

A New Solitary Octocoral, *Taiaroa tauhou* gen. et sp. nov. (Coelenterata: Protoalcyonaria) from New Zealand

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Abstract

A solitary octocoral (*Taiaroa tauhou* gen. et sp. nov., family Taiaroidae, new fam.) discovered off the east coast of the South Island of New Zealand is described. Anatomy and histology were studied from sections prepared by the traditional paraffin technique and from specimens embedded in epoxy resin. Sclerites are illustrated by scanning electron micrographs.

INTRODUCTION

In 1973, the late Dr Elizabeth Batham of the University of Otago, New Zealand, collected two specimens of a peculiar solitary octocoral polyp from a depth of 720 m off the Otago Peninsula, N.Z., and in 1974 many more examples of it were dredged in the same vicinity. As the specimens at first were thought to be burrowing sea anemones, they were referred to Dr Cadet Hand, who was visiting the Portobello Marine Laboratory at the time. Dr Hand immediately recognized the animals as octocorals. Acting upon his suggestion, Dr Keith Probert solicited the assistance of the first author in identifying these unusual animals. They have proved to be solitary octocoral polyps, unlike the typically colonial members of the subclass Octocorallia.

In 1894, Sydney J. Hickson erected a new suborder of the Alcyonaria for those forms having "the remarkable character that they remain solitary — they do not, in fact, form compound colonies by gemmation." He named this suborder Protoalcyonaria and included in it the genera *Haimea* Milne Edwards and *Harteria* E. P. Wright, for which Wright (1865: 216) had erected the subfamily Haimeinae, and *Monoxenia* Haeckel. Following this, Adam Sedgwick (1898: 178) adopted Hickson's classification. G. C. Bourne (1900: 15), however, divided the Alcyonaria into two "grades," one solitary and the other colonial, and to the former applied the name Protalcyonacea. Delage and Hérouard (1901: 382) recognized the family Haimeinae in the suborder Alcyonidae, including *Haimea* Milne Edwards, *Harteria* E. P. Wright, *Psuchastes* T. S. Wright, and *Monoxenia* Haeckel, without assigning the solitary forms to a special higher taxon. Hickson (1906: 342) maintained the "Grade Protalcyonacea," albeit with some reservations, in the *Cambridge Natural History* and assigned to it also the curious octocoral collected by the Siboga Expedition, which later was named *Bathyalcyon robustum* by Versluys (1906: 549). By 1930, however, Hickson had abandoned the idea of solitary octocorals and said that "The 'grades' Protalcyonacea and Synalcyonacea may now be discarded, as no clear evidence of the existence of solitary Alcyonaria (e.g., *Haimea* and *Monoxenia*) has been established" (Hickson 1930: 234). Hyman (1940: 371, 541) stated that all alcyonarians are colonial, and this view has been held generally in subsequent years.

In contemporary accounts, only Tuzet (1961: 174) has recognized the "Sous-classe des Protalcyonaires" for the family Harmeidae [*sic*]. Hand (1972: 160), however, accepted *Hartea elegans* as a presumed solitary alcyonarian without formally dividing the subclass Octocorallia into solitary and colonial subgroups. With the discovery of the solitary form from New Zealand, the re-establishment of the order Protoalcyonaria Hickson, 1894, is warranted in order to include it. The subclass Octocorallia now consists of seven Recent orders: Protoalcyonaria, Stolonifera, Telestacea, Alcyonacea, Coenothecalia, Gorgonacea, and Pennatulacea. An eighth order, Trachypsammia, is known from the Permian, but its affinity with the Octocorallia is not firmly established.

DESCRIPTION

Order PROTOALCYONARIA Hickson

Protoalcyonaria Hickson, 1894: 328.—Sedgwick, 1898: 178.

Protalcyonacea Bourne, 1900: 15.—Hickson, 1906: 342.

DIAGNOSIS: Permanently solitary, monomorphic octocorals composed of a single autozoid.

REMARKS: This order contains the family Haimeidae E. Perceval Wright, 1865, and the new family Taiaroidae Bayer and Muzik, established here.

Family Taiaroidae, fam. nov.

DIAGNOSIS: Protoalcyonarians with tall, cylindrical polyps fastened in soft substrate by numerous filamentous holdfasts, distinctly divided into anthostele and fully retractile anthocodia. Anthostele covered by a thin cuticle; body wall supported by strong, spindle-shaped calcareous sclerites.

REMARKS: In the genera comprising the family Haimeidae E. P. Wright, the polyps are attached directly to a solid substrate and lack stolons or filamentous holdfasts. They are sexually mature (*Hartea*, *Monoxenia*) at a small size (height of polyp of *Hartea* with folded tentacles about 18 mm, diameter 4 mm, estimated from original illustration, as no measurements were given), and where known (*Hartea*), the sclerites of the anthostele are octoradiates and those of the anthocodia are complicated, branching bodies (E. P. Wright 1865: pl. 9, figs. 3, 4).

