and has no ovicells, but the possibility exists that this might be *S. errata*, based also on its reddish brown color. In that case, *S. mazatlanica* would have priority over *S. errata* (Waters), 1878, a widespread warm temperate species found in the Mediterranean, along the Atlantic African coast and from North Carolina, the Caribbean and Brazil.

Hayward and Ryland (1979) synonymized Pouyet's (1971) *S. violacea* (Canu and Bassler) from the coast of Tunisia with *S. errata*. Pouyet illustrated diamond shaped zooids with the single avicularium originating from a single areolar pore adjacent to the apertural sinus. Rampant frontal budding of vertical body walls produces elaborate branching colonies. A similar, undescribed species from Hawaii has single avicularia originating from three to five areolar pores proximal to the aperture. We did not find elaborate colonies, however. The Hawaiian ovicells more resemble those of *S. unicornis* than *S. errata/violacea*.

Type Locality and Type Specimens. Elkhorn Slough, Monterey bay, central California. SBMNH-AHF Bryozoa Holotype No. 222.

Distribution. The distribution of *S. pseudoerrata* must be limited at this time to central and southern California pending further study. *S. errata, sensu lato* is a warm-temperate-subtropical species that has been reported primarily from harbors as a fouling organism from Britain to the Mediterranean, western Africa, the Red Sea and Persian Gulf, in the western Atlantic from South Carolina to Brazil, and in the Gulf of Mexico. On the eastern Pacific coast, it apparently occurs in the Gulf of California, if the form with two avicularia is included.

Schizomavella Canu and Bassler, 1917

The genus *Schizomavella* was defined briefly by Canu and Bassler as follows: "The operculum closes the ovicell. The muscular attachment is usually in the immediate vicinity of the border of the operculum. The rimule [sinus] is wide and arched. The frontal is a tremocyst. The median avicularium occurs on the frontal wall...."

Although Osburn (1952) mentioned the criterion that the ovicell is closed by the operculum in *Schizomavella* whereas it is not in *Schizoporella*, there is a mistake in his key (1952: 316) which indicates that the ovicell in neither genus is closed by the operculum, an error that should be disregarded. The ovicells of some supposed *Schizomavella* species resemble more the smittinid ovicells, with perforate hoods bordered distally by imperforate ectooecium or encroaching frontal wall calcification.

Schizomavella auriculata (Hassall, 1842)

Plate 77 A-D

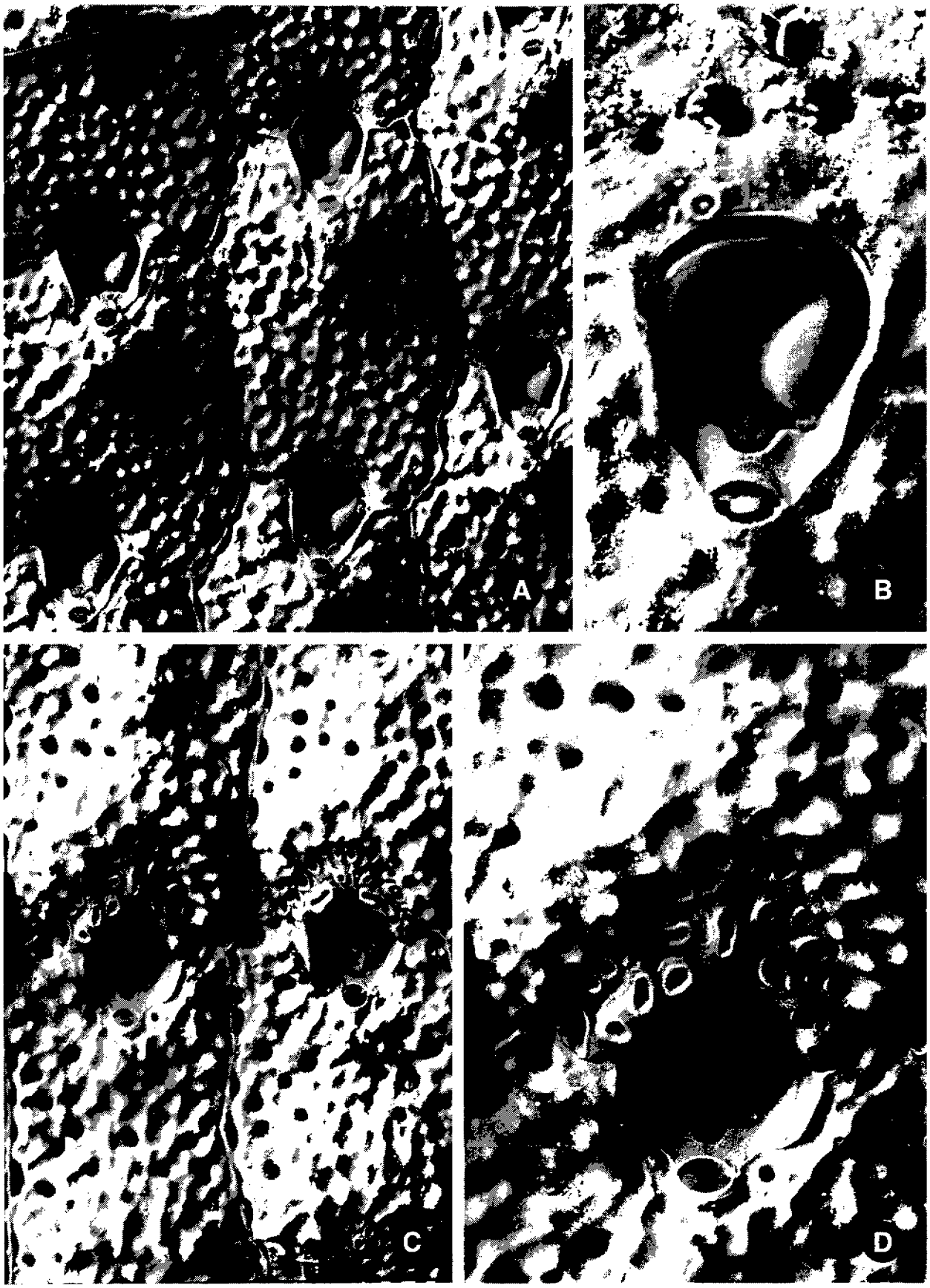
Lepralia auriculata Hassall, 1842: 412.
Schizoporella auriculata: Hincks, 1880c: 260, pl. 29, figs. 3-6, 9.
Not *Schizoporella auriculata*: Robertson, 1908: 286, pl. 19, fig. 39. — Osburn, 1952: 331, pl. 38, fig. 5.
? Schizomavella auriculata: Hayward and Ryland, 1979: 176, fig. 72 A-D.

Material Examined. BMNH and AHF Collections.

Taxonomic Remarks. Although *Schizomavella auriculata* has been reported in the northeastern Pacific by Hincks (1880c), Robertson (1908) and Osburn (1952), this species probably does not occur in the northeastern Pacific.

The type species of the genus *Schizomavella* is *Lepralia auriculata* Hassall, 1842, from Ireland. There is considerable confusion as to the nature of this species, which Hassall described as a reddish crust, even when dried, but Johnston (1847) described it as white to cream colored. Hincks (1880), described the British species as bright red, with 3-4 spines, with a small or large median suboral avicularium, both occurring in a single colony. The avicularia appear to lie proximal to the aperture and sinus, outside of the dental ledge, and not be connected with it in Hincks' illustrations. However, his specimens indicate otherwise.

The *S. auriculata* from the British Isles may be a mixture of species, although it is known to have considerable variation due to secondary growth and frontal budding. Supposedly it has a mixture of suboral avicularia, some small and rounded, and some longer and spatulate, and three to four spines. A Hincks specimen from Plymouth, BMNH 1963.3.30.176 (illustrated here) is reddish, and has only small rounded avicularia which are an integral part of the dental ledge. The ledge itself provides articulation and has a strong, U-shaped sinus. The aperture is higher than wide, pyriform, with three or four spine scars, opening subtriangular, with the widest portion near the junction of the transverse walls, narrowing proximally. The name *auriculata* means ear shaped, which fits the subtriangular, or pyriform, aperture but not the form with round apertures and wide proximal sinus. Pyriform apertures are not seen in specimens identified by Osburn (1952) as *S. auriculata*. Hayward and Ryland (1979) concluded, as we have, that the species does not occur in the eastern Pacific, although the material they illustrated (1979: 177, fig. 72) does not have an ear shaped pyriform aperture. The ovicell is immersed, irregularly rugose, with a frontal arc of large, irregular, rimmed pores.


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D

Another British specimen, illustrated by Gordon (1984) as *S. auriculata*, has six spines, a round aperture, and large condyles separate from the dental ledge, which is slightly depressed at the lateral corners and contains a U-shaped sinus; it does possess two sizes of suboral avicularia. Gordon mentioned that Powell (1967a) described a BMNH specimen, without giving a specimen number, of *S. auriculata* from Guernsey with the triangular operculum such as that illustrated here in Plate 77, a characteristic Gordon attributed to the genus *Metroperiella*. However, that genus has no oral spines and has evenly perforate frontal walls and ovicells.

Several species may in fact be involved in British and Atlantic waters and that the eastern Pacific material must be redescribed. There may also be a need for separate genera or subgenera to represent those species with a pyriform aperture from those with a rounded aperture and wider sinus.

Schizomavella acuta Osburn, 1952

Plate 78 A-D

Schizomavella auriculata acuta, new variety Osburn, 1952: 332, pl. 38, fig. 7-9.

Material Examined. MMS Station: BRC-1. Other collections: AHF and BMNH.

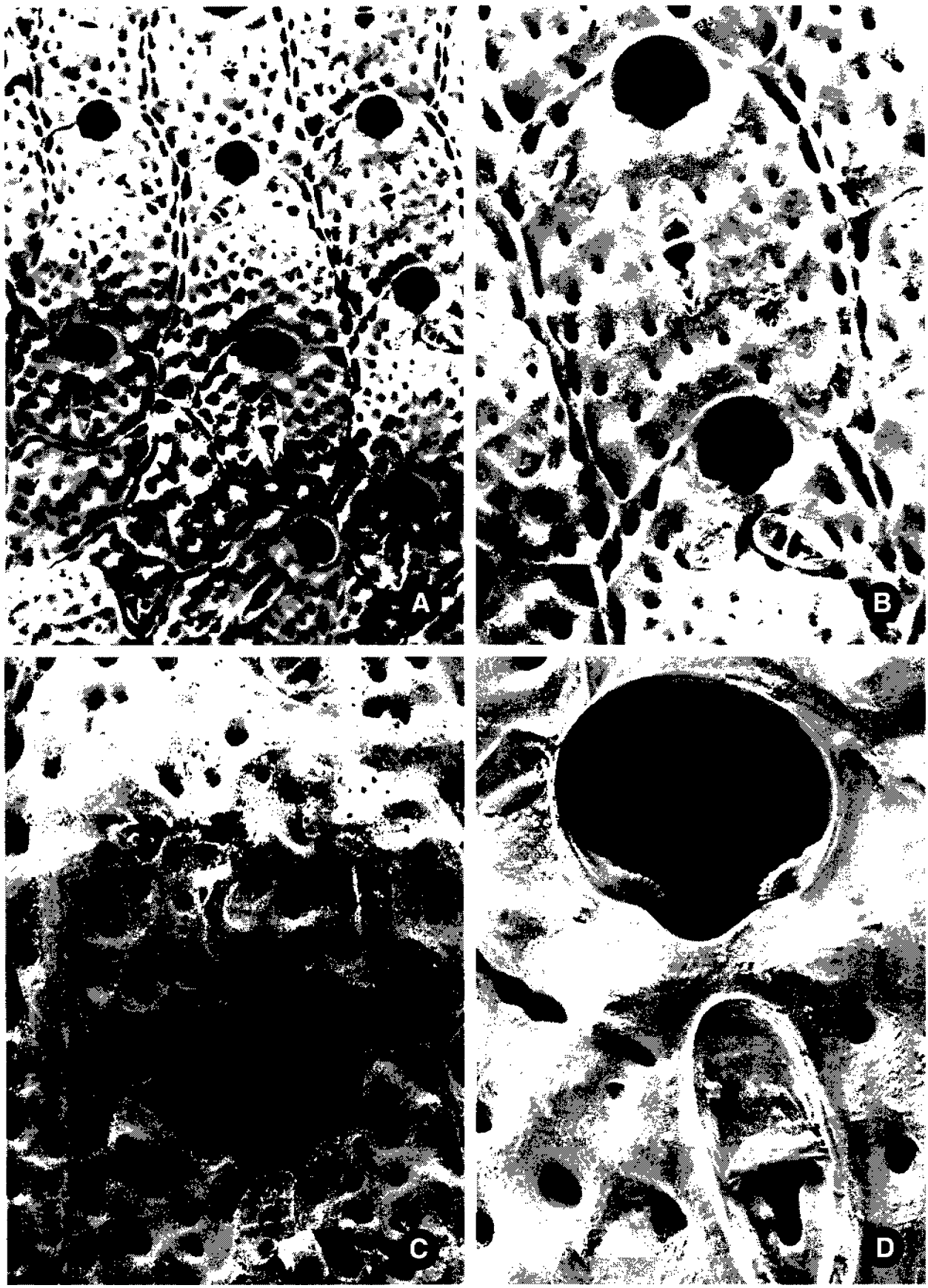
Description. Colonies encrusting; common. Zooids irregularly quadrate to rhomboid, 400-420 μm long, 310-335 μm wide, frontal wall rugose, weakly raised, with small pores, becoming reticulate, sometimes with calcified nodules (papillae). Kenozooids present; so-called sutural lines across frontal walls suggest frontal budding; zooids distal to ovicells shortened proximally. Zooidal walls distinct, bordered by areolar pores, with transverse walls joining the aperture below the distal rim. Aperture 100-110 μm wide, 100-110 μm high, rounded distally and laterally, with a very shallow proximal sinus, no dental ledge; condyles large, with layers producing a cogged appearance. Avicularia short or long, 100-190 μm long, 120-130μm wide, not raised, located upon the midline a short distance proximal to the aperture, not within or connected to sinus, acute mandible directed proximally or proximolaterally; avicularia distal to ovicelled zooids sometimes directed proximolaterally due to encroachment of the hood. Ovicells large, 330-350 μm wide and 320-340 μm long, globular, with tiny perforations all over between radiate ridges, becoming sunken, hypercalcified and merged into next distal zooid.

Biology. Encrusts rock and shell. Depths reported from 35 m to 110 m.

Taxonomic Remarks. As discussed under the genus and the type species, above, there are differences in the British specimens of *S. auriculata* that distinguish them from the eastern Pacific material. The difference between the pyriform shape of aperture of *S. auriculata, sensu stricto* is distinctive. Other differences such as the inclusion of the avicularium within the sinus are difficult to observe without SEM. The suboral avicularium in the type of *S. auriculata, s.s.* is small and rounded, although Hayward and Ryland (1979) illustrated one form with raised, spatulate suboral avicularia. *Schizomavella acuta* has avicularia rounded distally with an acute mandible directed proximally, not raised, 100-190 μm long.

The juncture of the distal transverse walls at the sides of the aperture and the porous frontal of the ovicell with an imperforate surface distally in the type species is reminiscent of the *Neodakaria* spp., which lack avicularia. The ovicells in *S. acuta* and *S. robertsoniae* are more evenly perforate except where they become obscured by further calcification.

Plate 77. *Schizomavella auriculata.* BMNH 1963.3.30.176, from Jersey, U.K. A. Colony showing pyriform apertures with small avicularium as part of dental ledge below small sinus. B. Detail of aperture. C. Ovicells with frontal porous area, imperforate ectocyst merging with distal zooid. D. Detail of ovicell aperture with narrow sinus.


A
B
C
D

Winston and Heimberg (1986) described and illustrated *Schizomavella inclusa* (Thornely, 1906), from Komodo, Indonesia, which is similar to *S. acuta* in aperture and has a median avicularium that is more proximal but about half as long as those in *S. acuta*. It is an IndoPacific species.

Type locality and type specimen. Santa Cruz Island, California, AHF Sta. 1662-48. SBMNH-AHF Bryozoa Holotype No. 65.

Distribution. Previously known, as *S. auriculata acuta* (Figure 19), from Santa Cruz Island and Santa Catalina Island, off Whale Rock, Channel Islands, and off San Pedro Harbor, to Cortes Bank, off the California-Baja California border, and off Espiritu Santo Island, AHF1738-49, in the Gulf of California; the MMS station is in the Santa Barbara Channel, California. A specimen from Albemarle Pt. in the Galapagos Islands is a separate, undescribed species.

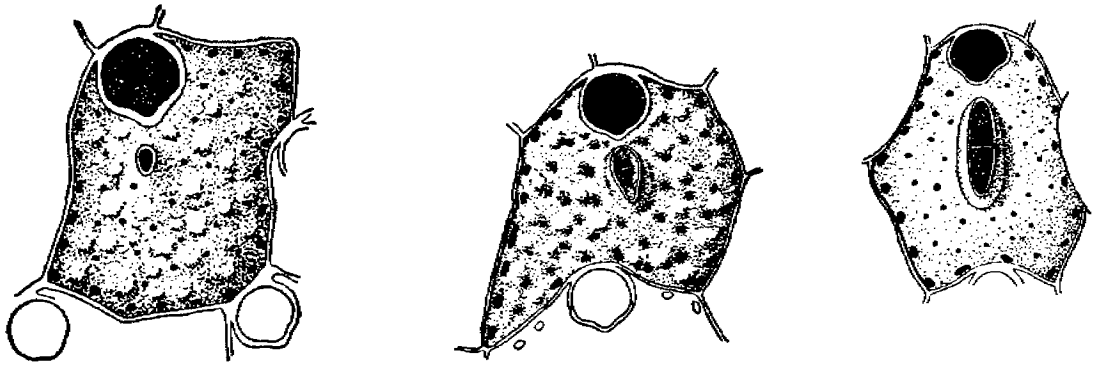
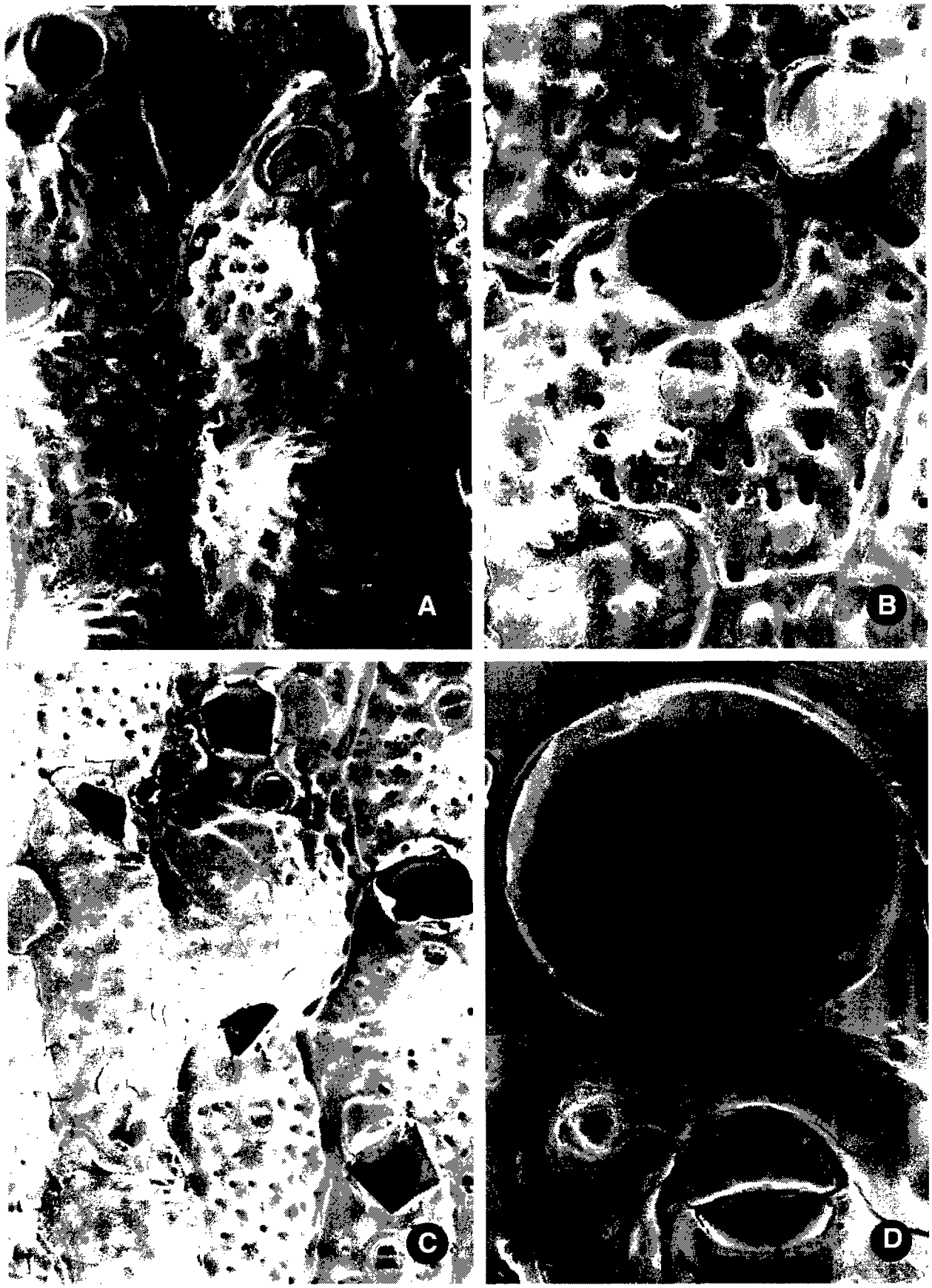


Figure 20. *Schizomavella auriculata acuta.*
From Osburn, 1952, pl. 38, figs 7-9.
All zooids from the same colony.

Plate 78. *Schizomavella acuta.* Cortes Bank, off Southern California. A. Colony with suboral avicularia directed proximally or proximolaterally. B. Zooids with avicularia variously oriented. C. Detail of ovicell with pores becoming hypercalcified, aperture narrowed. D. Detail of aperture with layered condyles; transverse walls join aperture at distolateral apertural rim. Suboral avicularium lies outside sinus.


A
B
C
D

Schizomavella robertsonae, new species

Plate 79 A-C

Schizoporella auriculata: Robertson, 1908: 286, pl. 19, fig. 39.
Schizomavella auriculata: Osburn, 1952: 331 (in part), pl. 38, fig. 5.

Material Examined. BMNH and AHF Collections.

Diagnosis/Description. Colonies encrusting. Zooids irregularly rhomboid to hexagonal, 370-450 μm long, 300-350 wide, with frontal wall mostly perforate, with nodules between pores. Aperture almost as high as wide, 115 μm wide, 95-110 μm high, sometimes with four spine scars, rim curving to large, blunt condyles, with a wide, shallow, V-shaped sinus proximally. Operculum very strong, with wide rim sclerite, fitting sinus as well. Below the sinus, a small, round or oval avicularium directed proximally, sometimes on a rugose or nodular umbo or pedestal. Ovicell with a nodular, ridged hood, with small perforations before hypercalcification.

Biology. First reported by Robertson as *Schizoporella auriculata* from off the Coronado Islands just south of the California-Baja California border, at 182 m depth.

Etymology. Named for Dr. Alice Robertson, whose publications through the University of California at Berkeley were the first to examine the living central and southern California bryozoan fauna. She was a professor and department chair at Wellesley College prior to her untimely death, reportedly in a flu epidemic.

Taxonomic Remarks. If the proximal dental ledge containing the sinus in the *S. auriculata* specimen from Plymouth, shown in Plate 77, is considered to be a generic characteristic, then a number of species with rounded apertures and condyles separate from the dental ledge, if present, do not belong to the genus, or should be in separate subgenera.

Hayward and Ryland (1979) interpreted *Schizomavella auriculata ochracea* (Hincks, 1880c: 260, pl. 29, figs. 3-9), as being the form of *S. auriculata* in which the preponderance of avicularia were longer and subspatulate. The specimens originally marked *S. ochracea* by Osburn in the AHF collections having a suboral avicularium that is rounded distally and acute proximally, are now incorporated into *S. acuta*, elevated herein from *S. auriculata acuta*, new variety, Osburn, 1952. The suboral avicularia of *S. robertsoniae* are single, small and round, sometimes on an umbo, whereas those on *S. triavicularia* may occur as a single oval suboral one or be flanked laterally by a pair of similar avicularia. The ovicell of *S. robertsoniae* is nodular and ridged with small pores between, while that of *S. triavicularia* has large frontal pores with an imperforate ectooecium covering much of the hood.

The calcified nodules on the frontal wall (the papillae of others) are also found on *S. acuta*. They may be further evidence of frontal budding, supporting a new layer. The so-called sutural lines are more likely the beginnings of new vertical zooid walls for frontal budding.

Type Locality and Type Specimens. Robertson's types have been lost by mixing them with other specimens at the CAS. The type locality of the new species is AHF Station 1281-41, off Santa Rosa Island, California Channel Islands at 26 fms (47.5 m) depth. SBMNH-AHF Bryozoa Holotype No. 223.

Distribution. Presently known from the Channel Islands to the Coronado Islands in deeper waters.

Plate 79. *Schizomavella robertsonae.* Santa Rosa Island. A. Growing edge of colony with crater-like avicularian rostra in rugose umbones. B. Zooid with operculum overturned beside it; suboral avicularium. C. Uncleaned colony with ovicell, pores obscured. D. Detail of aperture with layered condyles and sinus.

Schizomavella triavicularia, new species

Plate 80 A-C

Schizomavella, species A: MMS record.

Material Examined. MMS Station: BRC-1. AHF Collections.

Diagnosis/Description. Colonies encrusting. Zooids mostly quadrate, 480-520 μm long, shorter distal to ovicells, 470-500 μm wide, distinct, with a moderately raised frontal wall with small pores, becoming reticulate; areolae small next to distinct lateral walls. Aperture surrounded by a low peristome, distal portion bearing 3 erect spines; transverse walls meeting aperture proximal to spines, aperture rounded distally and laterally; proximally, large, blunt condyles behind small U-shaped sinus in a narrow dental ledge, incised on either side. Below sinus and not connected to it, a small median avicularium 50-60 μm long, with complete hinge bar, with a rounded mandible directed proximally, 2 small pores flanking base of avicularium. On zooids with mature ovicells, 3 oval avicularia, 1 median, proximal to aperture directed proximally, and a pair flanking the aperture directed proximolaterally. Ovicells globose, 280-310 μm wide, with a porous irregular frontal area, smoothly calcified ectooecium distally.

Biology. Encrusting rock and shell. Depths reported as 69-73.5 m.

Etymology. The name *triavicularia*, refers to the three avicularia.

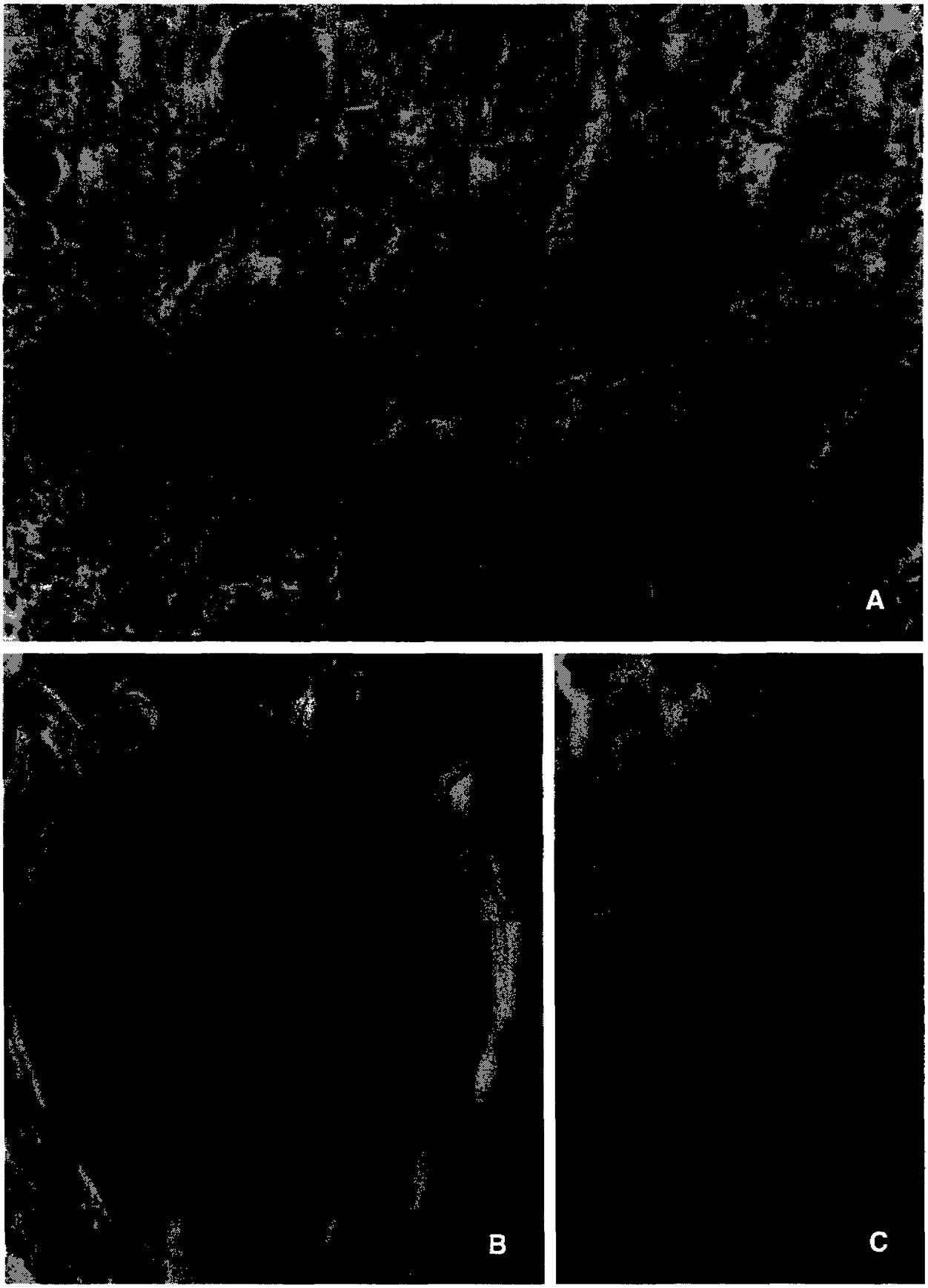
Taxonomic Remarks. Affinities of the new species are close to *Schizomavella incurvata* (Uttley and Bullivant, 1972); however it has an imperforate frontal wall with only a single row of areolar pores. Gordon (1989) examined the paratype of *Lacerna incurvata*. His description and SEM indicate the presence of four or five spines, six to 14 areolar pores that are set in from the lateral walls, and a frontal shield that is smooth. The aperture is pyriform but the condyles are curved downward toward the sinus, which is immediately distal to the small, rounded suboral avicularium. Sometimes there are additional oval avicularia flanking the ovicelled peristome, as is the case in *S. triavicularia*. Uttley and Bullivant reported five or six spines as compared to three spines in the new species.

The ovicell in *Schizomavella auriculata* (Plate 77) is similar to that in *S. triavicularia*. The position of the transverse walls and the nature of the ovicells are reminiscent of those in *Neodakaria* spp., which lack avicularia.

Type Locality and Type Specimens. Locality AHF Station 1304-41, off Santa Cruz Island in the Santa Barbara Channel; SBMNH-AHF Bryozoa Holotype No. 224.

Distribution. Channel Islands off California, southward to the Galapagos Islands.

Plate 80. *Schizomavella triavicularia*. MMS station 001 in the Santa Barbara Channel. A. Colony showing zooids with one median, suboral avicularium, ovicelled zooids with one median and two lateral oral avicularia, directed proximally or proximolaterally. B. Aperture with three spine scars, suboral avicularium proximal to sinus, not connected to it, shelflike blunt condyles, small sinus. C. Detail of ovicell, with arched perforate frontal area, imperforate distally.


A
B
C

Family Smittinidae Levinsen, 1909

The original description of the Smittinidae focused on the presence of a median denticle (lyrula), and prominent lateral oral condyles (cardelles), with the genus *Smittina* described as having either a perforate frontal wall or areolae only. The aperture is rounded, sometimes with distal spines, and with a secondarily developed peristome, which may or may not surround a suboral avicularium. In the older concept of the genus, avicularia might be median suboral, or lateral frontal (adventitious), or interzooecial (vicarious). Ovicells might be perforate or not, often with pores in the primary ovicell layer and the secondary covering encroaching from adjacent zooids in various ways. We consider that the large grouping with perforate ovicells, often bounded by a secondary rim, is typically smittinid; Gordon (1994) uses it as a superfamily in contrast with the superfamily having ridged "schizoporellid" ovicells, usually with tiny pores.

Osburn (1952) contributed significantly by dividing the genus *Smittina*, limiting that genus to species with a porous frontal, usually a porous ovicell not closed by the operculum, and a median suboral avicularium. His genera *Smittoidea* and *Parasmittina* have areolar pores only, the former with a median avicularium and the latter with lateral avicularia, often paired, and porous ovicells not closed by the operculum. *Parasmittina* spp. dominate the Hawaiian fauna (D.F. and J.D. Soule, 1973), whereas both *Parasmittina* and *Smittina* are well represented in the eastern Pacific.

Osburn also included in the Smittinidae the genus *Porella*, which has only areolar pores, an imperforate ovicell and a small lyrula, and the genus *Rhamphostomella*, usually having an eccentric suboral avicularium beside a sinus. He indicated that *Rhamphostomella* probably should be divided into two groups: those with a lyrula and/or condyles, and those without a lyrula. Hayward and Thorpe (1988) created the genus *Rhamphosmittina* for an Antarctic species with a lyrula and condyles and a transverse suboral avicularium. This limits *Rhamphostomella* to species that lack lyrula and possibly condyles, and have a costate frontal wall; these probably should remain in *Rhamphostomella*, the type of which lacks a lyrula. It is a northern hemisphere circumpolar group. Kluge (1962, 1975) created the family Rhamphostomellidae, removing the genus from Smittinidae. Gordon and Grischenko (1993) examined the type species of two genera, *Ramphostomella scabra*, and *Rhamphosmittina bassleri*, placing them, with *Porella*, in Porellidae, elevated from subfamily Porellinae Vigneaux, 1949.

Other genera have been added to the Smittinidae over the years, some with lyrula and some without. Among the lyrulate forms, the genus *Alismittina* D.F. and J.D. Soule, 1964 has interzooecial avicularia, as have some *Parasmittina* species (D.F. and J.D. Soule, 1973). *Smittina pseuodacutirostris* Gostilovskaya, 1957: 451, fig. 4, is an arctic deep water species that should be placed in *Alismittina*, based on the description of Kluge, 1975: 534, fig. 284.

The genus *Hemismittoidea* D.F. and J.D. Soule, 1973 with the type species *H. corallinea*, from Hawaii, has a lyrula and a median suboral avicularium which arises from a median pore and a distolateral areola, whereas *Smittoidea* avicularia arise from a distolateral pore on each side. We add herein the genus *Dengordonia*, which parallels the symmetry of avicularium formation in *Hemismittoidea* but has a porous frontal wall. The type species is *D. uniporosa*, new species.

Gautier (1962) established the genus *Prenantia* for species with a lyrula, and without spines, without suboral avicularia, and with ovicells having numerous pores, or with few or none. Hayward and Ryland (1979) modified this tentatively to include species with suboral avicularia. Hayward (1979) added the genus *Porelloides* for some specialized forms with a lyrula, and Hayward and Ryland (1979) included *Palmicellaria*, which lacks a lyrula, in the Smittinidae.

Another new genus *Raymondcia* added herein, with the type species *R. osburni*, has an ovicell formed with tripartite layers contributed by adjacent zooids, with pores few or none, restricting *Smittina* to species with pores more or less uniformly over most of the ovicell primary layer, such as those in the type species *Smittina landsborovii*, redescribed below and figured.

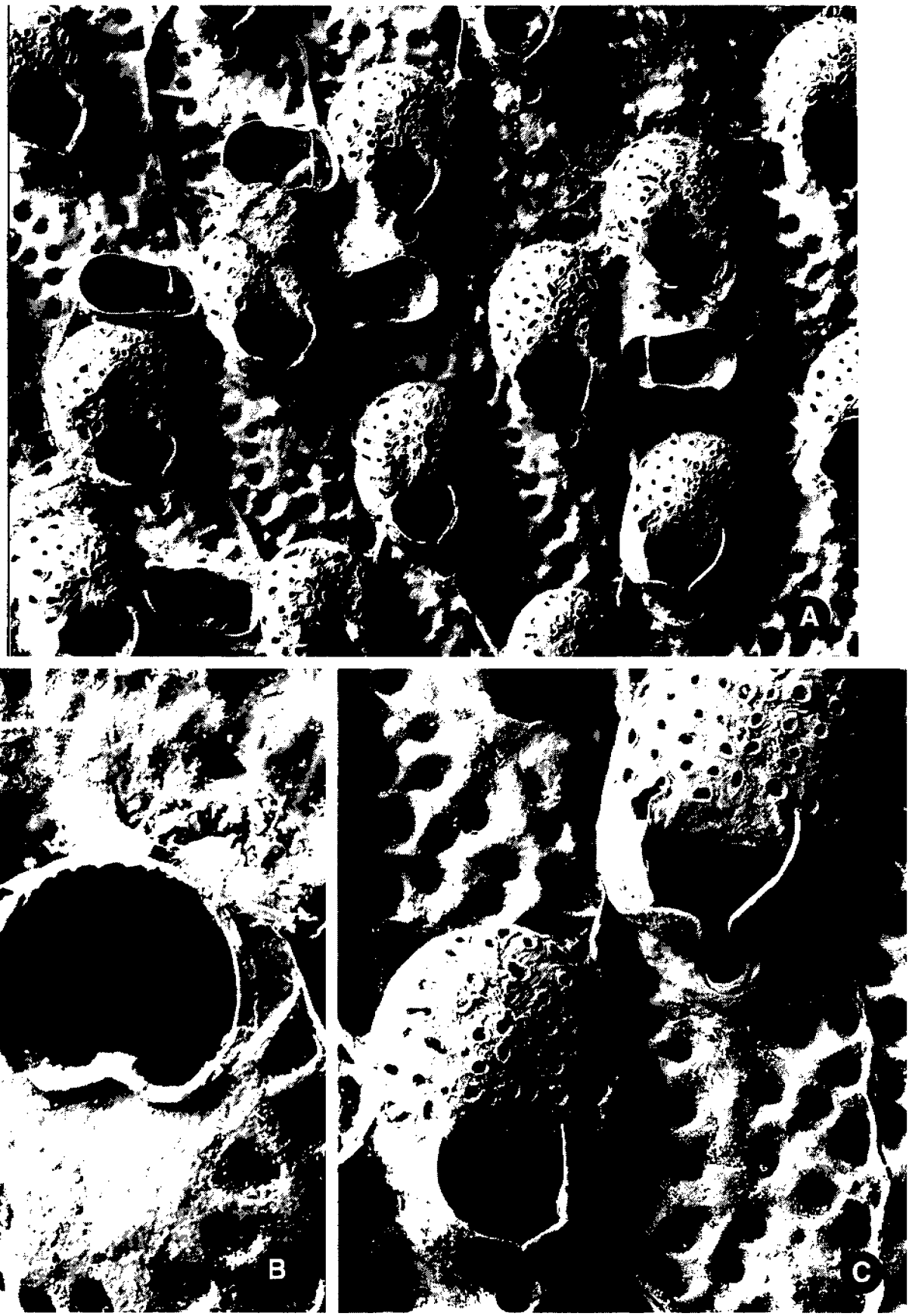
Gordon (1984) resurrected the genus *Schizosmittina* Vigneaux (1949) for species with a sinus instead of a median lyrula, with or without suboral avicularia, and with or without interzooecial avicularia. The species lacks condyles or a lyrula but the sinus is within a strong dental ledge, rather than being of frontal origin. Gordon (1989), added species to the genus with condyles and without a strong dental ledge. We believe that this group may eventually receive multiple genera and familial status as more species, apparently prominent in the south Pacific, become known. Gordon (1994) placed *Schizosmittina* in the previously fossil family Bitectiporidae MacGillivray, which he revived for Recent species, as discussed under the Hippoporinidae.

Osburn (1952) included the alyrulate, tremocystal genus *Codonellina* in the Smittinidae based on its median suboral avicularium, although the zooids are much lighter in structure, lack a lyrula, and the porous ovicell is closed by the operculum. The genus *Pleurocodonellina* was created for the similar pleurocystal form by D.F. and J.D. Soule (1973), with reservations as to its affinity with the Smittinidae. Gordon (1984) included the genera *Emballotheca* and *Hippomonavella* in the Smittinidae as resembling codonellinids, but later (Gordon, 1989) moved *Emballotheca* to Hippoporinidae.

Another problem is presented with the alyrulate genera *Codonellina* and *Pleurocodonellina*. Both have an almost circular aperture, with small, thin condyles, and a median suboral avicularium, large or small, which lies outside the apertural rim and originates from lateral paired areolae. The type for *Codonellina* Canu and Bassler, 1934 (= *Codonella*, Canu and Bassler, 1927) is *Lepralia galeata* Busk, 1854, from Tierra del Fuego; his brief description indicates "Cells ovato-ventricose, punctured all over; mouth orbicular, entire, unarmed; an avicularium immediately below the mouth; mandible oval. Ovicell globose, punctured." Busk's illustration (pl. 94, fig. 2) shows a low peristome with no sinus, and the avicularium appears to originate bilaterally; the ovicells are quite regularly perforated and clearly marked at the distal margin. Lopez Gappa (1981) illustrated specimens from Argentina having a large, projecting proximal peristomal lip overhanging the median avicularium; the frontal wall is reticulate, and the ovicells are irregularly perforate with pores of varying sizes, bounded distally by an ectooecial rim. To determine whether this is actually Busk's species would require an SEM of the type. We examined it some years previously before SEM was available and found it more similar to *Codonellina anatina* Canu and Bassler, 1927b (see D.F. and J.D. Soule, 1973, figs. F, G, although the type lacks the giant avicularium. *Codonellina* spp. lack oral spines, in contrast to *Schizomavella* spp., which have oral spines. *Schizomavella* spp. have a more typically smittinid ovicell as well. Until the type of *Codonellina* can be examined by SEM, we cannot resolve the question of its family assignment. If it is like that shown by Lopez Gappa (1981), then perhaps *C. anatina* and *C. hastingsae* belong in a new genus, and perhaps, a new family. Their uniformly porous ovicells do not ally them with *Bitectipora* and questionably with the Bitectiporidae.

The genus *Pleurcodonellina* D.F. and J.D. Soule, 1973, is alyrulate, with no hint of a median denticle that has been reduced to a small point in some *Parasmittina* spp. *Pleurocodonellina* also lacks oral spines, and the ovicells tend to be sunken, more or less uniformly porous and not covered by encroaching ectooecium. Their median avicularia, small or giant, arise from a median pore and a lateral areola, as is the case in *Hemismittoidea* spp. Some of the species assigned to *Pleurocodonellina* by various authors may not belong there, but that does not negate the genus. Placing alyrulate species in Smittinidae, in our opinion, is, like the current "pop" culture expression, an oxymoron, although they may belong to the same superfamily.

Canu and Bassler (1917) described the genus *Metroperiella*, with the type *Schizoporella lepralioides* Calvet, *in* Jullien and Calvet, 1903, but Bassler (1953) placed the genus in synonymy with *Schizomavella*, as schizoporelloid species with a suboral avicularium, oral spines, porous frontal wall and porous ovicell but with a distinct proximal sinus. Hayward (1974) placed *Metroperiella lepralioides* in synonymy with *Flustra montferrandii* Audouin, 1826, which had been placed in *Codonellina* by Harmer, 1957, and subsequently by others, including Hayward (1974). Gordon (1994) examined the type of *Metroperiella, M. lepralioides* by SEM and states that the suboral avicularium originates from only one side although it is


A
B
C

placed more or less suborally. He includes the genus in the newly resurrected family Bitectiporidae, although the type of the genus *Bitectipora* has irregular frontal pores, an inflated suboral avicularium with a raised rostrum and an umbo, and the ovicell is very like the smittinids, with irregular large and small pores and an encroaching ectooecium distally.

Emballotheca monomorpha Gordon, 1984, appears to be similar to condonellinids but other species in that genus such as *E. latifrons* and *E. obscura*, both Osburn, 1952, do not. Hayward and Thorpe (1988) transferred the encrusting *E. monomorpha* to the genus *Thrypticocirrus*, an Antarctic genus with erect colonies, which Gordon (pers. comm.) places in the Smittinidae; it lacks the median denticle (lyrula) but has a smittinid-like ovicell. The large and small median frontal avicularia resemble those in *Codonellina anatina* and *C. hastingsae*, n. sp., described in this paper. There is no median secondary mucro in these species as there is in some species attributed to *Thrypticocirrus*.

Smittina landsborovii (Johnston, 1847)

Plate 81 A-C

Lepralia landsborovii Johnston, 1847: 310, pl. 54, fig. 9.
Smittina landsborovii: Hayward and Ryland, 1979: 98, fig. 34. — Brown, 1952:319 [designated neotype].
Not *Smittia landsborovii*: Robertson, 1908, pl. 23, fig. 74. — Osburn, 1952: 400 pl. 47, figs. 1, 2. — Soule and Duff, 1957: 119. — J. D. Soule, 1961: 32.

Material Examined. MMS Station: BRA-16 is not *S. landsborovii*; Other collections: BMNH and AHF.

Description. We examined part of the type of *S. landsborovii*, BMNH 11.0.1.1434, illustrated in Plate 81, which was also figured by Hayward and Ryland (1979). The type shows the following: primary aperture wider than high, serrate (denticulate) distally, with narrow lyrula formed by ends of the apertural rim; lateral condyles present. Mature aperture pyriform, with low distal rim, with high peristomal collar laterally fusing or almost fusing above median avicularium, leaving spiramen when fused. Suboral avicularium small, oval, with rostral area outside peristome. Wide, shoeshaped frontal avicularia, about 300 μm long, lying transversely across frontal wall, originating from a marginal pore, sometimes encroaching sufficiently to replace the suboral avicularium. Ovicell with numerous pores, merging with high peristome laterally, no distal frontal wall encroachment.

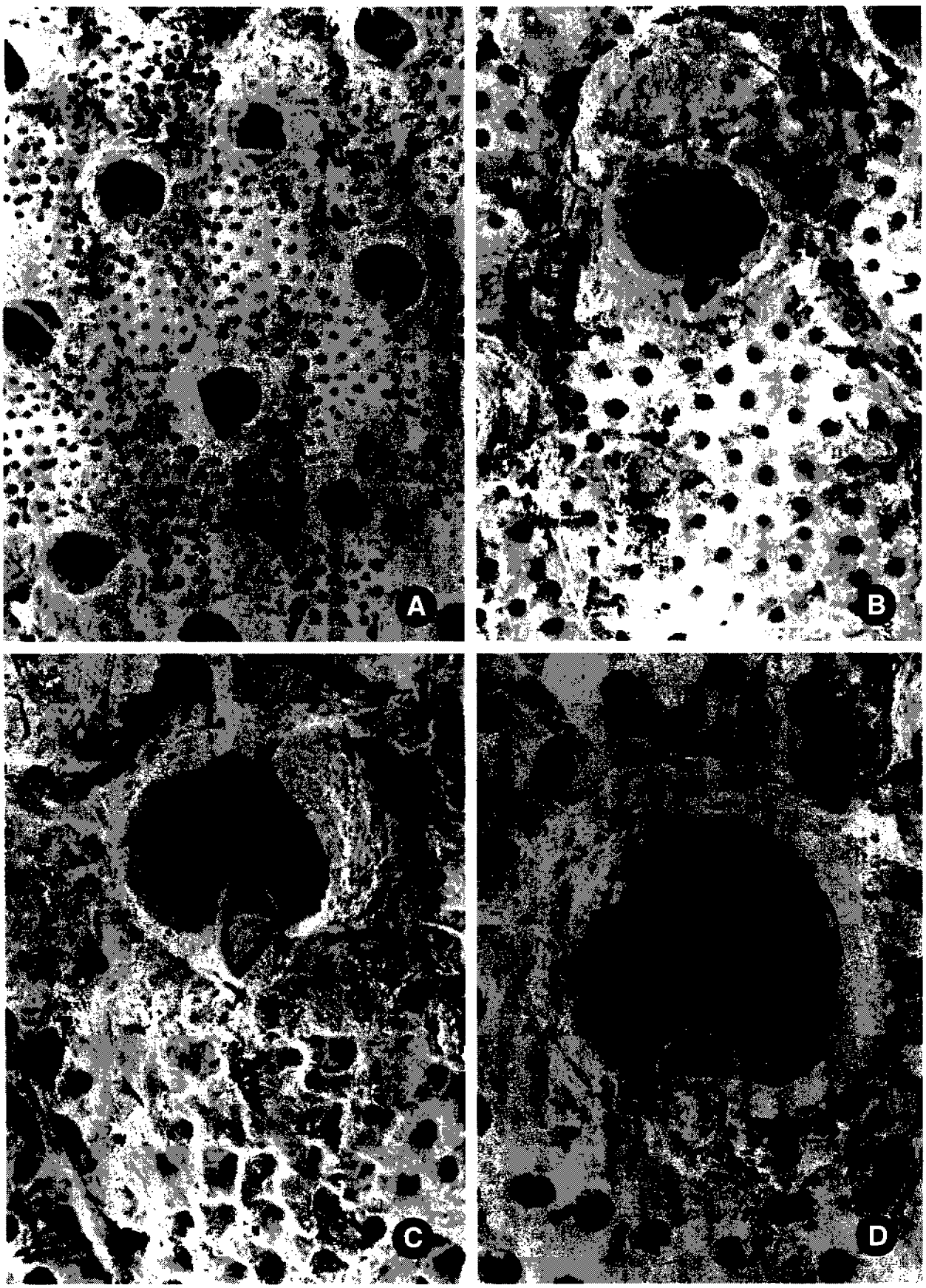
Biology. Encrusting rocks, shells. Records in the Mediterranean are from 20-150 m (Gautier, 1962).