As one of the original specimens of *Psuchastes glacialis* T. S. Wright (1859: 113) had two polyps and was attached by a spreading base, that species probably belongs to the Stolonifera.

Taiaroa, gen. nov.

DIAGNOSIS: Taiaroids with anthostele containing spinous spindles longitudinally arranged in eight interseptal tracts; anthocodiae fully retractile, armed with eight converging tracts of spindles beneath the tentacles, separated by eight narrower tracts of spindles longitudinally placed along the septal insertions. Tentacles and pinnules abundantly supplied with spinous rods. Sclerites of the introvert mostly transverse, the upper ones forming a collaret beneath the subtentacular points, with which they gradually merge distad; proximad they converge in eight interseptal tracts of inverted chevrons and merge with the longitudinally placed spindles of the anthostele.

ETYMOLOGY: From Taiaroa, the name of one of the submarine canyons where the animal was first collected.

TYPE SPECIES: *Taiaroa tauhou*, sp. nov., here designated.

Taiaroa tauhou, gen. nov., sp. nov.

(Figs. 1-10)

MATERIAL EXAMINED: Papanui Canyon off the Otago Peninsula, South Island, New Zealand, 45°51'S, 171°02'E, 730 m, 4' Agassiz trawl, Station Mu 67-142, November 27, 1967, E. J. Batham, coll.: 2 specimens.

Papanui Canyon off the Otago Peninsula, South Island, New Zealand, 45°52'S, 171°02'E, 720 m, 2' Agassiz trawl, Station Mu 73-125, June 13, 1973, E. J. Batham, coll.: 2 specimens.

Papanui Canyon off the Otago Peninsula, South Island, New Zealand, 45°51'S, 171°01'E, 420-320 m, 2' Agassiz trawl, Station Mu 74-92, March 24, 1974, P. K. Probert, coll.: 46 specimens.

Taiaroa Canyon off the Otago Peninsula, South Island, New Zealand, 45°46'S, 171°05'E, 660-600 m, 2' Agassiz trawl, Station Mu 74-95, March 25, 1974, P. K. Probert, coll.: 49 specimens.

Papanui Canyon off the Otago Peninsula, South Island, New Zealand, 45°52'S, 171°01'E, 500 m, 2' Agassiz trawl, Station Mu 74-202, November 7, 1974, P. K. Probert, coll.: 1 specimen.

HOLOTYPE: National Museum, Wellington, N.Z., Register No. NMNZ Co. 110.

PARATYPES: National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A., Catalogue Nos. 54270, 54271. Also in the British Museum (Natural History), London (BM (NH) 1976.1.16.1 and .2) and Seto Marine Biological Laboratory (269, 270), Shirahama, Wakayama-ken, Japan.

ETYMOLOGY: Tauhou, Maori for "strange."

DESCRIPTION

Each solitary polyp cylindrical, with a zone of many filamentous holdfasts at the base and eight pinnate tentacles at the oral end (Figs. 1, 2). Body distinctly divided into

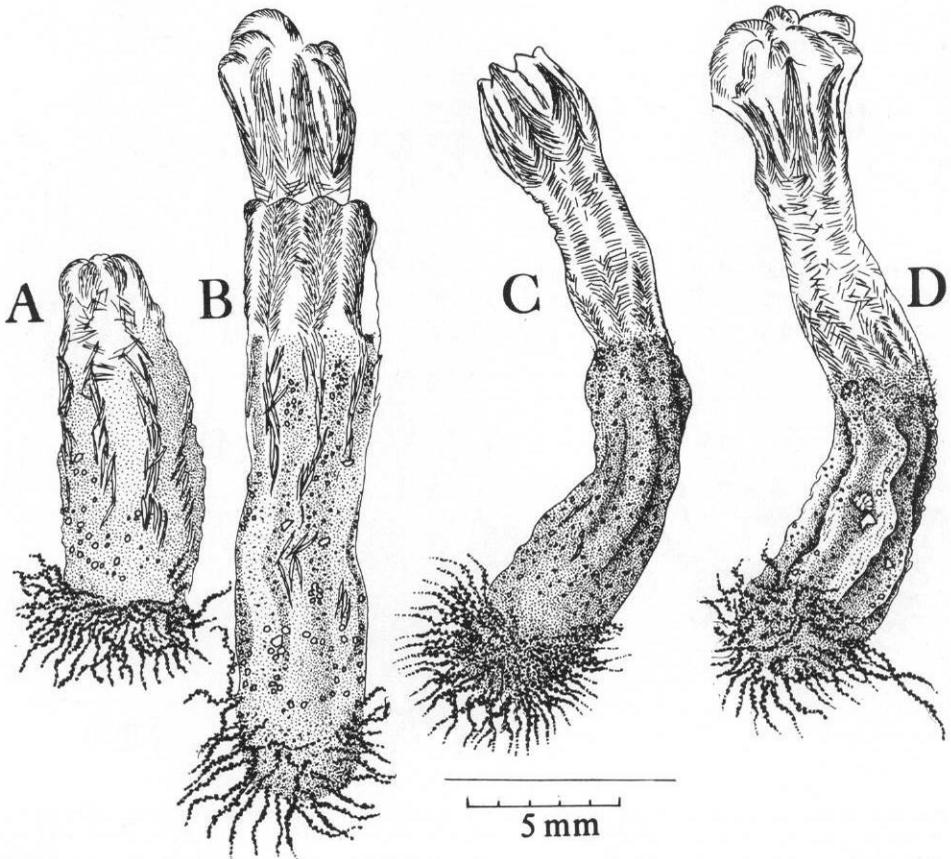


FIG. 1.—A-D, Preserved specimens of *Tiaroa tauhou* in various stages of retraction.