Taxonomic Remarks. According to Hayward and Ryland (1979), the suboral avicularium may sometimes be replaced with a large, spatulate avicularium, directed proximally. The frontal wall is reticulate, with high vertical wall lines. This resembles *Smittina spathulifera* (Hincks, 1884), but lacks the large frontal pores and irregular marginal gaps found in that species (Plate 83E). The forms found in southern California called *S. landsborovii* are not that species, but are, in part, described below as *Smittina veleroa*.

Type Locality and Type Specimens. Birterbuy Bay, Ireland. Neotype BMNH 1911.10.1.1434, designated by Brown (1952), consists of two specimens; one a small young colony on a small shell fragment

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Plate 81. *Smittina landsborovii.* BMNH Type 11.0.1.1434, Biterbuy Bay, Ireland, courtesy of Dr. Paul Taylor. A. Colony with small, round suboral avicularium, larger transverse frontal avicularium, perforate ovicell. B. Developing primary aperture with denticulate rim, median denticle (lyrula) with interior pore, beginning of suboral avicularium chamber. C. Zooids with peristomal collar merging with ovicells, closing proximally or not to form spiramen.


A
B
C
D

with a small rounded avicularium, and a larger colony on a larger shell fragment which contains some large spatulate avicularia. Brown described only the small fragment in his neotype description. The SEM of the type is courtesy of Dr. Paul Taylor.

Distribution. *"Smittina landsborovii"* has been cited as occurring on the Pacific coast from Oregon to the Galapagos Islands by Osburn (1952) and earlier by Robertson (1908) from San Pedro, California. The form reported by C.H. and E. O'Donoghue (1923, 1926) was tentatively identified by them as *S. landsborovii* var. *porifera*, but this may not be the same as *S. porifera* Osburn, 1912, from the Woods Hole area. The true *S. landsborovii* is apparently an eastern Atlantic boreal species.

Smittina veleroa, new species

Plate 82 A-D

? *Smittia landsborovi*: Robertson, 1908: 305, pl. 23, fig. 74.
Smittina landsborovi: Osburn, 1952: 400, pl. 47, figs. 1, 2.

Material Examined. AHF and BMNH Collections.

Diagnosis/Description. Colony encrusting. Zooecia 600-800 μm long, 350-500 μm wide, frontal wall with numerous large pores, lateral walls not raised, frontal becoming hypercalcified. Aperture about 200 μm wide, 180 μm high, peristome raised distally and laterally, tapering down proximally to median avicularium. Lyrula wide, formed of 3 parts, 2 from apertural rim, 1 from primary frontal wall, condyles absent. Median avicularium opesia on denticle, rostrum directed proximally, not much raised, about 100 μm long. No other avicularia. Ovicell shallow, 400 μm wide, 240 μm high, perforate with the peristomal rim forming proximal border, encroaching frontal wall bordering distally; ovicells becoming indistinct, encrusted.

Biology. Encrusting shell, rock. Depth from low tide, but the range is unknown due to the confusion in identification. The type locality depth is 25.6 m.

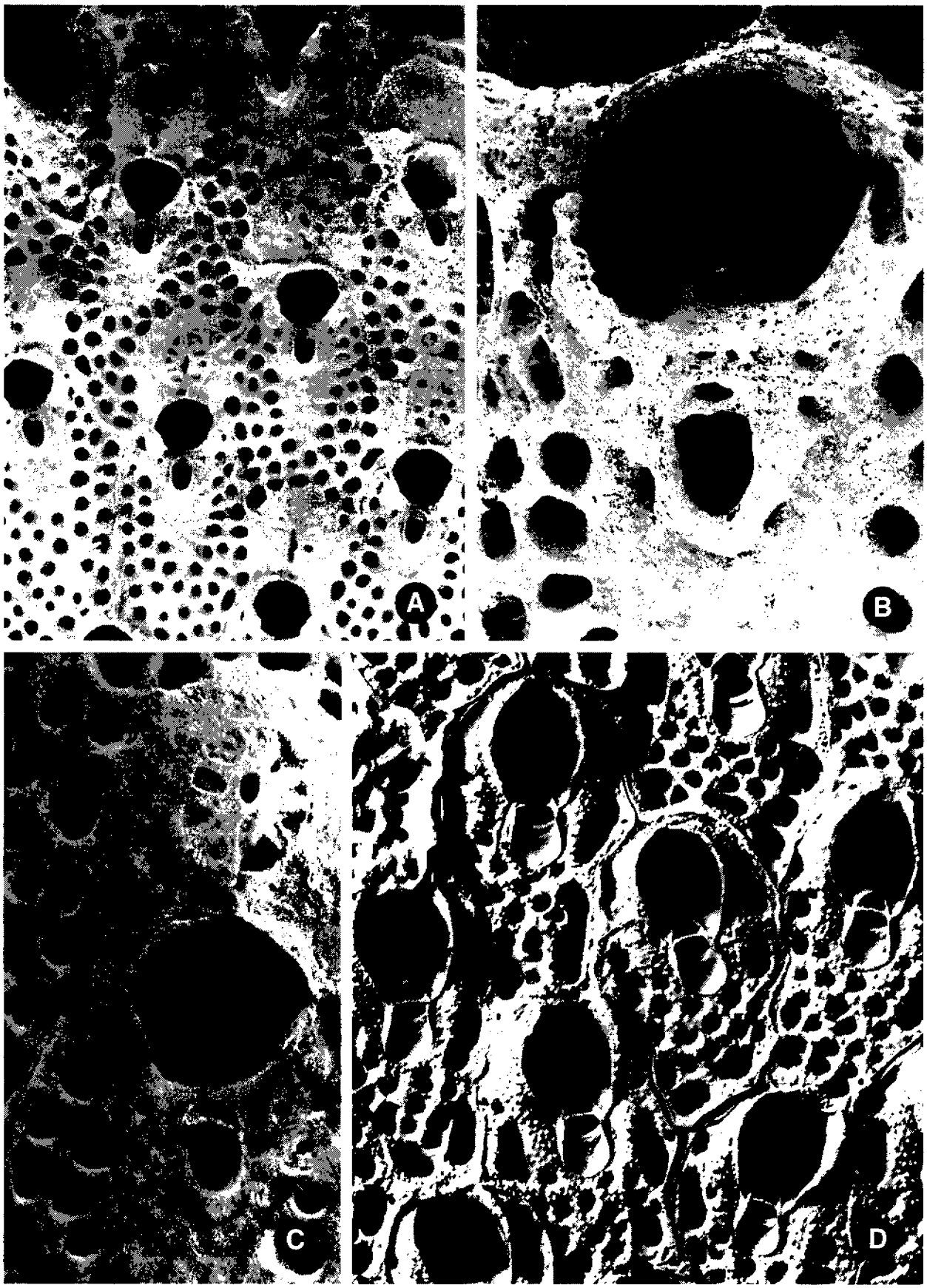
Etymology. Named for the research vessels *Velero III* and *Velero IV* from which most of the original AHF Collections were obtained, provided by the late Captain G. Allan Hancock to the University of Southern California.

Taxonomic Remarks. D.F. and J.D. Soule (1972) discussed the various formations of the median denticle (lyrula) from portions of the apertural rim and, sometimes, with the median frontal wall contributing the center section. A pore may lie beneath the denticle.

Osburn (1952) discussed the inadequacy of the original description and some of the later citations of *Smittina landsborovii*, but examination of specimens by light microscope is sometimes inconclusive. In the absence of the very large frontal avicularia (Plate 81), in Pacific material, the more subtle differences in the aperture and ovicell might not be noticed. Robertson's (1908) *Smittia landsborovii* might be the same as the new species but the loss of her specimens by the California Academy of Sciences in San Francisco leaves this open to question.

Smittina maccullochae Osburn,1952 also has a tubular peristome, but it differs in being continuously high around the aperture, with the suboral avicularium, when present, on the raised proximal peristome.

Plate 82. *Smittina veleroa*. Formerly included in *S. landsborovii*, from Pulpito Pt., Gulf of California, AHF 674-37. A. Colony with ovicells immersed. B. Shallow ovicell with pores. C. Zooid without ovicell showing contribution of transverse wall and distal frontal wall to peristome, tripartite formation of wide denticle with avicularium base on it. D. Zooid with mature denticle, bluntly acute avicularium base on denticle, mandible outside of peristome wall.


A
B
C
D

Type Locality and Type Remarks. Pulpito Point, Gulf of California, AHF Station 674-37. SBMNH-AHF Bryozoa Holotype 225.

Distribution. Robertson (1908) reported the species from San Pedro Bay, which would be the type locality if her specimens had not been mixed with other collections. Osburn (1952) reported "*S. landsborovi* from "stations too numerous to list" from the Oregon coast to the Galapagos Islands.

Smittina ovirotula, new species

Plate 83 A-C

Not *Smittia spathulifera* Hincks, 1884a: 52, Pl. 4, Fig. 3.
? *Smittina spathulifera:* Osburn, 1952: 401, Pl. 47, Fig. 3.

Material Examined. MMS Station: BRC-1, not *S. spathulifera*; Other collections: AHF and BMNH.

Description. Colonies reddish brown, encrusting. Zooecia large, convex, elongate, 640-880 μm long, 300-440 μm wide, distinct in newly formed areas, becoming immersed. Frontal wall reticulate, with larger marginal pores, large frontal pores except in central frontal wall area. Aperture wider than high or rounded, peristome low, not enclosing avicularium, with a wide, about 70 μm, anvil-shaped median denticle (lyrula) inside the proximal rim; strong condyles curved downward flanking the denticle tip. Median avicularium a short distance proximal to aperture, a tapered oval, 100-110 μm long, mandible yellowed, directed proximally. Ovicells 300-320 μm wide, immersed, with a central circle of irregular pores in a wagon wheel formation, becoming calcified, sunken.

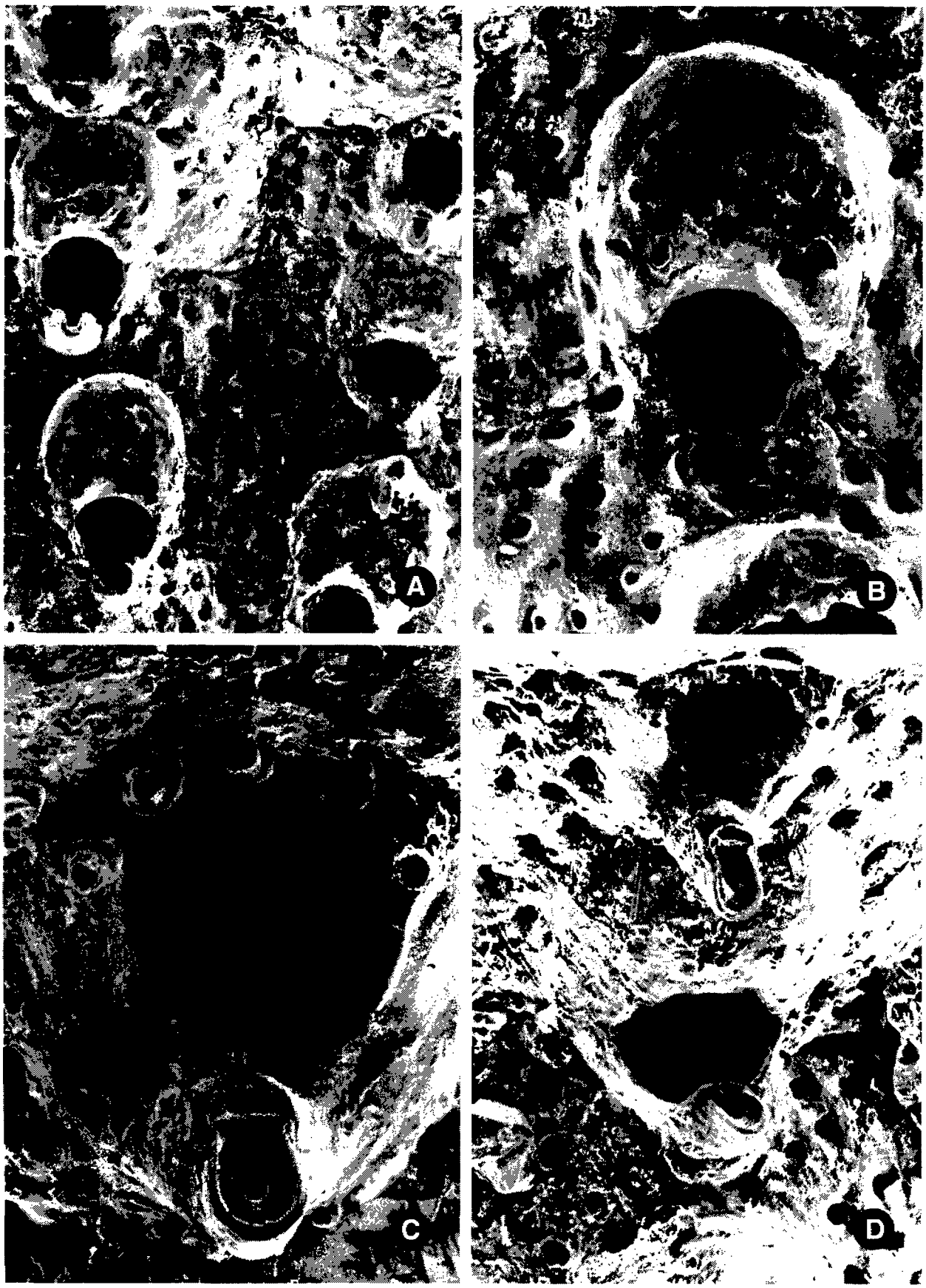
Biology. Encrusts shell and other hard substrates. Recorded to 150 m.

Etymology. Latin *ovi-*, for egg, referring to the ovicell, and *rotula*, meaning little wheel.

Taxonomic Remarks. Examination of BMNH collections indicated that *S. spathulifera* Hincks, from Houston Stewart Channel, British Columbia is a different species from the MMS form found in the Santa Barbara Channel and south to Baja California and the Gulf of California. The BMNH type catalogue lists BMNH 1886.3.6.7 as the type. Examination of BMNH 1886.3.6.39, thought to be part of type material, on a large shell shows that *S. spathulifera* has a much wider shoe-shaped avicularium that lies within the aperture on the denticle base. Its frontal wall has large pores, and marginal pores are merged into irregular gaps and slits, with a distinct groove between zooids (Plate 83D). Hincks described the ovicell as roughened, immersed, with pores around the edge. Osburn (1952) did not find ovicells on his material. The distinctive ovicells are present on the MMS specimen from Sta. BRC-1. Osburn may have had Hincks' species confused with *S. landsborovii* when he wrote of horizontally directed avicularia. Hayward and Ryland (1979, fig. 34 E) showed a form included in *S. landsborovii* which resembles Hincks' *S. spathulifera*, illustrated here in Plate 83D.

The new species has fewer pores in the ovicell than in the type species *S. landsborovii*, nor does it seem to exhibit the tripartite layers shown in the new genus *Raymondcia*. *Smittina punctata* Powell, illustrated by Gordon (1984, pl. 32, fig. A), shows an ovicell similar to that in *S. ovirotula*, but it has a narrower, almost bifid lyrula and the frontal wall has smaller pores.

Plate 83. *Smittina ovirotula*. A-C. Pt. Conception, California. A. Colony with typically patterned ovicells, bluntly oval suboral avicularia. B. Detail of primary aperture with anvil shaped lyrula, bluntly hooked condyle showing. C. Detail of ovicell with wheel shaped central opening. D. *Smittina spathulifera*, BMNH 1886.3.6.39, probably part of type, showing much larger avicularia, large, irregular areolae.


A
B
C
D

Type Locality and Type Specimens. Locality AHF Station 1304-41, off Santa Cruz Island. SBMNH-AHF Bryozoa Holotype No. 226.

Distribution. Pacific coastal waters, from the Channel Islands southward to Natividad Island, Baja California, Mexico, and San Francisquito Island, Gulf of California.

Schizosmittina pedicellata, new species

Plate 84 A-D

Schizomavella auriculata: Osburn, 1952: 331 (in part).

Material Examined. AHF and BMNH Collections.

Diagnosis/Description. Colony encrusting. Zooecia irregular, 350-450 µm long, 300-350 µm wide, with large frontal wall pores except for the suboral pedestal-like umbo. Aperture rounded distally with 5 stout spines; proximally, very wide, shelflike condyles, dental ledge deeply incised with narrow, U-shaped sinus; a median suboral avicularium, mounted on pedestal, originating from a lateral pore on each side below the peristome, with a small oval mandible in spout-shaped rostrum. Peristome becoming raised, merging with pedestal. Other occasional pedestals on frontal without avicularia. Ovicell with large, irregular pores, becoming partly covered; spine bases remain visible in ovicellate zooids, with operculum not closing ovicell.

Biology. Encrusting broken shell in mud bottom. Depth 101 m.

Etymology. Latin, *pedicellus*, diminutive of *pes*, foot or stem.

Taxonomic Remarks. This species was formerly included in the AHF Collections with *Schizomavella auriculata*. We have not yet located other material of the new species. SEM illustrations show that the operculum does not close the ovicell, which makes it different from species of *Schizomavella*, in which it was formerly placed. The genus *Schizosmittina* Vigneaux, 1949, indicates that there is a suboral avicularium just below the U-shaped sinus formed in the dental ledge, reinforced by large condyles to form a deeper cleft. The contradiction of a smittinid without a median denticle (lyrula) when the definition of the family is the presence of one, creates an ongoing problem of placement of such genera as *Codonellina* and *Pleurocodonellina* (see above discussion) and species such as *Smittia signata* Waters, which has variously been placed in *Lacerna*, *Rimulostoma*, *Parasmittina*, and *Pleurocodonellina*. The ovicells of supposed species of *Schizomavella* are more like those of many Smittinidae, especially *Parasmittina*, in having a porous frontal area and partial secondary covering forming a distal rim or cover, than they resemble *Schizoporella* ovicells, suggesting a more appropriate placement in *Schizosmittina*.

The new species resembles *Schizomavella cristata*, described by Hincks, 1879, from one specimen from Hastings, Sussex; another was collected by Harmer from Plymouth. *Schizomavella cristata* is a very small species with a raised peristome which surrounds the suboral avicularium, according to Hayward and Ryland (1979). Gordon (1984) illustrated *Schizomavella neptuni* (Jullien, 1883), from the Kermadec Ridge, off the Tonga Trench, which had previously been described and recorded only from off the Iberian Peninsula in deep water. According to Gordon, it has 10 spines, a suboral avicularium plus occasional lateral avicularia and sometimes a large spatulate avicularium replacing one of the lateral avicularia. Gordon

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Plate 84. *Schizosmittina pedicellata*. Santa Cruz Island, California. A. Colony with porous frontal wall, ovicells, pedicellate suboral avicularia. B. Detail of ovicell pores with frontal wall encroaching distally, spine bases almost hidden, pedicellate avicularium broken away to show bilateral origin. C. Detail of spine five bases, thick condyles fusing to form deep sinus with suboral avicularium having serrate rostrum. D. View from distal end, lower zooid with little peristome, showing sinus; upper ovicell with peristomal collar between hood and avicularium pedestal, with sinus hidden.

(1984) also figured a supposed *Schizomavella punctigera* (MacGillivray, 1883), which has four to six spines and a suboral avicularium directed proximally on an umbo, although MacGillivray stated that the avicularium is transversely placed, not directed proximally. The new species and *S. punctigera* share the shelflike condyles and deep sinus of *Schizosmittina*.

Type Locality and Type Specimens. AHF Station 1304-41, 3 nautical miles north of Arch Rock off Santa Rosa Island, California Channel Islands, 34° 06 25 N by 119° 41 05 W. SBMNH-AHF Bryozoa Holotype No. 227.

Distribution. Channel Islands, California.

Raymondcia, new genus

Diagnosis. Colonies encrusting. Zooecia resembling *Smittina*, with porous frontal wall, and with granules extending down into both the frontal pores and the slightly larger areolae; distal and distolateral margins of primary aperture composed of a distal flap and/or 2 flaps appearing to be from adjacent zooids, lateral margin from frontal wall, apertural opening wider than high, with lateral oral condyles, a median denticle (lyrula), with median suboral avicularium formed from bilateral areolae and median oral pore. Base of avicularium opesial area partly against denticle or not, mandible directed proximally, aperture becoming pyriform in maturity. Ovicell forming from granular distal segment, 2 lateral segments interior to areolae of ovicelled zooid and adjacent zooids, sometimes leaving one or 2 pores on central segment; becoming indistinct in colony.

Etymology. The genus is named for the late Dr. Raymond C. Osburn for his contributions to knowledge of bryozoan faunas of the western Atlantic and the northeastern Pacific. Without his three volume *Bryozoa of the Pacific Coast of America*, completed when he was 80, knowledge of that fauna would have been greatly reduced. He had previously retired as chairman of the Department of Zoology at Ohio State University.

Taxonomic Remarks. The apertural rim differs from many smittinids in being composed of distal, lateral and frontal segments, and the ovicell is composed of a distal and two lateral segments, sometimes with one or to small pores left open. The usual smittinid ovicell consists of a frontal entooecium with many pores in various patterns bordered by an imperforate layer distally. Examples of the *Raymondcia* form of ovicell are seen in the literature: e.g., in Kluge (1975) in *Smittina rigida* and *Smittina beringia*; and in Hayward and Ryland (1979) as *Prenantia bella*. All the species appear to be arctic-cold water forms including *Raymondcia. macginitiei*, new species, described below.

Type species. *Raymondcia osburni*, new species.

Raymondcia osburni, new species

Plate 85 A-D; Plate 86 A-B

Not *Lepralia landsborovii* Johnston, 1847: 310, Pl. 54, Fig. 9.
Not *Smittina landsborovi*: Osburn, 1952: 400.

Material Examined. MMS Station: BRA-16, not *S. landsborovii*. Other collections: BMNH and AHF.

Description. Colonies encrusting. Zooecia 700-750 μm long, 420-500 μm wide, rectangular to ovoid. Frontal wall moderately inflated, coarsely granular with many large, irregular pores, having minute knobs or granules on pore walls. Primary aperture wider than high, becoming pyriform, distal rim from a distal frontal segment, lateral rims from lateral frontal segments; with low, wide median denticle on the proximal rim, becoming worn down, strong lateral burred condyles. Suboral avicularium raising below denticle mostly outside peristome, small (70-80 μm long), with small opesia, blunt oval mandible directed proximally. Ovicells at first wider than high, 300-350 μm wide, 200-220 μm high, composed of merging segments contributed from adjacent zooids, leaving suture lines and a single pore or none, becoming immersed, almost indistinguishable except for solid frontal walls bordered by areolae.

Biology. Encrusts shells and rock. Depth 91.5-123 m. A cool temperate species.

Etymology. Named for Dr. Raymond C. Osburn, author of *Bryozoa of the Pacific Coast of America.*

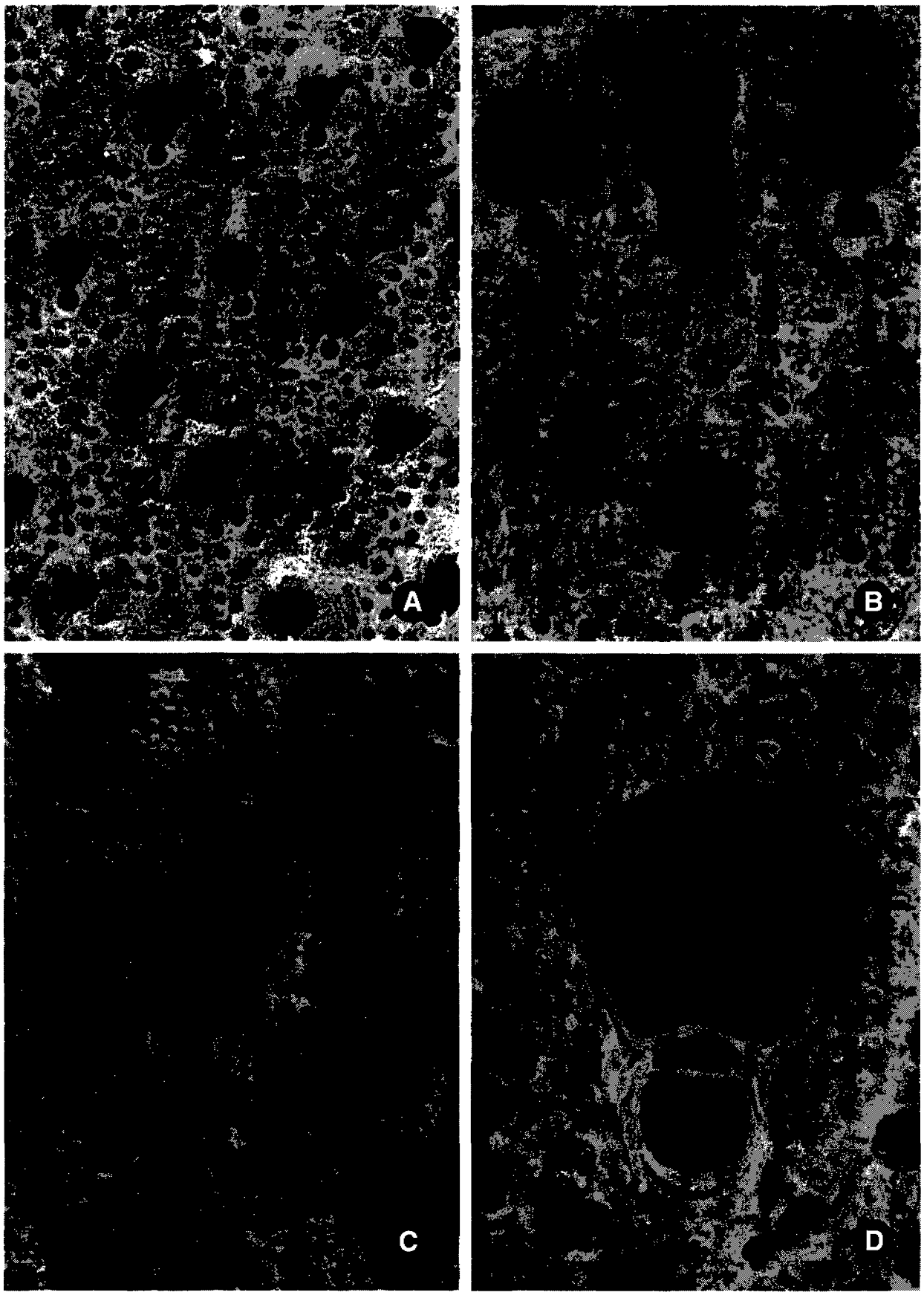
Taxonomic Remarks. The name *Smittina landsborovii* has been used for numerous forms having an oval suboral avicularium, because these small specimens and the still smaller avicularia are so difficult to distinguish without SEM. Part of the type of *S. landsborovii*, from Birterbuy Bay, Ireland (BMNH 1911.0.1.1434) is described and illustrated above (Plate 81). Its ovicells are raised and bear numerous pores in contrast to the new species. We found a number of AHF and BMNH specimens purporting to be of *S. landsborovi* but containing a mixture of forms, most probably undescribed.

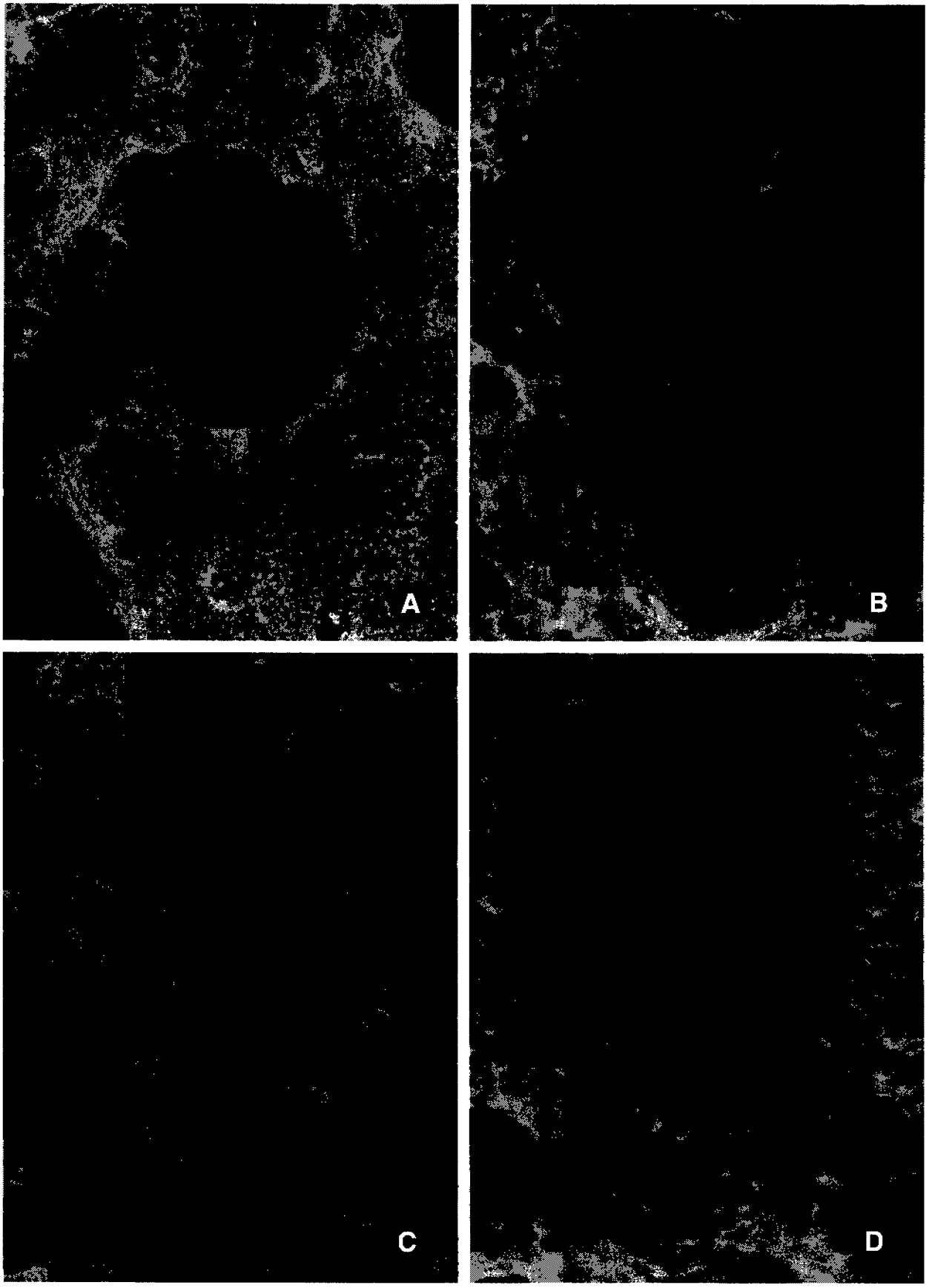
The differences between *R. osburni* and another new species, *R. macginitiei*, described below, are that the suboral avicularium on *R. osburni* lies mostly outside the peristome and the ovicell is wider than high, whereas in *R. macginitiei* the suboral avicularium is within the aperture, and the ovicell tends to be higher than wide, especially in initial stages. The lyrula is larger in *R. macginitiei*. Both species have granular spicules inside the frontal pores.

Type Locality and Type Specimens. Locality AHF Station 1447-42, off Point Arguello, California. SBMNH-AHF Bryozoa Holotype No. 228.

Distribution. Off Purisima Point and Point Arguello. No other distribution known.

Plate 85. *Raymondcia osburni.* [OVER, LEFT] Purisima Pt., California. A. Colony with many sunken ovicells, large frontal pores, round suboral avicularia. B. Growing margin with younger ovicell top right, older ovicell immersed in bottom center. C. Mature ovicell. D. Detail of aperture showing deepset condyles, worn lyrula, juncture of transverse walls at mid-lateral margins, distal frontal wall flaps. Note granules or knobs in frontal pores.


A
B
C
D


A
B
C
D

Raymondcia macginitiei, new species

Plate 86 C-D; Plate 87 A-D

Not *Lepralia bella* Busk, 1860: pl. 26, figs. 2, 3.
Smittina bella: Osburn, 1952: 403 (in part), pl. 47, figs. 4, 5.

Material Examined. AHF and BMNH Collections.

Description. Colony encrusting; zooecia with indistinct boundaries, irregularly shaped, 700-800 μm long, 300-450 μm wide, frontal walls with granules, numerous pores, some with granules and tiny, irregular processes inside. Aperture formed of distal frontal segment and/or of 2 segments from adjacent frontal walls, set off by areolae, laterally and proximally a low, rolled peristome, becoming pyriform, about 145 μm wide, 160 μm wide; denticle at first wide, blunt, flanked by small condyles, becoming worn; suboral avicularium with opesial area on denticle, oval mandible directed proximally, almost entirely within peristome. Developing ovicell long, narrow, up to 350 μm long, about 180 μm wide, becoming covered by distal segment, 2 lateral segments that at first leave a long open slit; mature ovicell with segments fused, sometimes leaving a single pore open, about 200 μm wide, 250 μm high; difficult to determine margins between zooecia and ovicells.

Biology. Encrusting shell, rock in shallow water. A cool water species.

Etymology. Named for the late George E. MacGinitie, who collected the specimens identified by Osburn as *Smittina bella*. MacGinitie was then scientific director of the Arctic Research Laboratory and subsequently director of the California Institute of Technology Kerckhoff Laboratory at Corona Del Mar, California, along with his wife Nettie; later they were consultants at the U.S. Navy Marine Research laboratory at Pt. Mugu, California. Their volumes on the natural history of marine invertebrates of southern California were the pioneering and definitive works on the local ecology.

Taxonomic Remarks. *Raymondcia macginitiei* is similar to *R. osburni*, but the former has the avicularium within the pyriform aperture and the ovicell is higher than wide, whereas the latter has the avicularium almost entirely outside the aperture and the ovicell is wider than high.

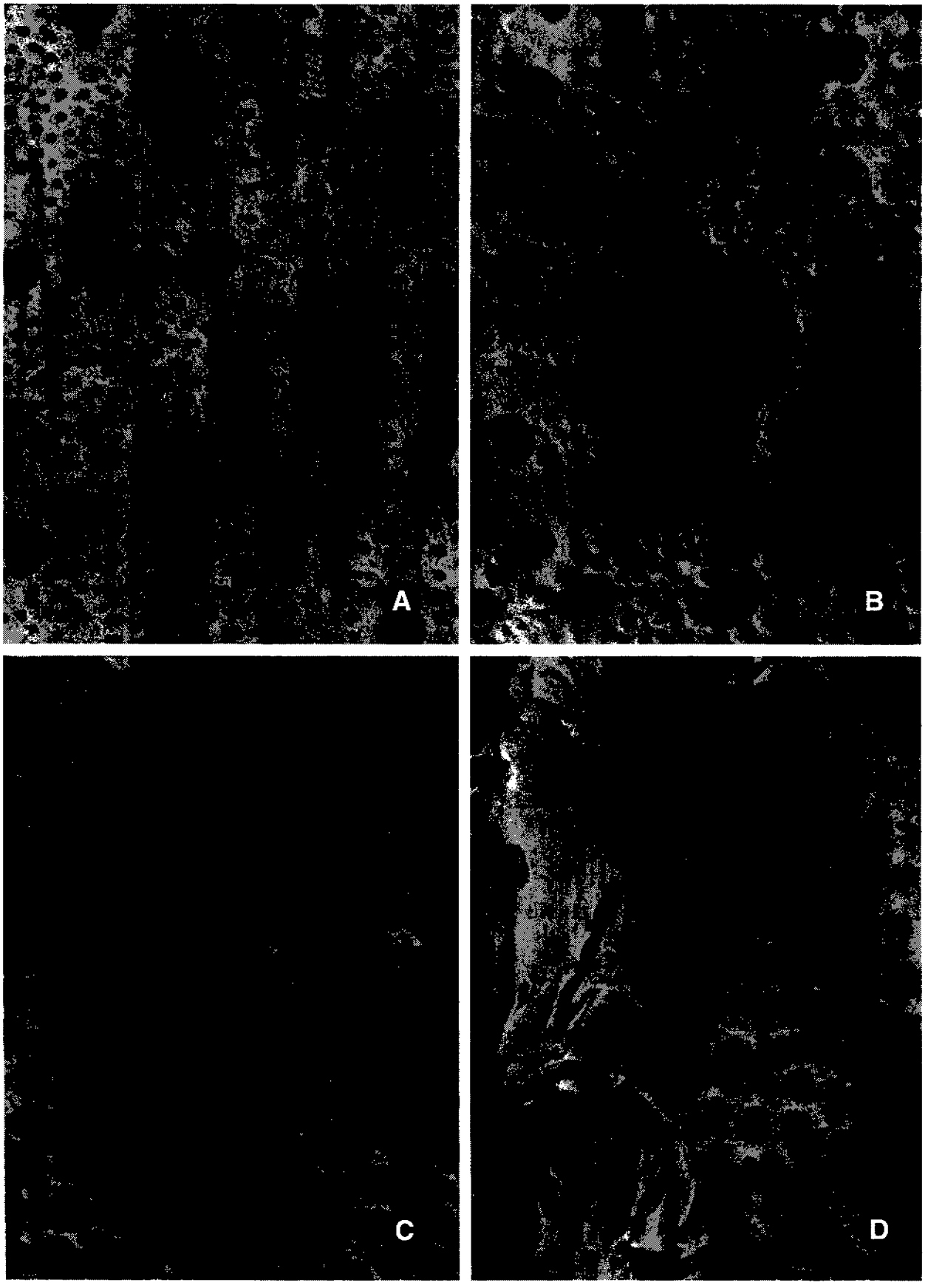
Raymondcia macginitiei is similar to *Smittia arctica* Norman, 1894, but that species has a narrow denticle; its ovicell is somewhat different, with only lateral secondary coverings, but it probably belongs in the new genus, although our material is very limited for determination. Like *Dengordonia uniporosa*, new species, it has a small pore in the ovicell until it becomes occluded. *Smittina arctica* has a bilaterally connected suboral avicularium chamber, whereas *Dengordonia* does not.

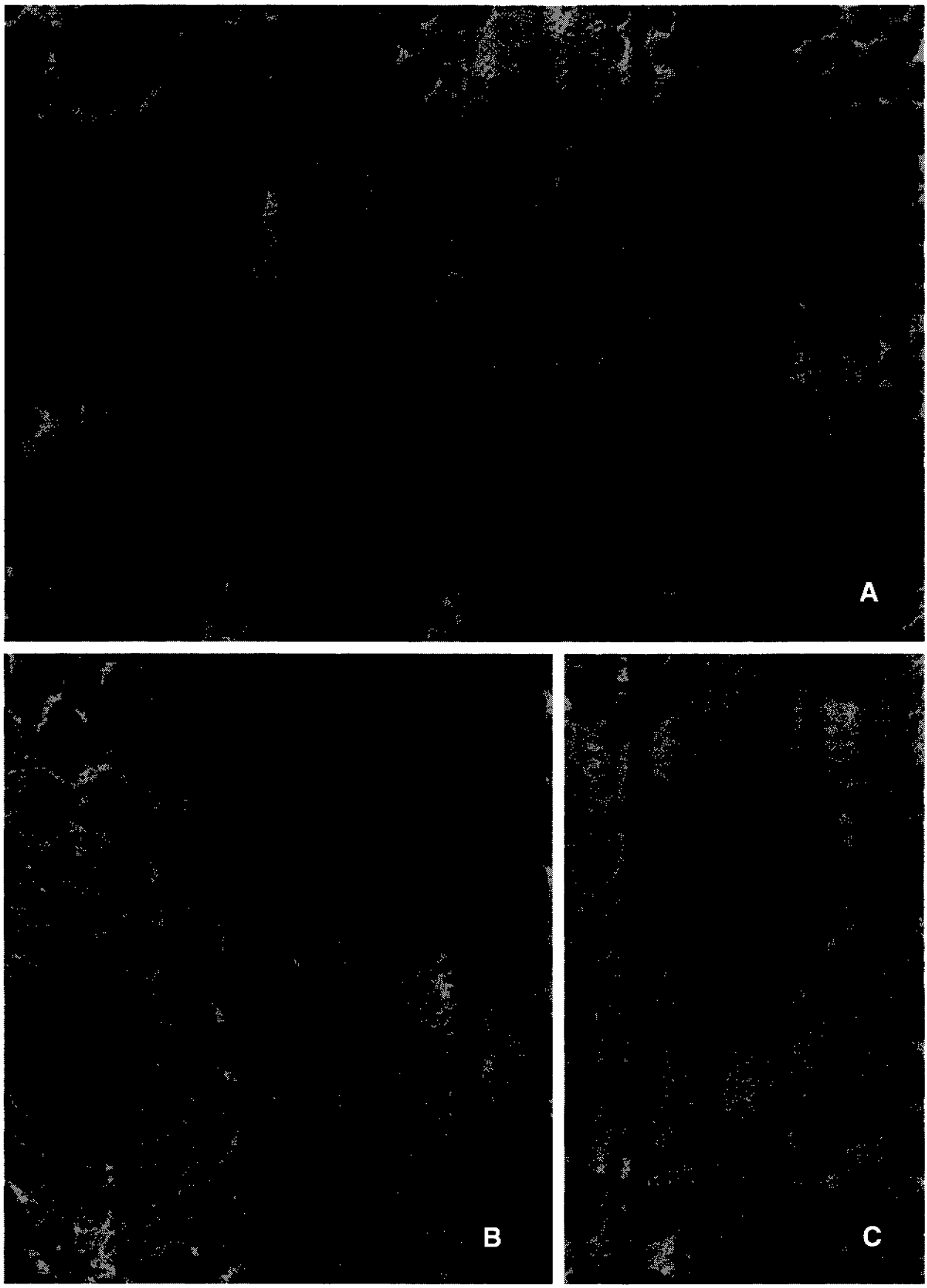
Type Locality and Type Specimens. The type locality is Point Barrow, Alaska. SBMNH-AHF Bryozoa Holotype No. 229.

Distribution. *Raymondcia macginitiei* may have a circumpolar distribution. Just how far down the northeastern Pacific coastal waters the boreal-arctic species may extend is open to question because of the lack of collecting along the coasts of Washington, Oregon and northern California. Although *Smittina belli* has been reported as occurring in southern California that seems to be erroneous.

Plate 86. [PREVIOUS, RIGHT] *Raymondcia osburni*, A-B. A. Detail of frontal wall granules extending down into frontal pores. B. Detail of denticle (lyrula), condyles and avicularium lying mostly outside peristome. *Raymondcia macginitiei*, C-D, from Pt. Barrow, Alaska. C. Detail of frontal pores with granules, spicules. D. Detail of aperture with wide denticle, smaller blunt condyles.

Plate 87. *Raymondcia macginitiei.* A. Colony view with ovicells entirely immersed. B. Detail of mature ovicell with three flaps merging; aperture with wide denticle, avicularium within peristome. C. Ovicell formation elongate, with long slit closing to pore, which usually disappears; avicularium showing bilateral origin from distal areolar pores. D. Beginning of elongate ovicell; lateral wall pores to left.


A
B
C
D


A
B
C

Dengordonia, new genus

Diagnosis. Frontal wall uniformly porous, as in *Smittina* spp., with median denticle (lyrula), strong lateral condyles opposite tips of denticle; suboral avicularium formed of a lateral suboral pore, a median pore under the denticle and a lateral marginal areolar pore, coming to rest on the denticle, lying within the pyriform secondary aperture. Ovicell composed mostly of distal subtriangular section bearing 1 large pore, meeting raised, rolled lateral margins of aperture along the sides.

Etymology. Named for Dr. Dennis P. Gordon of the New Zealand Oceanographic Institute, Wellington, New Zealand, whose research and publications have been of great value to us in reexamining the California fauna and have contributed to better understanding of phylogenetic relationships in the Bryozoa.

Taxonomic Remarks. The origin of the suboral avicularium from three pores differs from that of many species; they generally originate from bilateral suboral or areolar pores. The ovicell differs in being formed mostly from a distal section bearing one large pore meeting the rolled peristomal collar, in place of the typical smittinid ovicell with a frontal wall perforate area bordered by imperforate outer layer, or from the tripartite form of *Raymondcia*.

Type Species. *Dengordonia uniporosa*, new species.

Dengordonia uniporosa, new species

Plate 88 A-C

Not *Lepralia bella* Busk, 1860: 144, pl. 27, figs. 2, 3.
? *Smittina bella*: Osburn, 1923: 10D (list): 1933: 49. — Dick and Ross, 1988: 59, pl. 11B.
Smittina bella: Osburn, 1952: 403 (in part).
? *Prenantia bella*: Hayward and Ryland, 1979: 106.

Material Examined. MMS Station: BRA-2. Other collections: AHF and BMNH.

Description. Colonies encrusting. Zooecia 650-1,000 μm long, 500-600 μm wide. Frontal wall coarsely perforate, zooecial margins sometimes indistinct. Primary aperture higher than wide, about 280 μm high, 220 μm wide, distal rim formed separately from distal wall, lateral rims from lateral margins; mature aperture rounded to pyriform, with median proximal denticle and strong condyles, giving an almost tripartite appearance. Peristome wide, low, with rolled edge; median suboral avicularium apparently formed from 1 lateral suboral and 1 central suboral pore beneath denticle plus 1 lateral marginal areolar pore, avicularium coming to lie inside peristome against median denticle, avicularium small, oval, 50-60 μm long, with complete hinge bar dividing it medially, blunt mandible directed proximally. Ovicell 240-260 μm wide, formed mostly from distal frontal wall, meeting lateral peristomal margins, with a single large frontal pore, sometimes becoming closed; the hood developing early at growing edge, becoming immersed with only a distal border of areolar pores.

Biology. Encrusts rock and shells. Depths recorded from intertidal to 50 m for *Smittina bella*; the MMS record extends the depth to 110-126 m.

Plate 88. *Dengordonia uniporosa*. Pt. Conception, California. A. Colony with ovicells bearing a single pore, merging with rolled peristome of zooid. B. Narrow denticle with small condyles, avicularium within peristome. C. Origin of avicularium from right hand areolar pore, one suboral pore and one beneath denticle.

Etymology. Named for the single pore in the center of the ovicell hood.

Taxonomic Remarks. The suboral chamber pore connections in *D. uniporosa* are not bilateral, similar to the situation in the genus *Hemismittoidea* D.F. and J.D. Soule, 1973, rather than being of bilateral origin as they are in *Smittina* and *Smittoidea*.

Osburn (1952) identified the few AHF specimens as *S. bella*, although the Busk (1860) description and illustration of that species (see Figure 21), from Shetland, had numerous, fairly large pores on the ovicell, like those on the frontal wall, without visible suture lines. Hincks (1880), in his *History of British Marine Polyzoa*, reproduced Busk's figures, but said that he had not otherwise seen the species in collections. Osburn (1933) reported it from the northern Atlantic south to Mt. Desert, Maine, and from Pt. Barrow, Alaska (1952), the latter location referable to the new species.

Hayward and Ryland (1979) tentatively placed Busk's *Lepralia bella* in the genus *Prenantia*, but illustrated a form in which adjacent zooecia contribute calcification to form the secondary layer, with a few scattered pores between. That is unlike the ovicell of the type species, *Prenantia cheilostoma* (Manzoni, 1869), which has a primary layer with many pores bordered by the secondary layer. Gautier (1962) stated that the genus had no avicularia, as is the case in the type species of *Prenantia*. *Lepralia bella* does have a small avicularium within the peristome, which required changing the generic description of *Prenantia* to accommodate it, according to Hayward and Ryland.

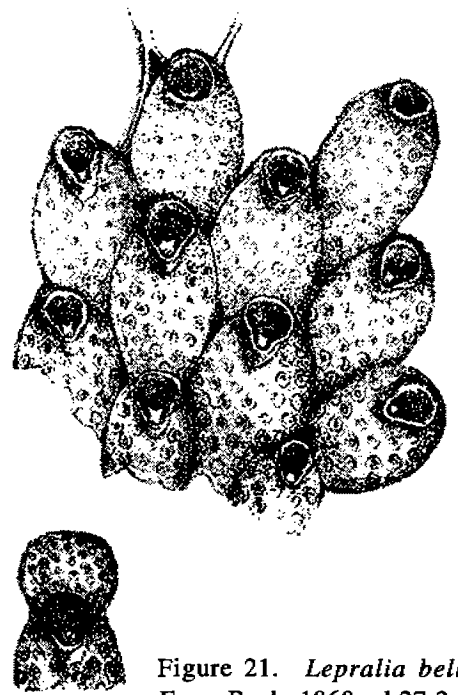


Figure 21. *Lepralia bella*. From Busk, 1860, pl 27:2-3

Dengordonia uniporosa is unlike most *Smittina* in having only one pore in the ovicell, but it is somewhat similar to *Raymondcia*, although it does not show the encroaching secondary calcification that occurs in *R. osburni* and the *"P. bella"* of Hayward and Ryland.

Dick and Ross (1988) described and illustrated as *S. bella* a form with lateral areolae and a few scattered frontal pores rather than the numerous frontal pores in the *S. bella* of Hincks and of Hayward and Ryland, or the new species, although all three have a submerged ovicell with a single pore. Dick and Ross's species requires a new name; its distribution is limited, so far as is known, to Alaska.

Smittina retifrons Osburn, 1952, has a single slitlike pore in the ovicell, a frontal wall with much larger reticulations and raised vertical walls, but the avicularium chamber is connected to pores on both margins.

Type Locality and Type Specimens. Locality AHF Station 1304-41, off Santa Cruz Island. SBMNH-AHF Bryozoa Holotype No. 230.

Distribution. If northern citations are of the same species, the distribution is from the Arctic to southern California.

Parasmittina tubulata Osburn, 1952

Plate 89 A-D

Parasmittina tubulata Osburn, 1952: 420, pl. 49, figs. 1-4.

Material Examined. MMS Station: BRC-2. AHF Collections.

Description. Colonies encrusting. Zooecia large, 650-1,000 μm long, 400-480 μm wide. Frontal wall inflated, finely granular; irregular areolar pores well defined, a few other pores around base of spatulate avicularium. Primary aperture higher than wide, with small, shallow sinus, a narrow median denticle widening at top; peristome soon becoming tubular, high, with irregular points and projections, often broken off, and with a narrow U-shaped secondary proximal sinus. No spines or spine scars found. Avicularia on either side of frontal wall, never suboral or median: large or small spatulate avicularium directed proximolaterally, smaller acute frontal avicularium directed proximally, and small acute avicularia near margins directed variously. Ovicells large, 380-450 μm wide, 400 μm high, coarsely perforate, peristome continuing as complete tube in front of ovicell; becoming almost completely immersed so that only a semicircle of pores is visible on colony surface.

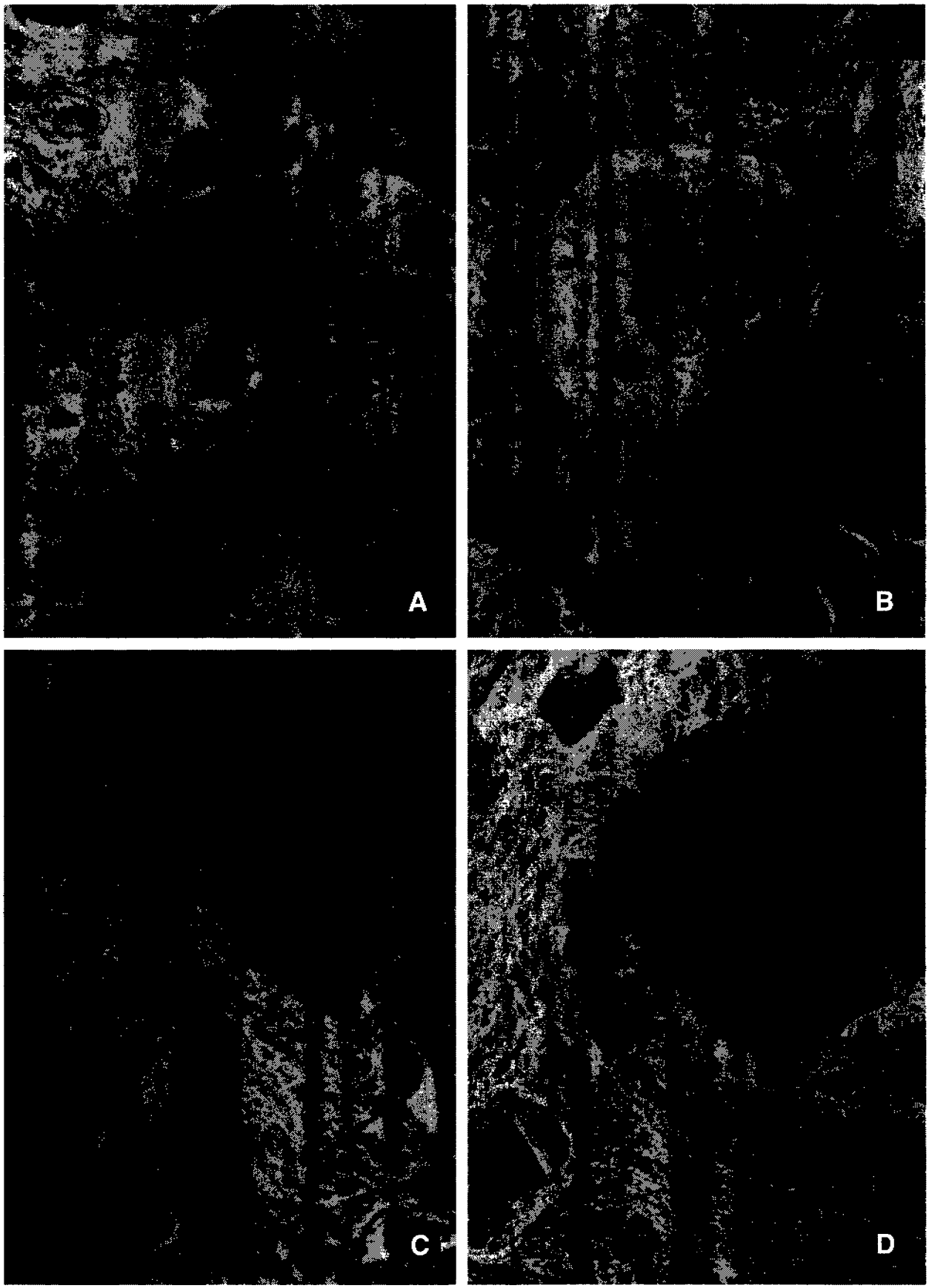
Biology. Depths previously recorded from 82 m to over 150 m; the MMS depth was from 110-126 m.

Taxonomic Remarks. Most *Parasmittina* spp. have a tubular peristome with a low space distally, sometimes occupied by spines, where the ovicell develops (e.g., *P. hastingsae* from Hawaii, D.F. and J.D. Soule, 1973), whereas *P. tubulata* has no known spines. The denticle is so deeply set in mature zooids that it cannot be seen unless the peristomal collar is broken away.

Type Locality and Type Specimens. AHF Bryozoa No. 90, AHF Station 1978-50, Ranger Bank off Baja California, Mexico, 28° 26'45"N, 115° 31'30"W.

Distribution. MMS station BRC-2 is in the Santa Barbara Channel; the known range is from Rocky Point, northern California southward to Pt. Dume, and to the south of Ranger Bank, northwest of Scammons Lagoon, Baja California, Mexico.

Plate 89. *Parasmittina tubulata.* [OVER] A, C from MMS off Pt. Conception; B, D from AHF 1276-41, off Pt. Dume, southern California. A. Colony with raised tubular peristomes, lateral frontal avicularia spatulate, directed proximally, small acute avicularia oriented randomly. B. Younger ovicell raised, with numerous infundibular pores, deep sinus. C. Older ovicell almost immersed, peristome higher; several avicularia. D. Aperture with peristome broken away to show denticle, one condyle.


A
B
C
D

Family Romancheinidae Jullien, 1888
Family Exochellidae Bassler, 1935 (= Family Escharellidae Levinsen, 1909)

Osburn (1952) included the genus *Mucronella* Hincks, 1880 in the Smittinidae, based on the deep set median denticle in the primary aperture in at least some of the eastern Pacific species. Later authors have transferred *Mucronella* spp. to various genera in several families, including the Escharellidae Levinsen, 1909 (e.g., Hayward and Ryland, 1979), or Exochellidae Bassler, 1935 (e.g. Gordon, 1989).

The genus *Escharella* Gray, 1848, on which the family Escharellidae is based, includes species having a frontal wall with marginal pores only, with a primary aperture typically with lyrula and condyles, becoming enclosed by a well developed peristome and conspicuous oral spines. Avicularia are absent, and ovicells are prominent, without pores (e.g., Hayward and Ryland, 1979). Gordon (pers. comm.) states that d'Orbigny (1852) described *Escharella*, which would be a junior synonym to Gray's *Escharella*, 1848, and thus the genus and family Escharellidae d'Orbigny is invalid. Levinsen's family is based on Gray's genus, but is a junior homonym of d'Orbigny's family and hence invalid. Gordon suggests the family Romancheinidae Jullien, 1888, which has been overlooked by authors, and would also avoid confusion.

Jullien's original description of Romancheinidae, states that in the genus *Romancheina* the aperture is perpendicular to the zooecial axis, the aperture lacks denticles on its lips, there are no spines on the subcircular or transversely oval opening; the frontal wall is thickened, covered with numerous large pseudopores ("origelles" [pseudopores capable of budding]) around the periphery in more or less concentric lines; the ovicell bud ("nid de pigeon" [pigeon's nest]) was seen distally but was otherwise unknown. The type species, *R. martiali*, has a suboral transverse avicularium, originating from two suboral pores in Jullien's illustration (1888: pl.5, figs. 1, 2). Jullien states that the dorsal surface is largely open and radicles extend from the lateral walls. The type species has a mucro apparently derived from frontal wall. It is a south Atlantic species. The too-brief and inaccurate description in Bassler (1953) reads; "Incrusting. Frontal a tremocyst with small pores; ovicell much smaller than zooecia. Avicularia thin, transverse, triangular." While the elevation of the aperture and the distribution of pores may suggest family Romancheinidae for *Exochella*, *Escharella* and *Haywardipora*, new genus, it requires much modification to include the features such as the presence of the median denticle, avicularia, and oral spines.

Bassler (1953) defines the family Exochellidae as having an oblique aperture without a lyrula (median denticle), rimule (sinus) or cardelles (condyles), with a frontal mucro, and an hyperstomial ovicell embedded in the distal zooecium. Yet he defines the genus *Exochella* Jullien, 1888 as having spines, a median and two lateral teeth, coalescing in some, the frontal wall surrounded by areolae and a lateral frontal avicularium present. The type is *Mucronella tricuspis* Hincks, 1881. Gordon (1989: pl. 13, figs. D-F; pl. 14, figs. A-G) illustrated several species of *Exochella*, which have one row of areolae and paired or single lateral frontal avicularia and show what he called a pseudolyrula, a term for the median denticle (mucro) derived from the secondary frontal rather than from the primary apertural rim. They form pseudosinuses, sometimes fusing to form spiramina, but some also have a true lyrula at the base of the pseudosinus folds. *Escharoides*, usually comprising species with paired avicularia, was transferred to the family Exochellidae Bassler, 1935, based on having an umbonuloid frontal wall (frontal shield) formation.

Gordon (1989: 30) transferred the genus *Escharella* Gray, 1848 to the family Exochellidae based on the umbonuloid nature of the frontal wall of New Zealand species he examined, and on that of the type species of the genus. Gordon gave the type as *Berenicea immersa* Fleming, 1828, from the north Atlantic (Bassler, 1953, stated that *Berenicea* Lamouroux, 1821 is a stenolaemate genus, but according to Osburn, 1953, both Norman, 1903a, and Borg, 1944, maintained that it was in fact as cheilostome, and its use should be discarded). Hayward and Ryland (1979) gave the type as *Lepralia immersa* Fleming 1828. The

umbonuloid nature of the frontal wall is sometimes a difficult determination to make with limited material, usually requiring SEM examination of the interior surface of the frontal wall for a characteristic ring scar, something that cannot easily be done for all the species belonging in a faunal assemblage. In some cases superficially similar species may become rather widely separated. Also, umbonuloid frontals may occur more widely than has been recognized. Further research is necessary, as Gordon (1993) has shown. The type, as described by Hayward and Ryland (1979) has six oral spines, small condyles, a bifid lyrula, a small suboral mucro, tiny areolae that become marked slits, no avicularia, and with a prominent, imperforate ovicell. Gordon (1989: pl. 15, fig. D) showed an SEM of that species with 2-3 rows of additional pores around the distal half of the frontal wall. Gordon enlarged the generic description to include *Escharella bensoni* (Brown, 1954) which has a descending ridge instead of a lyrula, although this is not clear in Brown's description or illustration. We would place that species in our new genus *Haywardipora*.

Mucronella ventricosa (Hassall, 1842) was placed in *Escharella* by Hayward and Ryland 1979. However, the *"M. ventricosa"* of Osburn is not that of Hassall, and is redescribed below as *Haywardipora rugosa*. The *"M. major"* (Hincks, 1884) of Osburn (1952) is composed of at least three species. The supposed BMNH type mistakenly labeled as *M. major* is a *Porella major* specimen and cannot be used. A neotype designation is needed.

Two species described below have numerous pores except in the central portion of the frontal wall, but two species formerly included in *M. major* by Osburn (1952) have pores over almost all of the frontal wall and distal to the aperture. For these species we propose the new genus *Haywardipora*. The frontal pseudopores appear, under light microscopy, to be linked by tubules to the areolar pores, but cannot be identified in cleaned SEM material. For the present, we maintain these species in the family Escharellidae; formation of frontal walls appears to be a puzzling combination of cryptocystidean and umbonuloid modes.

Haywardipora, new genus

Diagnosis. Colonies encrusting. Zooecia ovate to hexagonal, with low lateral walls, frontal walls high, convex, with tubular peristome erect, placed subterminally from distal margin; small pores in multiple rows except in small or large imperforate frontal wall area; pores apparently connected by tubules beneath secondary calcification as pores move up the frontal wall and peristome; pores sometimes closed by calcareous membrane or armed with spinules projecting into pore. Apertures rounded, with spines, a median denticle deep set in primary aperture, sometimes a median mucro suboral to aperture or extending down a vertical ridge within the peristome descending to the denticle. No avicularia. Ovicells with a few small pores or imperforate.

Etymology. The genus is named for Dr. Peter Hayward, whose faunal studies around the world, and in particular of the eastern Atlantic-boreal species, has greatly assisted us in recognizing the differences in the eastern Pacific fauna. His contributions and counsel have been invaluable.

Taxonomic Remarks. The new genus differs from *Exochella* and *Escharella* in having multiple rows of pores on the frontal wall, ranging from three rows around an imperforate central area up to covering the entire frontal wall, including distal to the more or less erect (perpendicular) apertural area. Pores in *Exochella* and *Escharella* generally are limited to one row of areolae which may become elongate, giving the frontal a costate appearance, while in others the pores are tiny, almost obscured. Sometimes a few other pores occur near the peristome. The type species, *Haywardipora rugosa* has long spinules inside the pore lumina, but these were not seen in the other species examined. In all the species discussed, apertural spines or spine scars are visible even when ovicells encroach on them. All have a median lyrula in the primary aperture and a frontal suboral mucro, but *Haywardipora* lacks the elaboration into a pseudosinus or spiramen such as occurs in *Exochella*, and lacks paired frontal avicularia such as those in *Exochella* or the mucro avicularium such as that in *Allerescha* (which may be a junior synonym of *Romancheina*). Some *Haywardipora* have a ridge that extends down the interior of the secondary peristome formed by the mucro to the denticle. Ovicells are moderate sized to small, imperforate or have scattered small pores; the more erect the peristome, the more the ovicells appear to be suspended distally from it.

Type species. *Haywardipora rugosa*, new species.

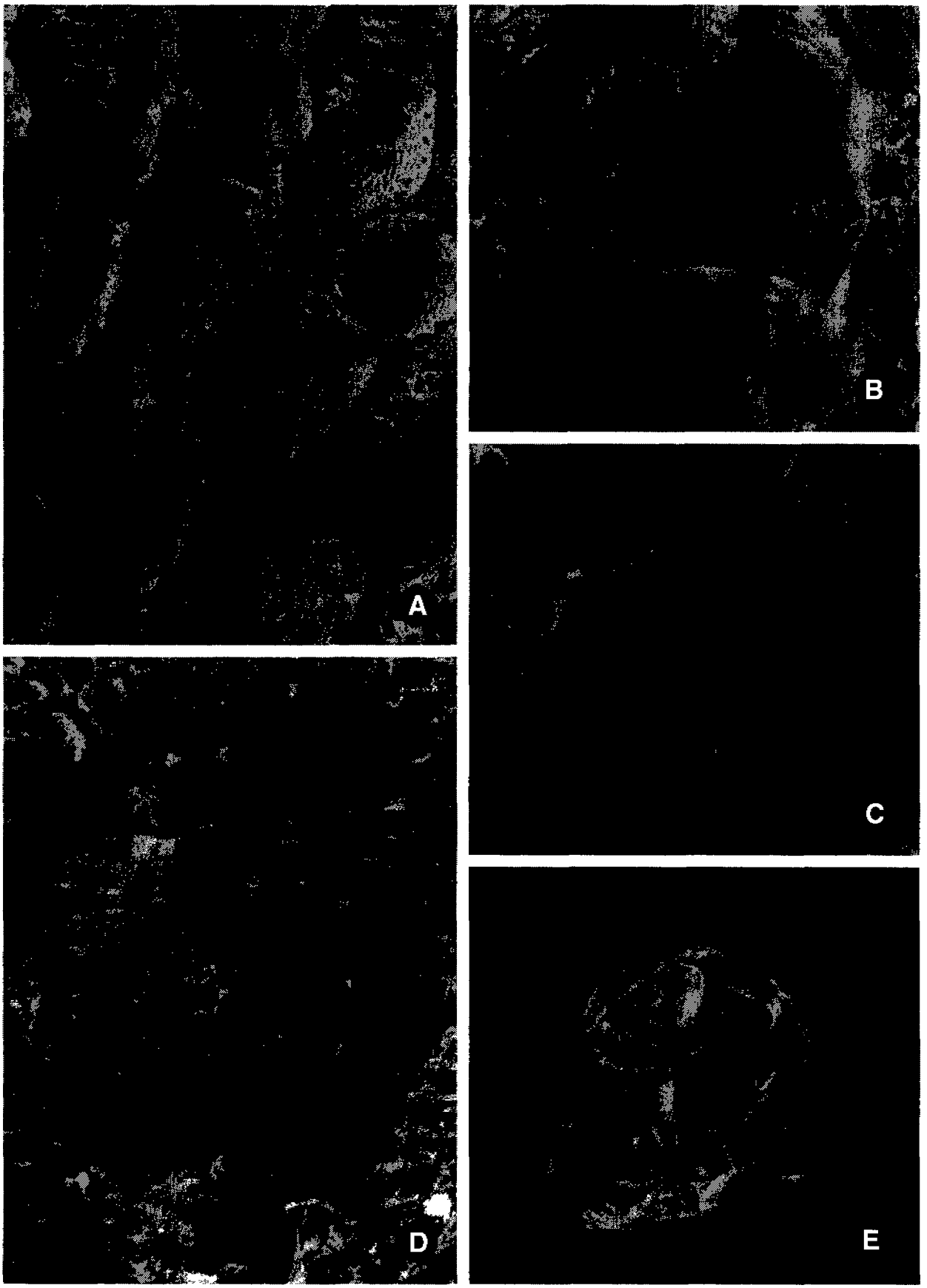
Haywardipora rugosa, new species

Plate 90 A-E

Not *Lepralia ventricosa* Hassall, 1842: 412.
Not *Mucronella ventricosa*: Hincks, 1880: 363.
? *Mucronella ventricosa*: C.H. and E. O'Donoghue, 1923: 188; 1926; 116.
Mucronella ventricosa: Osburn, 1952: 436 (in part).
? *Escharella ventricosa*: Kluge, 1975: 487 (in part?).

Material Examined. MMS Station: BRA-27. Other collections: BMNH and AHF.

Description. Colonies encrusting. Zooecia distinct, ovoid to hexagonal, 680-1000 μm long, 420-600 μm wide, with convex, inflated frontal wall, deep grooves between, frontal wall lightly granular, with rugose striae in radiating lines; small, distinct pores in up to 3 rows around margins, pores with long, thin, pointed spicules projecting into center; central frontal wall imperforate. Aperture about 125 μm wide, 110 μm high, somewhat raised, with pores distal to it, rounded distally bearing four stout, erect spines, sometimes 2 smaller ones opposite denticle; primary proximal rim slightly curved with low median denticle, medium width, becoming hidden by a raised umbo, sometimes with an acute tip (not an interior mucro); small, low,


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blunt condyles present or worn away. No avicularia. Ovicells prominent, globose, coarsely granular, 400-440 μm wide, 300-340 μm high, with 4 stout spines; ovicelled zooids 900-1,100 μm long, a small brim on margin of hood, blending into next distal frontal wall.

Biology. Encrusts hard substrates such as rock, bryozoans and shells. MMS depth 96-126 m. Depth ranges for *Escharella ventricosa* given by Kluge (1975) are from 5 to 450 m, with a temperature range of -1.7 to 6.2C.

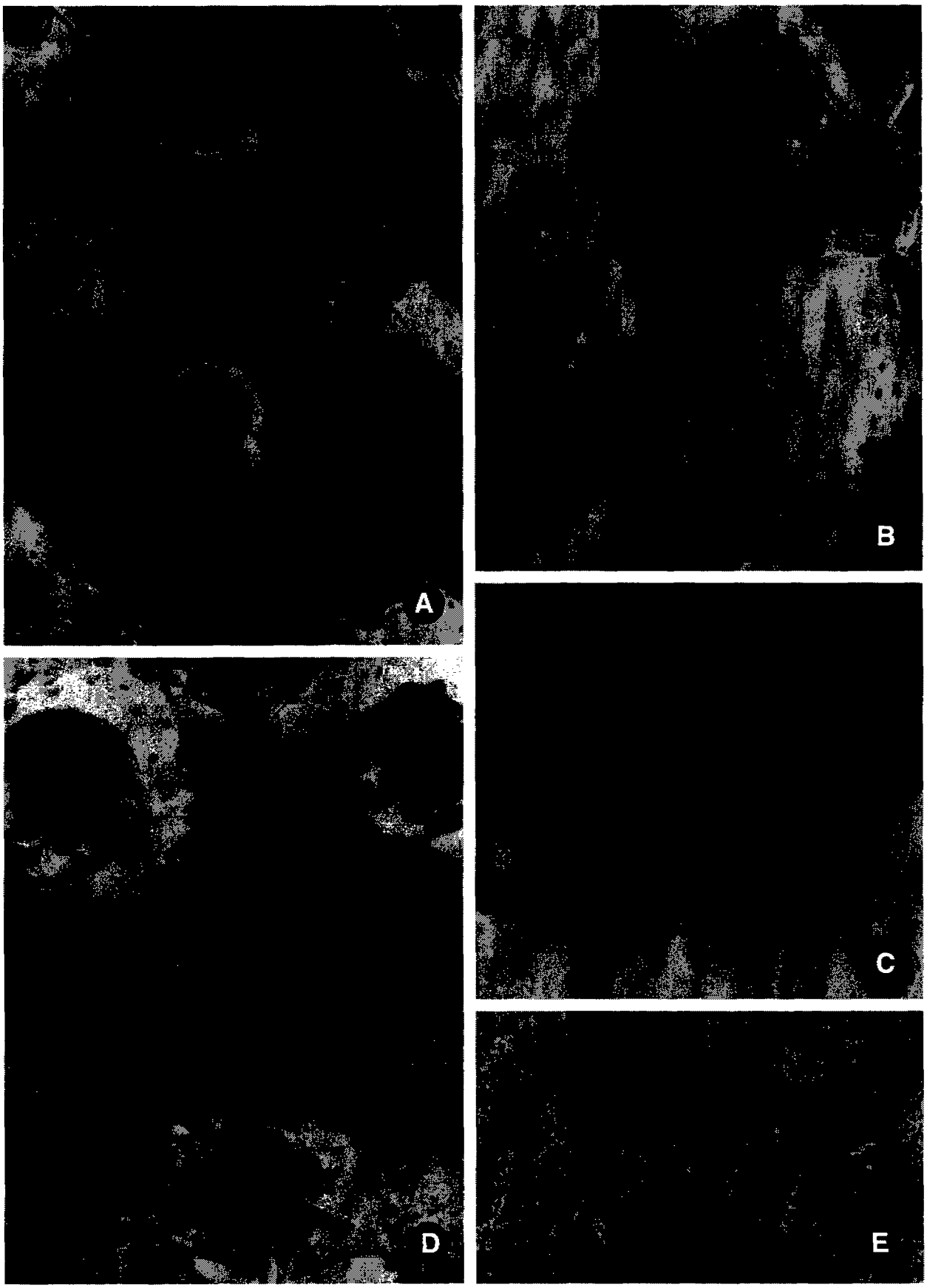
Etymology. Latin *rugosa,* diminutive for *ruga,* meaning wrinkled, for the rugose nature of the frontal wall.

Taxonomic Remarks. The MMS survey was the first to report *Escharella ventricosa* (Hassall, 1842) south of Puget Sound, and the specimen is similar to the arctic-boreal material. *Haywardipora rugosa* differs from the Hassall species, as illustrated by Hayward and Ryland (1979), in a number of ways: zooids of *H. rugosa* are much larger, the lateral frontal pores occur in multiple rows, there are usually six oral spines on mature zooids, the lyrula is low, not cusped at the tips, the umbo comes to an acute or blunt tip, not a truncate erect projection. Kluge's description of *E. ventricosa* is more similar to *H. rugosa* in zooidal size, in having one or two rows of readily visible pores, a lyrula of medium width with straight border, and a mucro (umbo) pointed, rounded or broader but not truncate. The spinules in the pores have not previously been reported, so far as we know.

Type Locality and Type Specimens. Locality AHF Station 1287-41, off Santa Cruz Island. SBMNH-AHF Bryozoa Holotype No. 231. *Lepralia ventricosa* was described from the Dublin Bay, Ireland.

Distribution. *Haywardipora rugosa* was collected off the central California coastoff Morro Bay and off Santa Cruz Island. Osburn (1952), C.H. and E. O'Donoghue (1923, 1925, 1926) and Kluge (1975) listed *Escharella ventricosa* as an Arctic-boreal, circumpolar species, found on both sides of the Atlantic to the western Mediterranean and Cape Cod, although all citations may not be the same species (Hayward and Ryland, 1979). Osburn (1952) listed it from Pt. Barrow, Alaska and Puget Sound and at *Albatross* station 2886, off the Oregon coast, but we have not been able to determine the southern extent of the supposed arctic *H. ventricosa* or the range of *H. rugosa.*

Plate 90. *Haywardipora rugosa.* Morro Bay, central California. A. Colony showing 2-3 rows of marginal pores with striate central portion, imperforate ovicells, 4-6 spines. B. Aperture with four spines, small denticle, blunt condyles, suboral umbo. C. Growth of porous frontal wall (right). D. Upper ovicelled zooid with four spines, umbo; lower zooid with four large spines, two small spines, umbo. E. Detail of spicules projecting inward.


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Haywardipora major (Hincks, 1884)

Plate 91 A-E

? *Mucronella spinosissima* form *major* Hincks, 1884a: 53, pl. 3, fig. 3.
? *Phylactella spinosissima* var. *major*: Canu and Bassler, 1923: 170, pl. 30, figs. 8, 9.
Mucronella major: Osburn, 1952: 438 (in part).

Material Examined. AHF and BMNH Collections.

Description. Colonies encrusting. Zooecia large, 840-1,000 μm long, 600-800 μm wide, ovate to hexagonal, raised. Frontal wall inflated, pores very small, tubular, in 2 - 4 irregular rows peripherally, central area smooth. Aperture raised, subterminal, with high peristome bearing 10 erect, slender, jointed, spines, spine bases remaining erect, incorporated in peristome; a small, slim, acute pointed mucro (not an umbo) in median proximal lip, continuing down inside peristome as a ridge to meet wide, anvil-shaped denticle. No avicularia. Ovicells small, at first appearing on distal peristome like a small suspended bag, becoming recumbent distally, imperforate, measuring 275-300 μm wide, 150 μm high; 10 spines present.

Biology. Encrusts rock and shells. Depths for *Haywardipora major* reported from shallow water to 300 m, but identifications have been confused.

Taxonomic Remarks. Hincks reported 6-10 spinous processes in his *Mucronella spinosissima* form *major*, and the specimen from Pt. Barrow, Alaska, illustrated in Plate 91, most resembles his illustration (pl.3, fig. 3) from the Queen Charlotte Islands. However, the BMNH slide 1886.3.6.26 labeled "type" is not a *Mucronella* but *Porella major* Hincks 1884, illustrated below in Plate 94, which Osburn (1952) synonymized with *Porella acutirostris* Smitt, 1867. Osburn remarked, as did Hincks (1884a), that the pores in *H. acutirostris* seemed to be tubules that extend from the margins up the frontal wall beneath the surface to openings closed by a calcareous diaphragm. In two new species from southern California, as well as in material from Pt. Barrow, Alaska, pores occur over most or all of the frontal wall.

Haywardipora. major is similar to *Escharella octodentata* (Hincks, 1880), an arctic and eastern Atlantic boreal species found in waters 50-200 m deep, figured by Hayward and Ryland (1979: 142, fig. 55), but the latter has only a partially visible row of tiny areolae and is much smaller. *Mucronella simplissima* var. *perforata* C.H. and E. O'Donoghue, 1923: 188, from the Vancouver Island area, may be *H. major*, but it was not illustrated and we were unable to examine specimens.

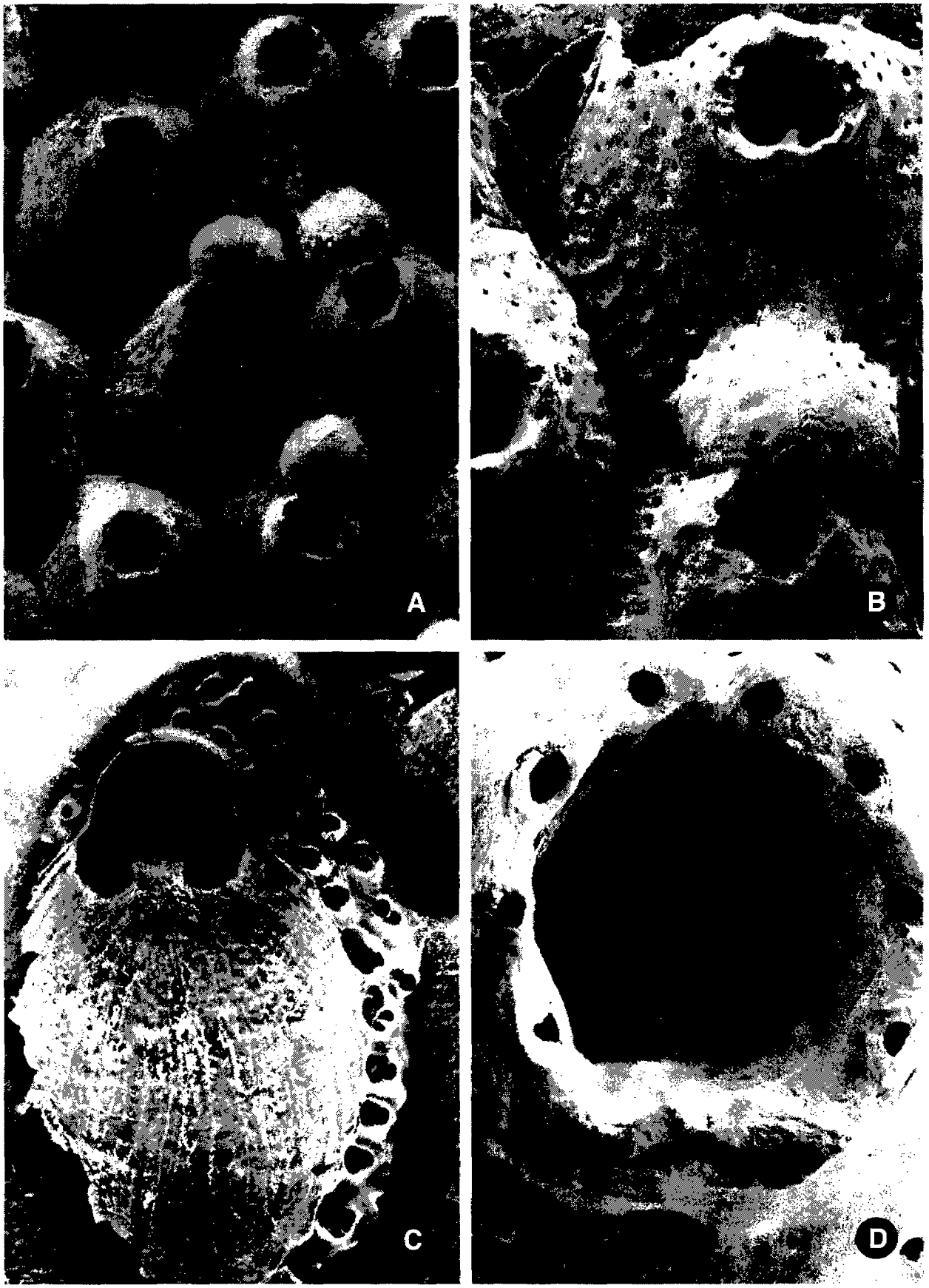
Kluge (1962, 1975: 497, fig. 264) recorded *Escharella macrodonta* Levinsen, 1916, which is similar, but has two rows of pores well separated from the granular frontal wall and a flared lyrula. He reported it from the high arctic, Greenland and the East Siberian Sea.

Type Locality and Type Specimens. Queen Charlotte Islands, British Columbia. BMNH 1886.3.6.26 is labeled part of type, but is *Porella major* instead. A neotype needs to be designated.

Distribution. Very common in British Columbia. Osburn (1952) reported *Mucronella major* from British Columbia southward, and in the Galapagos Islands, the latter perhaps erroneously. Canu and Bassler reported the species from the Pleistocene of Santa Monica, as *Phylactella spinosissima* form *major*, a genus which lacks a lyrula. We have not seen their material, but it is more likely to be *Haywardipora orbicula*, from southern California. There has been much confusion about *Phylactella*, with that genus

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Plate 91. *Haywardipora major*. Pt. Barrow, Alaska. A. Colony of raised zooids, 2-4 irregular rows of tiny pores, small ovicell with few pores, 10 spines and median oral mucro. B. Ovicells hung from distal side of peristome; spine bases incorporated into peristome. C. Detail of aperture with mucro extending downward as a column to wide, wedge shaped denticle, condyles not visible. D. Apertures with mucro as median ridge. E. Frontal pores closed with membrane, without internal spicules.


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limited to species with porous frontal walls and ovicells and a proximal peristomal collar that is low distally. Osburn (1952: 481) gave the type as *Lepralia collaris* Norman, 1867, but Hayward and Ryland (1979) gave the type as *Lepralia labrosa* Busk, 1854.

Haywardipora rylandi, new species

Plate 92 A-D

Mucronella major: Osburn, 1952: 438 (in part).

Material Examined. AHF and BMNH Collections.

Diagnosis/Description. Colonies encrusting. Zooecia moderately large, 600-750 μm long, 600-670 μm wide, irregularly hexagonal, with low lateral walls, high, convex frontal walls, frontal wall bordered by several rows of areolae, numerous small sunken frontal pores, fewer or absent proximal to peristomal mucro, with irregular ridges between pores, pores sometimes calcified over or occluded; tubular peristome subterminal to distal wall. Aperture rounded, about 150 μm in diameter, peristome thick, rapidly surrounding 8 spine bases, a wide, anvil shaped median denticle in primary aperture, condyles at midlateral level, small, rounded or absent; a secondary suboral hollow mucro sometimes bearing a pointed tip on lip of peristome, usually broken off. Ovicell small, 300-350 μm wide, 210-250 μm high, with scattered small pores, or dimpled, imperforate, 6-8 spine bases remaining visible in peristome collar.

Biology. Encrusting shell, rock.

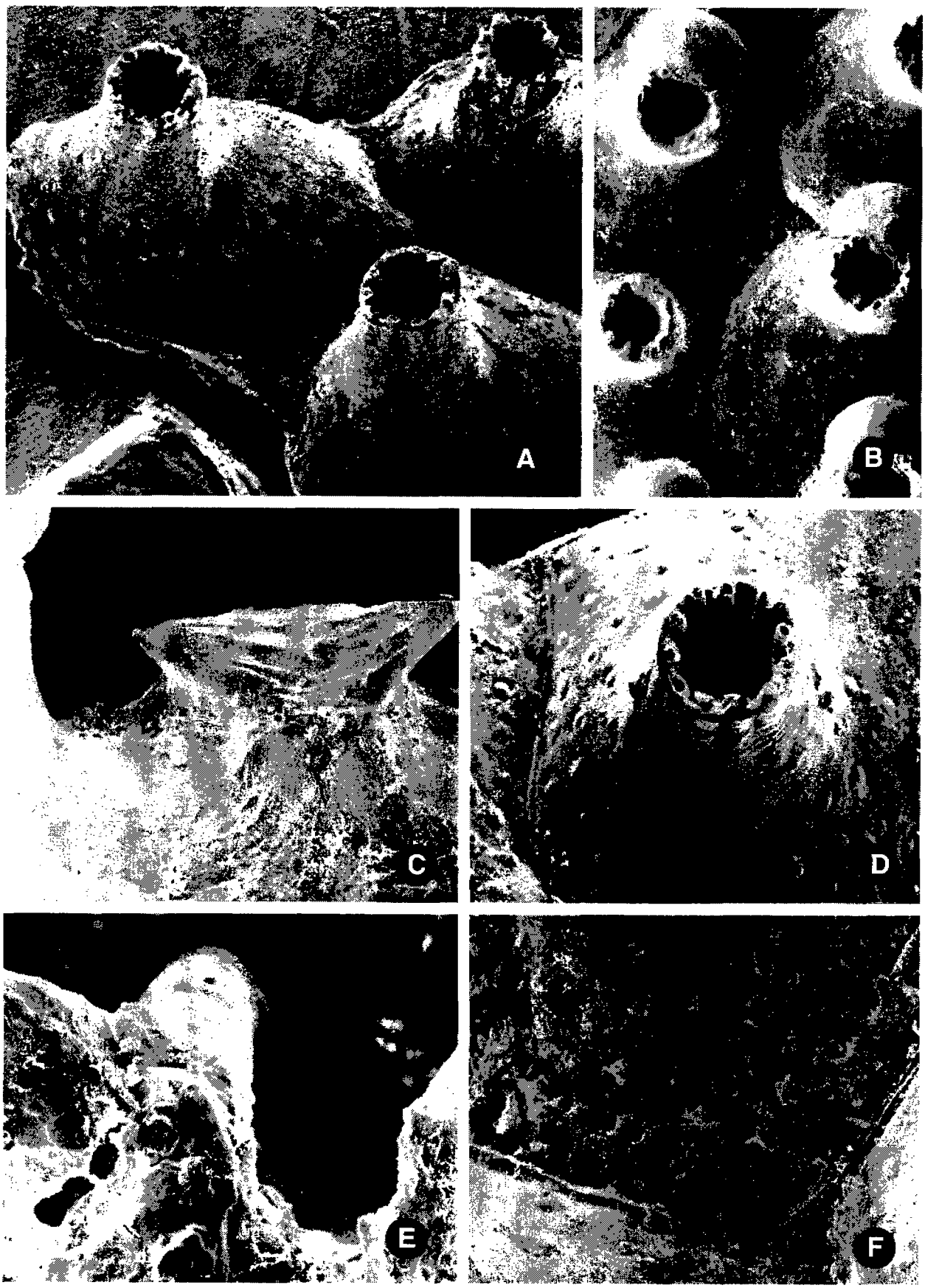
Etymology. Named for Dr. John Ryland, retired Professor at the University of Wales, Swansea, who has contributed so much to knowledge of bryozoans during his career, and who co-authored the valuable volumes on the British fauna.

Taxonomic Remarks. This species was originally included in *Mucronella major* by Osburn (1952). It is similar to *Escharella octodentata* (Hincks, 1880) as refigured by Kluge (1975) and Hayward and Ryland (1979). However, *E. octodentata* is smaller, has only a few indistinct areolae at the margins and there are distinct condyles opposite the tips of the lyrula. Its ovicells are imperforate.

Examination of the obverse side of *H. rylandi* indicates that the basal wall is narrow, leaving a large uncalcified basal window. The interior of the frontal wall as seen through the basal window shows an imperforate shield with lengthwise striations and some concentric rings like growth rings with scattered small pits. Zooids are surrounded by several rows of large areolae, including eight marking the position of the external hollow spines. The large areolae become subdivided, continuing between the primary and secondary frontal wall layers to surface at the exterior frontal pores. The tubules are clearly visible by illumination from beneath with a light microscope. (See also the tubules in Plate 92B beneath surface where peristome is broken off.)

Type Locality and Type Species. Pt. Barrow, Alaska, collected by G.E. MacGinitie. SBMNH-AHF Bryozoa Holotype No. 232.

Plate 92. *Haywardipora rylandi.* A, B, D, from Pt. Barrow, Alaska. A. Raised zooids with pores over most of frontal wall, eight spines, small ovicells. B. Growing margin, porous frontal with irregular ridges between. C. *Albatross* specimen, Station 3621 off San Diego, collected 1898. Interior of frontal wall viewed through large basal window; several rows of areolae present, some hidden by basal wall margin; pores around distal aperture correspond to spine locations. D. Detail of aperture with mucro broken away to reveal wide, anvil shaped denticle, no pronounced mucro ridge inside.


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Distribution. Pt. Barrow, Alaska, possibly to western Baja California. Plate 92C shows a specimen from Steamer *Albatross* Station 3621, off San Diego, collected in 1898. C.H. and E. O'Donoghue (1923, 1926) listed a number of *Mucronella* species and varieties but did not describe or illustrate them. We have not yet been able to check these forms at the BMNH.

Haywardipora orbicula, new species

Plate 93 A-F

? *Mucronella simplissima* var. *perforata* C.H. and E. O'Donoghue, 1923: 188; 1926: 116.
Mucronella major: Osburn, 1952: 438 (in part). — J. D. Soule, 1961: 38.

Material Examined. MMS Station: BRA-16. Other collections: BMNH and AHF.

Description. Colonies encrusting. Zooecia hexagonal, 800-1,000 μm long, about 560-800 μm wide, with low lateral walls, frontal wall inflated, convex, with pores raised, rimmed or covered, extending to top of peristome and distal to it; peristome circular, about 200 μm in diameter, raised, placed subterminally; aperture usually with 10 long, stout spines, bases becoming incorporated as secondary wall rising up around peristome, a medial proximal, vertical, hemicylindrical ridge extending down inside peristome to deeply set, wide denticle (lyrula) almost an inverted triangle; no condyles seen. Ovicells large, 330-360 μm wide, 210-220 μm high, appearing imperforate but small pores may be present beneath ectocyst.

Biology. Encrusting stones, shells, stems, corallines, bryozoans. Osburn (1952) gave the depth range of shallow water to 247 m, but this may be incorrect given the mixture of species. The MMS site is 91.5 to 123 m deep.

Etymology. Latin, *orbicula*, meaning little circle, for the round peristome.

Taxonomic Remarks. Osburn (1952) tended to use composite illustrations, but *H. orbicula* comes closest to the *"Mucronella major"* depicted in his plate 52, figures 4 and 5. He described the frontal wall as being a smooth pleurocyst at first, with two or 3 rows of small marginal pores that are carried up as microscopic tubules, a circumstance first mentioned by Hincks (1884b: 27) for his species *Mucronella spinosissima* form *major*, shown in Plate 91, which although closely related, is judged here not to be the same species. The pores in *H. orbicula* are raised, pustular, covered with a heavy ectocyst, appearing under light microscopy to be connected to the margins by tubules but no trace of tubules was found in dissection or in SEM of cleaned material. Regenerative areas indicate a "tremocystal" (reticulate) formation, although the original frontal wall may be a mixture of tremocystal and umbonuloid modes.

Type Locality and Type Species. Locality AHF Station 1447-42, off Point Arguello, central California. SBMNH-AHF Bryozoa Holotype No. 233.

Distribution. Osburn reported *H. orbicula* as *M. major* from the Channel Islands and off western Baja California. At least some of the Gulf of California material (J. D. Soule, 1961) is *H. orbicula*, but the Galapagos Islands material is open to question. It is possible that it extends northward to Vancouver Island, given the listings of C.H. and E. O'Donoghue.

Plate 93. *Haywardipora orbicula*. A, C, D, E from off Purisima Pt., B, F from off Santa Catalina Island. A. Margin of colony showing erect peristomes with 10 spines, a median suboral mucro; frontal wall pores over entire frontal wall. B. Imperforate ovicells, spine bases and mucro. C. Wedge shaped denticle at base of peristome. D. View from distolateral side showing spine bases, mucro descending to denticle. E. Column of mucro descending to denticle, outer tip broken off. E. Porous regeneration of new frontal wall over old one.

Family Porellidae Vigneaux, 1949

The genus *Porella* has been placed in the Smittinidae by many authors because of the obvious presence of a median lyrula and a suboral avicularium connected bilaterally to areolar pores. Vigneaux (1949) created a subfamily of Smittinidae, Porininae, which Gordon and Grischenko (1994) elevated to family status. The genus obviously differs from smittinids in having an imperforate ovicell, but those authors also have found differences in the formation of the frontal shield (wall), with the porellids having an umbonuloid mode indicated by an interior ovoid line of calcification proximal to the primary aperture that represents the attachment scar of the frontal membrane. The frontal walls externally are imperforate with marginal areolae. Oral spines typically absent but spine bases or spines seen on *P. columbiana* and *P. porifera*.

Porella major Hincks, 1884

Plate 94 A-E

? *Porella acutirostris* Smitt, 1867: 21, 22. — Osburn, 1952: 394. pl. 46, fig. 4. — Kluge, 1975: 550, fig. 300. — Dick and Ross, 1988: 63, pl. 8A.
Porella major Hincks, 1884a: 51, pl. 4, fig. 5.

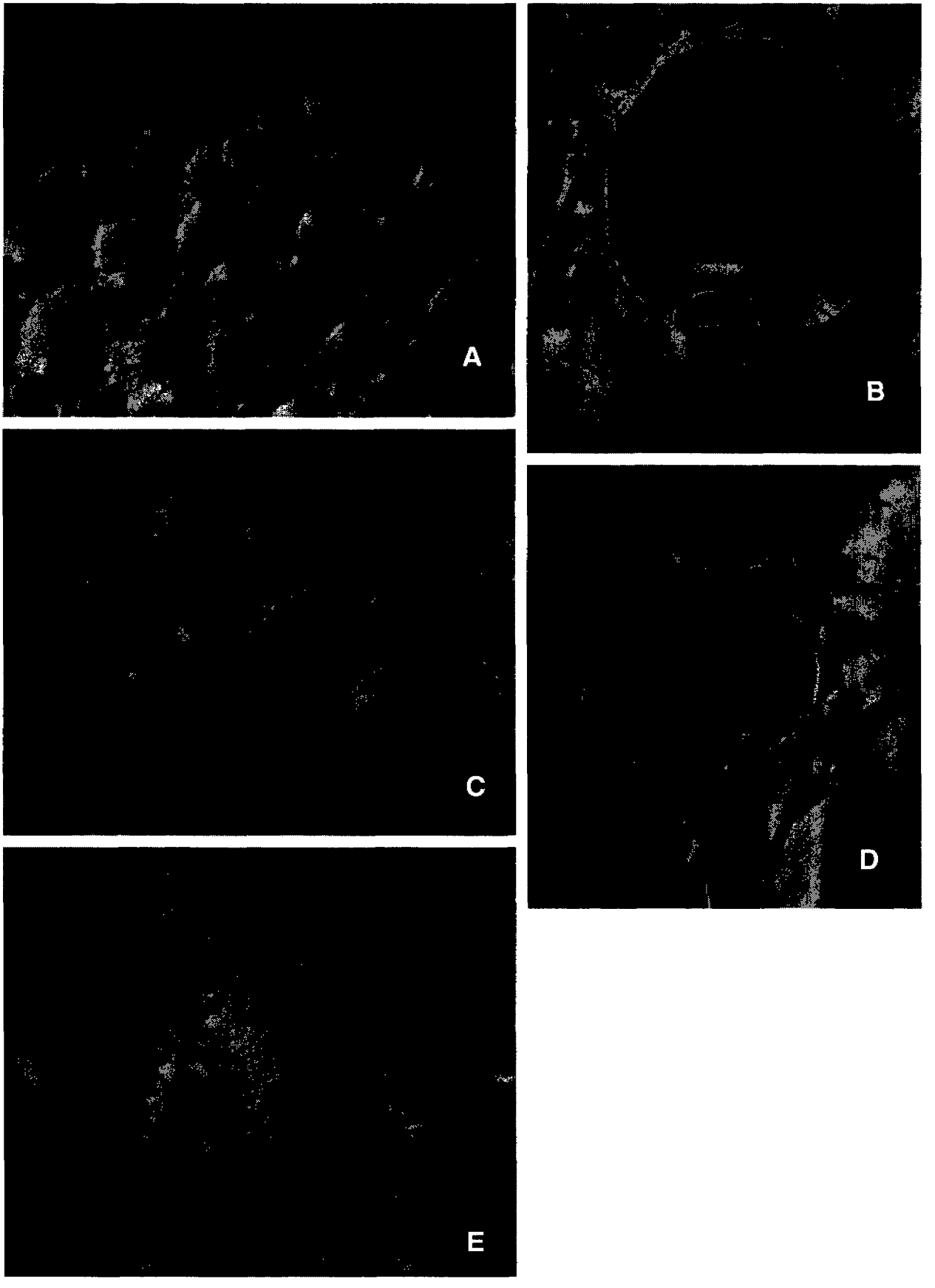
Material Examined. AHF and BMNH Collections; BMNH type 1886.3.6.26.

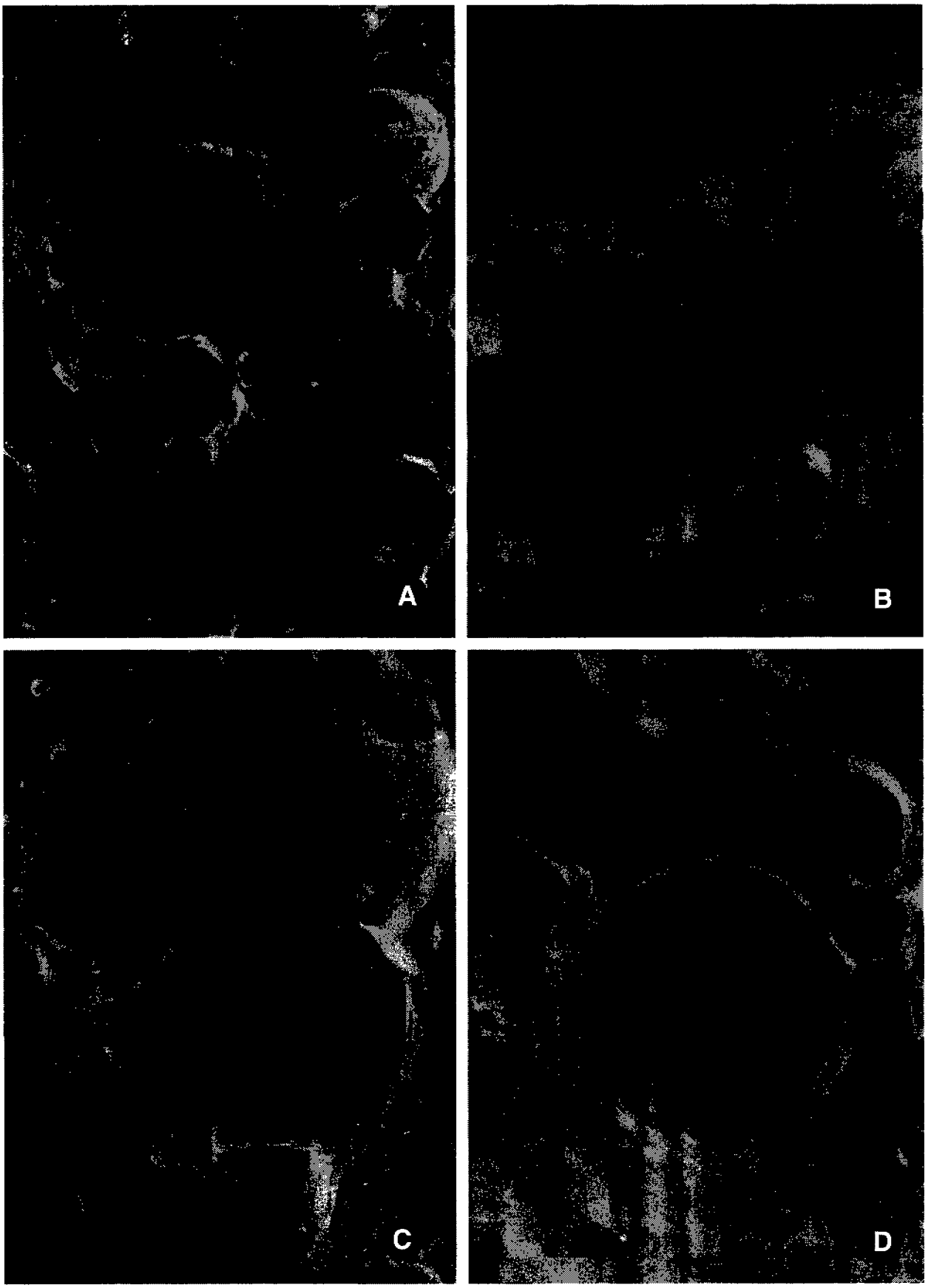
Description. Colony flat, zooids oval to hexagonal, 450-600 µm long, in radiating rows, frontal wall smooth, with small granules, lateral walls raised, distinct, with a single row of medium to large areolae, 6-10 on each side. Primary aperture rounded distally, no marginal spines, condyles small, flattened, with a low, wide, truncate or mound shaped lyrula composed of a thin denticular rim and a large primary frontal wall component. A median suboral avicularium at base of lyrula directed proximally, developing from a wide chamber connected to 1 - 2 areolae on each side, becoming somewhat inflated; mandible acute, a complete hinge bar; peristome becoming raised, including avicularium in a V-shaped rim. No ovicell on type. Ancestrula with a large aperture curved distally, straight proximally, with 8 spines; frontal wall small, V-shaped, narrowing to tail proximally, surrounded by 5 buds.

Biology. Zoarium light brown, encrusting shells. Depth range unknown.

Taxonomic Remarks. Osburn (1952) placed Hincks' species in synonymy with *Porella acutirostris* Smitt, 1867, a common arctic species extending down the Atlantic coast to Cape Cod. Kluge (1975: 550-551, fig. 300) did not repeat this synonymy, but he erroneously cited Hincks (1884) as having recorded *P. acutirostris* instead of *P. major* in the Queen Charlotte Islands. Since we located Hincks' BMNH type, we are doubtful that the southern California specimens belong to the arctic species. Kluge gave the temperature range as -1.61 to 2.56°C and depths from 0 to 395 m. We have not seen the Smitt type. Osburn's illustration indicates a more bulbous avicularian chamber outside the peristome, as does Kluge's illustration of *P. acutirostris*, than is found in the type of *P. major*, which is a young colony. Kluge described the areolae as a few depressions on each side with small pores at the bottom, as compared to the 6-10 rather large areolae on each side located flush with the lateral walls in the type. Smitt's (1867) description is inadequate and his illustration poor, giving little clue to details.

Plate 94. *Porella major*. BMNH type 1886.3.6.26 from Queen Charlotte Islands, British Columbia. A. Colony with ancestrula left of center, with three small distal buds, two large proximal buds, imperforate frontal walls, single row of even areolae. B. Detail of aperture with low denticle, avicularium inside peristome, condyles tiny, flush with rim. C. Growing edge of colony. D. Detail of ancestrula with eight spines. E. Avicularium chamber developing on right from areolar pores on both sides; completed zooid with acute suboral avicularium to left.


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C
D

Ovicells of *P. acutirostris* were described by Osburn (1952) as rounded, smooth, prominent with a small raised brim developing around opening; Kluge (1975) described them as coarsely granular, and Dick and Ross (1988) described them as globose, 200-2300 μm across, imperforate, granulose like the frontal wall. Dick and Ross also described the cardelles (condyles) as low, broad and inconspicuous, seemingly unlike the tiny, flattened ones in the type.

Type Locality and Type Specimens. Houston-Stewart Channel, Queen Charlotte Islands, common on shells. BMNH 1886.3.6.26 is listed as the type.

Distribution. If *P. major* is, as we suspect, a separate species and not a junior synonym of *P. acutirostris*, its range is from the Queen Charlotte Islands to Santa Barbara Island and to Newport Harbor Channel, south of Los Angeles, California.

Porella columbiana C.H. and E. O'Donoghue, 1923

Plate 95 A-D

Porella columbiana C.H. and E. O'Donoghue, 1923: 183, pl. 3, fig. 28. — Osburn, 1952: 398, pl. 46, figs. 7, 8. — Dick and Ross, 1988: 64, pl. 5 B, C.
Smittina columbiana C.H. and E. O'Donoghue, 1926: 115.

Material Examined. AHF and BMNH Collections; BMNH 1964.1.2.15.

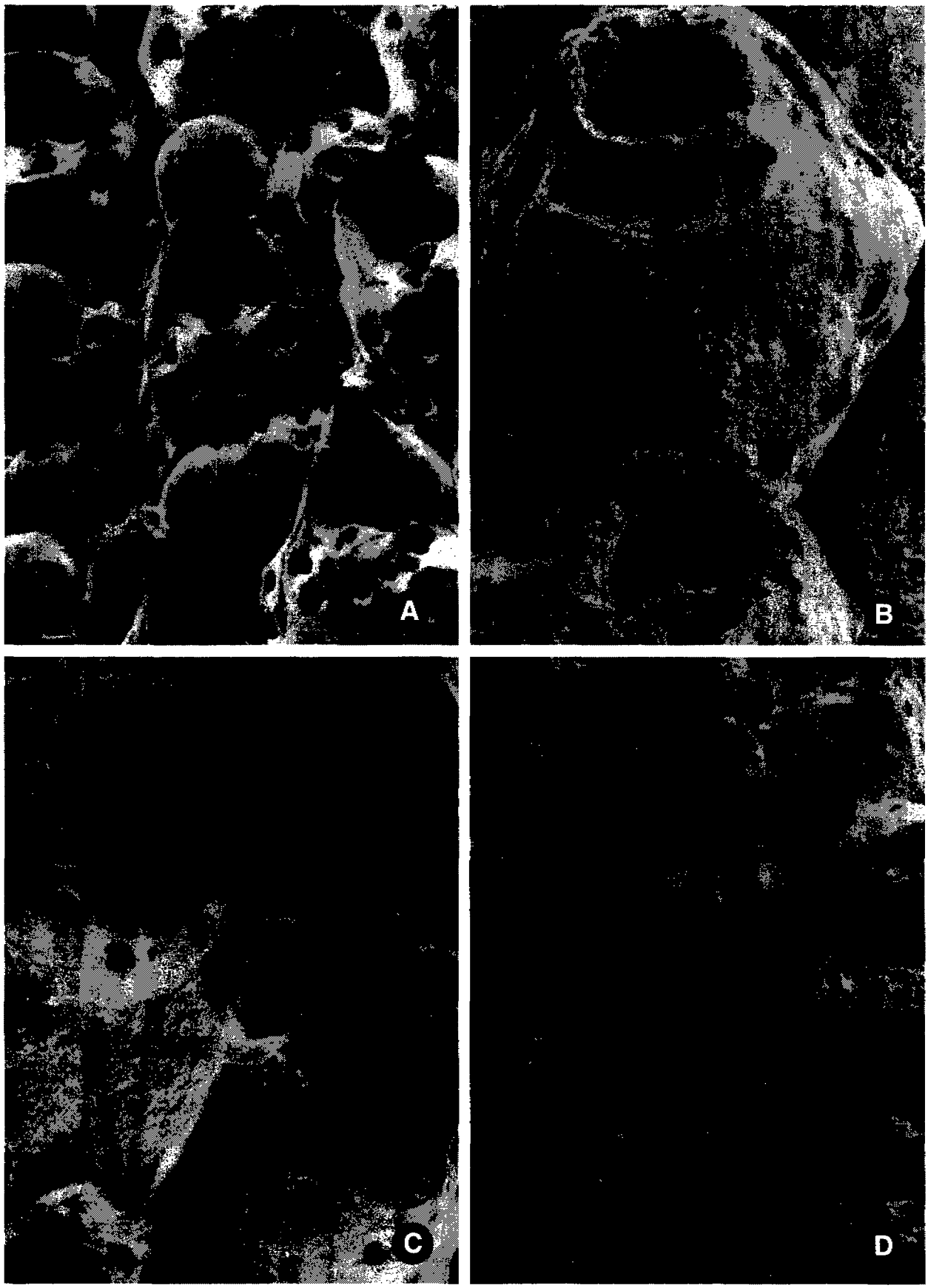
Description. Colonies encrusting, thin, glistening, yellowish white. Zooids distinct, ovoid, 450-600 μm long, 250-350 μm wide, frontal wall inflated, imperforate, ventricose, with 4-5 large areolar pores separating contiguous zooids, becoming sunken, buttressed. Primary aperture rounded, distal rim curved, ending at transverse walls, lateral peristome curving inward, ending at knobbed condyles, secondary aperture composed of an incurved distal frontal lappet from secondary calcification covering 4 spine bases, meeting erect lateral peristomal lappets at lateral wall sutures; proximal lip slightly convex, with a low median lyrula; a small, bluntly acute, median suboral avicularium directed proximally; peristome lowering proximally to include avicularium rostrum; 2-3 small pores at base of small, inflated avicularian chamber. No other avicularia. Ovicells separated by groove or slits from distal zooid, about 210 μm wide, 150 μm high, globular, imperforate, with a brim above opening.

Biology. Encrusts rock, shell and algae. Zooids tend to remain distinct even in older colonies. Depths reported from shallow waters to 110 m.

Taxonomic Remarks. AHF material from southern California was more heavily calcified than the O'Donoghue's BMNH specimen, sometimes making the areolar pores less distinct and the ovicell partly immersed. Osburn (1952: 393) indicated in his key that the species has two to four small spines and the mandible is not acute. However, the BMNH specimen in the O'Donoghue collection is young, shows no spines (when examined by light microscope) and has an acute or subacute mandible. The specimen from a kelp holdfast at Santa Monica shows, with SEM, the preservation of spine bases beneath the distal flap.

Dick and Ross (1988) indicated that their zooids were smaller, 330-430 μm in length, than the California material of 450-600 μm length. The avicularian chamber was larger in their illustration than that in ours, but the two or three pores at the chamber margin can be seen in both.

Plate 95. *Porella columbiana.* Kelp bed off Santa Monica, California. A. Zooids with few large areolae on each side, imperforate ovicells, avicularia hiding internal denticle. B. Developing ovicell, right, complete on left; note large areolae. C. Ovicell aperture with spine bases enclosed by peristome, narrow denticle, small condyle, bluntly acute suboral avicularium. D. Autozooid aperture with spine bases hidden in peristome; avicularium within peristome but not on denticle.


A
B
C
D

Type Locality and Type Specimens. *Porella columbiana* initially was reported from a number of localities in British Columbia. No type has been designated in the BMNH Collection. The above specimen, BMNH 1964.1.2.15, is here designated as the lectotype.

Distribution. Queen Charlotte Islands, British Columbia, Puget Sound, Washington; Redondo Beach and Santa Monica, California, washed ashore on kelp holdfasts. Osburn also listed the species from the Galapagos Islands, which we have not been able to confirm.

Porella porifera (Hincks, 1884)

Plate 96 A-C; Plate 97 A-B

Porella marsupium form *porifera* Hincks, 1884a: 50, pl. 4, fig. 4.
Smittina porifera: Canu and Bassler, 1923: 147, pl. 38, fig. 9.
Porella marsupium var. *porifera*: C.H. and E. O'Donoghue, 1923: 182; 1926: 115.
Cystisella aviculifera Canu and Bassler, 1923: 152, pl. 38, fig. 8.
Porella porifera: Osburn, 1952: 395 (in part). pl. 46, figs. 9-11. — J. D. Soule and M. Duff, 1957: 119. — J. D. Soule, 1961: 29.

Material Examined. MMS Station: BRA-1. Other collections: BMNH and AHF.

Description. Colonies commonly encrusting. Zooids 400-650 μm long, 300-400 μm wide, ovoid to rectangular in shape. Frontal wall inflated, smooth, imperforate except for a few small areolar pores; 3-4 other larger frontal pores at base of avicularium. Primary aperture rounded distally, bearing 4 thin spines, spine bases becoming covered by distal frontal wall; proximal apertural border having a narrow, short, truncate median lyrula, becoming hidden by peristome; lateral oral lappets present. Suboral avicularium chamber originating from 2 lateral pores, becoming raised, partly enclosed by the peristome, with a rounded or subtriangular mandible directed proximally. Additional avicularia appearing interzooecial, on mounds between zooids, with their own areolae, sometimes encroaching on adjacent apertures; sometimes absent over large areas of colony. Ovicells small, 160-180 μm wide, 150 μm high, globose, imperforate, with a small brim, becoming immersed.

Biology. Encrusts rock and shells. Depths to 250 m. The MMS depth is 69-73.5 m.

Taxonomic Remarks. The lectotype of *Porella porifera* is BMNH 1886.3.6.10 (see Plate 97A-B), and has many more interzooecial (vicarious) avicularia than the specimen from Santa Cruz Island (AHF station 1295-41) in Plate 96 A-C, but the two seem within a reasonable range of variation. The additional avicularia may be stimulated by some predator. Osburn (Figure 22) illustrated other, seemingly adventitious avicularia on the distal and

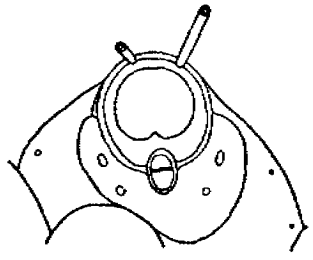


Figure 22. *Porella porifera*. From Osburn, 1952, pl. 46, fig. 10.

Plate 96. *Porella porifera*. Santa Cruz Island, California. A. Colony with mature, imperforate ovicells, few small areolae, few small pores as base of avicularium chamber; small interzooecial avicularia surrounded by areolar pores. B. Developing zooid with four spine scars, avicularium chamber connected to lateral frontal pores. C. Broken peristome showing small median denticle, small condyle. D. *Porella rogickae*, from Port Culebra, Costa Rica, showing larger, more numerous areolae, large pores at base of avicularium; wider denticle; interzooecial kenozooids, present but not shown, apparently lack an avicularium. Developing ovicells with central opening, becoming an imperforate lucidum when mature.

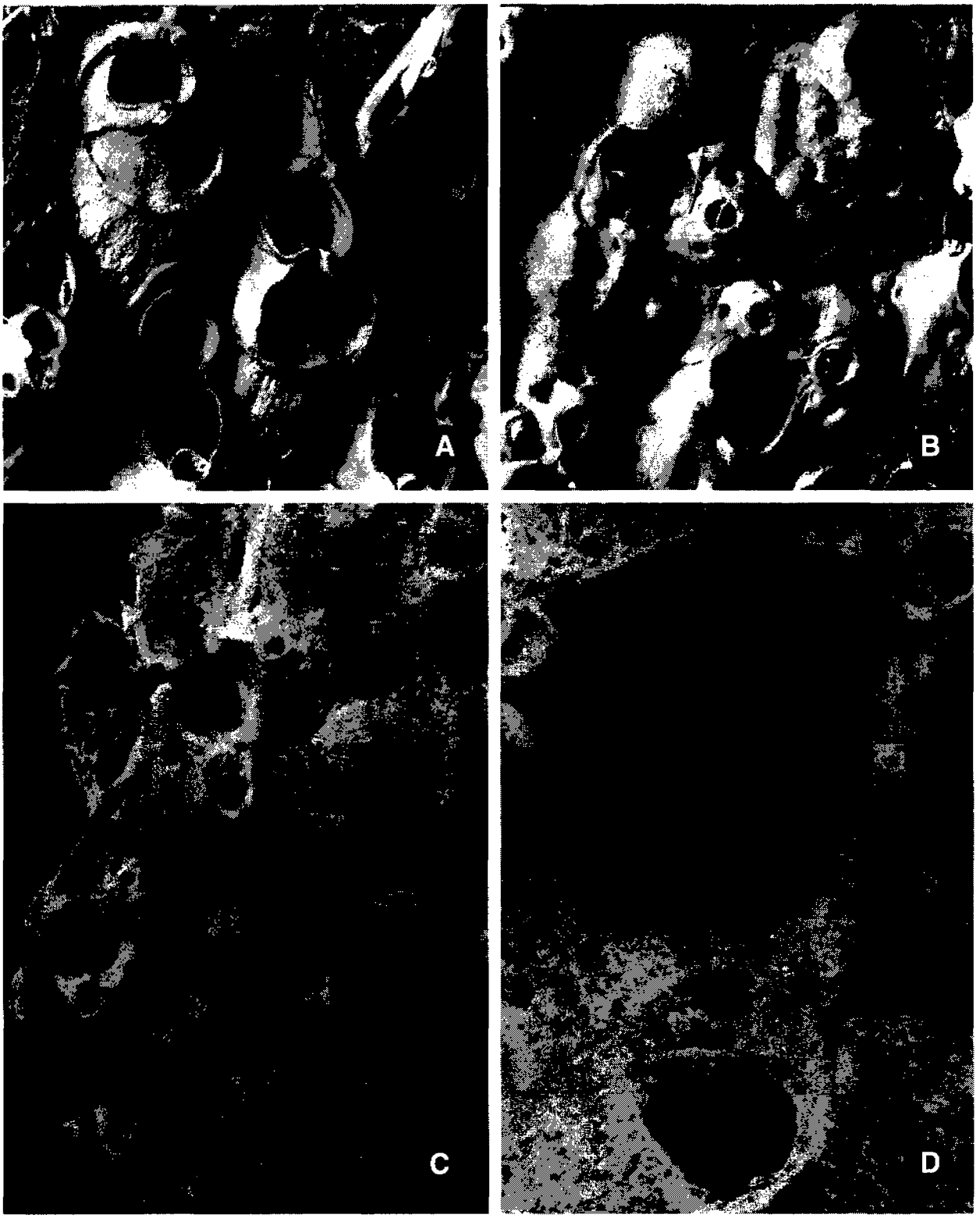


Plate 97. *Porella porifera*, A-B. A. BMNH lectotype 1886.3.6.10, showing development of avicularium chamber, four spines. B. Same, with pores at base of avicularium, additional, interzooecial avicularia. C-D. *Porella taylori*. MMS 001-BRA. C. Small colony showing imperforate ovicells, three avicularia. D. Same, aperture of ovicell with tiny avicularia flanking aperture distolaterally, larger suboral avicularium mostly outside peristome, tiny median denticle, no condyles seen.

proximolateral frontal wall. Such avicularia did not occur on the Santa Monica specimens.

Porella rogickae J. D. Soule, 1961 (pl. 96, fig. D), a Baja California species, is smaller than *Porella porifera*, and has 6-8 large areolar pores, plus four large pores beneath the suboral avicularium. *P. rogickae* has ovicells with a large central area not covered by ectooecium, which becomes an irregular depression closed only by the entooecium. Interzooecial kenozooids occur in *P. rogickae* which are similar in location to the interzooecial avicularia in *P. porifera* but apparently lack mandibles.

Type Locality and Type Specimens. Queen Charlotte Islands, British Columbia. Lectotype (in part) BMNH 1886.3.6.10.

Distribution. British Columbia south to the Channel Islands, California. Some specimens from San Benito Island west of Cedros Island off Bahía Viscaino, Baja California and Costa Rica, are *Porella rogickae*, described from the Gulf of California (J. D. Soule, 1961); *P. porifera* also was reported in the Gulf and off the west coast of Baja California (J. D. Soule, 1961).

Porella taylori, new species

Plate 97 C-D

Porella porifera: Osburn, 1952: 395 (in part).

Material Examined. MMS Station BRA-1. AHF Collections.

Description. Colony encrusting. Zooids subhexagonal, about 700 μm long, 500-550 μm wide, with a few areolar pores, frontal wall coarse, imperforate except for 5-6 small pores at base of suboral avicularium. Primary aperture almost quadrate, about 160 μm wide, 150 μm high, with a tiny, acute median lyrula, becoming sunken; suboral avicularium mostly outside peristome, widely ovoid with acute tip directed proximally, about 170-180 μm long; pair of smaller avicularia flanking distal corners of aperture. Ovicells imperforate, large, about 300 μm wide, 250μm high, with small brim.

Biology. Encrusting shell; known depths 69-73.5 m.

Etymology. Named for Dr. Paul D. Taylor, Department of Palaeontology, The Natural History Museum, London, who provided SEMs of some of the BMNH type material and has been most helpful during our research efforts there, in addition to providing helpful comments in reviewing this manuscript. His contributions in helping to bridge the gap between fossil and Recent genera is significant.

Taxonomic Remarks. The type specimen of *Porella taylori* is the only one available of the form described, until collections of *"P. porifera"* can be reexamined. It is somewhat similar to the form incorporated by Osburn (Figure 23) of *P. porifera*, but the new species does not have the interzooecial avicularia nor distal frontal ones. The suboral avicularium is larger, and the ovicells are much larger than those in other species discussed: about 300 μm wide as compared to 160-200 μm in *P. porifera* and about 210 μm in *P. columbiana*.

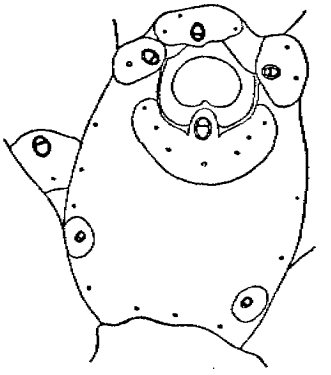


Figure 23. *Porella porifera.* From Osburn, 1952, pl.46, fig. 11.

Type Locality and Type Specimens. Locality AHF Station 1304-41, off Santa Cruz Island. SBMNH-AHF Bryozoa Holotype No. 234.

Distribution. The Santa Barbara Channel is the only distribution presently known.

Family Phylactellidae Canu and Bassler, 1917
? Family Teuchoporidae Neviani, 1895

The genus *Phylactella* Hincks, 1879, on which the family Phylactellidae is based, has had a confused history. Osburn (1952) gave as its type *Lepralia collaris* Norman, 1867, a species with lageniform (flask shaped) zooids, imperforate frontal walls except for areolae, and perforate ovicells borne on the distal wall of the peristome, whereas Bassler (1953) created *Phylactellipora* with that species as the type. Hayward and Ryland (1979) list *Phylactella labrosa* (Busk, 1854), with a perforate frontal wall and ovicell, as the type species. Both of those genera lack avicularia, which made it necessary to amend the family to include the genera *Lagenipora* and *Lagenicella* in the family.

Osburn (1952) placed perforate lageniform Pacific species with avicularia in *Lagenipora*, a genus with imperforate frontal walls and ovicells, including it in Phylactellidae Canu and Bassler, 1919. Cheetham and Sandberg (1964) later created the genus *Lagenicella* for those species with perforate (tremocystal) frontal walls, placing it in Phylactellidae "Jullien", apparently an erroneous attribution.

More recently Hayward and Ryland (1979) and Gordon (1989) have placed *Lagenipora* in the Celleporidae, based on the paired avicularia and the semilunar porous area in the ovicells of some celleporids. Conversely, one might conclude that some perforate celleporinids belong in the Phylactellidae in the genus *Lagenicella*, or in a new genus that would provide for frontal budding rather than the characteristic terminal budding of *Lagenicella*. There is a problem in classifying some of the species that Osburn (1952) placed in the genus *Costazia* Neviani, 1895, including *"C. costazii"* (non Savigny and Audouin), *C. ventricosa*, and *C. robertsoniae*, all of which have reticulate (perforate) frontal walls, which have more recently been included in *Celleporina* in the Celleporidae. Both the type of *Celleporina*, *C. hassallii* (Johnston, 1847), and the type of *Costazia*, *C. costazii* (Savigny and Audouin) have imperforate frontal walls with only marginal pores.

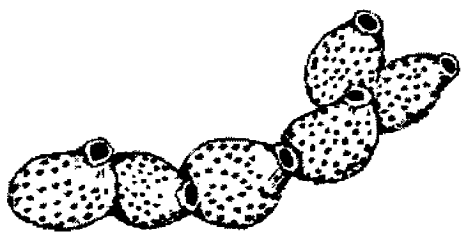


Figure 24. *Teuchopora castrocarensis*. From Neviani, 1895, pl. 2, fig. 14. After Manzoni.

Harmer (1957:806) made a case for use of the family Teuchoporidae for colonies with vase shaped zooids and porous frontal walls, based on the genus *Teuchopora* Neviani, 1895, a uniserial or biserial species with frontal perforations and a raised collar. Manzoni, (1875, pl.6, fig. 14) described *Teuchopora castrocarensis* and illustrated the uniserial/ biserial colony; this was copied by subsequent authors (poorly by Bassler, 1953), although his specimens lacked ovicells, which are crucial to determining the affinities of the lageniforms. We reproduce Neviani's illustration in Figure 24. Neviani stated that he considered creating a family Teuchoporinae, but concluded that the *Teuchopora* species belonged in the family Schizoporellidae because of the presence of a sinus. Poluzzi (1977) redescribed Manzoni's young figured specimen of *T. castrocarensis*, selecting a lectotype, No. 13385A, and photographed the uniserial and multiserial, mature colonies. One ovicell was shown, with a wide, compressed aperture and small, perforate hood; it occurred at a birfurcation and appeared to have a modified peristome. Examination by SEM is needed to compare this species with the lageniform species.

We are not inclined to agree that Harmer's grounds are valid for Neviani's family, of which Neviani himself was uncertain, giving it priority over Phylactellidae. The division of the similar lageniform species into separate families based on porous or nonporous frontal walls would be akin to splitting the family Smittinidae, ignoring the similarities of the genera. Future studies may indicate that just such a division based on developmental criteria is necessary. *Lagenipora* might be assigned to the Phylactellidae, or to the Celleporidae, *sensu stricto* and *Lagenicella* to Teuchoporidae under this system, which does not seem appropriate. We retain the *Lagenicella* in the Phylactellidae for the present.

Lagenicella ? punctulata (Gabb and Horn, 1862)

Plate 98 A-D

? *Entalophora punctulata* Gabb and Horn, 1862: 171, pl. 21 fig. 61.
Tubucellaria punctulata: Canu and Bassler, 1923: 170, pl. 40, figs. 1-4.
Lagenipora punctulata: Osburn, 1952: 485, pl. 60, figs. 1, 2. — J. D. Soule and M. M. Duff, 1957: 126. — J. D. Soule, 1961: 49.

Materials Examined. MMS Station: BRA-20. AHF Collections.

Description. Colonies erect, branching, cylindrical. Zooids flask shaped, frontal wall coarsely punctured, reticulate; primary aperture circular, developing a long apertural collar (peristome) ribbed, appearing as fused spines, ending in an irregular circle flanked by a pair of small spinules. A pair of small (100 µm long) pointed avicularia with their mandibles directed laterally located behind the spinules at apex of most collars. Small, globular ovicells prominent, suspended from distal rim of peristome, at first with the frontal wall semilunar portion finely reticulate, becoming occluded, the distal portion solid.

Biology. Depths recorded from shallow waters to 200 m. The MMS depth is 90-130.5 m.

Taxonomic Remarks. Gabb and Horn (1862) placed the species in the *Entalophora*, which are Cyclostomata (Stenolaemata) consisting of bundles of tubules that form branching colonies, not recognizing the lageniform zooids as ascophorans. Their illustration (Figure 25) is difficult to recognize as a *Lagenicella* species, but Canu and Bassler (1923) confirmed it in their examination of similar fossils from the Santa Barbara Pleistocene deposits.

Osburn (1952: 485) placed part of *L. spinulosa* Hincks and the *L. spinulosa* Hincks of Robertson (1908) in synonymy with *L. punctulata*. That synonymy is difficult to accept. Part of *Lagenipora spinulosa* Hincks (1884a: 57, pl.3, fig. 4) represents a recumbent colony with flask shaped zooids, perforate or reticulate up to the semierect tall, flaring, imperforate peristomes, perhaps with spines on the tips; he described the ovicell as small, rounded, smooth, placed far down the back of the tubule. The later part (1884a: 210, pl. 9, fig. 4) is an erect, branching form like that described for *L. punctulata* (Gabb and Horn, 1862), and by C.H. and E. O'Donoghue as *L. erecta* (1923: 33, pl. 3, fig. 22). The O'Donoghues described in detail the differences between *L. erecta* and *L. spinulosa*,

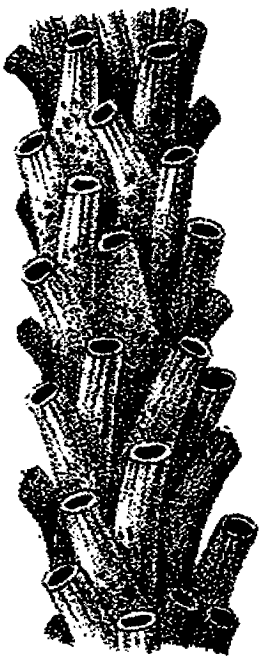
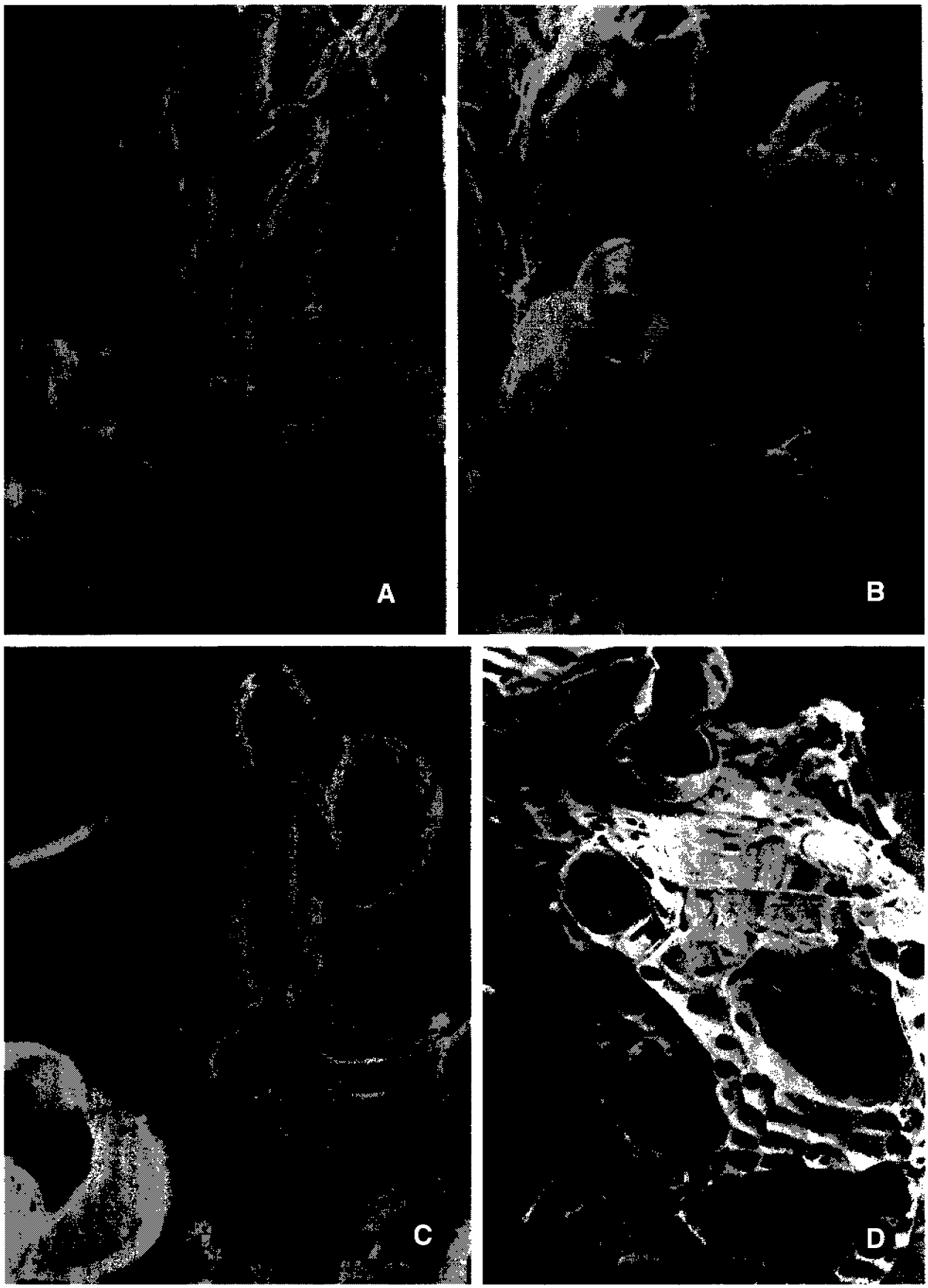


Figure 25. *Entalophora punctulata.* From Gabb and Horn, 1862, pl. 21, fig. 61.


A
B
C
D

including circular striations on the outer neck, not present on *L. punctulata* or *L. spinulosa* as identified by Osburn in the AHF collections. They may occur on *L. neosocialis*, however.

The *L. spinulosa* of Robertson (Figure 26) appears to be closer to that species as illustrated by Hincks, but may be an undescribed species with elaborate spine growth; there is no indication that some part of the material is of *L. punctulata*, as Osburn (1952) indicated. A specimen in the AHF collections suggests that Robertson's southern material differs from the Hincks species, but requires more comparative study.

Type Locality and Type Specimens. Pleistocene deposits, Santa Barbara, California. Existence of type specimens unknown.

Distribution. Fossil localities from Santa Barbara to Newport Bay; Recent from northern California to Baja California and the Gulf of California. Citations from British Columbia and Monterey Bay are questionable, as are reports from the Galapagos Islands.

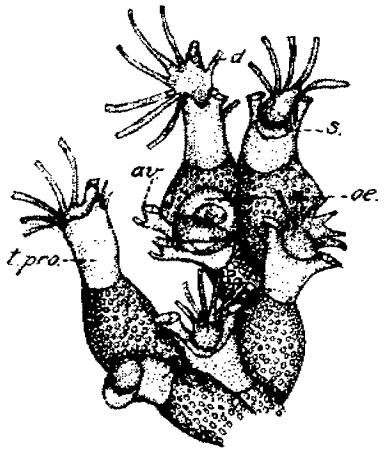
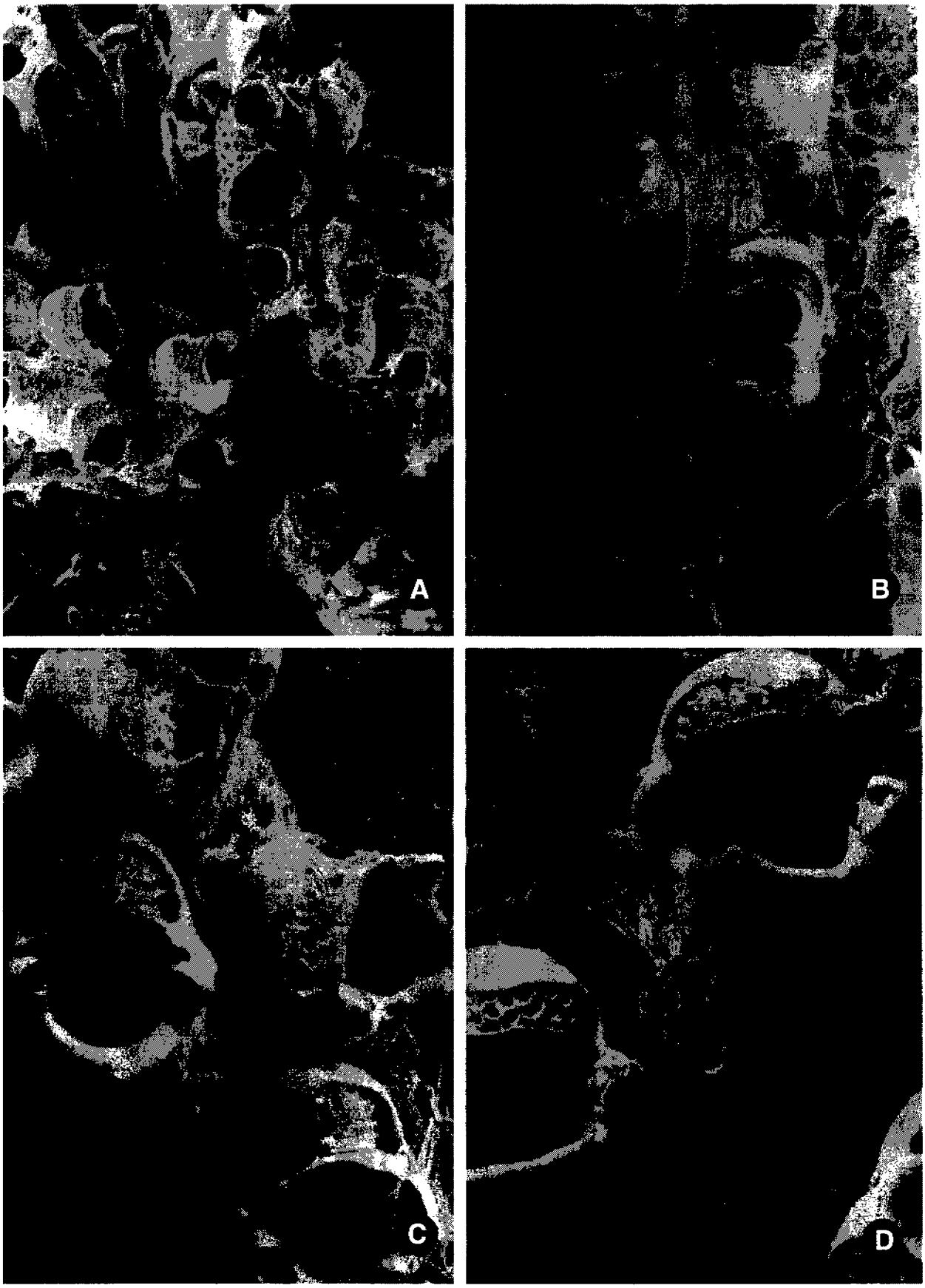


Figure 26. *Lagenicella spinulosa.* From Robertson, 1908, pl. 18, fig. 37

Plate 98. *Lagenicella punctulata.* Ensenada de San Francisco, Sonora, Mexico, AHF 737-37. A. Erect, branching colony, with reticulate, porous frontal walls, peristomes like fused spines. B. Zooids with ovicells suspended from distal peristome; paired, tiny, acute avicularia in lateral peristome. C. Ovicell with perforate tabulum across front of hood. D. Developing tip of branch with reticulate frontal walls, circular primary aperture, upper zooid with incomplete ovicell flanked by avicularia.


A
B
C
D

Lagenicella neosocialis Dick and Ross, 1988

Plate 99 A-D.

Not *Lagenipora socialis* (Hincks), 1877: 215.
Lagenipora socialis: C.H. and E. O'Donoghue, 1923: 175; 1926: 120. — Osburn, 1952: 488, pl. 60, figs. 3, 4. — J. D. Soule, 1961.
Lagenicella neosocialis Dick and Ross, 1988: 85, pl. 12F, 13A.

Material Examined. MMS Station: BRA-20. Other collections: BMNH and AHF.

Description. Colonies small, encrusting, recumbent. Zooids flask shaped, small, 400-550 μm long, irregularly directed, distinct, frontal area coarsely perforate beneath heavy ectocyst. Primary aperture round, a tube-like apertural collar (peristome) becoming raised, up to about 130 μm tall, smooth in mature colonies, sometimes with irregular margins, an acute median proximal point; flanked by a pair of small (100 μm) acute avicularia directed upward and laterally. Ovicells with a perforate crescentic frontal area, appearing to be suspended from distal peristome rim but opening inside above primary aperture, becoming recumbent on adjacent frontal walls.

Biology. Encrusts shells. Depths previously recorded shallow water to over 60 m; MMS depth range is 90-130.5 m.

Taxonomic Remarks. We examined BMNH 11.10.1.1636, Hincks Collection, which is apparently his type of *Lagenipora socialis*, from Hastings, England. *Lagenipora socialis* is a junior synonym of *L. lepralioides* according to Cheetham and Sandberg (1964). BMNH 11.10.1.1678, Norman Collection, are syntypes of *L. lepralioides* Norman, now the type of the genus *Lagenipora*. Hayward and Ryland (1979) agree with that conclusion.

Dick and Ross (1988), concluded that the name *Lagenicella socialis* was no longer available, and redescribed the Pacific species as *Lagenicella neosocialis*. They called attention to the more recumbent peristomes and ovicells embedded in secondarily calcified frontal wall in their Alaskan specimens; our specimens from Departure Bay, British Columbia are more erect and not submerged in the frontal wall crust, but otherwise seem to be the same species (but perhaps of younger material).

Type Locality and Type Specimens. Neva Cove, Kodiak Island, west end of Narrow Strait, Alaska. Holotype USNM 415799.

Distribution. British Columbia southward to the Channel Islands, California, and to Baja California, Mexico, including the Gulf of California.

Plate 99. *Lagenicella neosocialis*. Departure Bay, British Columbia. A. Recumbent colony, developing zooids below with round apertures, frontal wall perforate, reticulate beneath tough ectocyst. B. Uncleaned colony with short, raised peristomes bearing small, acute, paired avicularia directed outward; developing ovicells. C. Ovicells on back of peristomes with reticulate tabula; acute avicularia. D. Detail of ovicells.

Lagenicella spinulosa (Hincks, 1884)

Plate 100 A-D

Lagenipora spinulosa Hincks, 1884a: 57, pl. 3, fig. 4. — C.H. and E. O'Donoghue, 1923: 175; 1925: 106; 1926: 120. — Hastings, 1930: 730. — Osburn, 1952: 487, pl. 59, fig. 6.

? *Lagenipora spinulosa*: Robertson, 1908: 283, pl. 18, fig. 4. — Canu and Bassler, 1923: 171, pl. 40, fig. 7. — J. D. Soule, 1961: 50.

Materials Examined. MMS Station: BRA-27. Other collections: BMNH and AHF.

Description. Colonies encrusting, irregular, small. Zooids small, flask shaped, distinct, 450-500 μm long and 270-300 μm wide. Frontal wall coarsely perforate beneath heavy ectocyst (cuticle). Primary aperture circular, appearing to have spine scars; apertural peristome becoming tall, tubular, ribbed, like fused spines, with irregular flaring tips topped by spinelike extensions; proximally, aperture flanked by a pair of small avicularia often raised high, above the collar rim; aperture with a median proximal umbo or mucro. Globular ovicells appearing as if suspended from peristome, with a wide, finely perforate crescentic frontal area; the proximal lip umbo becoming long, thick and wide, like a shelf.

Biology. Encrusts many substrates such as algae, rock, shell and other bryozoans. Depths from intertidal to over 120 m; the MMS record from 96-126 m.

Taxonomic Remarks. Hincks (1884) first described *Lagenicella spinulosa* from small colonies with a few raised, flared peristomes; later that year he described and figured a tiny erect colony as the same species. C.H. and E. O'Donoghue (1923) redescribed the latter as *L. erecta*. The ovicell illustrated by them (pl. 3, fig. 22) lies about half way down the peristome on some zooids. Such zooids were found on recumbent colonies in southern California and may be merely a developmental stage. Osburn identified a number of worn but still sturdy cylindrical colonies from bottom stations between Monterey Bay, California, the Channel Islands and the San Benito Islands off Mexico as *L. erecta*.

Robertson (1908) recorded *L. spinulosa* as scarce, from Santa Catalina Island on *Retepora* [now *Phidolopora] pacifica* and from Monterey Bay, but she indicated the presence, in protected locations, of specimens with long delicate spines and avicularia on very high stalks. It is possible that her material was of *Lagenicella admiranda* (Osburn, 1952), but her specimens have been lost.

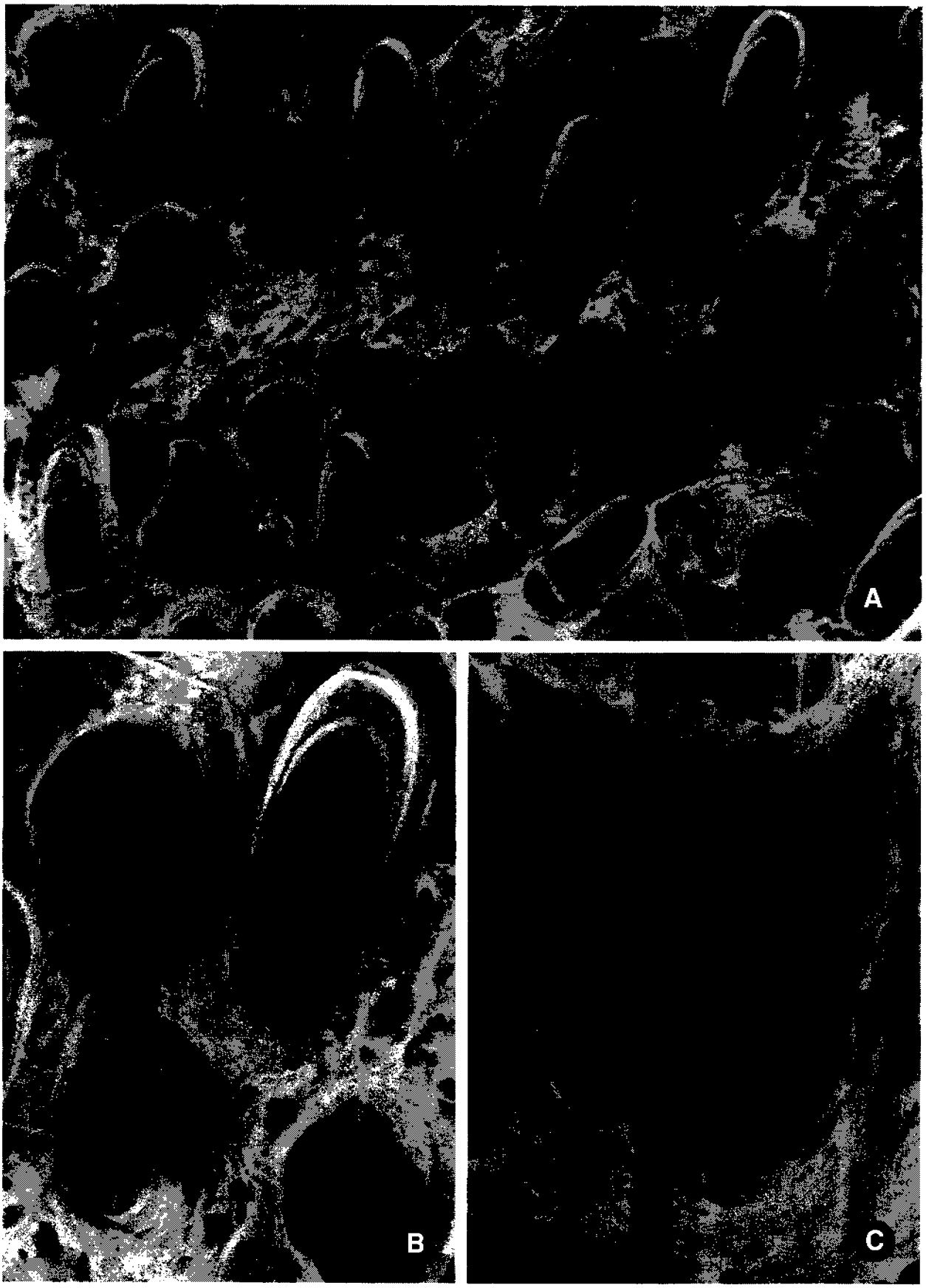
Canu and Bassler's (1923) fossil specimen from Deadmans Island, San Pedro (Los Angeles Harbor) is unidentifiable as *L. spinulosa*, as is an *Albatross* specimen from Hawaii labelled *L. spinulosa*.

Type Locality and Type Specimens. Queen Charlotte Islands, British Columbia. BMNH 97.5.1.928, J. Bracebridge Wilson Collection (specimen in bad condition).

Distribution. Canu and Bassler's record is from the Pleistocene of San Pedro, California. Osburn (1952) reported the species from Alaska, British Columbia, off southern California, and in the Gulf of California. Hastings recorded it from the Galapagos Islands, but found no spines on otherwise well preserved specimens, suggesting that it was another species, perhaps undescribed. The MMS station is off Morro Bay. The fragility of the peristomes and spines makes determination difficult.

Plate 100. *Lagenicella spinulosa*. AHF 1299-41, northwest of San Pedro Pt., Santa Cruz Island, California. A. Colony small, encrusting, frontal wall perforate; peristomes imperforate, like fused spines, flanked by paired, small, acute avicularia. B. Detail of ovicell with finely perforate tabula. C. Spinous processes, partly hollow, on peristome, avicularia on tall stalks. D. Top view of ovicelled zooid with median suboral mucro much widened into shelf.


A
B
C
D


A
B
C

Family Celleporidae Busk, 1852,
Family Holoporellidae Levinsen, 1909,
Family Celleporariidae Harmer, 1957

The family Celleporidae was attributed to Busk, 1852, by Osburn (1952), Hayward and Ryland (1979) and Gordon (1984); to Busk, 1854, by Kluge (1975); and to Johnston, 1838, by Gordon (1989). The validity of the genus *Cellepora* and the family Celleporidae was questioned by a number of investigators including Harmer (1957), but Hayward (1979) showed that the type species is recognizable and the genus and family valid.

The genus *Holoporella* was established by Waters (1909) for celleporids with a round aperture (holostomatous) as opposed to schizostomatous species (with a sinus), which have been placed in a variety of genera. *Cellepora* is now defined as not having spines or interzooecial (vicarious) avicularia, while *Holoporella* spp. may have spines and/or interzooecial avicularia. Levinsen (1909) created the family Holoporellidae. After being considered unrecognizable for years, the genus *Celleporaria* Lamouroux, 1821, was revived by Harmer (1957), with much the same characters as *Holoporella*. Harmer (1957) created the family Celleporariidae, with the type *Celleporaria cristata*; the family was supposed to have umbonuloid frontal wall development, but there is disagreement on this for some or all genera/species (see Hayward and Ryland, 1979: 274; Gordon, 1989: 32).

Family Celleporariidae Harmer, 1957

Celleporaria brunnea (Hincks, 1884)

Plate 101 A-C

Cellepora brunnea Hincks, 1884: 56. — C.H. and E. O'Donoghue, 1926: 121.
Holoporella brunnea: Hastings, 1930: 731, pl. 16, fig 7. 108-110. — Osburn, 1952: 496, pl. 62, figs. 10-12. — J. D. Soule and Duff, 1957: 127. — J. D. Soule, 1961: 55. — D.F. and J.D. Soule, 1964: 38.

Material Examined. AHF and BMNH Collections.

Description. Coarse brown or gray colonies encrusting, sometimes rising to form irregular cylindrical structures. Zooids heaped, erratically oriented due to frontal budding, 500-600 μm long and 250-300 μm wide, boundaries indistinct except at the growing edges, with numerous areolar pores. Apertures rounded distally, with 2 spines in young zooids, with almost straight proximal border having a midline notch, bounded by horizontal, shelflike condyles that almost meet in the center; the secondary peristome has an eccentric depression or pseudosinus beside a low umbo bearing a small, raised avicularium. Large interzooecial avicularia sometimes present with an elongated blunt mandible with a large palate; mandible with a large spade shaped brown reinforcing sclerite in the midline, narrowed at the tip. Ovicells with shallow hood, becoming immersed.

Biology. Encrusting hard substrates. Depths from intertidal to over 200 m.

Plate 101. *Celleporaria brunnea.* Mussel Pt., central California. A. Colony with numerous interzooecial avicularia; zooid apertures with suboral avicularium eccentrically set on umbo, leaving a pseudosinus; ovicell, lower left, a shallow hood. B. Apertures with toothed avicularium rostrum on umbo, beside giant interzooecial avicularium. C. Primary aperture with straight, flat shelf-like condyles almost meeting in center to form small pseudosinus; small lateral condyles also present.

Taxonomic Remarks. *Smittia californiensis*, placed in synonymy with *Holoporella brunnea* by Osburn (1952) was removed by D.F. and J.D.Soule (1964) to the genus *Alismittina*. There is no consensus on the generic or family names (Soule, *et al.*, 1987), as discussed above. *Celleporaria brunnea* differs from *Cellepora* spp., (as defined, e.g., Hayward and Ryland, 1979), in having an ovicell with an open, imperforate, shallow hood; the proximal aperture, which is barely curved, has a tiny, shallow pseudosinus with shelflike condyles almost meeting in the center behind the pseudosinus, forming a notch or groove, and has large interzooecial avicularia. *Cellepora* spp. have a circular aperture without denticles or a sinus, the ovicells are imperforate but may contain irregular pores, and the species lack interzooecial avicularia.

Type Locality and Type Specimens. Queen Charlotte Islands, British Columbia. BMNH 1886.3.6.33 is labeled "part of type".

Distribution. From British Columbia southward to Ecuador. One of the most common species in California and Baja California waters.

Family Celleporidae Busk, 1852

Celleporina Gray, 1848

Celleporina is defined (e.g., Hayward and Ryland, 1979; Gordon, 1984) as having nodular or massive, sometimes erect colonies, the zooids without regular orientation, with the frontal wall imperforate except for marginal pores. The primary aperture is flanked by paired oral avicularia. The chief difference between *Cellepora* and *Celleporina* is that the former has a circular primary aperture, lacks interzooecial avicularia, and the ovicell has irregular pores, whereas the latter has a sinus in the primary aperture, interzooecial avicularia may be present, and the ovicell has a lunate frontal area with pores or slits between costae. Although the California species give the appearance of having imperforate frontal walls with marginal pores, in fact they can be seen to develop from buds with reticulated frontal walls, and there are always a few frontal pores in addition to the marginal pores showing. The crowding of zooids permits little frontal wall space beyond that taken up by avicularium chambers, which are imperforate. Osburn (1952) stated that the pores traveled up the frontal walls as in the *"Mucronella" (Haywardipora)* but we have not observed this. The semi-erect nature of the zooids relate them to *Lagenicella*, although the growing tips of *Lagenicella* show spinous and reticulate irregular terminal growth as compared to the budding of apertures surrounded by a circle of reticulate frontal wall in frontal budding of *Celleporina*. Both genera have paired lateral oral avicularia and ovicells with a crescentic, perforate entooecium. The ovicells suggest inclusion of *Lagenicella* in the Celleporidae, although the budding differs.

Celleporina souleae Morris, 1979

Plate 102 A-D; Plate 103 A-B; Plate 104 A.

Costazia costazi (Audouin): Osburn, 1952: 506 (in part), pl. 62, figs. 3-4.
? *Costazia robertsoniae* Canu and Bassler: Osburn, 1952: 507 (in part).
Celleporina souleae Morris, 1979: 482, figs. 1, 2C, 2F, 2I, 4.

Material Examined. AHF and BMNH Collections.

Description. Colonies encrusting, pisiform when growing around stems, or nodular on other substrates; multilaminar from frontal budding. Zooids irregularly oriented, heaped, semierect, 500-650 μm long, 300-400 μm wide. Frontal wall developing as reticulate circle with central opening, pores becoming immersed. Primary aperture elongate, 170-200 μm long, 130-150 μm wide, curved distally, almost straight laterally, curving to form condyles, flush with apertural rim, on which corners of operculum rest, proximal rim with a narrow, V-shaped sinus; peristome becoming raised, tubular, secondary aperture pyriform. Two small, nodular avicularia flanking aperture, 90-100 μm long, on raised bulbous rostra, turned toward each other or erect, mandible almost circular except for hinge area; sometimes a small, distal or proximal medial avicularium on zooids lacking ovicells or sometimes appearing on top of old ovicell. Rarely, a large oval interzooecial avicularia about 200 μm long, with tan to brown mandible replacing apertures of zooids below, covered by frontal budding. Ovicells large, up to 300-350 μm wide, about 240 μm high, prominent, with a semicircular frontal area (tabula) containing a radial row of 5-8 costae, large, subtriangular or rounded pores between. Ancestrula tatiform, with eight spines.

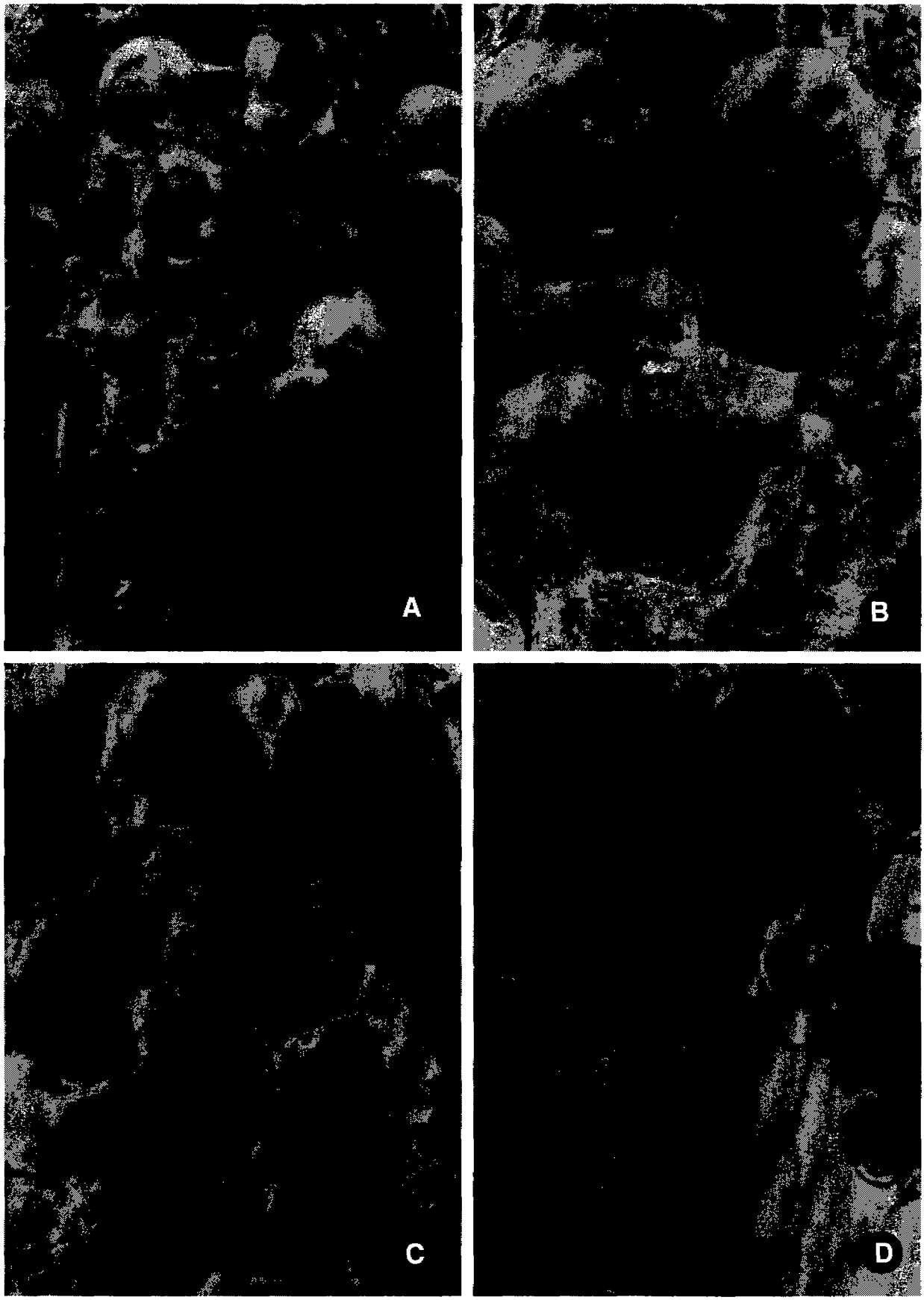
Biology. Colonies encrusting erect hydroids, small algal stems, coralline algae, cyclostome bryozoans, worm tubes, shell; the holotype is on a seagrass blade. Few depth records exist due to confusion over identification of species; known from shallow water down to 60 m.

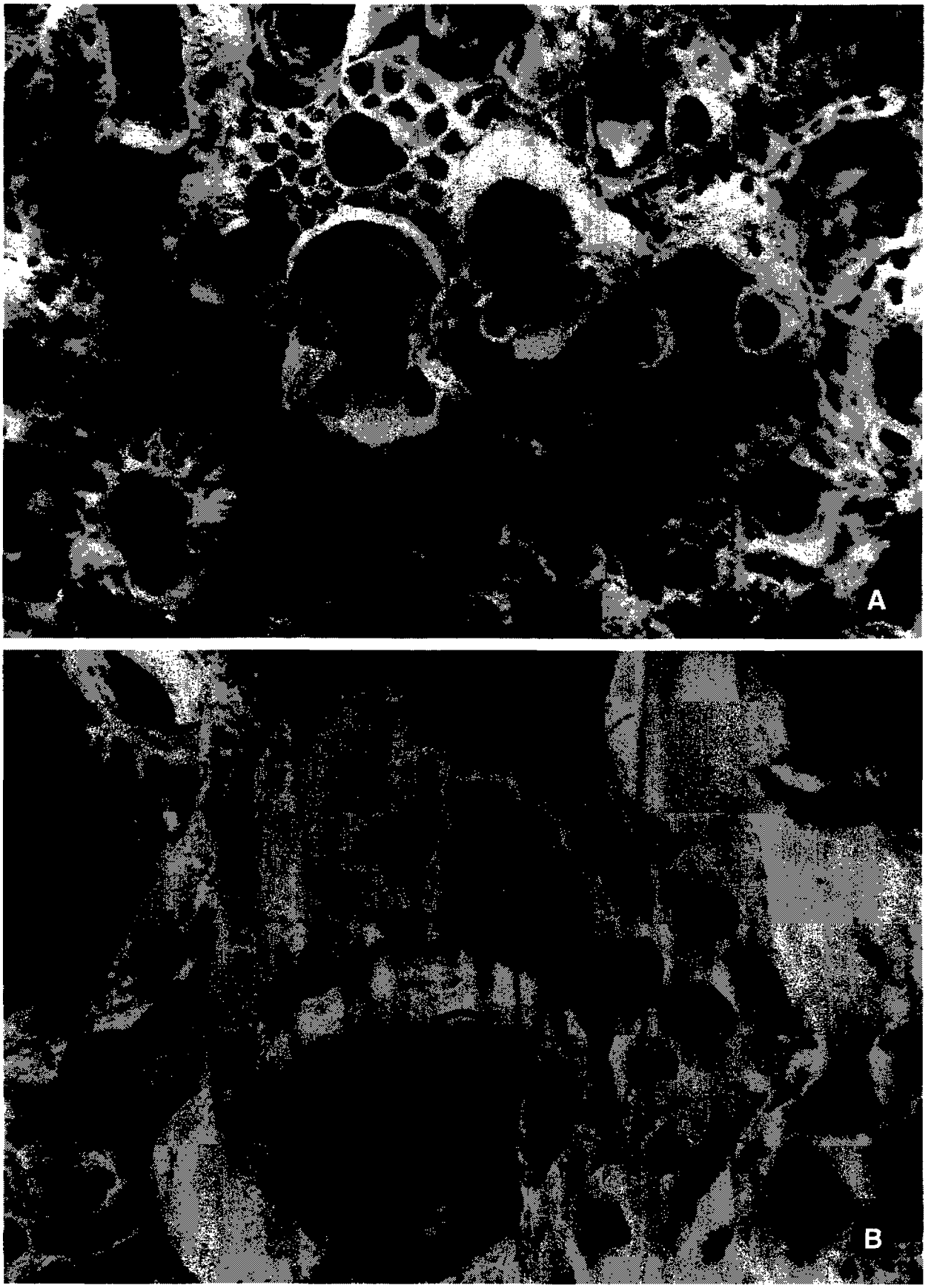
Taxonomic Remarks. Morris (1979) indicated that *C. costazii* does not occur on the Pacific coast, renaming Osburn's *"Costazia costazi"* as *C. souleae*. Gordon (1984) confirmed this with his SEM study showing that *C. costazii* apparently has an imperforate frontal wall with small marginal pores, and the ovicell has a much larger crescentic area with 16-20 costae and narrow slits between rather than the 5-8 costae in *C. souleae*. We have long thought that Savigny and Audouin species, described from Egypt, do not occur in the eastern Pacific. Problems of identification arise in sorting the large number of specimens in the AHF collections under the light microscope because of the heaped, unoriented zooids in the multilaminar colonies. We are convinced that colony form in the eastern Pacific species is dependent on substrate and is not a species characteristic. Also, it is possible that the display of interzooecial avicularia depends on the age of the colony and perhaps on the presence of predators.

According to Morris (1979), five species of *Celleporina* occur on the Pacific coast of North America: *C. surcularis* (Packard, 1863), *C. procumbens* (Osburn, 1952), *C. nordenskjoldi* (Kluge, 1929), *C. ventricosa* (von Lorenz, 1886) and *C. souleae*. Morris (1979) divided *C. robertsoniae* (Canu and Bassler, 1923), between *C. ventricosa* and *C. souleae*.

Plate 102. *Celleporina souleae*. [OVER, LEFT] San Nicolas Island, AHF 1205-41. A. Colony growing on stem fragment, not cleaned, with erect, paired avicularia, ovicells. B-C from off San Francisco. B. Older colony with apertures oriented variously, a small U-shaped sinus, avicularia larger, flanking aperture, also additional medial proximal or distal avicularia. C. Giant spoon shaped interzooecial avicularium. D. San Nicolas Island. Giant avicularium with mandible present, smaller avicularia erect with round mandibles.

Plate 103. *Celleporina souleae*. [OVER, RIGHT] Dillon Beach, north of San Francisco. Colony area with developing ovicells, reticulate, frontally budded zooid with deeper sinus, in upper center. B. Detail of ovicell with seven ribs, two lateral avicularia.


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A
B

Dick and Ross (1988) renamed the non-polar "*C. ventricosa* (von Lorenz, 1886)" of Osburn (1952) as a new species, *Cellepora aspera*, based on examination of arctic specimens of *C. ventricosa*, which have larger zooids (1.0 mm) and a slight difference in the apertural shape. Von Lorenz' illustration shows short, very small paired avicularia, with no additional avicularia. Kluge (1975) did not indicate any pores or costae in the ovicell, which are often not visible in uncleaned material. Dick and Ross indicated that there are many ovicell peripheral slits in *C. aspera* in the triangular frontal area (tabula of some authors), which is consistent with Osburn's illustration of *C. ventricosa* (1952, pl. 63, fig. 4). Osburn illustrated a small, more acute interzooecial avicularium, whereas Kluge (1975, fig. 389) illustrated an almost round interzooecial avicularium more than 400 μm long, and Dick and Ross stated that there are no interzooecial avicularia in *C. aspera*. This would exclude placing *C. souleae* in synonymy with either *C. ventricosa* or *C. aspera*.

Type Locality and Type Specimens. San Francisco; SBMNH-AHF Bryozoa Holotype No. 184.

Distribution. Osburn (1952) indicated the problems of distribution due to confusion of species but limited local occurrence of his *C. costazi* to San Nicolas Island and off San Pedro breakwater, California. Morris gave the range of *C. souleae* from Bodega Head, north of San Francisco, southward to southern California, but included some citations of *C. ventricosa* (now *C. aspera* Dick and Ross) and some of *C. robertsoniae*; she recorded *C. souleae* in the Pleistocene of California and Oregon. Both *C. souleae* and *C. robertsoniae* were collected at Dillon Beach, a few miles south of Bodega Head, indicating that their ranges overlap.

Celleporina robertsoniae (Canu and Bassler, 1923)

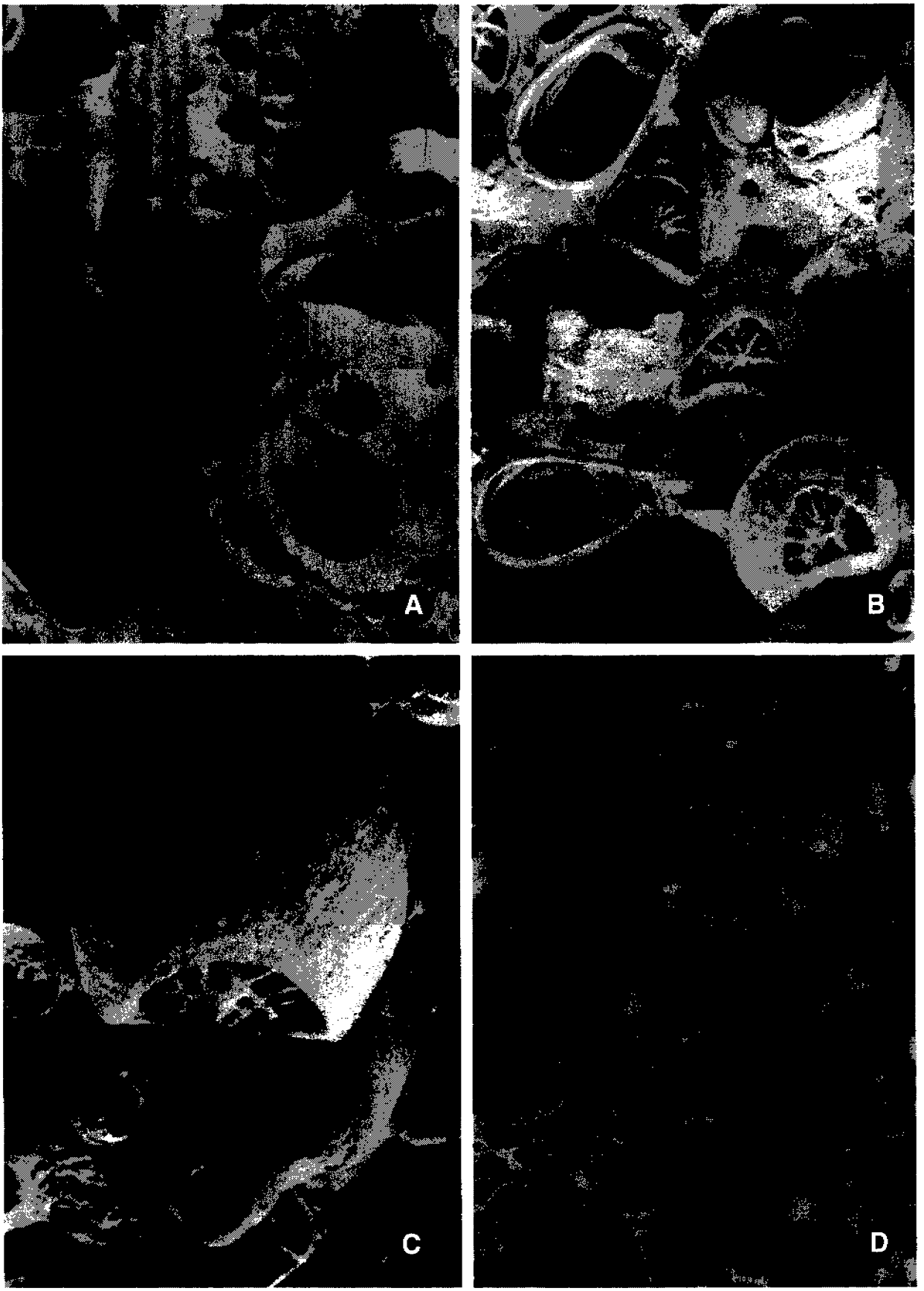
Plate 104 B-D

Cellepora costazi: Robertson,1908: 313 (in part), pl. 24, fig. 89.
Costazzia robertsoniae Canu and Bassler, 1923: 181, pl. 39, figs. 10-12.
Costazia robertsoniae: Osburn, 1952: 507 (in part), pl. 62, figs. 1, 2.
Celleporina ventricosa: Morris, 1979; 479 (in part).
Celleporina robertsoniae: Dick and Ross, 1988: 90, pl. 7,G.

Material Examined. AHF Collections.

Description. Colony encrusting erect stems. Zooids irregular, initial zooids recumbent, others becoming erect; frontally budded zooids forming large, raised, reticulate circle with central opening, aperture becoming more terminal, frontal wall more calcified but leaving marginal and some frontal pores outside rostral chamber areas. Primary aperture small, about 120 μm wide, almost circular except for V-shaped proximal sinus, with corners of operculum resting on condyles that are flush with peristome, not separated; secondary aperture oblong, compressed by columns of avicularia; aperture flanked by 2 raised, bulbous avicularium chambers leaning inward or outward, rostra with complete hinge bar, bearing oval mandibles directed upward and proximolaterally; other avicularia numerous, raised on proximal and/or distal rim. Large interzooecial avicularia, probably replacing zooids in frontal budding, with stout hinge bar, varying from oval to spatulate, 250-500 μm long, mandibles tan, resembling small beetles on colony. Ovicells erect, 200-280 μm wide, 180-220 μm high, with crescentic or subtriangular area in face of frontal containing 12-16 irregular costae radiating from center of crescent rather than from proximal rim as in most species; ectooecium with numerous longitudinal striae; a suboral avicularium sometimes present in addition to the paired lateral avicularia.

Plate 104. *Celleporina souleae*. A. Dillon Beach. Developing aperture, lower right; large ovicell with five ribs above. B-D, *Celleporina robertsoniae*, from Dillon Beach. B. The same magnification as A, showing smaller ovicells with 12-16 ribs radiating from center, giant avicularia. C. Detail of ovicell with three avicularia. D. Colony area with many giant avicularia.


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Biology. The erect colony forms noted by previous authors are due to encrusting on stems of hydroids, coralline algae, algae, seagrasses, bryozoans or fragments of wood and shell; colonies are thus pisiform or terete around stems, or discoid, nodular around fragments. The species is known from the Pleistocene in southern California. Depths reported from shallow waters to 100 m, if all records are of the same species.

Taxonomic Remarks. Osburn (1952) stated that the species was the most common representative of the genus *Cellepora* in southern California, but we find that the many specimens in the AHF Collections have been mostly separated on the basis of colony form. Morris (1979) questioned the existence of *C. robertsoniae*, dividing specimens between *C. souleae* and *C. ventricosa*. Dick and Ross (1988) however, renamed the nonpolar representatives of the latter *C. aspera*.

Canu and Bassler (1923) renamed the *C. costazi* of Robertson (1908: 313) as *C. robertsoniae*. Morris examined the USNM type but found it in poor shape, as had Osburn. Canu and Bassler's USNM types are often tiny and in bad shape, especially fossil material, but in this case their illustration (1923, figure 12) clearly shows the large oval avicularia with complete hinge bar. Robertson's illustration (Figure 27) shows the raised, paired avicularia, some facing inward and some outward, sometimes with a third small avicularium placed distally in zooids without ovicells. Interzooecial avicularia are present. However, eight ovicell costae in the frontal area (tabula of some authors) radiate from the proximal margin in one zooid and many more radiate from a central core in others, suggesting a composite drawing. That, plus the larger size aperture and ovicell in *C. souleae*, are distinguishing characters dividing *C. souleae* from *C. robertsoniae*. The ovicell differs from the illustration of Osburn (1952, pl. 62, fig. 1) and that of Dick and Ross (1988, fig. 7G). The aperture is smaller and more circular in *C. robertsoniae*, and longer in *C. souleae*. SEM now makes it possible to see these differences.

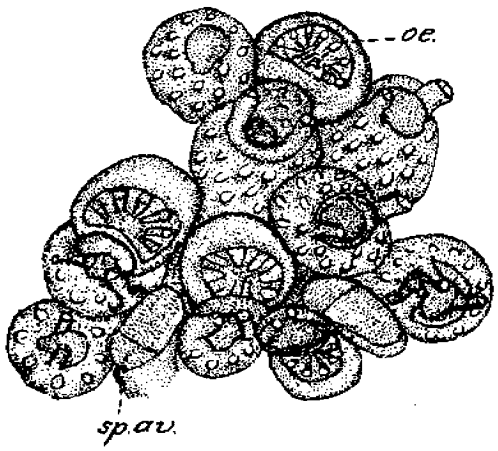


Figure 27. *Cellepora costazi (= robertsoniae).* From Robertson, 1908, pl.24, fig.89.

Two other species discussed by Osburn (1952) as *Costazia*, which seem to fit more readily in the *Celleporina* are *Cellepora nordenskjoldi* Kluge, 1929, and *Cellepora surcularis* Packard, 1863. Both have imperforate frontal walls with marginal pores only. Both are arctic species which occur in Alaska in the northeastern Pacific, although C.H. and E. O'Donoghue (1923, 1926) identified the latter as *Cellepora incrassata* in British Columbia, as did Robertson (1908), who reported it from the Pribilof Islands to northern California. *Celleporina procumbens* (Osburn, 1952), is a southern California species found in the Channel Islands south to the San Benito Islands off Baja California at 223 m. It differs from the *C. souleae* - *C. robertsoniae* - *C. aspera* complex in having the lateral oral avicularia incorporated in the raised peristomal collar; it has a smooth frontal wall with marginal pores but with some extra frontal pores.

Type Locality and Type Specimens. Pleistocene of Rustic Canyon, Santa Monica, California. USNM Catalogue No. 68714.

Distribution. Osburn (1952) stated that *C. robertsoniae* was the most common species of the genus in southern California, being dredged on the Channel Islands, with a range from Dillon Beach, north of San Francisco, south to Tanner Bank, off the California - Mexican border. Dick and Ross (1988) recorded several large colonies of it collected in 1982, but only a few small colonies were found later in the Kodiak Island group; 1982 was a warm water, El Niño year when tropical waters extended as far north as British Columbia.

Buffonellaria vitrea (Osburn, 1952)

Plate 105 A-C

Stephanosella vitrea Osburn, 1952: 369, pl. 42, fig. 6-8. — J. D. Soule, 1961: 23.

Material Examined. MMS Station: BRA-2. AHF Collections.

Description. Colonies encrusting, porcellanous. Zooids small, irregular, distinct at colony margins, 300-400 μm long, 200-310 μm wide. Frontal wall smooth, vitreous, few minute areolar (marginal) pores and very few frontal pores. Aperture 120-140 μm wide, rounded distally and laterally, ending proximally in curved, flattened condyles, with a proximal V-shaped sinus. Small, paired, lateral suboral avicularia, 90-100 μm long, with sharply pointed, setose or bluntly rounded mandibles. A larger acute or rounded avicularium sometimes also present, probably interzooecial in origin but recumbent on frontal wall, set off by pores. Ovicells globose, with an inverted, U-shaped, imperforate, entooecial frontal area (labium of some authors) with 18-20 tiny marginal pores and faint radial grooves.

Biology. Encrusts shells, rock, worm tubes. Depths recorded to 170 m.

Taxonomic Remarks. The genus *Stephanosella* Canu and Bassler, 1917, has been placed in various families: Osburn (1952) placed it in his Hippoporinidae (see earlier remarks on this family). Kluge (1962, 1975) and others placed *Stephanosella* in synonymy with *Schizoporella* because of the aperture shape. Hayward and Ryland (1979) placed the genus *Buffonellaria* in the family Schizoporellidae based on the sinus, but Gordon (1984) placed it in the Celleporidae, with which we agree.

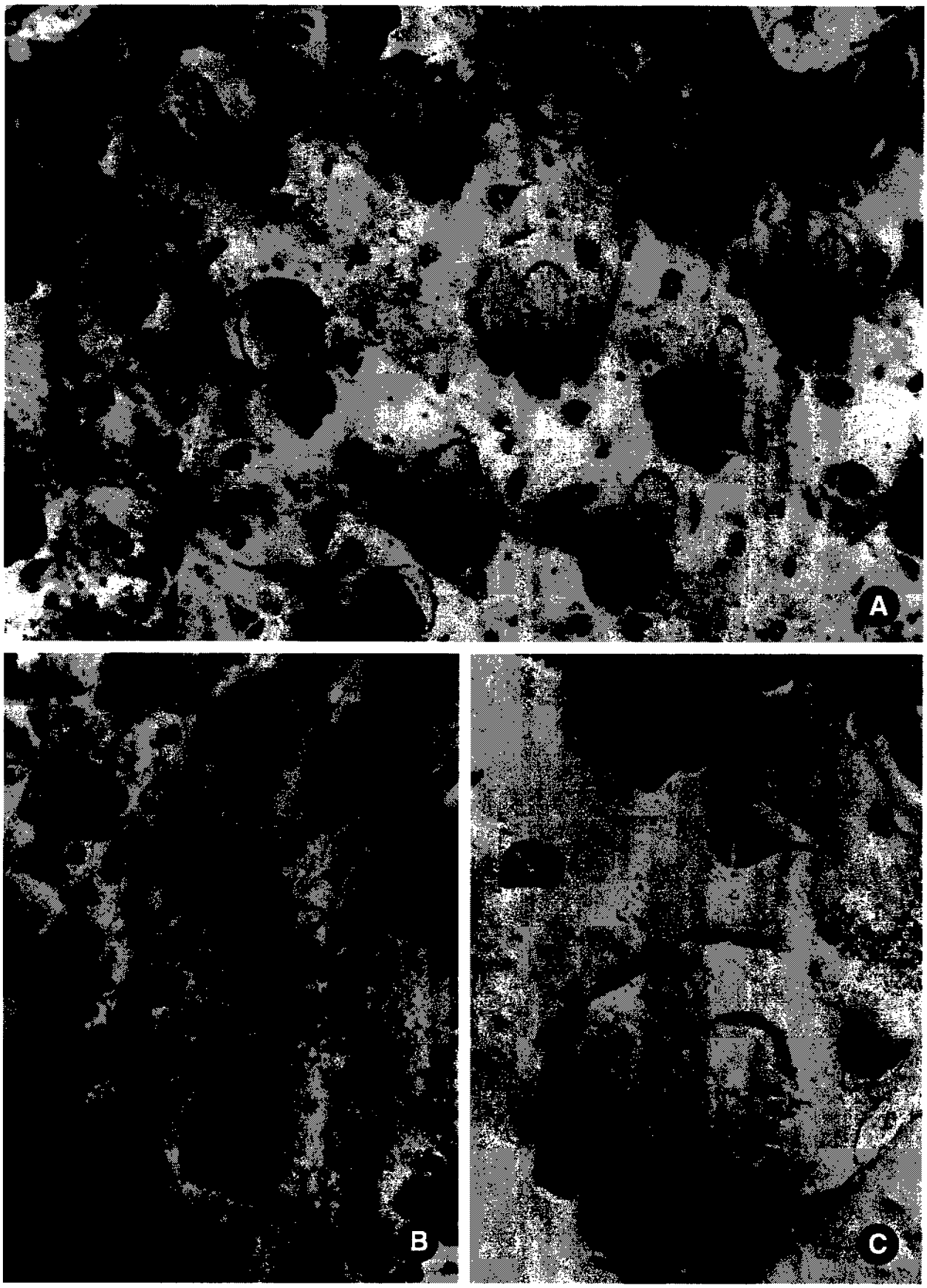
According to Osburn, confusion arose over the nature of the type species *Stephanosella biaperta* (*Eschara biaperta* Michelin, 1845) when later authors introduced material with a perforate frontal wall, while he believed it to be imperforate. Ryland (1969) examined material from a Miocene location in France some 50 km from the type locality, since Michelin's types do not exist. He clarified the status of *Stephanosella biaperta*, finding that it had a semicircular aperture with an almost straight proximal margin without condyles, a small sinus and a finely porous frontal wall. Therefore, species with imperforate frontal walls should not be in *Stephanosella*. *Hippothoa divergens* Smitt, 1873, is the type of the genus *Buffonellaria* Canu and Bassler, 1927; it has an imperforate frontal wall and the aperture has distinct condyles lateral to a widely V-shaped sinus, similar to that figured in *B. vitrea*.

Buffonellaria vitrea is considerably smaller than *B. divergens*, which is a circumpolar and northern European species but may occur in polar Alaskan waters. *B. bolini*, found near Monterey Bay and off Santa Rosa Island, California, has scattered frontal pores and two pairs of circumoral avicularia in addition to other frontal avicularia. Robertson's (1908: 287, pl. 19, fig. 41) *Schizoporella biaperta* resembles *S. bolini* in having scattered frontal wall pores and additional frontal avicularia but the ovicell is in question because the frontal area is probably obscured in Osburn's illustration of the latter (pl. 42, fig. 4).

Type Locality and Type Specimens. AHF Station 1388-41, off Santa Rosa Island; SBMNH-AHF Bryozoa Holotype No. 77.

Distribution. Puget Sound southward to the Galapagos Islands, if all records are of the same species.

Plate 105. *Buffonellaria vitrea.* [OVER] Pt. Conception. A. Colony with few areolae, few other frontal pores; ovicells erect, with frontal tabula set off by tiny peripheral pores; aperture with V-shaped sinus, flat condyles; paired lateral oral avicularia, other scattered acute or oval avicularia. B. Multilayered colony with interzooecial avicularia. C. Detail of aperture, ovicell.


A
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C

Family Phidoloporidae Gabb and Horn, 1862

The family Phidoloporidae was established by Gabb and Horn (1862) for their new genus and species *Phidolopora labiata*, a recognizable form from the Pleistocene (then thought to be Miocene) of Santa Barbara, California. They did not distinguish the frontal avicularia as such but these are evident in their illustration (Figure 28). The family group was more widely recognized under the name Reteporidae (Smitt, 1868) and the less well known Schizoporininae (Gregory, 1893), Sertellidae (Jullien, 1903), Hippellozooidae and Lepraliellidae (Vigneaux, 1949). However, Phidoloporidae has clear precedence.

Phidolopora pacifica (Robertson, 1908)

Plate 106 A-E

? *Phidolopora labiata* Gabb and Horn, 1862: 138, pl.19, fig. 21.
Retepora pacifica Robertson, 1908: 310, pl. 24, figs. 81-84. — C.H. and E. O'Donoghue, 1923: 189.
Phidolopora pacifica: Canu and Bassler, 1923: 154, pl. 39, figs. 1-7. — C.H. and E. O'Donoghue, 1925: 106; 1926: 118. — Osburn, 1952: 448, pl. 53, figs. 1, 2.

Material Examined. MMS Station: BRA-1. AHF Collections.

Description. Colony erect, fenestrate, capable of forming sizable, complicated meshwork rising from a rounded base attached to the substrate by kenozooids. Zoarial fenestrae ovoid to diamond shaped. All zooids opening on ventral surface; dorsal surface showing outlines of kenozooids, plus a large, hooked avicularium with acute mandible at base of fenestrae, with proximal end of the kenozooid based on frontal surface. Zooids ranging from 400-650 µm long, 250-300 µm wide; frontal wall smooth, with 3 to 5 scattered pores. Primary aperture rounded with beaded rim and small sinus, sometimes flanked by erect elongate spines, 1 or 2 on each side; peristome becoming sunken, with a notch (spiramen, pseudosinus) on the proximal border. No suboral avicularia; large frontal avicularia occasionally present on colony, rising to hooked rostrum, usually directed proximally. Ovicells globose, smooth, 180 to 200 µm wide, with large frontal area covered with primary calcified layer only (labium, labellum), with concentric ridges, ectooecium forming a granular hood distally.

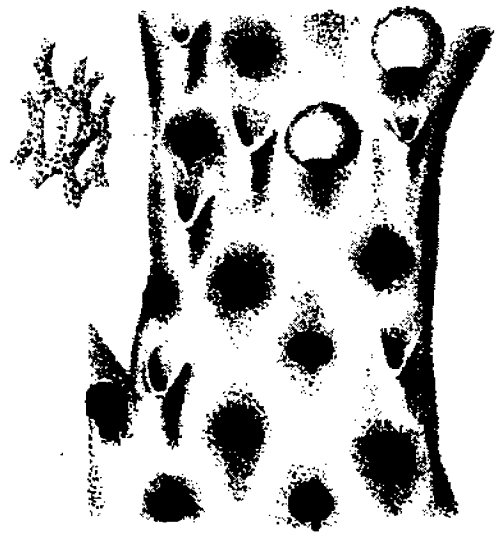


Figure 28. *Phidolopora labiata*.
From Gabb and Horn, 1862, pl. 19, fig. 21.

Biology. Attached to hard substrate. Depths recorded from shallow waters to 200 m; can withstand bottom currents. The MMS depth was 69-73.5 m. Bright orange in reproduction; otherwise yellowish or grayish.

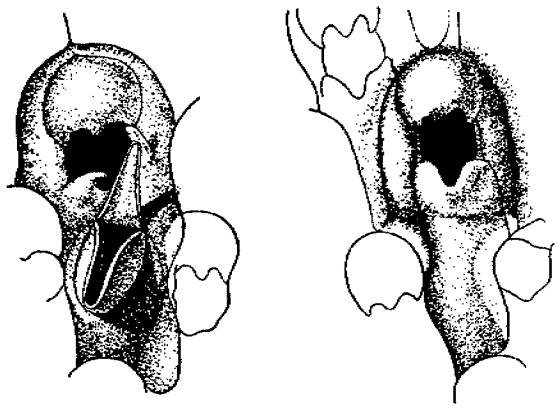


Figure 29. *Phidolopora pacifica.*
From Osburn, 1952, pl. 53, figs. 1-2.
Two views from same colony.

The family Phidoloporidae was well defined and illustrated for its time, and predates Reteporidae Smitt,1867 and Sertellidae Jullien,1903, although Osburn considered Gabb and Horn's description to be "worthless and misleading"; this is true of many of the early descriptions by other authors as well. Osburn (1914) in some sort of *lapsis*, placed *P. pacifica* as a junior synonym of *Retepora marsupiata* Smitt, 1873: 67, pl. 13, figs. 245-254, a species described 11 years after Gabb and Horn's species. Smitt's illustrations clearly show a vertical slit in the ovicell, typical of some *Reteporella* and *Sertella* species but not of *Phidolopora.*

Type Locality and Type Specimens. Puget Sound, Washington. Robertson types apparently mixed in with other specimens in collections at CAS.

Distribution. Known range from British Columbia southward to Mexico and the Galapagos Islands.

Taxonomic Remarks. There is little discernible difference between the Pleistocene fossil species *P. labiata* and the modern *Phidolopora pacifica*; meaning that *P. pacifica* could well be a synonym of *P. labiata.* The labium on the ovicell in Osburn's illustration (Figure 29) is longer than is usually seen; Robertson (1908) illustrated the species thoroughly, also emphasizing the prolonged labium (her denticle, d), although she indicates that it is sometimes absent (Figure 30).

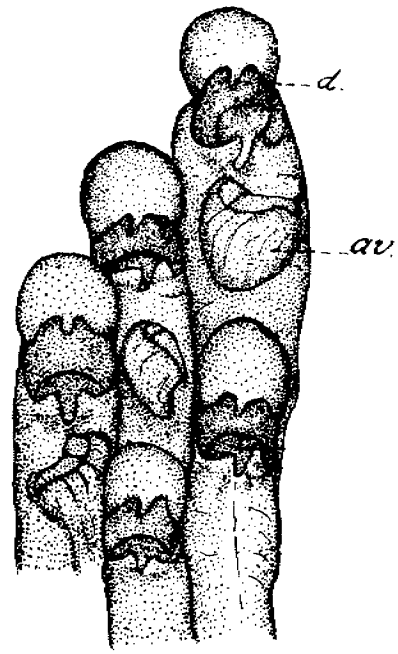
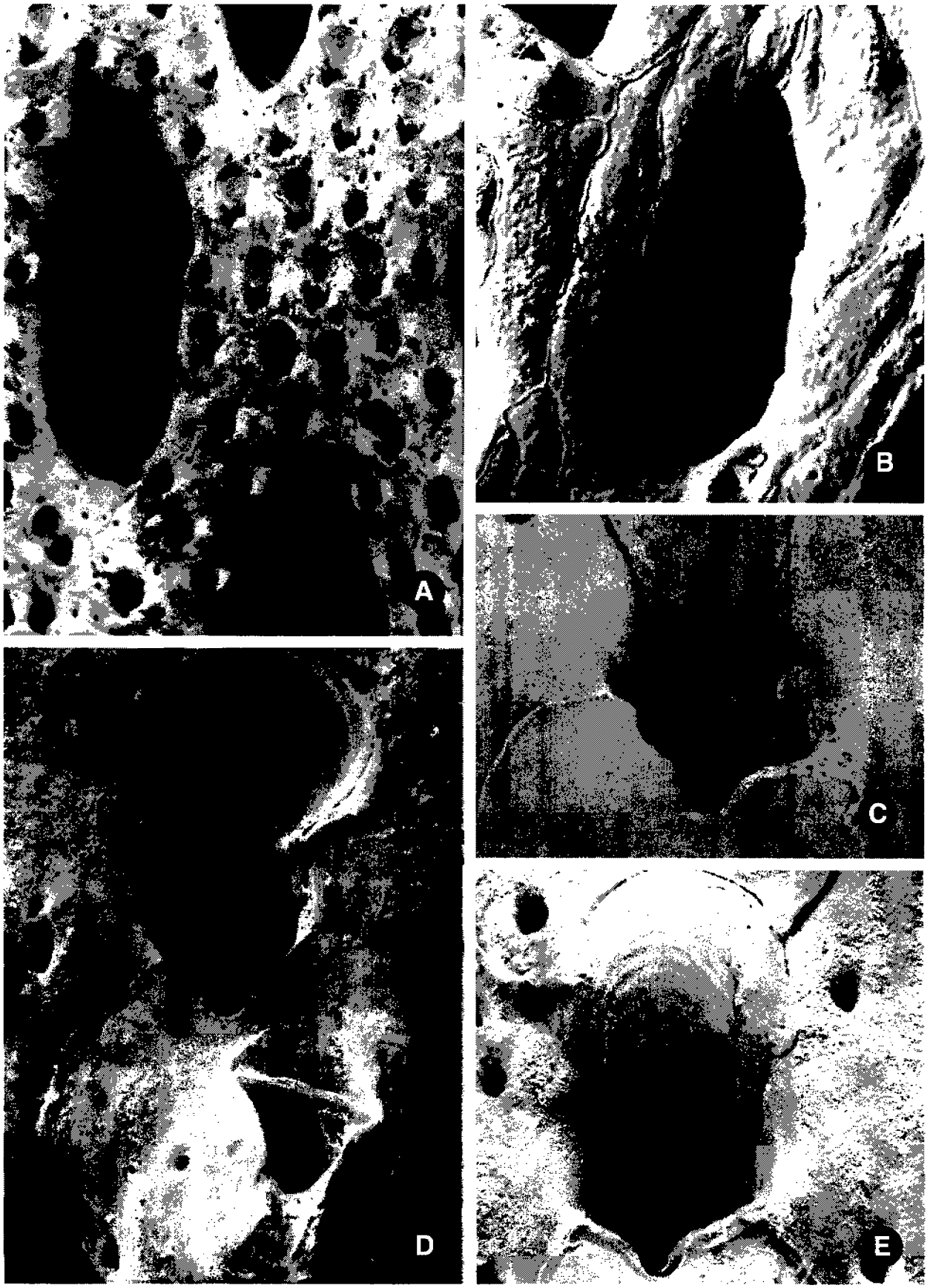
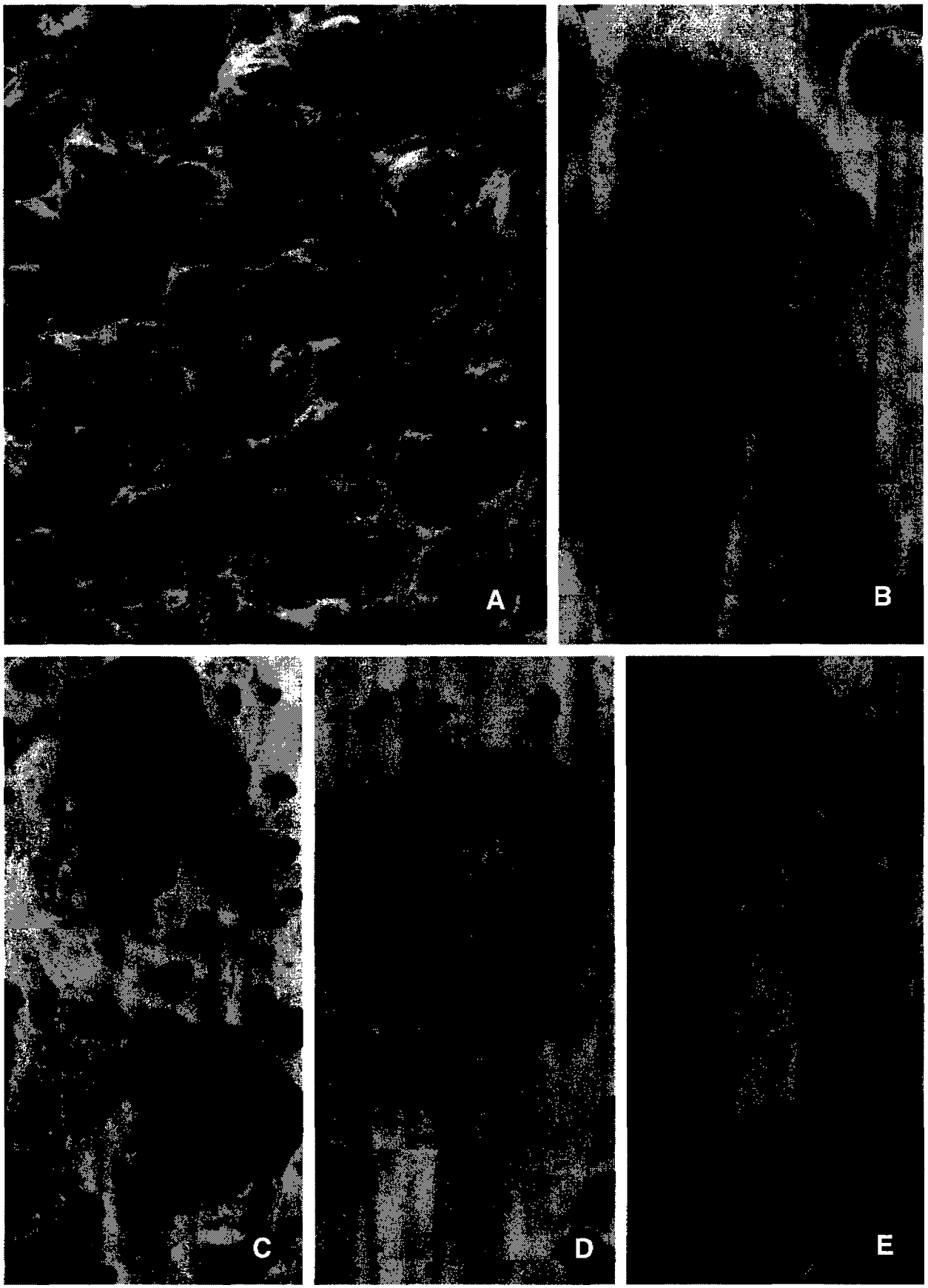


Figure 30. *Retepora pacifica.*
From Robertson, 1908, pl. 24, fig. 83.

Plate 106. *Phidolopora pacifica.* Puget Sound. A. Ventral (frontal) surface of fenestrate colony with developing ovicells, frontal walls with few scattered pores. B. Obverse (dorsal) surface with kenozooecial walls outlined, acute avicularia at lower margin of fenestrae. C. Detail of beaded apertural rim, secondary suboral pseudosinus. D. Developing ovicell; giant avicularium below pseudosinus. E. Ovicell with entooecium (labellum) having concentric rings, sometimes projecting downward into opening, surrounded distally and laterally by ectooecium.


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E


A
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E

Rhynchozoon rostratum (Busk, 1855)

Plate 107 A-E

Lepralia rostrata Busk, 1855: 4. — Busk, 1856: 178.
Schizoporella tumulosa Hincks, 1882: 252.
Rhynchozoon rostratum: Hastings, 1930: 728, pl. 14, figs. 84, 85, 93-96. — Osburn, 1952: 456, pl. 54, figs. 1-3. — J. D. Soule, 1961: 43. — D.F. and J.D. Soule, 1964: 33. — Dick and Ross, 1988: 84, pl. 6I.
Rhynchozoon tumulosum: Osburn, 1952: 458, pl. 54, figs. 4, 5, 12. — J. D. Soule and M. M. Duff, 1957: 125. — McCain and Ross, 1974: 14.

Material Examined. MMS Stations: BRA-17, BRA-21. AHF Collections.

Description. Colonies encrusting. Zooids irregularly shaped, indistinct except in young zooids at periphery of colony; zooids measuring 430-500 µm long, 300-320 µm wide; frontal wall moderately inflated, smooth, with up to 12-14 marginal pores, with weak costal ridges between in young zooids. Primary aperture almost circular, 2 spines in young zooids, with distinct interior beading, strong condyles; proximal margin with a sinus. Just proximal to aperture in secondary peristome an avicularian chamber with hooked rostrum and triangular mandible, directed laterally, leaving eccentric notch (pseudosinus, spiramen). Avicularian chamber becoming bulbous, erect, giving older colony a honeycombed appearance, with rows of large mounds and sunken apertures. Large frontal avicularia randomly oriented. Ovicells globular, at first erect, separated by pores and slits from adjacent zooids, becoming sunken; with a distinct, almost circular frontal area of primary calcified layer (entooecium), with a distal outer cover of ectooecium which meets below to enclose the circle of entooecium when mature.

Biology. Encrusts rock, shells and other hard substrates. Depths recorded from shallow waters to 200 m.

Taxonomic Remarks. D.F. and J.D. Soule (1964) synonymized *R. tumulosum* with *R. rostratum* based on the variability of characters, depending on growth stage and substrate. The ovicell structure is similar to that in the genus *Paracleidochasma* Soule, Soule and Chaney (1991), which also has a beaded apertural rim, and has a wide, shallow sinus; the type species is *P. contractum* Waters, which has been temporarily placed in many genera over the years. Gordon (1993) placed the genus as a junior synonym to *Brodiella* Uttley and Bullivant, 1972, which has a deep, narrow sinus; he stated that ..."the shape of the sinus is a dubious character at the family and genus level...." Since the family Schizoporellidae is based, in part, on the sinus, and Gordon uses a superfamily Schizoporelloidea, this seems too sweeping a statement and we do not agree that *Paracleidochasma* is a junior synonym. Gordon (1994) synonymized *Brodiella* under *Stephanollona* Duvergier (1920).

It is possible that the tropical Pacific and Indian Ocean *Paracleidochasma*, including *P. eopacificum* from the Galapagos Islands, belong in the Phidoloporidae, as defined by various authors. Gordon (1993) regards the genera *Metacleidochasma, Plesiocleidochasma* and *Schedocleidochasma*, Soule *et al.*, 1991, as Phidoloporidae based on the beaded apertural rim, but we regard this as a premature assignment, since the ovicells, for example, differ considerably. *Cleidochasma, sensu stricto*, lacks a beaded vestibular rim and has a labellate ovicell.

The placement of encrusting species in the same family as the large, erect and sometimes fenestrate "Reteporidae" is still a source of reluctance for us after seeing these very distinctive and attractive erect

Plate 107. *Rhynchozoon rostratum.* Purisima Pt. A. Honeycomb colony with embedded ovicells; suboral avicularium inside secondary aperture on umbo. B. Ovicell with central lucidum, almost surrounded by ectooecium; secondary peristome with umbo, avicularium almost hidden, eccentric pseudosinus. C. Avicularia, directed laterally beside pseudosinus, with hooked rostral tips. D. Detail of beaded aperture, two condyles, spine scar inside secondary peristome; avicularium directed laterally with pseudosinus at base. E. Large frontal avicularia.

forms throughout the tropical Pacific. *Phidolopora pacifica* is the only eastern Pacific representative of the erect, fenestrate species. *Rhynchozoon rostratum* is a common encrusting species with a beaded apertural rim and ovicell with the entooecial labium. We would prefer to see a family based on *Rhynchozoon* used for the encrusting genera and species. Surely if the family Smittinidae, based as it has been on the prominent median denticle, can be divided to separate the equally denticulate Porellidae from it, certainly the encrusting genera with vestibular primary apertures could be separated into two families as well.

Type Locality and Type Specimens. Mazatlan, Mexico. Busk Collection of the BMNH, no type designated.

Distribution. Alaska, British Columbia (as *R. tumulosum*), southward to Panama and South America.

Family Stomachetosellidae Canu and Bassler, 1917

The definition of the family Stomachetosellidae is of zooids with a very thick frontal wall, marginal or frontal pores, built up around the aperture to form a notch (pseudosinus, spiramen). The primary aperture was said to lack a lyrula or condyles, but Dick and Ross (1988: 69, pl. 11C) described *Stomachetosella sienna*, which has low flat condyles, like those in *Buffonellaria*. Avicularia are present or absent, and ovicells are submerged, with a single pore in the center.

Stomachetosella condylata, new species

Plate 108 A-D

Not Lepralia sinuosa Busk, 1860: 125
? *Schizoporella sinuosa* Hincks, 1884:17. — C.H. and E. O'Donoghue, 1923: 177.
? *Stomachetosella sinuosa*: C.H. and E. O'Donoghue, 1925: 103; 1926. 108. — Osburn, 1952: 306 (in part ?).
? *Stomachetosella sienna* Dick and Ross, 1988: 70, pl. 9B.

Material Examined. MMS Station: BRC-2. AHF Collections.

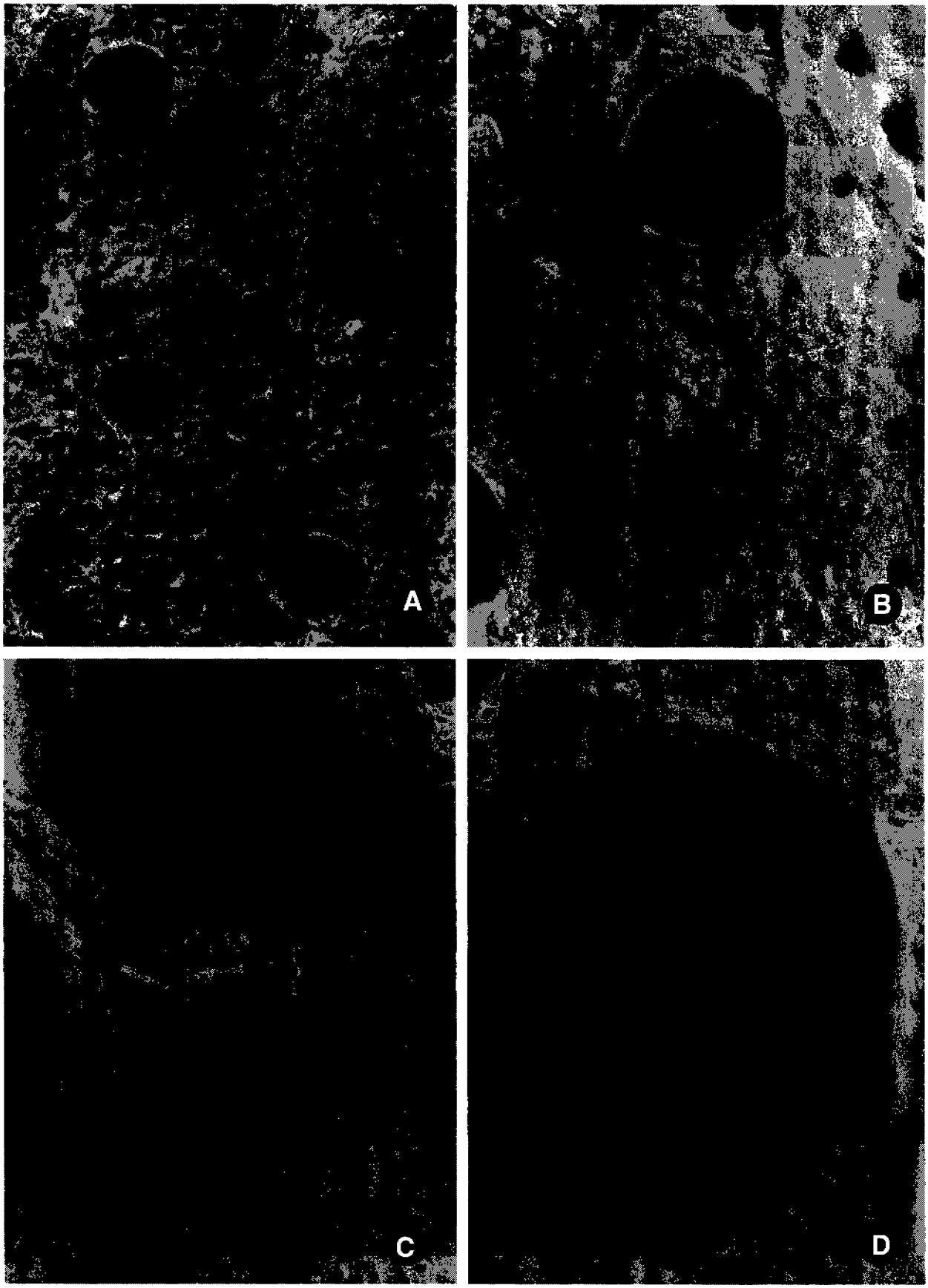
Description. Colonies encrusting, rose colored to purple circular patches. Zooids moderate in size, 550-670 µm long, 300-350 µm wide; transverse walls often joining aperture below distal arch. Frontal wall weakly raised, with a few large frontal pores. Primary aperture well rounded distally and laterally, almost straight proximally with a wide U-shaped sinus formed in narrow dental ledge; primary rim ending in wide, low, shelflike condyles; aperture becoming sunken, with secondary aperture raised, notched by pseudosinus. No apertural spines. No avicularia. Ovicells subglobular, immersed, with an irregular rounded pore on the frontal face, marked by small areolae distally.

Biology. Encrusts shells and rock. Depths shallow water to 110-126 m (MMS record).

Taxonomic Remarks. This species was included in specimens identified by Osburn as *Stomachetosella sinuosa*. It appears that the obviously immersed zooids and color have been the distinctive characters in identifying *S. sinuosa*, although Busk (1860) and Hincks (1883) did not mention color. Osburn (1952) reported it as ranging from delicate rose in young colonies to deep purple in old colonies, while

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Plate 108. *Stomatochetosella condylata.* Puget Sound. A. Colony peristomes with secondary sinus (pseudosinus), mostly imperforate frontal walls with large areolae; ovicells immersed, with large pore in center. B. Primary aperture symmetrical, with inner rim ending at flat condyles, with U-shaped sinus. C. Developing margin of colony, with lateral wall pores. D. Detail of aperture.


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Kluge referred to a reddish crust, and Hayward and Ryland (1979) recorded *S. sinuosa* as forming a thick, red or purplish crust. None of these authors indicated the presence of any type of condyle or dental ledge comparable to the flattened structures on *S. condylata*.

Dick and Ross (1988) described *S. sienna*, from Kodiak Island, Alaska, as being reddish-brown, with zooids larger than those in *S. sinuosa*, up to 900 μm long, and with a semicircular aperture with a wide median proximal sinus bordered by coarse, low cardelles (condyles). Their SEM specimen figured (pl.11 C) does not include a primary aperture so the condyles and primary sinus are not shown, but the sinus drawn on *S. sinuosa* is much narrower (pl. 9 B).

Our few specimens of *S. condylata* seem to have fewer pores than the *S. sinuosa* illustrated by others and a distinct primary sinus and condyles. It may be synonymous with *S. sienna*, but that cannot be determined without SEM studies of material not available at present. *S. sinuosa* was described from Shetland, Scotland, and is an Arctic-boreal species.

Type Locality and Type Specimens. Middle Bank, Puget Sound. SBMNH-AHF Bryozoa Holotype No. 235.

Distribution. Point Barrow, Alaska, Puget Sound, and MMS station 002 in the Santa Barbara Channel, California. *S. sinuosa* has not been reported south of Puget Sound.

In the discussion of the Smittinidae, the problems with, and affiliations of, *Codonellina* and *Pleurocodonellina* were discussed. These genera have been included in the Smittinidae in the past in spite of their lack of a median denticle (alyrulate). The ovicell of the type of *Codonellina, Lepralia galeata* has ectooecial encroachment onto the porous entooecium, whereas it merely delimits the margin of the hood in *C. anatina* (Canu and Bassler, 1927), from Pt. Alia on the north coast of the island of Hawaii, *Albatross* Station 4055, and in our new species *C. hastingsae*, from the Galapagos Islands. The genus *Pleurocodonellina* has as its type *P. lahainae* D.F. and J.D. Soule, 1973, from AuAu Channel, off Lahaina, Maui, Hawaii.

In D.F. and J.D. Soule (1973), the similarities of the *Schizomavella* and *Codonellina* were pointed out, with a principal difference based on the formation of the proximal apertural rim and the medial avicularia. Similarities of the *Pleurocodonellina* to the *Hippomonavella* were also discussed. The difference between the *C. anatina* from Hawaii and that discussed by Osburn (1952) is that the giant avicularium in the *C. anatina* in Hawaii covers most of the frontal wall, about 450 μm long, and is shaped more like a ping pong paddle (described by Canu and Bassler as a duck's bill), whereas the *C. anatina* of Osburn (1952) from the Galapagos Islands is certainly a separate species having a small acute suboral avicularium or a large, foot shaped, spatulate avicularium about 260 μm long that does not cover the entire frontal wall. It seems likely at this point that *C. anatina* and *C. hastingsae* may differ sufficiently from the type to warrant a new genus, but this requires SEM study of the type. We are of the opinion that these genera do not belong in Smittinidae, in spite of some similarities nor do they belong in Bitectiporidae, and a new family may be required for them eventually.

Codonellina hastingsae, new species

Plate 109 A-D

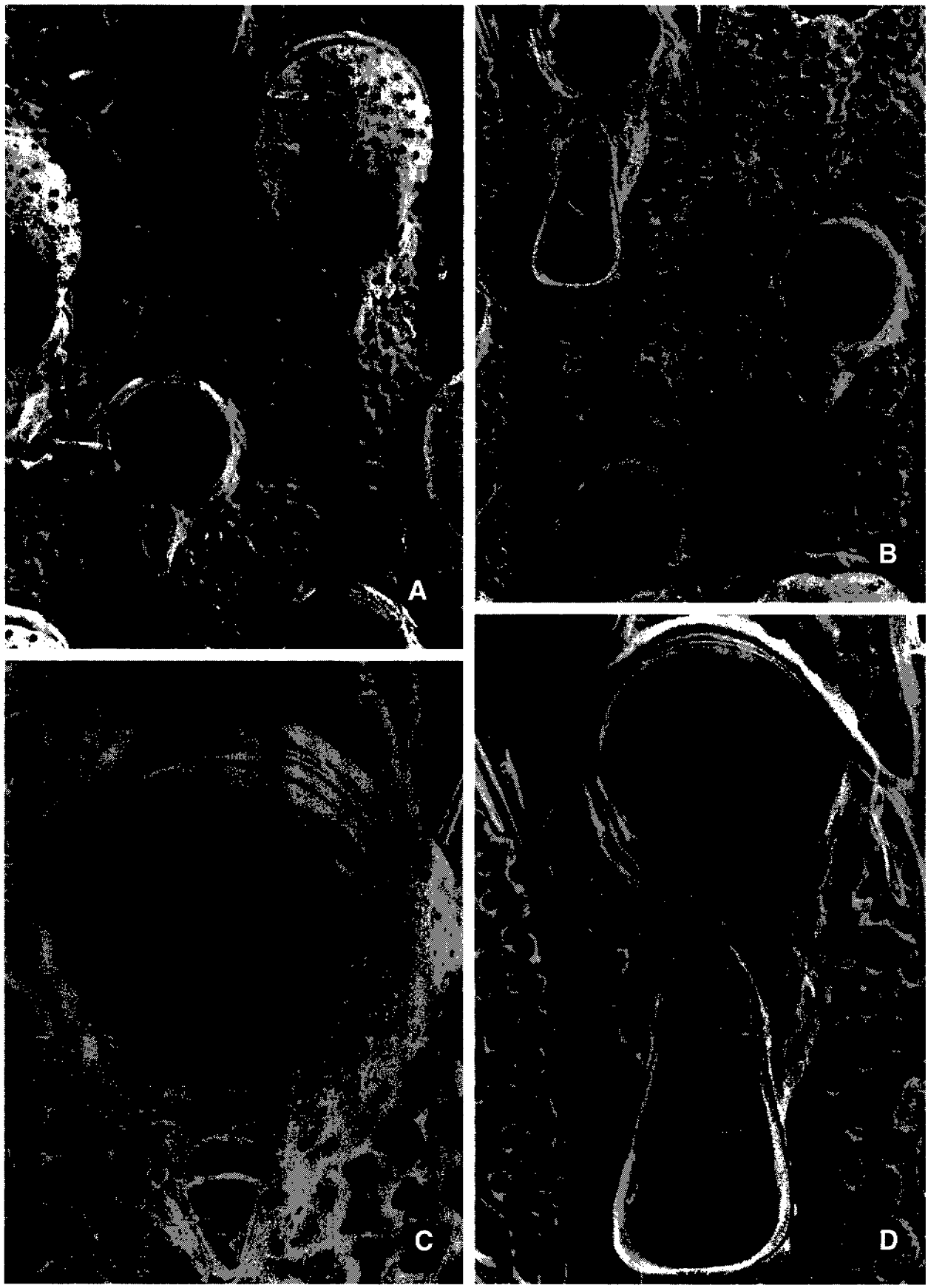
? *Codonella granulata* (manuscript name) Canu and Bassler, 1927: 26 (*nomen nudem*); 1930: 29, pl. 4, figs. 6-8.
Codonella granulata?: Hastings, 1930: 725, pl. 13, figs. 80-83.
Codonellina anatina: Osburn, 1952: 422, pl. 46, figs. 14, 15.

Material Examined. USNM, AHF, BMNH and Soule collections.

Diagnosis/Description. Colony delicate, encrusting. Zooids elongate with curved distal wall, variable in size, 450- 900 μm long, 260-450 μm wide, frontal wall entirely perforate except over avicularium chamber, granular between pores. Aperture almost circular, about 180 μm in diameter, with distinct condyles at the ends of the primary distolateral margins, proximal rim a wide shallow arc. A median suboral avicularium with acute mandible directed proximally, with complete hinge bar, replaced at times with widely spatulate avicularium up to about 260 μm long, 150 μm wide near tip, connected to pores bilaterally. Ovicell about 250 μm in diameter, with numerous pores, not encroached on by ectooecium but rimmed distally.

Biology. Encrusts shells, coralline algae, coral, worm tubes, other bryozoans. Osburn (1952) gives the depth range (as *C. anatina*) as 30 - 200 m, but the identity of the species involved is doubtful. The type locality is at about 49 m in a crater on coral.

Etymology. Named for the late Dr. Anna B. Hastings, of the BMNH, who contributed so much to the knowledge of "Polyzoa" and who devoted a great deal of time to helping other bryozoan researchers around the world.


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Taxonomic Remarks. Canu and Bassler (1927), in describing *Codonella anatina* from Hawaii, mentioned a new species being described as *C. granulata* in a manuscript in preparation on the Galapagos Islands with a small, acute, median avicularium. When the name was published (1930) they placed it in the Smittinidae but described a schizoporellid peristome with a rounded primary aperture; their illustrations (pl. 4, figs. 6-8) did not show a sinus.

Hastings (1930) illustrated *Codonella granulata ?* from the Galapagos Islands, showing a somewhat narrower and smaller (about 160 μm long) large spatulate avicularium, smaller than that in *C. anatina*. She saw no evidence of the granular frontal wall between the pores, but that may be due to a difference in microscopy or in definition of granular. We are inclined to believe that her material and Osburn's are the same (Figure 31), but we cannot presently place either of those in the Canu and Bassler species, so we have described it as new. *Codonella granulata* resembles *Codonella montferrandii* (Savigny and Audouin), which supposedly has a wide tropical distribution in the Red Sea, Indian Ocean and western Pacific (Harmer, 1957; Gordon, 1984).

Type Locality and Type Species. AHF station 194-34, off Onslow Island, north of Charles Island, Galapagos Islands. SBMNH-AHF Bryozoa Holotype No. 236.

Distribution. Osburn (1952) listed the species from 14 stations among the Galapagos Islands, and at three stations in the mid-Gulf of California. Hastings had two stations at Tagus Cove on Albemarle Island, on rock overhung by rock or in a rock cave in 10-12 fms. This species could well be found in sheltered locations on the Banks near the California-Mexico border and in warmer waters of the Channel Islands.

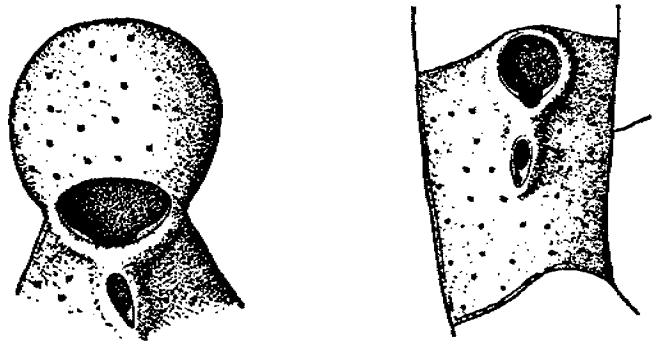


Figure 31. *Codonellina anatina* (Canu and Bassler, 1927).
From Osburn, 1952, pl. 46, figs. 14-15.

Plate 109. *Codonellina hastingsae*. Onslow Island, north of Charles (Floreana) Island, Galapagos Islands. A. Perforate ovicell, frontal wall with acute median suboral avicularium. B. Colony with spatulate avicularium replacing acute avicularium; developing ovicell below. C. Detail of aperture with small acute suboral avicularium, small acute condyles. D. Detail of zooid with large spatulate avicularium.

Codonellina santabarbara, new species

Figures 32-33

Schizoporella longirostrata: Robertson, 1908: 291, pl. 20, fig. 49.
Schizomavella longirostrata: Canu and Bassler, 1923: 109, pl. 35, fig.11.
Hippomonavella longirostrata: Osburn, 1952: 365 (in part).

Material Examined. MMS, AHF and BMNH Collections.

Diagnosis/Description. Colony forming thin encrustations. Zooids about 500 to 600 μm long, 350-450 μm wide, frontal walls raised, granular with numerous small pores except in central suboral area. Aperture slightly higher than wide, rounded, with distinct condyles, curved proximally. A short or long acute avicularium on the lateral frontal wall or medially, directed proximolaterally, originating from a median suboral chamber, possibly connected to a suboral pore and a lateral frontal pore. Ovicell about 265 μm wide, 225 μm high, globose, perforate, closed by the operculum.

Biology. Encrusting worm tubes, algae. Depths uncertain due to confusion over identifications; MMS depth is 69-73.5 m.

Etymology. Named for the type locality, the Pleistocene of Santa Barbara, California.



Figure 32. *Schizomavella longirostrata.*
From Canu and Bassler, 1923, pl. 35. fig. 11

Taxonomic Remarks. The species was illustrated by Canu and Bassler (1923) from a fossil specimen, but was in reasonably good condition, although their photograph is retouched (Figure 32). It clearly shows numerous small pores, the typical avicularia varied in position, and the porous ovicell. They pointed out that their material differed from Robertson's illustration (Figure 33), which had larger apertures on ovicells than on autozooids. Both have numerous pores scattered over the frontal wall, as illustrated, probably placing the species in the *Codonellina*.

AHF material from southern California has numerous frontal pores, although the area of the avicularium chamber in the central frontal is probably imperforate, which might have placed it in *Hippomonavella longirostrata* (now *P. longirostrata*) or *P. californica*.

Type Locality and Type Specimens. The Canu and Bassler (1923) manuscript gives the locality as Pleistocene of Santa Barbara. USNM Catalogue No. 68572.

Distribution. Robertson, 1908, reported the perforate form from off Santa Catalina Island and off San Pedro. It has not been recognized since, perhaps reflecting its fossil history, or the confusion with *Pleurocodonellina*. Osburn (1952) noted the occurrence of *"H. longirostrata"* at 18 stations in the southern California Channel Islands, and it is possible that both *P. longirostrata* and *C. santabarbara* occur there. The northern and more southern distribution of the newly recognized species is unknown.

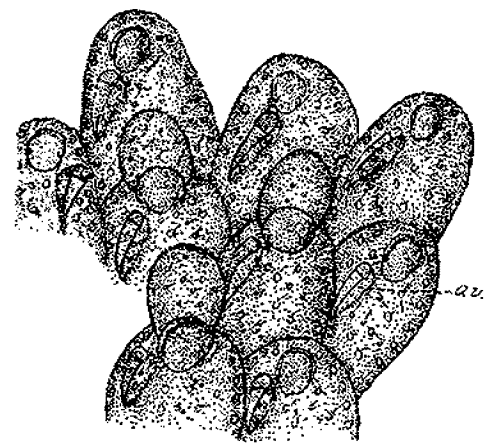


Figure 33. *Schizoporella longirostrata.*
From Robertson, 1908, pl. 20, fig. 49.

Pleurocodonellina longirostrata (Hincks, 1882)

Plate 110 A-D

Schizoporella longirostrata Hincks, 1882: 251; 1883: 447, pl. 17, fig. 4. — C.H. and E. O'Donoghue, 1923: 178.
Not *Schizoporella longirostrata*: Robertson, 1908: 291, pl. 20, fig. 49.
Not *Schizomavella longirostrata*: Canu and Bassler, 1923: 109, pl. 35, fig. 11.
Schizomavella longirostrata: C.H. and E. O'Donoghue, 1925: 102; 1926: 105.
Hippomonavella longirostrata: Osburn, 1952: 365 (in part), pl. 43, fig. 2.
? *Hippomonavella longirostrata*: J. D. Soule, 1961: 22.

Material Examined. MMS Station: BRA-16. Other collections: BMNH and AHF.

Description. Colonies encrusting. Zooids irregularly rectangular, 600-650 μm long, 500-550 μm wide, with frontal wall raised, granular, 1 row of marginal areolar pores, a few scattered frontal pores. Aperture rounded distally with 2 small spines on some, with moderately straight lateral margins, with lappets flanking them, ending at strong condyles curved downward, and a wide, shallow curved (sinuate) proximal margin with a narrow ledge usually covered by encroaching frontal wall; occasional apertures more elongate, possibly those with beginning ovicell buds. A small acute median avicularium or a long narrow, acute avicularium located proximolateral to the aperture, with mandible directed proximolaterally, apparently originating from a lateral pore and a suboral or proximal apertural pore, with a small sulcus in the secondary frontal wall below 1 condyle connecting with avicularium chamber; the avicularium chamber covering the central suboral frontal wall. Ovicells large, 300-350 μm wide, 250-300 μm high, globose, finely perforate, becoming somewhat immersed distally.

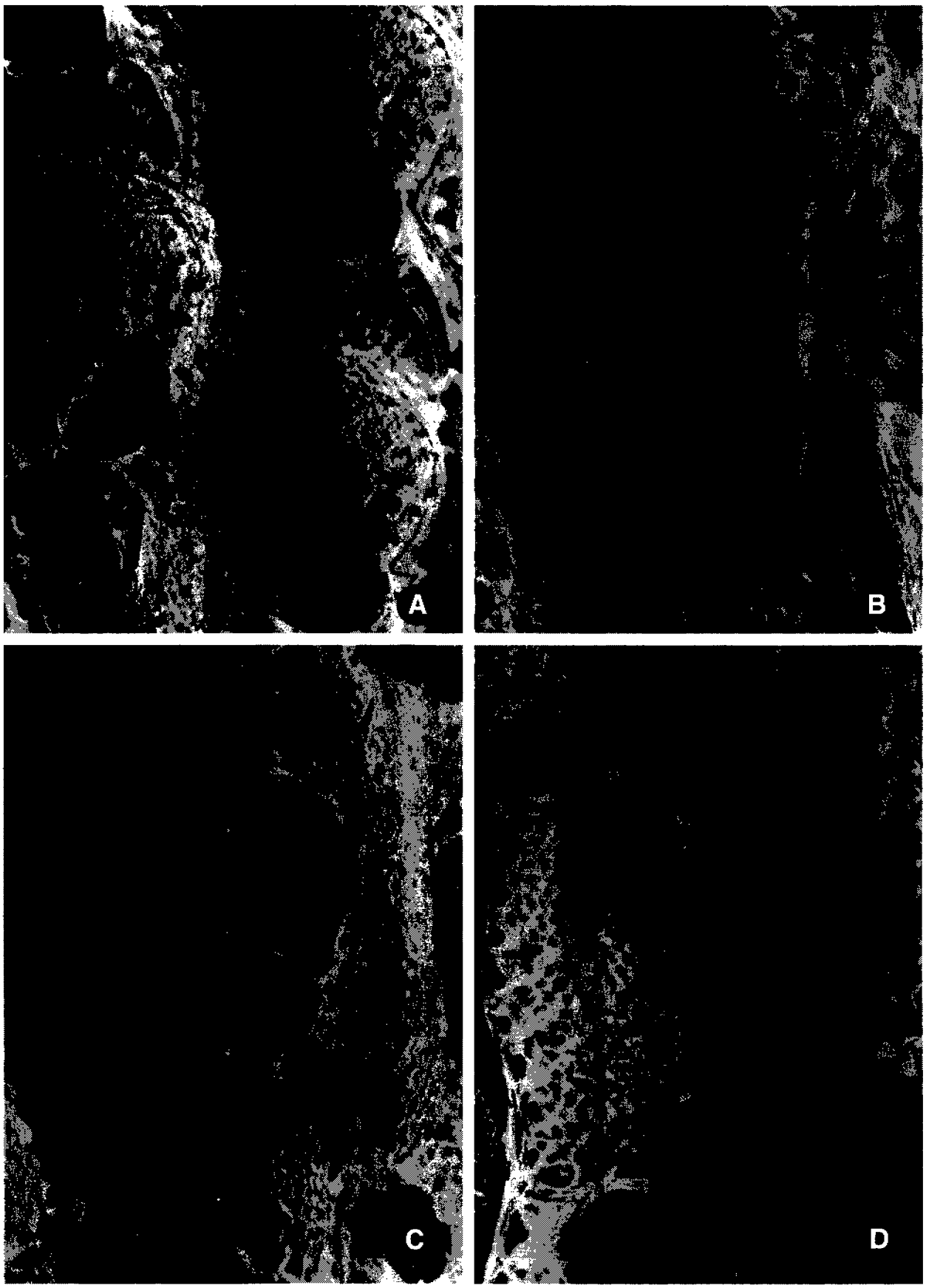
Biology. Depths reported from shallow waters to 200 m, if all reports are of this species.

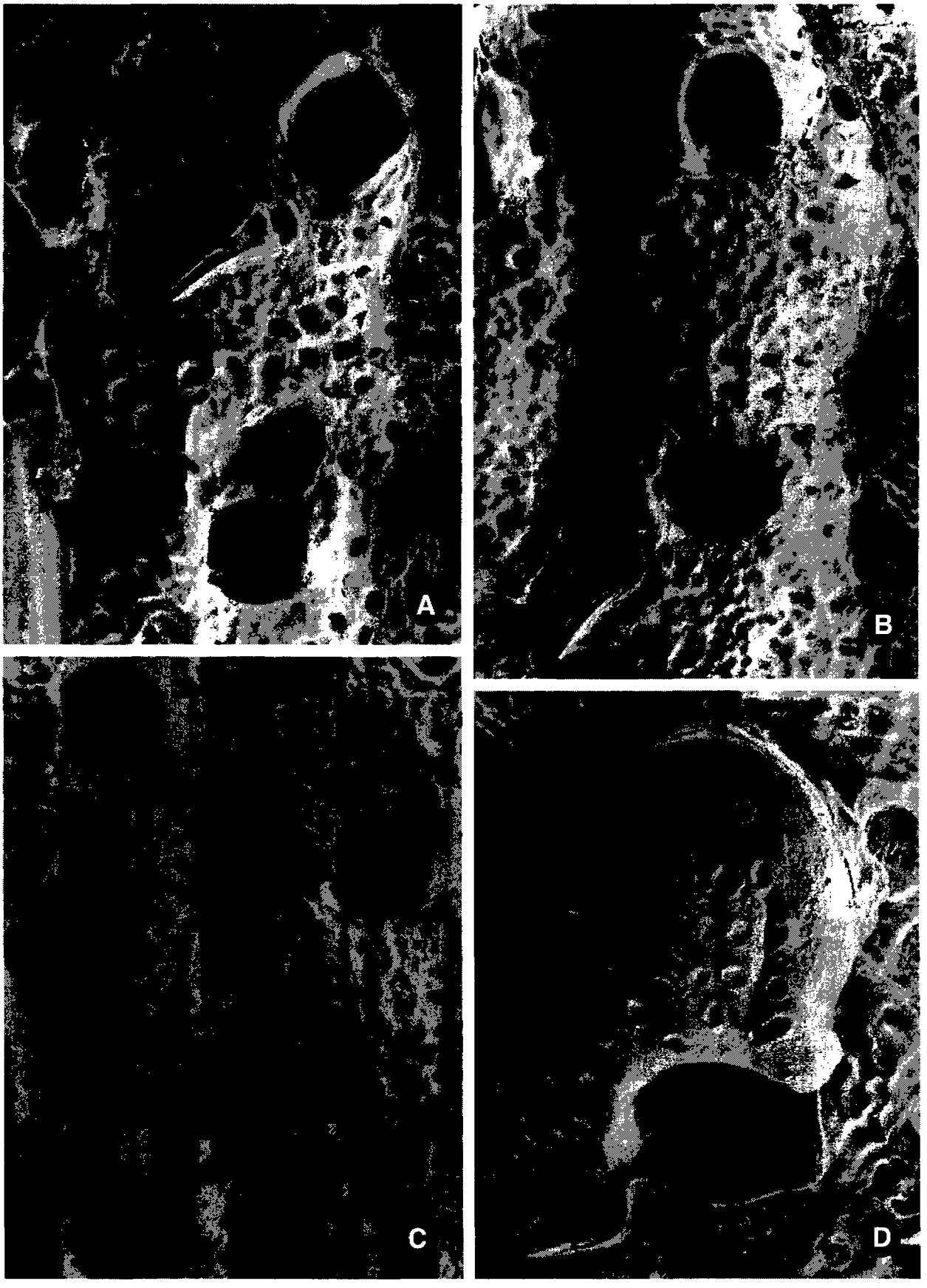
Taxonomic Remarks. We question placing this species in *Hippomonavella*, described from Australia, which seems to have a raised area in the midproximal apertural rim that connects with the small median suboral avicularium. The aperture of *P. longirostrata* is not typically schizoporellid, as originally classified by Hincks (1882), with a sinus within the proximal apertural rim, although it has a narrow, curved proximal rim, apparently with a frontal wall component (D.F. and J.D. Soule, 1973). Osburn placed the genus in his Hippoporinidae, which was improperly founded, based on an erroneous type designation, as discussed earlier. *Pleurocodonellina longirostrata* has an imperforate frontal wall with a few central pores and a row of small areolar pores that are distinct in cleaned specimens. The ovicells resemble those in *Hippopodina feegeensis*, the type species of the genus, on which the family Hippopodinidae Levinsen, 1909 is based. However, the aperture of *H. feegeensis* is wider than high, curved in to the condyles and then widens, curving tightly to a wide, straight proximal lip (See Ryland and Hayward, 1992). Gordon (1984, 1989) placed the *Hippomonavella* in the Smittinidae, although they have no lyrula, and the colony is much more fragile than most smittinids. *Pleurocodonellina lahainae* has 1-2 tiny distal spines, as does *P. longirostrata*.

The MMS material from the Santa Barbara Channel identified as *Hippomonavella parvicapitata* elsewhere, may be *P. longirostrata* or *P. californica*, but the material was too fragmentary to determine with certainty. Osburn (1952) gave the dimensions of the ovicell on *P. longirostrata* as 240 to 280 μm in

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Plate 110. *Pleurocodonellina ? longirostrata.* [OVER, LEFT] Friday Harbor, Puget Sound. A. Ovicells, on left, note median suboral avicularium; on right, ovicell with shorter frontal wall, avicularium skewed to side. B. Detail of ovicell with large oral condyles, chevron shaped avicularian hinge bar. C. Colony tilted to show lateral wall with small pores, oral lappets on aperture. D. Developing margin, with avicularium placed laterally but chamber extending to medial suboral area; frontal walls imperforate, with marginal areolar pores.


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B
C
D


A
B
C
D

diameter, although our specimen illustrated has much larger dimensions.

Type Locality and Type Specimens. Cumshewa Harbour, Queen Charlotte Islands. Slide BMNH 1886.3.6.31 is labeled "part of type".

Distribution. *Pleurocodonellina longirostrata* was described from the Queen Charlotte Islands, British Columbia and has been identified in Southern California.·

Pleurocodonellina californica, new species

Plate 111 A-D

Hippomonavella longirostrata: Osburn, 1952: 365 (in part).
? *Hippomonavella longirostrata*: J. D. Soule, 1961: 22.

Material Examined. MMS Station: BRA-16. AHF collections.

Description. Colony encrusting. Zooids regular or not, varying from 450-800 μm long, 400-600 μm wide, with 3 or more rows of large frontal pores, present except on avicularian chamber. Aperture sometimes with 3-5 tiny spines; apertures of 2 sizes; circular, about 150 μm wide and height, and elongate, 140-150 μm wide, 160-180 μm high, with a thin rim later forming lateral oral lappets, raided distally, with 2 hooked condyles proximally, bounding a curved proximal lip. A small acute avicularium, 120-140 μm long, median or to directed to 1 side, connected to the peristome by a small sulcus at the corner of the proximal aperture, or a longer avicularium 250-300 μm long, either with a complete hinge bar bent forward in the center (chevron shaped). Ovicell about 240 μm wide, 225 μm high, with large pores but with the distal portion imperforate.

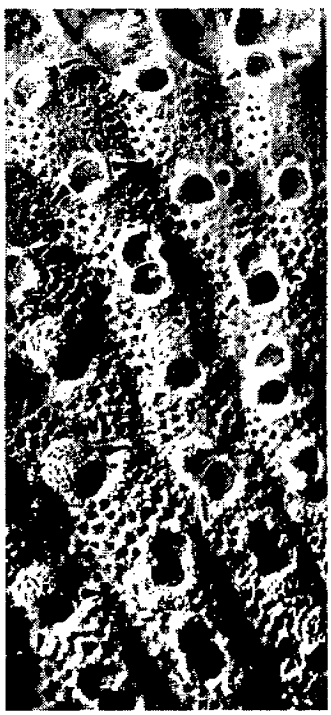


Figure 34. *Hippomonavella (=Pleurocodonellina) parvicapitata.* From Canu & Bassler, 1930, pl. 2, fig. 7. Note paired avicularia.

Biology. Colonies encrusting rock and shell. The depth of the MMS material was 91.5-123 m; AHF material from 150 m off Redondo Beach.

Etymology. Named for California, the only known locality for the species.

Taxonomic Remarks. This species is similar to *Pleurocodonellina parvicapitata* Canu and Bassler (1930: 19, pl. 2, figs. 7-11) from the Galapagos Islands, which Osburn (1952) also recorded from the Gulf of California, the Galapagos Islands and Colombia. There are some differences seen; as illustrated by Canu and Bassler, the avicularia tend to be paired and originate at the level of the condyles or above beside the lateral apertural rim. They did not mention spines. The

Plate 111. [PREVIOUS PAGE] *Pleurocodonellina ? californica.* Redondo Beach, southern California. A. Zooid oriented diagonally in SEM, with long median frontal avicularium. B. Zooids with avicularium absent or skewed to side. C. Zooids with rounded apertures, lateral oral lappets, smaller frontal avicularia, 3-5 spine bases, ovicell bud on zooid with aperture higher than wide. D. Detail of untreated ovicell, aperture with wide arcuate proximal rim, hooked condyles.

avicularium hinge on *P. parvicapitata* was described by Osburn as incomplete and the ovicell pores as small, whereas our few AHF specimens from southern California have a complete chevron-shaped hinge bar and ovicell pores are larger than those in *P. longirostrata*. The ovicell is about the same width as that given by Osburn for *P. longirostrata* but is smaller than that in the specimen we illustrate.

Type Locality and Type Specimens. Off Redondo Beach, California at 150 m. SBMNH-AHF Bryozoa Holotype No. 237.

Distribution. The MMS record is from off Purisima Point. At present the distribution is limited to southern California but it may extend into the Gulf of California.

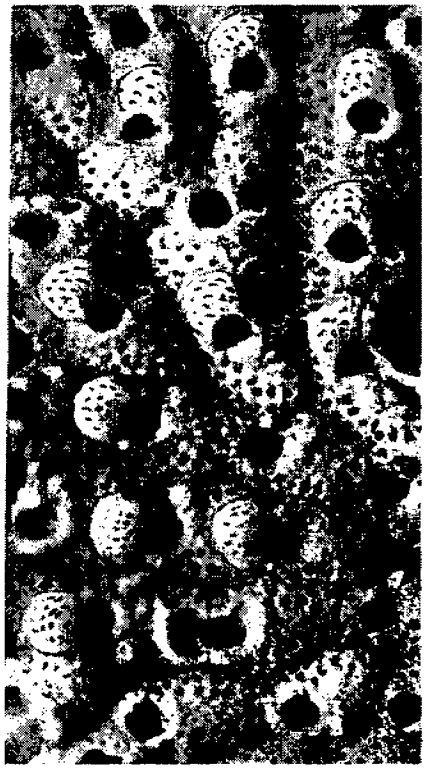
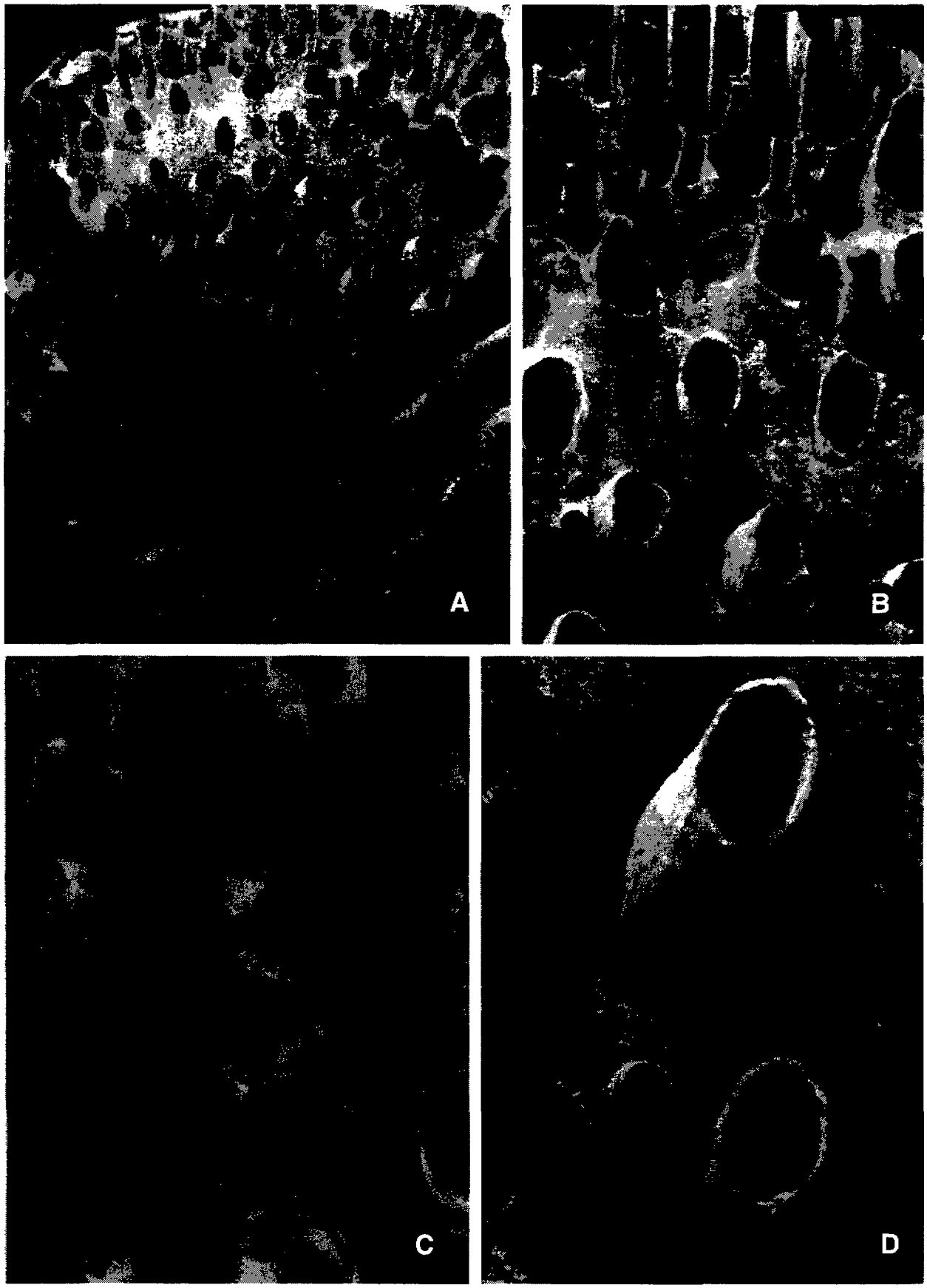


Figure 35. *Hippomonavella (=Pleurocodonellina) parvicapitata.* From Canu & Bassler, 1930, pl. 2, fig. 8. Note single avicularium.


A
B
C
D

Class Stenolaemata

Order Cyclostomata (Tubuliporata)

Suborder Tubuliporina

Family Diastoporidae Gregory, 1899

Diplosolen harmelini, new species

Plate 112 A-D

Not *Tubulipora obelia* Johnston, 1838: 269, pl. 31, figs. 7, 8.
Not *Diplosolen obelia*: Hayward and Ryland, 1985b: 102, fig. 35.
? *Diastopora obelia*: C.H. and E. O'Donoghue, 1923: 156.
? *Diplosolen obelium*: C.H. and E. O'Donoghue, 1925: 95; 1926: 70, pl. 2, fig. 17.
Diplosolen obelium: Osburn, 1953: 640, pl. 73, fig. 1.

Material Examined. AHF and BMNH Collections; BMNH 1899.7.1.4205.

Diagnosis/Description. Colonies flattened, developing in fan shape, becoming irregularly circular or lobate. Zooids embedded for much of their length, with semierect, rounded or elliptical peristomes projecting above the surface, peristomes on margins sometimes irregularly pointed. Few small nanozooids occurring between autozooidal tubes or fused to tubes only at, or below, colony crust. Tubal openings oval, about 150 μm by 180-240 μm, nanozooid openings round, about 80 μm in diameter. Gonozooid lobate, spreading among tubules, little inflated, with large surface pseudopores, a small circular ooeciostome, about 120 μm in diameter, intermediate in size between autozooid tubule and nanozooid, curving over slightly.

Biology. Mostly colonizing hard substrates. Depths from shallow water down to 160 m have been reported. According to Silén and Harmelin (1974), the nanozooids in *Diplosolen obelium* have a polypide reduced to a single tentacle which sweeps debris and small organisms from the colony; that species occurs in the northeastern Atlantic from the Barents Sea to Morroco and throughout the Mediterranean.

Etymology. Named for Dr. J.-G. Harmelin, of the Centre d'Océanologie de Marseille, Station Marine d'Endoume, Marseille, France, who has contributed so much to the knowledge of the cyclostomes and to clarification of their systematics and ecology.

Taxonomic Remarks. Harmelin (1976), in a monograph on Mediterranean Cyclostomata, and Hayward and Ryland (1985a) in their synopsis on British Cyclostomata, have redescribed *Diplosolen obelia* (Johnston), eliminating much confusion. It has a small nanozooid attached to every autozooid peristome, usually extending well above the colony surface, whereas nanozooids are relatively infrequent and mostly independent of autozooids above the colony surface in *D. harmelini*. The diameter of the autozooid opening is about 150 μm in both species, but the diameter of the nanozooids in *D. obelium* illustrated by Hayward and Ryland is less than 50 μm, whereas it is about 80 μm in the new species. Harmelin gave the diameter

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Plate 112. *Diplosolen harmelini*. Pt. Barrow, Alaska. A. Fan shaped colony with calcified frontal exterior wall except at growing margin (some frontal wall broken away to show autozooid tubes in upper right); large autozooid tubes, a few small nanozooid tubes, intermediate sized ooeciostome in center of raised gonozooid surrounding autozooid tubules. B. Detail of A. C. Nanozooid not fused to autozoid on left, fused on right below surface level of gonozooid wall (surface removed). D. Detail of tiny pseudopores on surface of gonozooid; ooeciostome between larger tubes.

as 85 μm in Mediterranean populations. *Diplosolen obelium* var. *arctica* Waters, 1904, may be a related deep water, circumpolar species but the nanozooids are the same length as the autozooids (Kluge, 1975).

Type Locality and Type Specimens. The type locality of *D. harmelini* is Point Barrow, Alaska, collected by G.E. MacGinitie. SBMNH-AHF Bryozoa Holotype No. 238. The earliest record of *D. obelium sensu stricto* was from Kinglade Harbour, near Cork, Ireland.

Distribution. Distributed from arctic Alaskan waters southward to Santa Cruz Island in the Channel Islands off southern California.

Family Annectocymidae Hayward and Ryland, 1985

Diaperoforma, new genus

Diagnosis. Colony erect, massive, dichotomously branching, sometimes reticulate, branches flattened, not cylindrical; zooids large tubes with small pores, connate to curved, semi-erect, single, or in bundles (fascicles) of 4-5 tubes, expanding to 8 or more on each side of ventral surface before branching; apertures rounded or oval, large, 200-220 μm in diameter; where fasciculate tubes meet, outer wall is incomplete, tube lined with hooked barbs at outer ends. Gonozooids lying below bifurcations of branches, inflated, with larger pores than surface, penetrated by autozooid tubes; ooeciostome short, subterminal or near center of gonozooid, with wide collar at end, flaring or compressed.

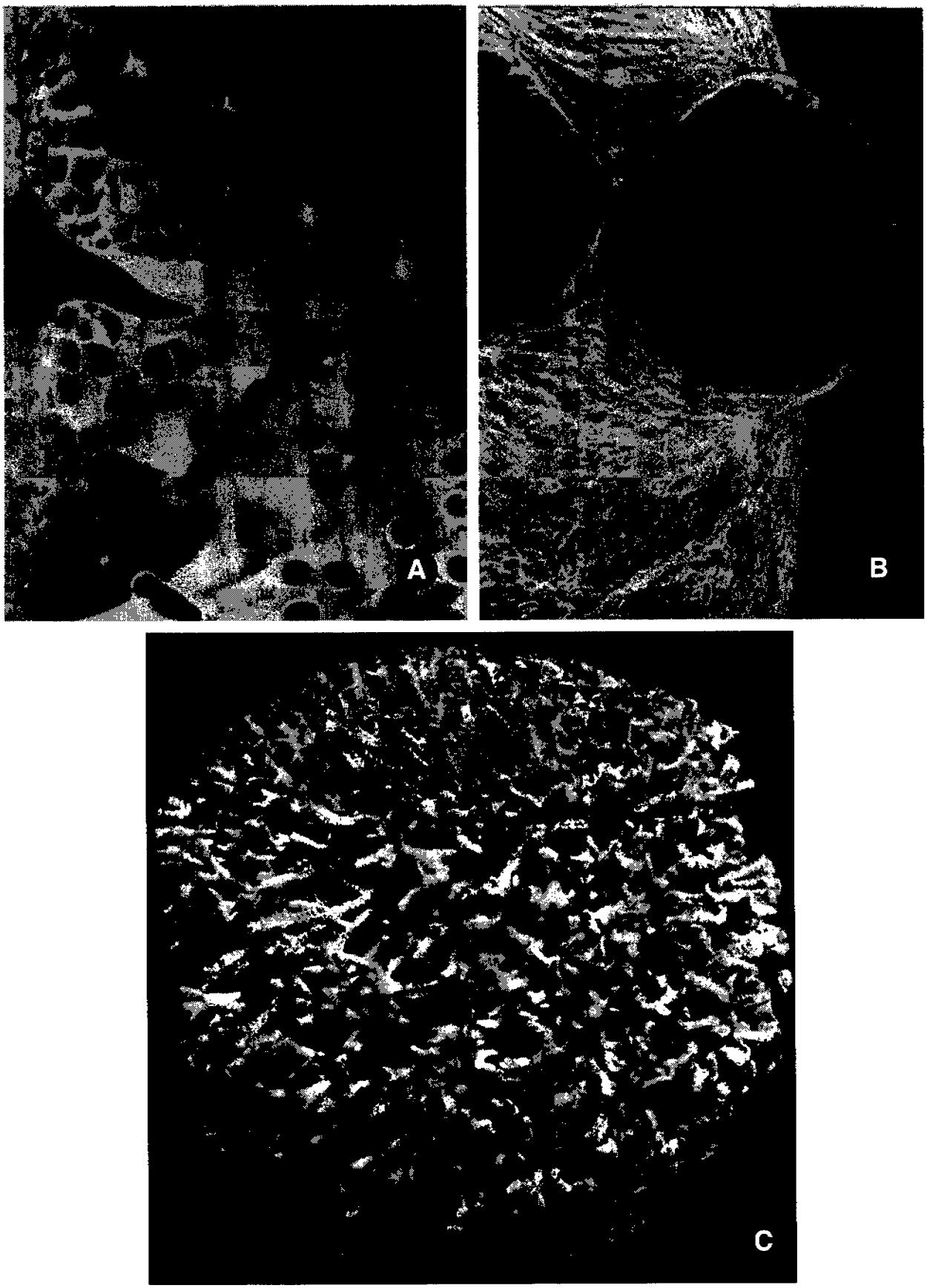
Type Species. *Diaperoforma californica* (d'Orbigny, 1852).

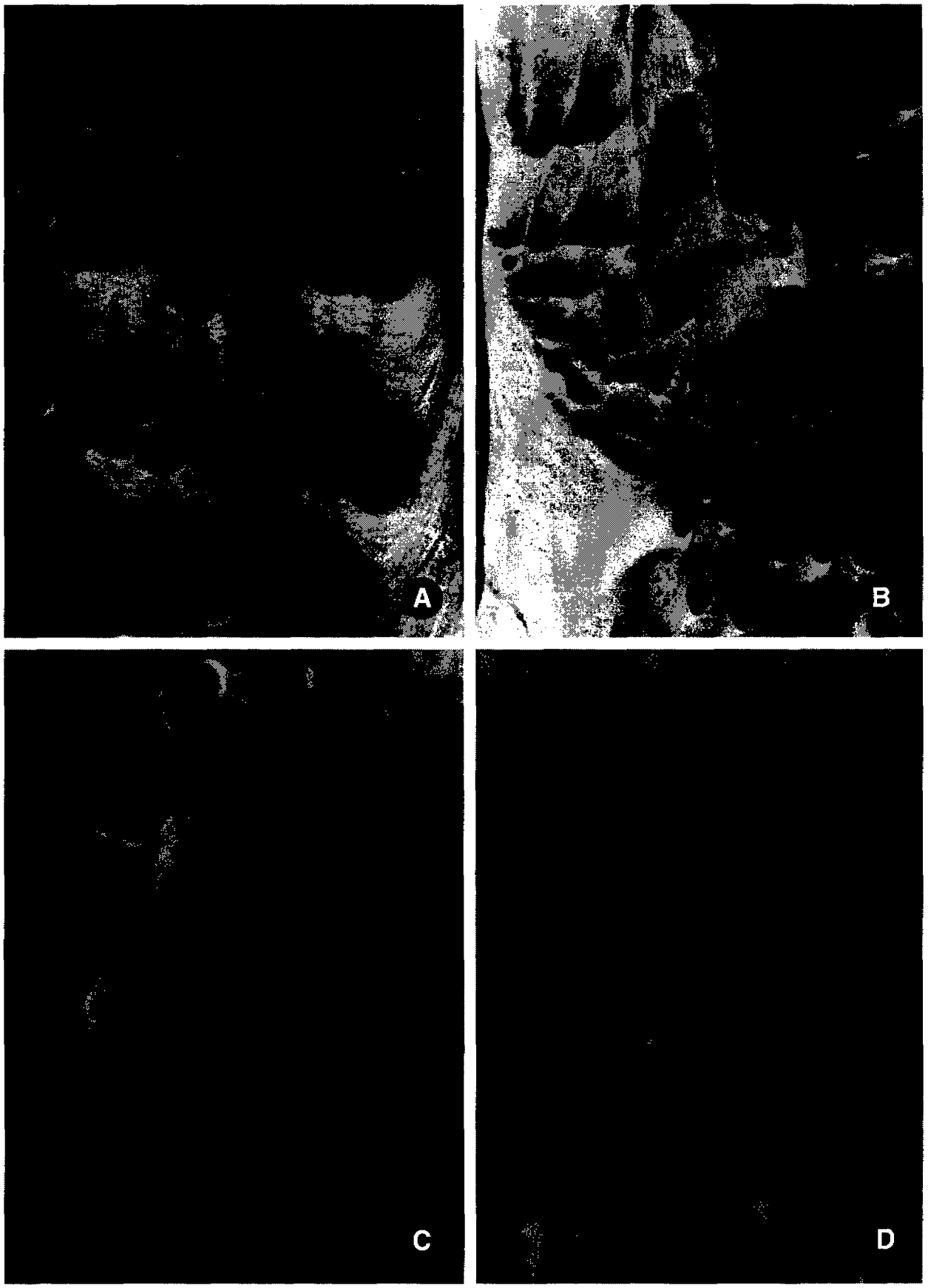
Taxonomic Remarks. Hayward and Ryland (1985a) introduced the family Annectocymidae and the genus *Annectocyma* for the European species formerly assigned to *Diaperoecia* Canu, 1918, on the grounds that the genus was poorly defined, and should be restricted to its Australian type species, *D. intricaria* Busk. That species is still restricted to South Australia and known only from the type slide (BMNH 1875.5.29.35), a fragment of an erect, cylindrical colony lacking a gonozooid, but the slide could not be located for our examination. It is clear from Hayward and Ryland's study and the work of Harmelin (1976) that the familiar eastern Pacific species *D. californica* requires a new generic designation. The name *Diaperoforma* was selected to closely approach the locally well known *Diaperoecia*.

Hayward and Ryland (1985a) selected for the type of the genus *Annectocyma*, *Alecto major* Johnston, 1847. Osburn (1953) placed the eastern Pacific form he called "*A. major*" in the genus *Proboscina*, which, according to him, has flat, adnate strap-like lobes. According to Pitt and Taylor (1990), *Probiscina* is an unrecognizable genus. *A. major, sensu stricto,* probably does not occur in eastern Pacific waters.

Diaperoforma differs from *Pseudonevianipora* Brood, 1976, in having larger brood chambers penetrated by autozooecial tubes, whereas the latter has small brood chambers not penetrated by autozooecial tubes. *Nevianipora* Borg, 1944, has a deeply immersed brood chamber with indistinct, irregularly shaped lobes, with its proximal portion lying between autozooid tubes.

Plate 113. *Diaperoforma californica*. Los Angeles. A. Growing tips of colony with tubes immersed in fascicles, peristomes raised. B. Detail of fused tubes, with interior hooks in tube walls. C. Colony form grown around rope, attached by intertwined kenozooids in interior. Optical photograph.


A
B
C


A
B
C
D

Diaperoforma californica (d'Orbigny, 1852)

Plate 113 A-C; Plate 114 A-D

Idmonea californica d'Orbigny, 1852: 732. — Conrad, 1855: 441.
Idmonea californica: Gabb and Horn, 1862: 168, pl. 21, fig. 56. — Robertson, 1910: 253, pl. 23, figs. 39-41. — Canu and Bassler, 1923: 199, pl. 43, figs. 1-9. — C.H.and E. O'Donoghue, 1923: 154; 1926: 73.
Diaperoecia californica: Osburn, 1953: 642, pl. 67, figs. 1, 2. — J. D. Soule and M.M. Duff, 1957: 131.

Material Examined. MMS Station: BRA-1. Other collections: AHF and BMNH; BMNH 1968.1.18.211.

Description. Colonies often forming massive, dichotomously branched, sometimes reticulate, structures 12-15 cm high, often around cables and stems, attached by intertwined kenozooids. Zooids large, tubular, peristomes curved, more or less erect, all facing one direction on one side (ventral surface); dorsal surface imperforate with horizontal striations; apertures solitary or gathered into bundles (fascicles); where fasciculate, exterior surface wall not completely surrounding tube, tubes sharing a perforate vertical wall, outer end lined inside with hooked denticles; apertures rounded to oval or squared, large, 200-240 μm in diameter. Gonozooids lying below bifurcations in branches, penetrated by autozooidal tubes, inflated, large, with numerous pores; ooeciostome short, subterminal, often near center, with a flared collar, trumpet shaped or laterally compressed, usually connate with autozooid.

Biology. Depths reported from shallow water to over 200 m; more common in deeper water than in shallow waters. The MMS depth was 69-73.5 m.

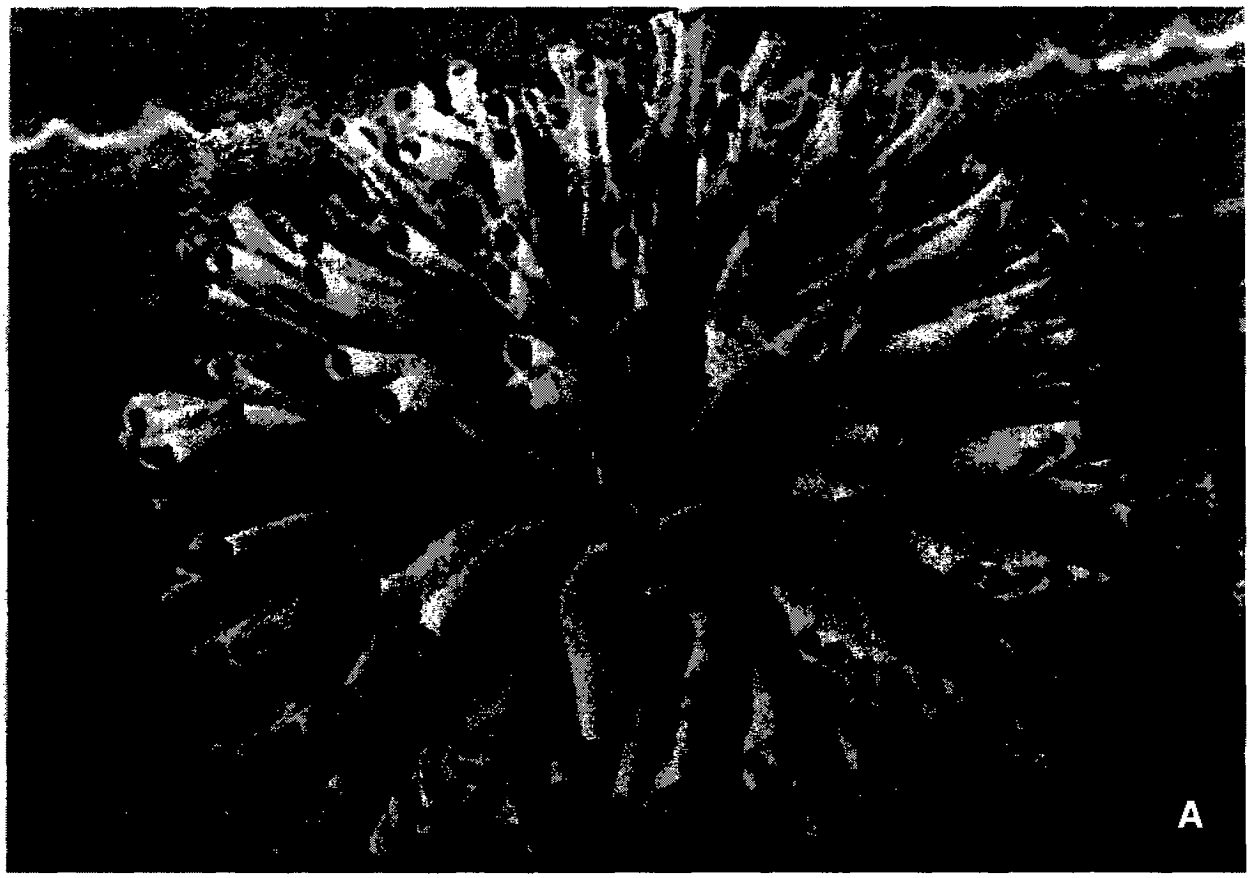
Taxonomic Remarks. Branches may be narrower and more erect in deeper waters and recumbent, shorter and wider in exposed, shallower water locations; Osburn (1953) placed *Idmonea palmata* C.H. and E. O'Donoghue, 1923, in synonymy with *D. californica* on this factor, but we were not able to locate the BMNH *I. palmata* specimen. *Idmonea californica* was reported from the Pleistocene of California by Conrad (1855), Gabb and Horn (1862), and Canu and Bassler (1923). The Hincks species *Tubulipora dawsoni*, from the Queen Charlotte Islands, may be *D. californica*; it was illustrated only by a tiny sketch of the colony but the connate tubes are clearly indicated.

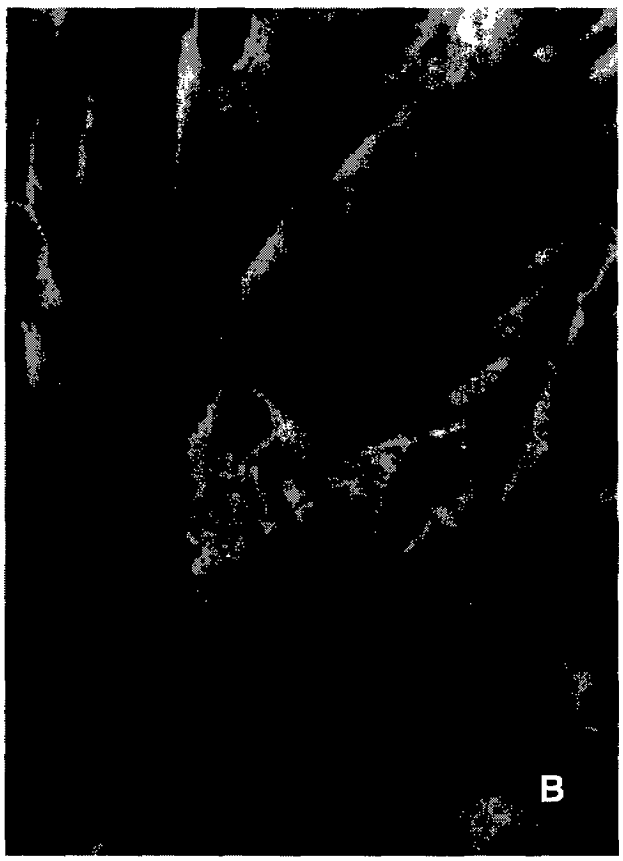
On the basis of our collecting in the Hawaiian Islands, we are doubtful that *D. intricata* (Canu and Bassler, 1927) from Hawaii is synonymous, although it is similar; however, the branches are thicker and may simply reflect the local environment rather than a species difference.

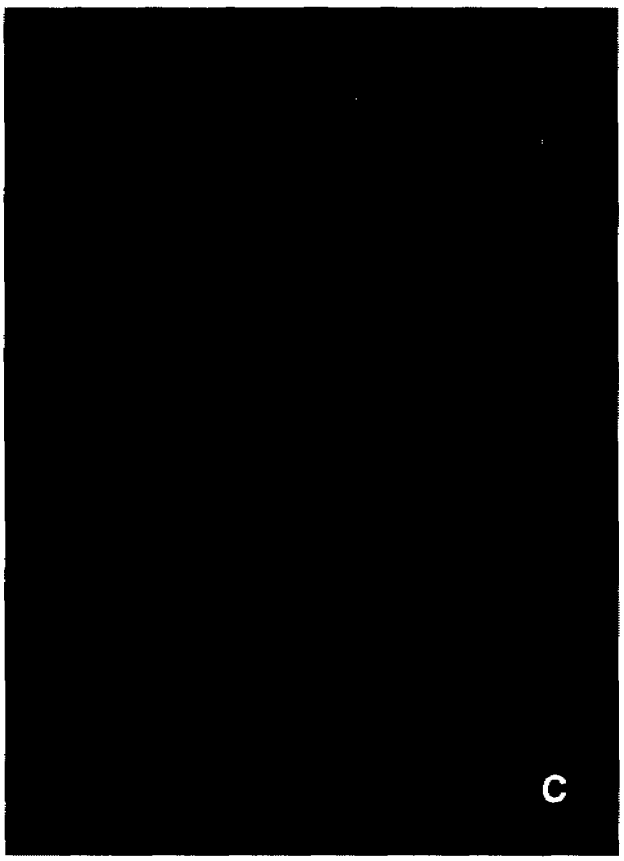
Type Locality and Type Specimens. None designated. The d'Orbigny specimens were from "Ile de Venada, Nicaragua, Mer Vermeille [Vermilion Sea, = Gulf of California] et Californie." His specimens are in the Museum National d' Histoire naturelle, Paris, France.

Distribution. *Diaperoforma californica* is common along the eastern Pacific coast, ranging from British Columbia south to the Coronados Islands. Osburn (1953) listed it as common in the Gulf of California, but according to J. Soule, mistakenly counted specimens he listed in his notes only as "*D. californica*" which actually referred to *Disporella californica* instead. J.D. Soule (1963) did not find *Diaperoforma californica* during the Puritan-American Museum of Natural History Expedition in the Gulf of California, although it had been recorded from there by d'Orbigny. The MMS specimen is from the Santa Barbara Channel.

Plate 114. *Diaperoforma californica*. Los Angeles. A. Double row of 4-5 tubules at growing tip. B. Detail of gonozooids (left branch) dissected to show tubules surrounded by chamber (surface is upper vertical bar in center) with ooeciostome tube intact to right center. C. Growing tip end of branch. D. Ooeciostome opening with flared collar.


A


B


C

Family Tubuliporidae Lamarck, 1816

Tubulipora pacifica Robertson, 1910

Plate 115 A-C

Tubulipora pacifica Robertson, 1910: 248, pl. 22, figs. 27, 28. — C.H. and E. O'Donoghue, 1923: 150; 1926: 71. — Osburn, 1953: 652, pl. 68, fig. 1. — J.D. Soule, 1963: 6. — D.F. and J.D. Soule, 1964: 41.

Material Examined. AHF Collections.

Description. Colonies small, usually flat, fan-shaped to circular, rarely wider than 3 mm. Zooidal tubes rising separately or in irregular radial or biradial rows, connate for much of their length, passing distally into elongated slender peristomes with circular terminal apertures; walls bearing scattered tiny pseudopores. Gonozooid low, weakly inflated, a single chamber with 1 to 3-4 lobes extending between tubes; surface with numerous, slightly larger pseudopores; bearing short ooeciostome with ovoid flaring aperture.

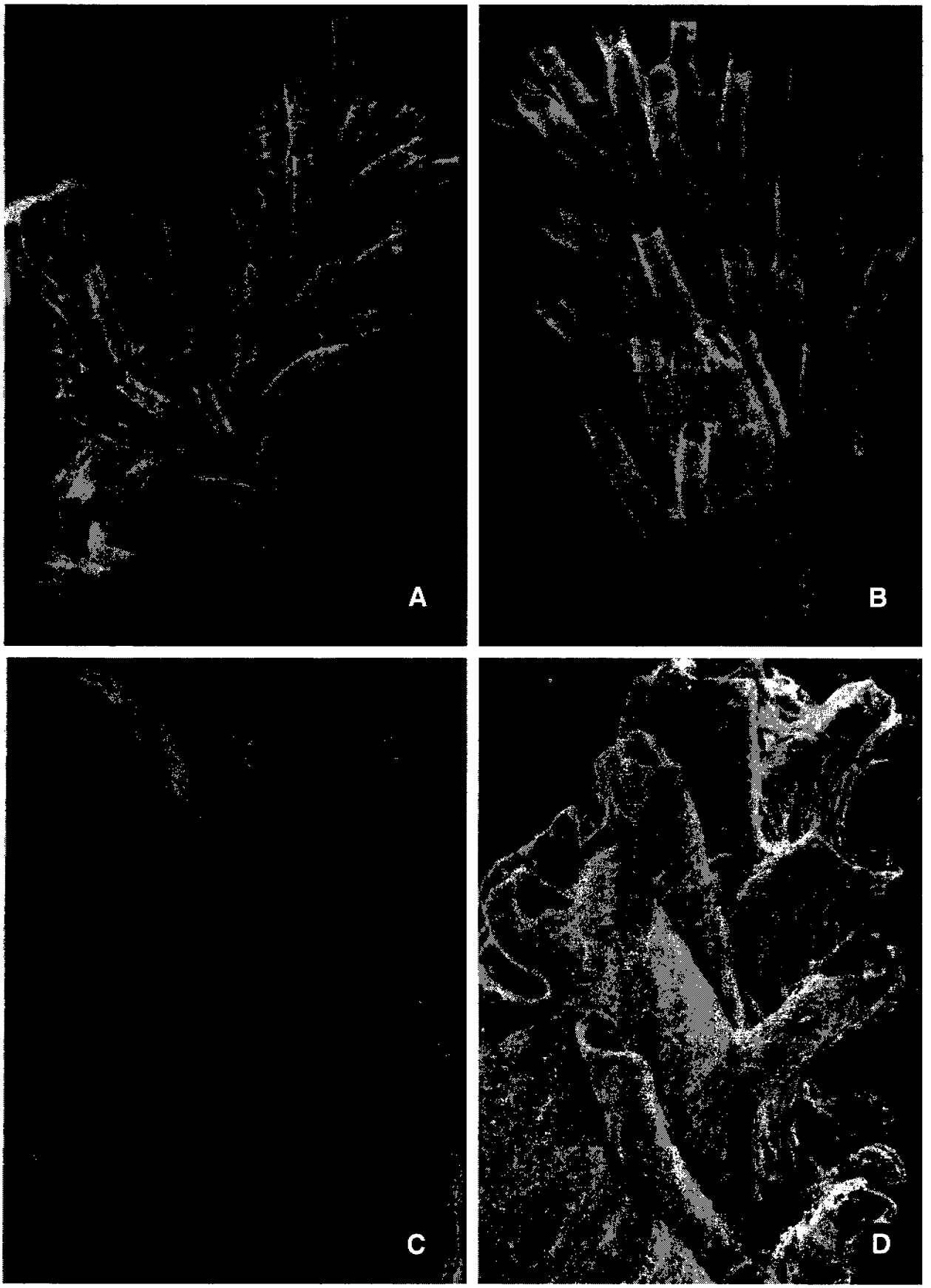
Biology. Encrusts rock, shell and algae. Depths from intertidal to over 100 m have been reported.

Taxonomic Remarks. Tubuliporid systematics has been greatly confused, with few recent studies and none in the eastern Pacific. Light penetration and turbulence in the habitat can cause considerable variation in colony growth form (e.g., Harmelin, 1973). Osburn (1953) compared *T. pacifica* with another eastern Pacific form which he identified as *T. pulchra* MacGillivray, 1885, as did Robertson (1910) and C.H. and E. O'Donoghue (1926). *Tubulipora pulchra*, from Victoria, Australia, with no other locality data, has rows of tiny "footlets" that hold the colony above the substrate. Waters (1887) described similar holdfasts on what he referred to as *T. fimbriata* form *pulchra* MacGillivray from Port Jackson, Victoria, but it may not have been the same species. MacGillivray did not mention the attachment processes and indicated more flask shaped tubes. *Tubulipora pacifica* differs in having most tubes connate for most of their length whereas the eastern Pacific "*T. pulchra*" tubes are mostly not connate.

Type Locality and Type Specimens. First recorded from off San Clemente Island. Robertson's types were mixed with other specimens in the CAS collections.

Distribution. Reported from British Columbia southward to Baja California and to Colombia, South America. The "*T. pulchra*" reported from British Columbia, the southern California Channel Islands, Clarion Island west of Mexico, Costa Rica and the Galapagos Islands has been described herein as *T. aliciae*, new species.

Plate 115. *Tubulipora pacifica*. Santa Catalina Island. A. Fan shaped colony with radiating rows of connate tubes except in central area, ooeciostome to right center. B. Connate tubules with three low, laterally compressed ooceiostomes left, right and top center. C. Detail of ooceiostome, left, tiny pseudopores on gonozooid surface.


A
B
C
D

Tubulipora aliciae, new species

Plate 116 A-D; Plate 117 A-D

Not *Tubulipora pulchra* MacGillivray, 1885: 95, pl. 2, fig. 1.
Not *Tubulipora fimbria* Lamk., forma *pulchra* MacGillivray: Waters, 1887: 258, pl. 7, figs. 1-3.
Not *Tubulipora organizans* d'Orbigny, 1839-47: 19, pl.9, figs. 1-3. — Busk, 1879: 198, pl. 10, figs. 20-25.
Tubulipora pulchra: Robertson, 1910: 210, pl. 23, figs. 32-35. — Osburn, 1953: 653, pl. 68, figs. 2-4.
? *Tubulipora pulchra*: C.H. and E. O'Donoghue, 1923: 150;1926: 71.

Material Examined. AHF and BMNH Collections.

Description. Colonies small, 2-3 mm in diameter, fan shaped or ovoid, delicate, glistening white, loosely attached, recumbent. Colony ancestrula originating from round disk with toothed margin composed of kenozooids or aborted zooids, giving rise to single tubular autozooid; tubes in zone of astogeny with large, subtriangular braces along lateral margins. Tubes not connate in erect portion, tending to divide in direction where branches form mature colonies, tube terminal ends often pointed, especially on outer margins of branches. On dorsal surface of colony, small projections with quadrate gridlike pattern where colony was attached to algal surface. Gonozooid a simple inflated tube near base or margin of colony, with terminal or subterminal ooeciostome, or becoming large, with 2-3 short lobes, between tubes; ooeciostome short, with flaring margin, opening sometimes compressed by adjacent tube. Gonozooid surface horizontally and vertically striate with tiny, slit-like vertical pores.

Biology. Encrusting algae, kelp holdfasts, multilaminar bryozoan colonies and shell. Depths known from intertidal to 64 m. Examination of coralline algal substrate shows that the basal attachments have made small indentations in the surface. The inner surface of the alga does not have the same regular, quadrate pattern of the basal wall projections.

Etymology. Named for Alicia Thompson of the University of Southern California Center for Electron Microscopy who has provided technical assistance during the lengthy SEM sessions for our publications.

Taxonomic Remarks. *Tubulipora pulchra* MacGillivray, 1885, was originally described from Victoria, Australia; he described the colony as "... at first flabelliform, becoming, by growth, various forms...usually lobed...cells are distinct throughout their whole length, for the greater part decumbent, and adhering to each other, but free and bent forwards toward the mouth...usually contracted towards the mouth, which is nearly circular and produced into a long, nearly erect peristome..." MacGillivray did not make any remarks regarding the base except that the colony starts as single or multiple flabelliform growth; his illustrations are of flabellate colonies, which seems to differ from the eastern Pacific form (Figure 36). We were unable to locate the O'Donoghue specimens at the BMNH, which they did not describe or illustrate, for comparison.

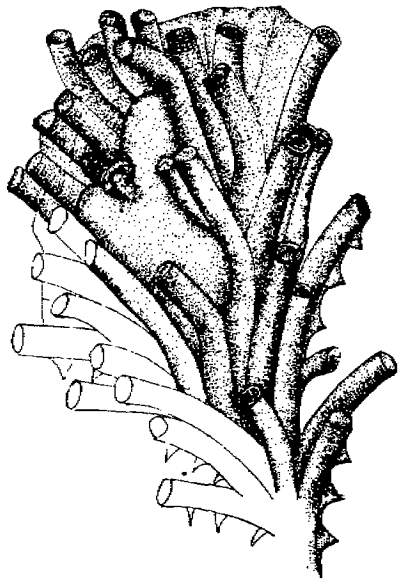


Figure 36. *Tubulipora pulchra*. From Robertson, 1910, pl. 23, fig. 32

Plate 116. *Tubulipora aliciae*. AHF bottom sample 72, east of Guadalupe Island, west of Baja California, Mexico. A. Colony form. B. Lobe with gonozooid a swollen tubular structure in lower center. C. Detail of simple, striate gonozooid with flared ooeciostome next to autozooid tubule. D. Larger striate gonozooid, on left, surrounding several tubules, ooeciostome on left center margin.

Waters (1887, pl. 7, figs. 1-3) redescribed and illustrated *T. fimbriata* form *pulchra* as having a fan-shaped colony rather than a lobate, branched one. He showed a supposedly denticulate ancestrular base and attachments along the margins.

D'Orbigny (1839-47) described *T. organizans* (also spelled *organisans*) from the Falkland Islands as having a bilobate colony with tubes in connate clusters of three, tending to lean to the sides. He did not show the attachment or gonozooids. However, Busk (1879) reported *T. organizans* from the Kerguelen Islands, which lie in the Atlantic-Indian Ocean Basin, roughly in the 50s south latitudes, as are the Falkland Islands, subject to the West Wind Drift that circles Antarctica. He described the colony growth as being "...in narrow, ligulate, dichotomously dividing branches that hardly expand at all at the extremity and which are composed of short irregular series of tubes diverging on either side from the median line..." The peristomes were illustrated as having flaring, sometimes pointed tips.

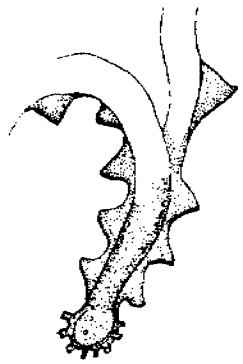


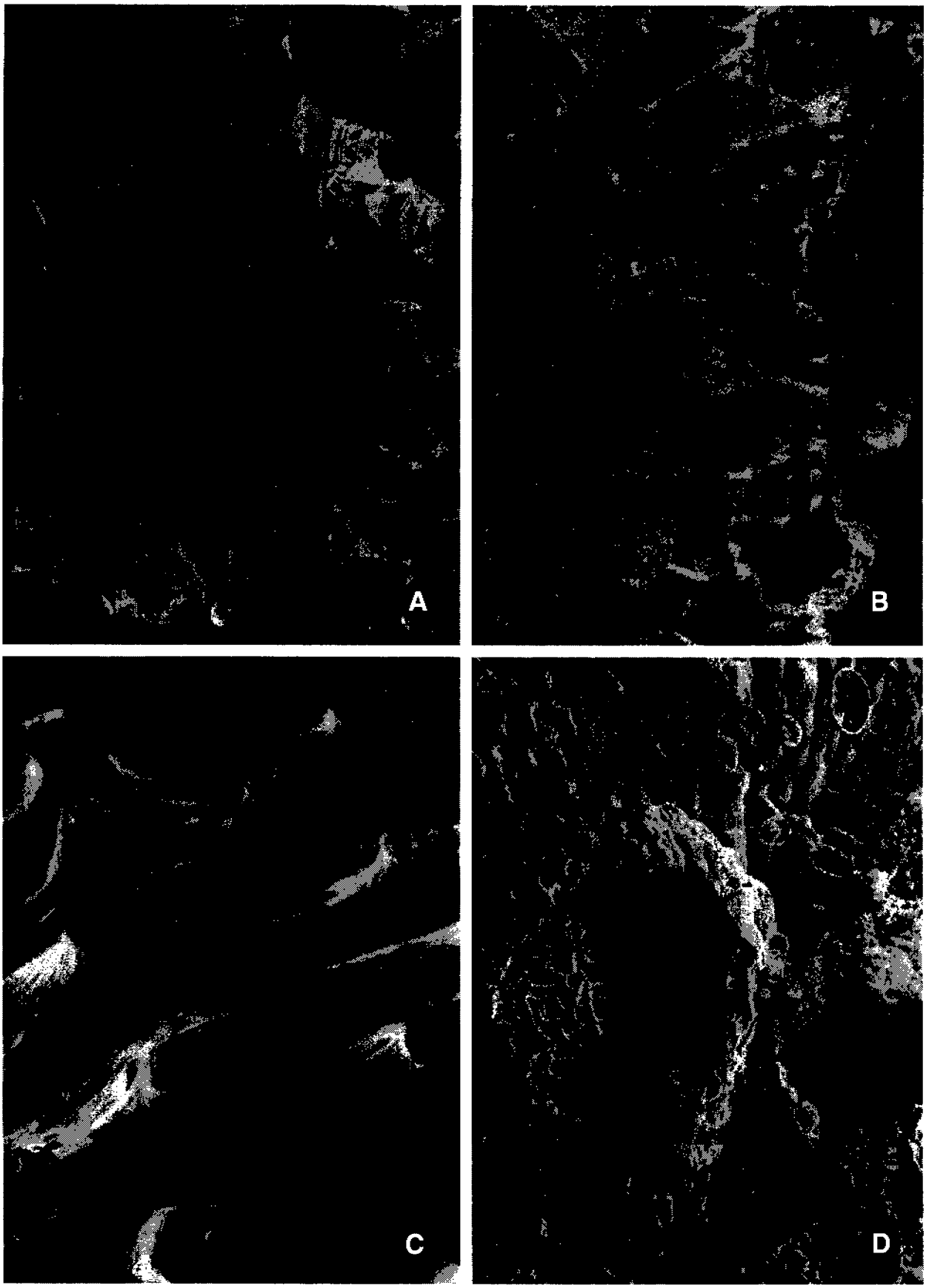
Figure 37. *Tubulipora pulchra*. From Robertson, 1910, pl. 23, fig. 34. Showing initial disk.

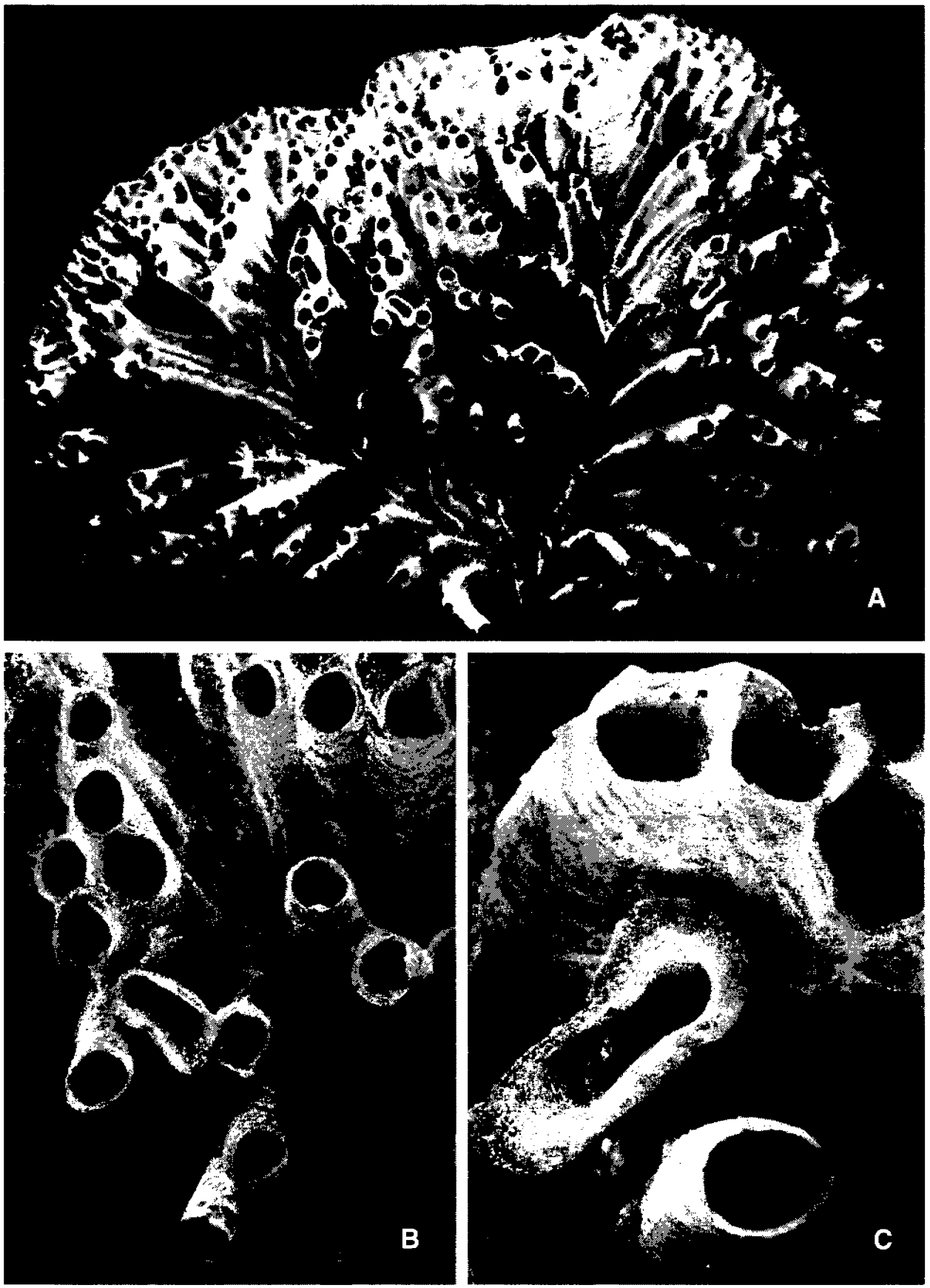
The illustrations by Robertson (1910) of the initial disk and attachment processes (Figure 37) are much like those of Waters and Busk. Thus, the so-called denticulate basal disk of the ancestrula may be a mode of attachment shared by more than one species of *Tubulipora*, an adaptation to particular surfaces such as the coralline alga illustrated herein for the recumbent mode of growth, rather than a species characteristic. As shown in plate 117, the basal disk is not "denticulate", as it was originally described, but has kenozooids (possibly aborted zooids) around the base, a feature that would give a denticulate appearance at lower magnification if viewed from the ventral side.

Type Locality and Type Specimens. Guadalupe Island, Mexico, off Bahía de Sebastian Viscaino. SBMNH-AHF Bryozoa Holotype No. 239.

Distribution. Robertson gave the distribution of her *"T. pulchra"* as several localities in southern California, on shore kelp at San Diego to depths of 58.5 m. Osburn extended the range to Tanner Bank, off the California-Baja California border, Clarion Island, off the coast of Mexico in the Revillagigedos Islands, and to the Galapagos Islands, the last of which may be another species, undescribed. It would be difficult to accept a distribution of only southern Australia and southern California if the species were synonymous with *T. pulchra*, although its algal substrate might allow transport on the hull of a heavily fouled vessel. There are instances of species occurring in southern Australia and/or New Zealand and in South America, but few, if any, well documented instances of a range that extends from the western Pacific, through tropical waters, to southern California, the Channel Islands and into British Columbia.

Plate 117. *Tubulipora aliciae*. Clarion Island, Revillagigedo Islands, Mexico. A. Basal view of rounded attachment disk for colony, with presumed kenozooecia giving a denticulate appearance to frontally exposed surface. B. Detail of bottom of basal disk with projecting kenozooecia. C. Dorsal side of recumbent colony with projections to attach colony branches loosely to algal substrate. D. Scars on algal substrate made by removing colony and dorsal projections.


A
B
C
D


A
B
C

Tubulipora tuba (Gabb and Horn, 1862)

Plate 118 A-C

Semitubigera tuba Gabb and Horn, 1862: 169, pl. 21, fig. 57.
Tubulipora occidentalis Robertson, 1910: 249, pl. 22, figs. 29-31. — C.H. and E. O'Donoghue, 1923: 150.
Tubulipora tuba; Canu and Bassler, 1923: 198, pl. 42, figs. 18-23. — C.H. and E. O'Donoghue, 1925: 95; 1926: 70. — Osburn, 1953:650, pl. 68, fig. 9.

Material Examined. AHF Collections.

Description. Colonies large, often irregularly rounded, encrusting, with a coarse appearance, gray, white or purplish. Zooids tubular, tall, up to 2 mm long, 120 μm in diameter, gathered in fascicles, appearing to radiate from central point on margin of colony. Gonozooid large, inflated, with large surface pseudopores, surrounding several fascicles, abutting the first tube in a fascicle; ooeciostome tall, conspicuous, compressed and flared at the tip, with slitlike opening.

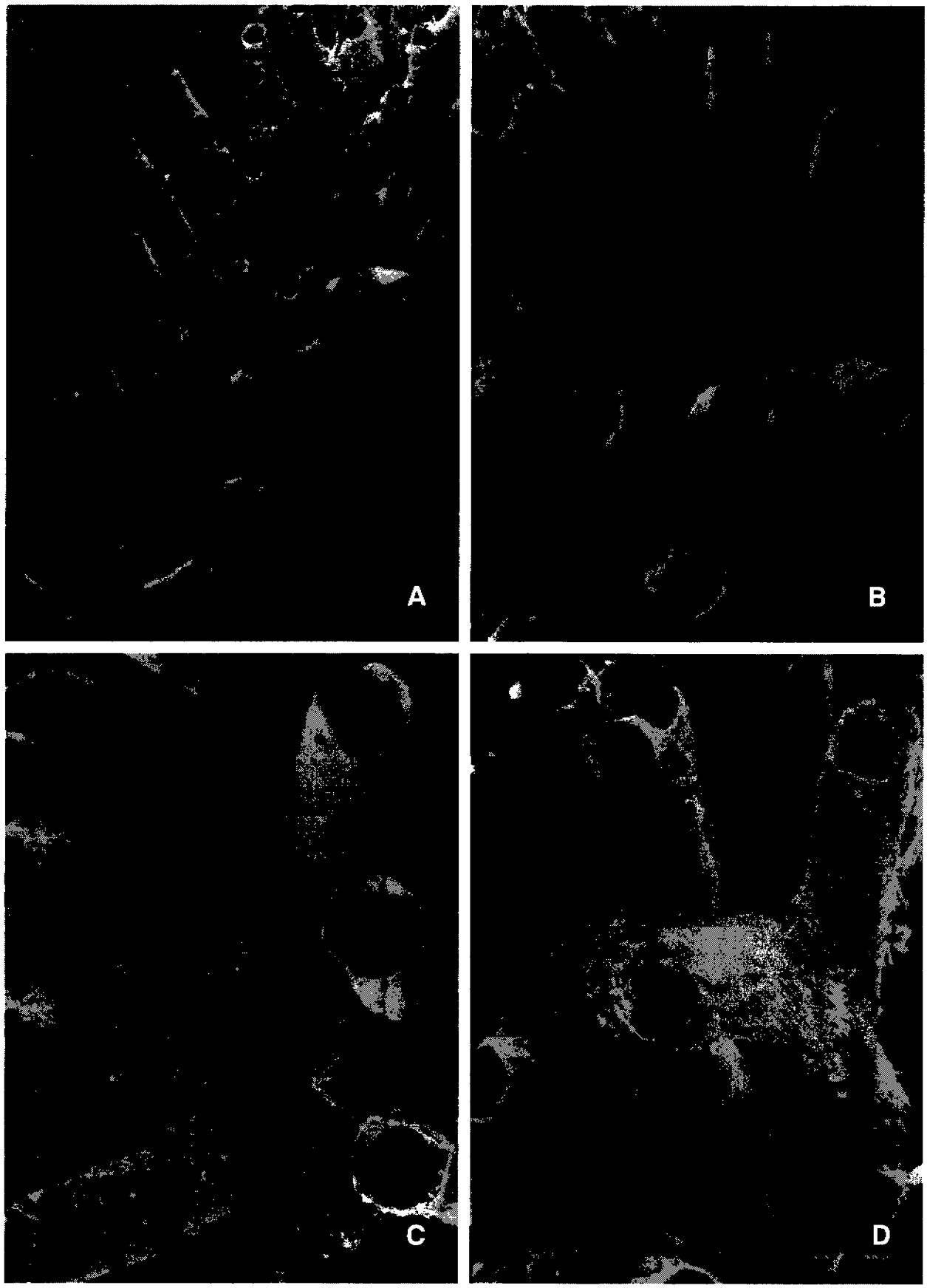
Biology. Encrusting a variety of surfaces including algae, shell and rock. Depths from intertidal to 235 m have been reported.

Taxonomic Remarks. *Tubulipora tuba* has an extensive Pleistocene record in southern California. Osburn (1953) could find no consistent difference between fossil and Recent specimens, although colonies can be quite variable. Osburn placed *T. occidentalis* Robertson (1910) in synonymy with *T. tuba*, as did C.H. and E. O'Donoghue (1923, 1926). Hincks (1884a) described a variety, *T. tuba* var. *falcifera* from British Columbia, with no further locality data, which Robertson included in *T. occidentalis*. According to Canu and Bassler (1923) the variety *falcifera* could be distinguished as having only six tubes to a fascicle, whereas *T. tuba* could have from six to 20, but Osburn felt that the variations found in colonies precluded separating the two taxa, which occur in the same habitats over the same geographic range.

Type Locality and Type Specimens. Pleistocene, Santa Barbara, California; type specimens not designated; location of specimens not known.

Distribution. Southward from British Columbia to southern California and Baja California, Mexico.

Plate 118. *Tubulipora tuba.* Pt. Fermin, Los Angeles. A. Irregularly fan shaped colony form, becoming rounded. B. Fasciculate autozooid tubes with laterally compressed ooeciostome in left center. C. Detail of flared ooeciostome; note small pores seen from inner sides of connate tubes.


A
B
C
D

Suborder Articulata

Family Crisiidae Johnston, 1838

Crisulipora occidentalis Robertson, 1910

Plate 119 A-D

Crisulipora occidentalis Robertson, 1910: 254. — Osburn, 1953: 686, pl. 72, fig. 6.

Material Examined. AHF Collections.

Description. Colonies forming large, stiff, tangled masses to 30 mm high; attached by jointed radicles to substrates. Internodes long, separated by yellowish chitinous joints; proximal internodes with 3-5 zooids, terminal (distal) internodes with 40 or more zooids, irregularly distributed. Zooidal tubes long, usually not connate, apertures circular. Gonozooid spindle shaped inflation on surface of internode, sometimes simple, between tubes, sometimes wrapped around a cluster of tubes; 2 types of ooeciostomes in same colony: ooeciostome at distal end of gonozooid, sometimes a straight tube fused to autozooid, with round opening, or hooded, or free-standing, short with flared opening.

Biology. Anchored to almost any firm substrate, from low tide to 86 m. The gonozooid contains a string of embryos in narrow passages between tubes, in different stages of development (polyembryony).

Taxonomic Remarks. This genus, created by Robertson (1910), seems to belong to the Crisiidae based on the presence of joints and radicles for anchoring the colony, but it more closely resembles the Tubuliporidae based on the nature of the gonozooid. *Crisulipora occidentalis* is the only described species in the genus. It was cited by Okada (1917) from Sagami Bay, Japan, and Marcus (1937, pl. 3, fig. 5) cited it from Santos Bay, Brazil, suggesting that it is either transported as a fouling organism, or there is more than one species. Marcus (1937) figured a much more slender colony, one or two tubes in width for much of the stem, plus a longer, more slender ooeciostome. This species should not be confused with *Crisia occidentalis*, also described by Robertson in the same 1910 paper.

Type Locality and Type Specimens. Robertson described the species as occurring from San Pedro to San Diego, with no type locality. Her types were mixed in collections at CAS.

Distribution. Osburn listed the Pacific coast distribution as from Point Conception to the Galapagos Islands to Peru. While it appears to be a warm temperate species, temperatures in the Galapagos Islands and Peru can be cool, depending on the particular habitat. Many of the Galapagos and South American species records, need to be reexamined, however.

Plate 119. *Crisulipora occidentalis*. Pt. Fermin, Los Angeles A. Colony branch with erect, non-connate tubules. B. Gonozooid surrounding many tubules, ooeciostome low, on right margin of gonozooeium. C. Detail of low ooeciostome with flared rim. D. Taller, erect ooeciostome fused to adjacent autozooid.


A
B
C
D

Bicrisia robertsonae, new species

Plate 120 A-D

Not *Sertularia cornuta* Linnaeus, 1758: 810.
?*Crisia cornuta*: Hincks, 1884a: 203. — Robertson, 1900:328. — C.H. and E. O'Donoghue, 1923: 149.
?*Crisia edwardsiana*: Robertson, 1910: 237, pl. 19, figs. 9, 10.
?*Crisidia cornuta*: C.H. and E. O'Donoghue, 1926: 64. — Osburn, 1953: 675, pl. 71, fig. 1.

Material Examined. MMS Station: BRA-16. Other collections: BMNH and AHF.

Diagnosis/Description. Colonies erect, feathery, small, jointed, dichotomously branched; internodes beginning with 1 zooid, sterile internodes usually of 2 zooids, sometimes of 3; zooids elongate, slender, 350-450 μm long, widening distally; a new zooid originating on either side of the aperture, or a zooid on one side and a long, slender kenozooidal spine or whip with 2-3 joints on other side, up to 1.2 mm long. Zooidal tubes with fine vertical striations, with extremely small diamond shaped pits (pseudopores ?) in center. Gonozooid a simple, inflated zooid not fused to other tubes, placed dorsolateral to zooids, with a terminal ooeciostome, without spine.

Biology. Found mixed with other crisiid species which form a turf on rock faces or on red algae and *Laminaria* holdfasts. Depths reported from intertidal to the MMS record of 91.5-123 m.

Etymology. Named for Dr. Alice Robertson, who contributed so much to the bryozoan literature, in particular of southern California, through her University of California, Berkeley publications.

Taxonomic Remarks. The new species seems to combine some of the earlier descriptions from the Pacific coast of so-called *Crisidia cornuta* and *Bicrisia edwardsiana* and Kluge's *Crisidia orientalis*. *Crisia cornuta* is an arctic-boreal Atlantic species which extends into the Mediterranean (Kluge, 1975; Hayward and Ryland, 1985a); it was termed the "goat's horn coralline" by Ellis, 1755, predating the Linnaean binomial system, and has internodes of a single zooid. *Bicrisia* spp. have two to six zooids per sterile internode and three to five in fertile internodes. Both genera have flexible, curved, jointed hollow spines.

The new species most closely resembles Robertson's (1910) and Osburn's (1953) *C. edwardsiana*, although Osburn remarked that Robertson confused the two species because of her description of internodes of single zooids and with two to five zooids. Our material of *C. edwardsiana* lacks good gonozooids. Kluge (1975) included C.H. and E. O'Donoghue's (1923, 1926) listings of *C. cornuta*, which were not illustrated, and both Robertson's *C. cornuta* and *C. edwardsiana* in his new species *Crisidia orientalis*. Our species apparently differs from all of these in having more than one zooid in nonfertile segments. The new species may ultimately be placed in synonymy, but for the present the lack of comprehensive comparative material leads us to consider it new.

Type Locality and Type Specimens. Off Anacapa Island, Channel Islands, California. SBMNH-AHF Bryozoa Holotype No. 239.

Distribution. The MMS station is off Purisima Point. Osburn listed distribution from British Columbia based on Hincks and O'Donoghue records of *C. cornuta*, and AHF records from off Monterey Bay, the Channel Islands and San Pedro Bay in southern California. He listed records of *B. edwardsiana* from Alaska, Puget Sound, southern California and Peru.

Plate 120. *Bicrisia robertsonae*, A, C, D from AHF 843-38, off Peru; B from AHF 1178 off Anacapa Island. A. Colony form. B. Internodes of 2-3 zooids; new zooids arising on either side of aperture, or one zooid replaced by a jointed spine. C. Gonozooid a single modified zooid, lateral view with terminal ooeciostome. D. Frontal (ventral) view of gonozooid.


A
B
C

Filicrisia franciscana (Robertson, 1910)

Plate 121 A-C

? Crisidia gracilis Trask, 1857: 101, pl. 5, fig. 3.
Crisia occidentalis: Robertson, 1903: 116.
Crisia franciscana Robertson, 1910: 233, pl. 18, fig. 1-4.
Crisidia franciscana: C.H. and E. O'Donoghue, 1923: 149; 1925: 94; 1926: 65.
Filicrisia franciscana: Osburn, 1953: 677, pl. 72, fig. 4. — J.D. Soule, 1963: 8.

Material Examined. MMS Station: BRA-6. AHF Collections.

Description. Colonies erect, frail, 15-20 mm high, with black or brown joints, with tubular zooids straight or weakly curved. From one autozooid per internode up to 3-5 in fertile internodes. Joints separating an internode are black or very dark brown. Gonozooid attached to adjacent zooid, conspicuously inflated, with short tubular ooeciostome, curving dorsally on frontal (ventral) margin.

Biology. Depths recorded from intertidal to 100 m. The MMS depth is 54-63 m.

Taxonomic Remarks. Robertson (1903) first described this species as *Crisia occidentalis*, and studied its embryology. The name was preoccupied by Trask (1857) and thus Robertson gave it the name *C. franciscana* because it was abundant on the shores of San Francisco Bay, where the coarse, dense colonies with black joints were distinctive. Black joints are not a limiting character for the genus, as indicated by Osburn (1953), but only for the California species; Hayward and Ryland (1985b) described and figured the type of the genus, *Filicrisia geniculata* (Milne-Edwards, 1838), as having pale joints; the internode consists of one nonfertile autozooid, while the fertile internodes are composed of three to five zooids with the gonozooid in the second, third or fourth position. The ooeciostome is located dorsally near the adjacent zooid with the opening curved somewhat ventrally; in *F. franciscana* it bends from the frontal dorsally or is erect (Figure 38). Hayward and Ryland state that the membranous sac of the gonozooid is divided into two compartments internally, which also occurs in *Crisidia* and *Bicrisidia* but not in *Crisia*.

Based on their illustrations, the species identified as *F. geniculata* by Robertson (1910) and Osburn (1953), is not the same as that illustrated by Hayward and Ryland (1985b) or Kluge (1975), because the number of zooids per internode is greater in the southern California material. C.H. and E. O'Donoghue (1923, 1926) only listed the species without description or illustration and we were unable to locate their specimens at the BMNH. The

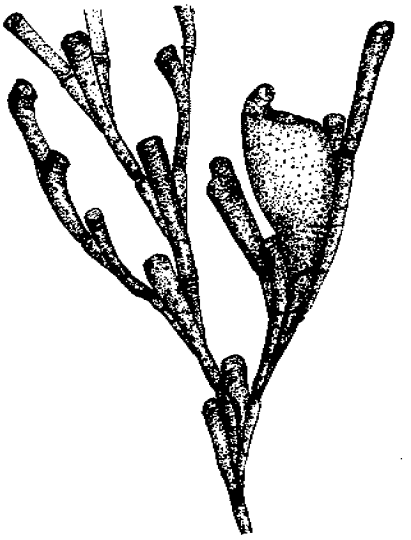


Figure 38. *Crisia franciscana.* From Robertson, 1910, pl. 18, fig. 2.

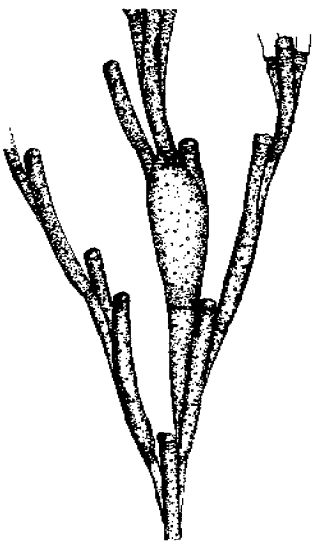


Figure 39. *Crisia geniculata.* From Robertson, 1910, pl. 18, fig. 7.

Plate 121. *Filicrisia franciscana.* Santa Rosa Island. A. Colony form. B. Simple gonozooid at tip of branch with short ooeciostome. C. View looking down on top of gonozooid; ooeciostome is the uppermost opening.

principal difference in the two local species identified as *F. geniculata* (Figure 39) and *F. franciscana* is the wide, flattened area of the top of the gonozooid in *F. franciscana* and the more slender, pyriform gonozooid with large pores in *"C. geniculata"* as illustrated by Robertson. We are unable to describe the local *"C. geniculata"* as a new species due to lack of comparative material, including the loss of Robertson's types.

Type Locality and Type Specimens. Named for San Francisco Bay, but first reported by Robertson from Orca, Alaska, to Channel Islands, southern California; type material was mixed in collections at CAS.

Distribution. *Filicrisia franciscana* has been reported from Alaskan waters southward to Baja California, Mexico. Okada (1917) listed it as common in Japanese waters. The MMS station is off Point Arguello. European *F. geniculata* is distributed from the Arctic to the Mediterranean. The nominal Pacific *"F. geniculata"* is probably distributed from Dillon Beach, north of San Francisco, to San Pedro, California. The nature of C.H. and E. O'Donoghue (1923, 1925, 1926) material and Kluge's (1975) specimens is open to question.

Crisia serrulata Osburn, 1953

Plate 122 A-D

Crisina serrata Gabb and Horn, 1862: 174, pl. 21, fig. 66.
Crisia pacifica Robertson, 1910: 242, pl. 20, figs. 16, 17. — C.H. and E. O'Donoghue, 1923: 149.
Crisia serrata: Canu and Bassler, 1923: 196, pl. 42, figs. 1-7. — C.H. and E. O'Donoghue, 1926: 64.
Crisia serrulata Osburn, 1953: 679, pl. 72, fig. 2. — J. D. Soule and M. M. Duff, 1957: 134. — J.D. Soule, 1963: 9.

Material Examined. MMS Station: BRA-16. AHF Collections.

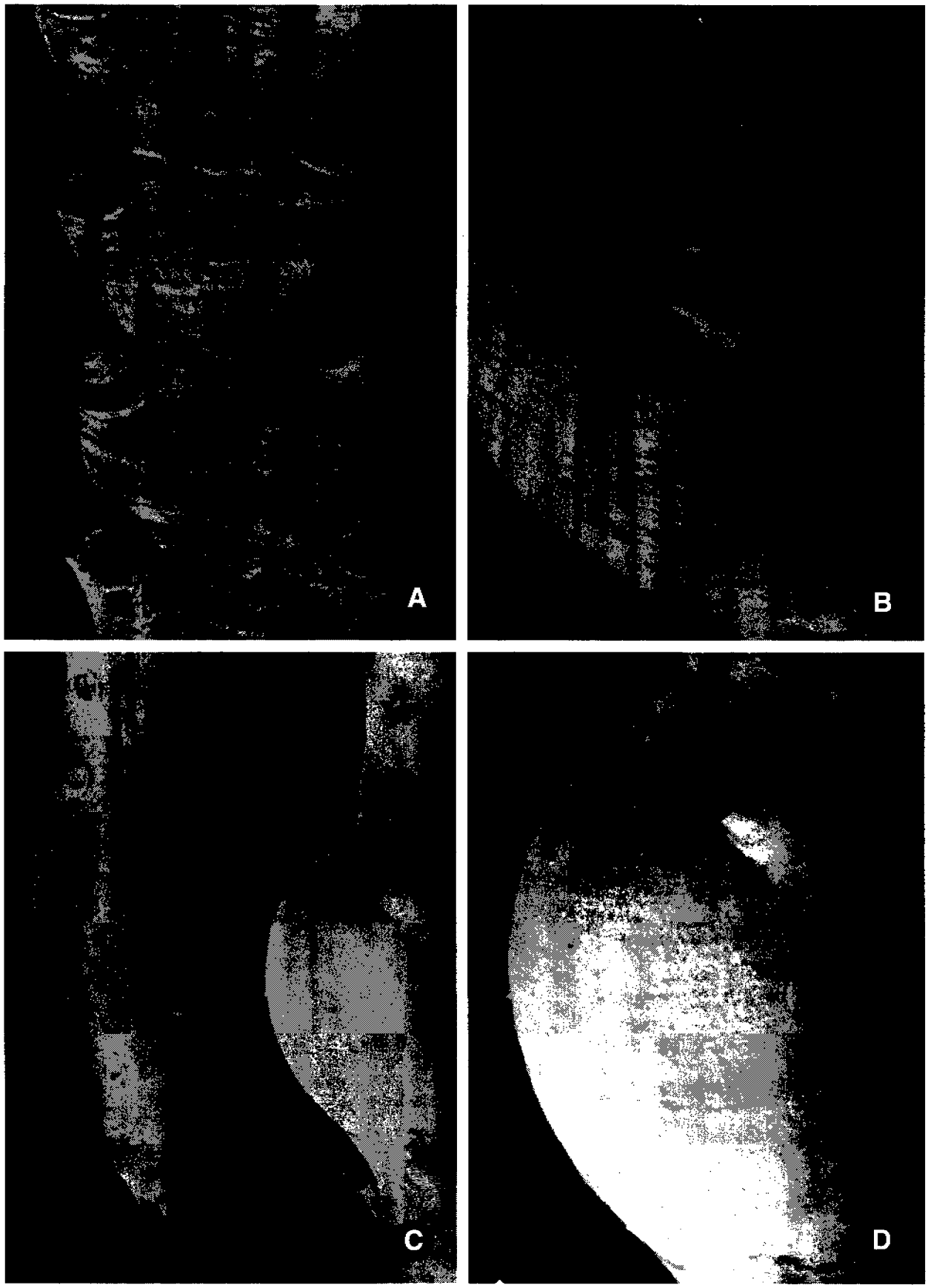
Description. Colonies erect, bushy, up to 25 mm high, with yellowish joints; bases of branches remaining visible across branch in mature zooids. Lengthy internodes (segments between joints) composed of 12 - 30 zooids; zooids without distinct boundaries, apertures in 2 series along stems, in alternating positions at margins, tubes hardly distinguishable, merged almost to their tips, these are turned forward, with frontally facing apertures; a short spinous process on the outer (dorsal) margin of the aperture giving internode margins a serrate appearance. Zooid interiors with regularly spaced pores; exterior surface striated horizontally and diagonally. Gonozooid a much enlarged zooid, attached for its full length, with a flattened distal end, sometimes covering other zooids; ooeciostome with elliptical opening at end of a short, straight, bulbous tube leaning forward just below adjacent autozooidal aperture displaced by the gonozooid.

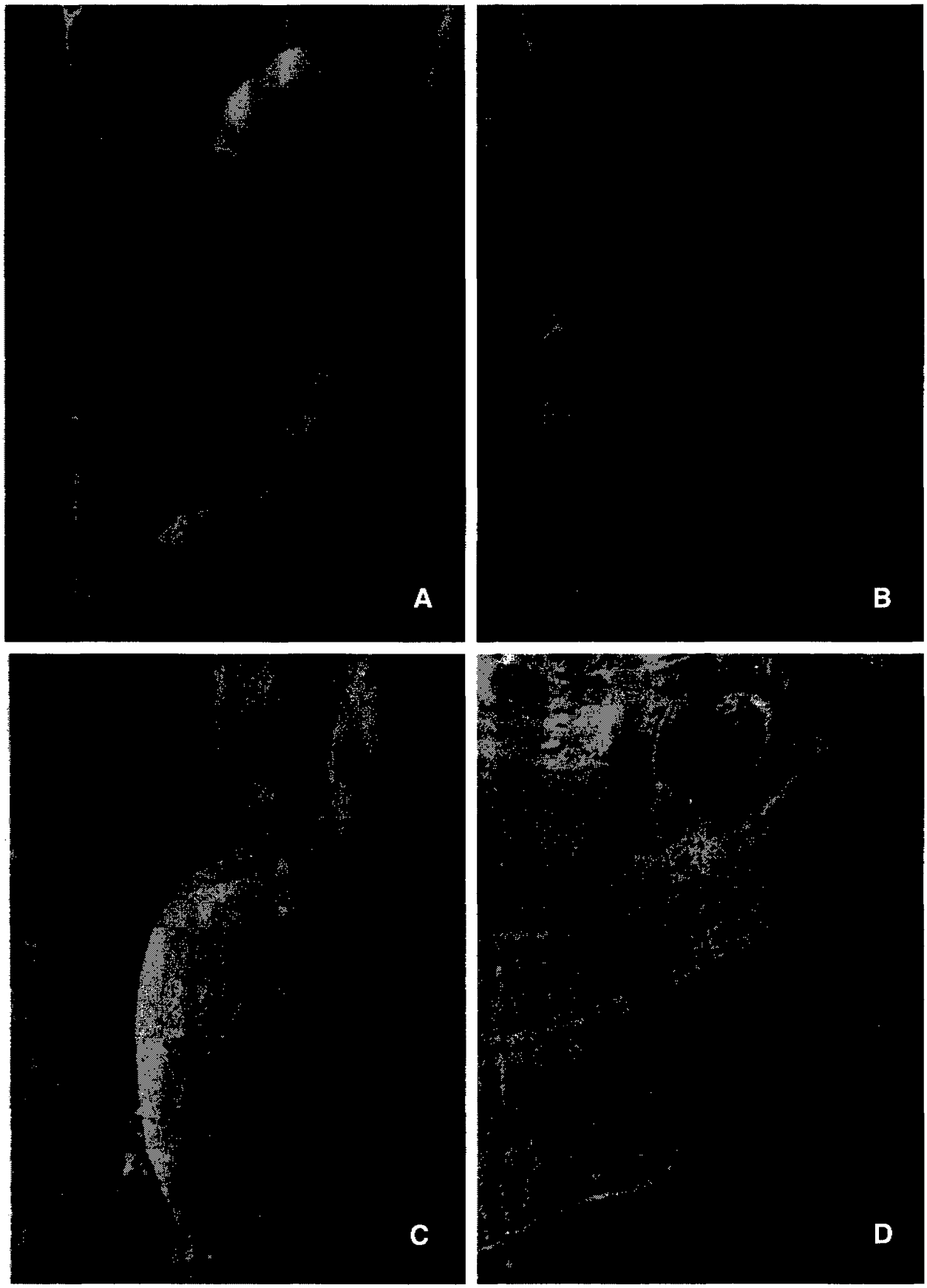
Biology. Depths reported from shallow waters to 135 m, but more common in shallow waters in the white, chalky, stiff crisiid turf. The MMS depth is 91.5-123 m.

Taxonomic Remarks. Osburn (1953) renamed the Gabb and Horn species *C. serrulata* because *C. serrata* was preoccupied by d'Orbigny, 1853: 598. Osburn placed *C. pacifica* Robertson in synonymy with *C. serrulata*, based largely on the configuration of the ooeciostome.

Type Locality and Type Specimens. Gabb, who was a geologist for the State of California, and Horn, described the species from the Pleistocene of Santa Barbara, California. No type was designated and the location of the specimens is unknown.

Plate 122. *Crisia serrulata*. San Pedro (Los Angeles Harbor). A. Erect branch with immersed zooids, acute tip at outer margin. B. View from above gonozooid, with submerged autozooid tubule, larger branch joint on right (with interior pores), ooeciostome bent over frontal wall below. C. Branch with internode joint at base; gonozooid on right branch. D. Gonozooid ventral view; note striations on surface.


A
B
C
D


A
B
C
D

Distribution. Canu and Bassler (1923) reported the species from the Pleistocene of Santa Barbara and Santa Monica, California, and Osburn (1953) reported it from the Pleistocene of San Pedro and Newport Bay, California. The species has been reported from British Columbia south to the Gulf of California, Mexico, and to the Galapagos Islands; it is most common in the Channel Islands of southern California. The MMS station is off Purisima Point.

Crisia maxima Robertson, 1910

Plate 123 A-D

Crisia maxima Robertson, 1910: 243, pl. 20, figs. 18, 19. — C.H. and E. O'Donoghue, 1923: 149; 1926: 64. — Osburn, 1953: 682, pl. 72, fig. 3.

Material Examined. MMS Station: BRA-27. AHF Collections.

Description. Colonies erect, coarse, shrublike, up to 50 mm high, with lengthy internodes, usually with 12-20 zooids per internode, but up to 40 or more found; zooids fused in 2 rows of connate tubes with only short raised peristomes, turned forward (ventrally), without distal projection; internodes 80-90 μm in diameter. Joints regressing, becoming dark brown with age. Gonozooid large, prominent, fused to colony, expanded; surface with horizontal striations and basket weave pattern; ooeciostome short, straight, directed upward, not curving, opening ventral to (frontal to) displaced adjacent zooidal aperture.

Biology. Previously reported from intertidal to depths of 90 m, on algal/crisiid turf; the MMS record extends the depth range to 126 m.

Taxonomic Remarks. This species (Figure 40) is very similar to *C. pacifica* (Figure 41), but forms a larger colony with more tubes per internode, and with dark brown joints. The character of a short distal projection or point at the outer end of the tube appears to occur in both *C. maxima* and *C. serrulata* irregularly, rather than being distinctive to *C. serrulata*. The ooeciostome in *C. serrulata* is recumbent

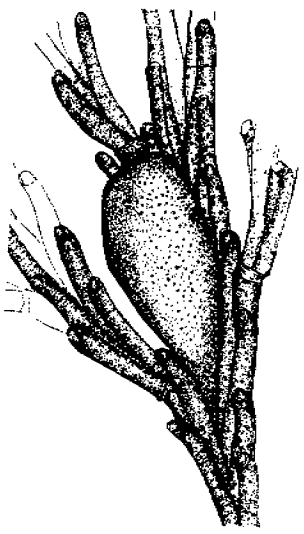


Figure 40. *Crisia maxima.*
From Robertson, 1910, pl. 20, fig. 18.

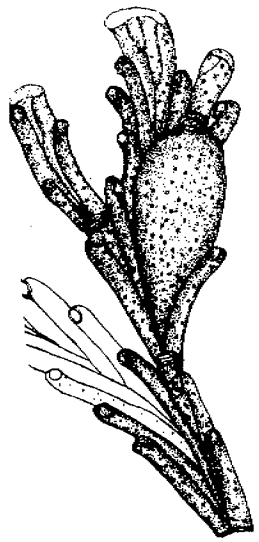


Figure 41. *Crisia pacifica (= serrulata).*
From Robertson, 1910, pl. 20, fig. 16.

Plate 123. *Crisia maxima.* Pescadero Pt. south of San Francisco. A. Colony form with numerous autozooids, two gonozooids. B. Detail of tubules with raised peristomes. C. Ventrolateral view of gonozooid with two branches behind it. D. Detail of ooeciostome, basket weave surface of gonozooid.

while that of *C. maxima* is only slightly turned ventrally. Osburn's illustrations of the two species (pl. 72, figs. 2 and 3) appear to be reversed, with the recumbent ooeciostome of *C. serrulata* attributed to *C. maxima*. Specimens figured by us were identified by Osburn, with *C. maxima* being a specimen to which he referred from Pescadero Point, collected by A.E. Blagg. There is little material in the AHF collections for comparison, and their geographic ranges are quite similar. Robertson (1910) indicated that in *C. pacifica*, which Osburn synonymized with *C. serrulata*, the gonozooid occupied the position of the third or fourth zooid in an internode, whereas in *C. maxima* it occupied the seventh position. Robertson's illustrations are more detailed than those in Osburn, bearing in mind the supposed synonymy of *C. pacifica*.

The basket weave pattern on the gonozooid is unusual but seems valid; routine treatment with sodium hypochlorite of other specimens for SEM has never produced this effect.

Type Locality and Type Specimens. First recorded from San Pedro Bay. Robertson's types and specimens were mixed with others at CAS.

Distribution. British Columbia waters, south to the Coronados Islands off Mexico, Baja California, and to the Galapagos Islands, according to Osburn. The MMS station is off Morro Bay, California.

Crisia occidentalis Trask, 1857

Plate 124 A-C

Crisia occidentalis Trask, 1857: 101, pl. 5, fig. 4. — Robertson, 1910: 239, pl. 19, figs. 11, 12. — C.H. and E. O'Donoghue, 1923: 149; 1926: 64. — Osburn, 1953: 680, pl. 71, figs. 3-5.
Crisia eburnea Robertson, 1903: 116.

Material Examined. MMS Station: BRA-1. AHF Collections.

Description. Colonies erect, in dense tufts up to 25 mm high, with small delicate branches; branches turned slightly toward each other, with 5-12 zooids per internode; zooid tubes immersed almost to tips, peristomes pointed on outer ends; terminal ends of branches sometimes spicate. Internode joints white to yellowish. Frontal surface of internodes weakly keeled longitudinally. Gonozooids moderately large, prominent, ooeciostome short, tubular, opening terminal, beside autozooid, openings about the same size; gonozooids marked with vertical striations and numerous, tiny, complex pseudopore-like structures measuring about 2.0 μm in diameter.

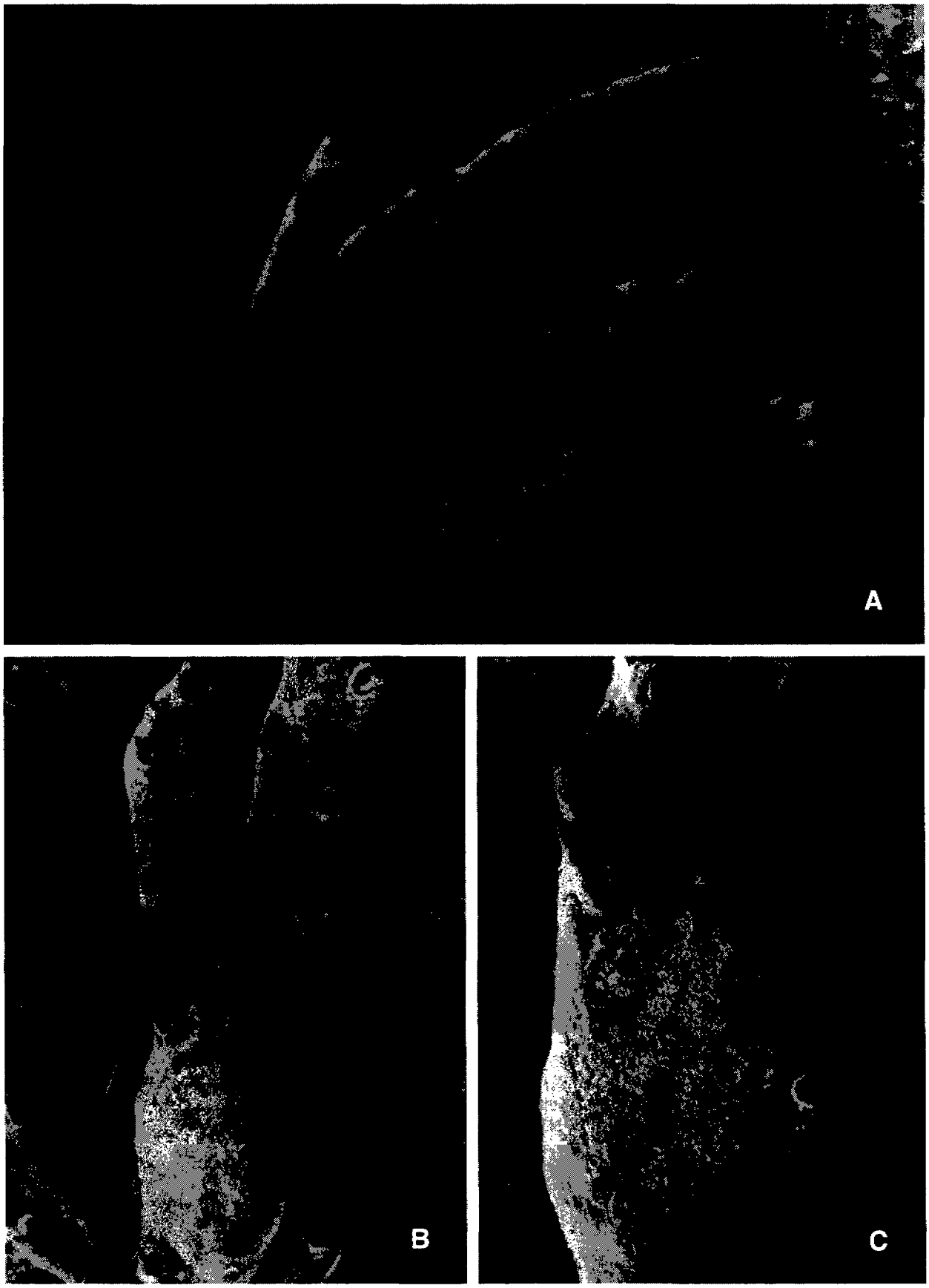
Biology. Depths have previously been reported from intertidal to over 60 m; the MMS record extends this to 69-73.5 m.

Taxonomic Remarks. Trask's original description was inadequate, but Robertson (1910) redescribed *Crisia occidentalis*, perhaps from Trask's original material. The longitudinal, keellike ridge between tubes helps to distinguish this species from the other small crisiids.

Type Locality and Type Specimens. Originally described from off San Francisco, California. The whereabouts of Trask's orginal specimens is unknown, but Robertson's were mixed with others at the CAS. The distal tips on the crissiid species discussed do not appear to be the bases of articulated spines but perhaps are undeveloped spines.

Distribution. This species has been reported from Puget Sound southwards to Costa Rica, and is rare in Galapagos Islands collections; it is most common in southern California. The MMS site is in the Santa Barbara Channel.

Plate 124. *Crisia occidentalis*. Puget Sound. A. Branch of erect colony with gonozooid in upper center. B. Detail of branch, with pointed tips on tubules. C. Gonozooid with ooeciostome attached to adjacent zooid. Surface has numerous whorl-like pseudopore markings.


A
B
C

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Appendix

Lists and Maps of Stations

Table A.1. Position of hard-substrate transects taken during the Phase I Reconnaissance.

Station BR	Beginning Latitude	Longitude	End Latitude	Longitude	Depth (m)
1 A/B	34°24.454′N	120°01.876′W	34°24.464′N	120°00.878′W	69-73.5
1 C/D	34°24.076′N	120°00.443′W	34°24.184′N	120°01.480′W	73.5-78
2 A/B	34°11.377′N	120°29.318′W	34°11.289′N	120°28.774′W	110-126
2 C/D	34°10.984′N	120°28.094′W	34°10.780′N	120°27.554′W	120-123
4 A/B	34°27.539′N	120°40.364′W	34°28.162′N	120°40.189′W	168-237
6 A/B	34°30.246′N	120°35.555′W	— —.—	— —.—	54-63
6 C/D	— —.—	— —.—	34°30.421′N	120°34.315′W	54-63
13 A/B	34°42.570′N	120°47.899′W	34°42.107′N	120°48.253′W	92-100
13 C/D	34°42.556′N	120°48.147′W	34°42.974′N	120°47.424′W	88.5-100.5
14 A/B	34°43.589′N	120°49.093′W	34°42.826′N	120°48.370′W	96-105
14 C/D	34°43.244′N	120°49.406′W	34°42.893′N	120°48.822′W	105-117
16 A/B	34°46.544′N	120°50.197′W	34°45.912′N	120°49.726′W	91.5-123
17 A/B	34°49.382′N	120°50.768′W	34°49.600′N	120°50.688′W	160.5-168
19 A/B	34°47.833′N	120°51.425′W	34°47.097′N	120°50.793′W	148.5-177
20 A/B	34°46.470′N	120°50.289′W	34°46.140′N	120°49.885′W	90-130.5
21 A/B	34°47.335′N	120°45.903′W	34°47.548′N	120°46.123′W	75-90
22 A/B	34°50.365′N	120°48.221′W	34°50.990′N	120°48.365′W	114-115.5
23 A/B	34°49.868′N	120°47.393′W	34°50.003′N	120°47.480′W	93-102
25 A/B	35°05.662′N	120°47.562′W	35°06.036′N	120°47.652′W	64.5-72
26 C/D	35°11.586′N	120°55.556′W	35°11.555′N	120°55.233′W	108-111
27 A/B	35°20.906′N	120°59.657′W	35°21.035′N	120°59.603′W	96-126
28 A/B	35°21.539′N	120°59.641′W	35°21.867′N	120°59.299′W	96-105
29 A/B	35°27.864′N	121°05.331′W	35°27.805′N	121°05.277′W	102-106.5

Table A.2. MMS Phase II - Locations of hard-substrate photosurvey stations.

Station	Latitude	Longitude	Depth (m)
PH-E	34°30.26′N	120°42.76′W	119
PH-F	34°30.81′N	120°42.36′W	105
PH-I	34°29.96′N	120°41.68′W	107
PH-J	34°29.82′N	120°41.82′W	117
PH-K	34°29.37′N	120°42.26′W	160
PH-N	34°29.21′N	120°42.05′W	166
PH-R	34°29.11′N	120°42.67′W	213
PH-U	34°31.48′N	120°43.51′W	113
PH-W	34°31.52′N	120°45.86′W	195

Table A.3. Sampling dates of MMS Phase II Monitoring Program.

Cruise	Date
1-1	October 1986
1-2	June 1987
1-3	May 1987
1-4	July 1987
2-1	October 1987
2-2	January 1988
2-3	May 1988
3-1	October 1988
3-2	May 1988

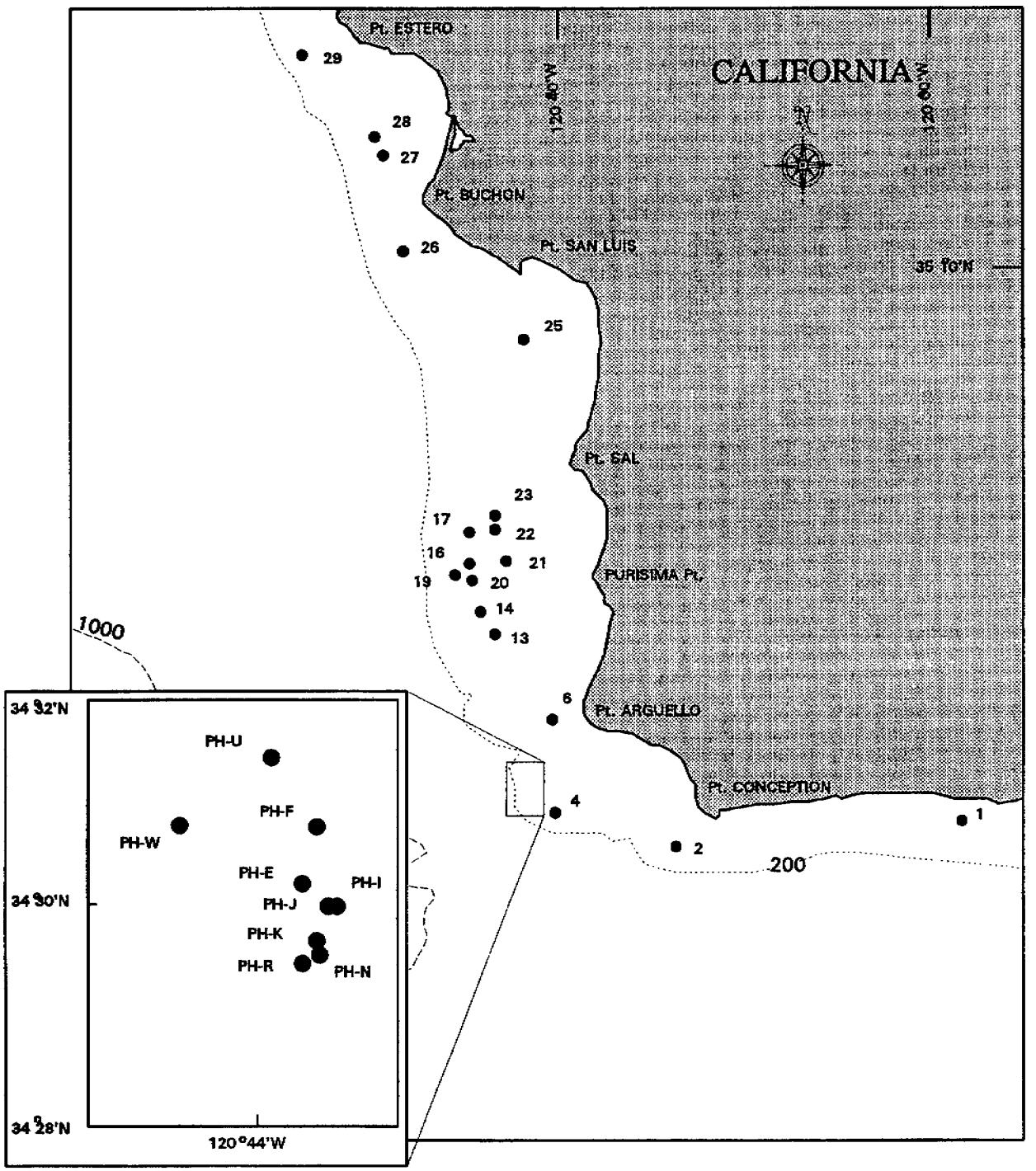


Figure A.1 Map showing locations of hard substrate stations from Phase I (BR stations) and Phase II MMS Reconnaissance and Monitoring Programs.



The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.



The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.