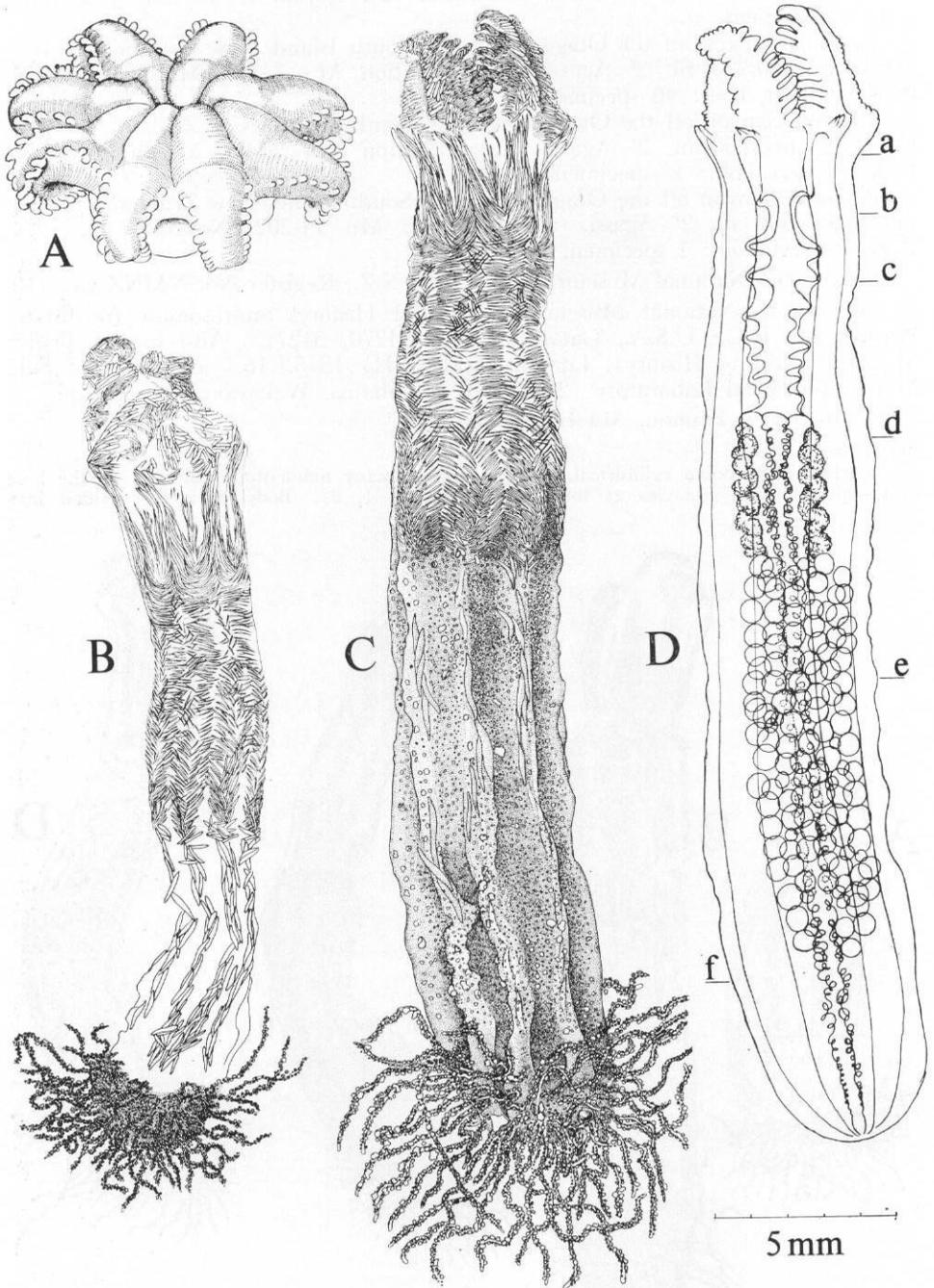


FIG. 2.—Gross structure of *Taiaroa tauhou*. A, Expanded tentacles, drawn from photograph of living animal. — B, Specimen preserved with anthocodia exsert, cuticle stripped off; the anthostele is shorter than usual. — C, Fully developed, exsert specimen. — D, Major regions of cleared polyp embedded in epoxy resin prior to sectioning (Letters indicate levels of sections illustrated in Fig. 4.)

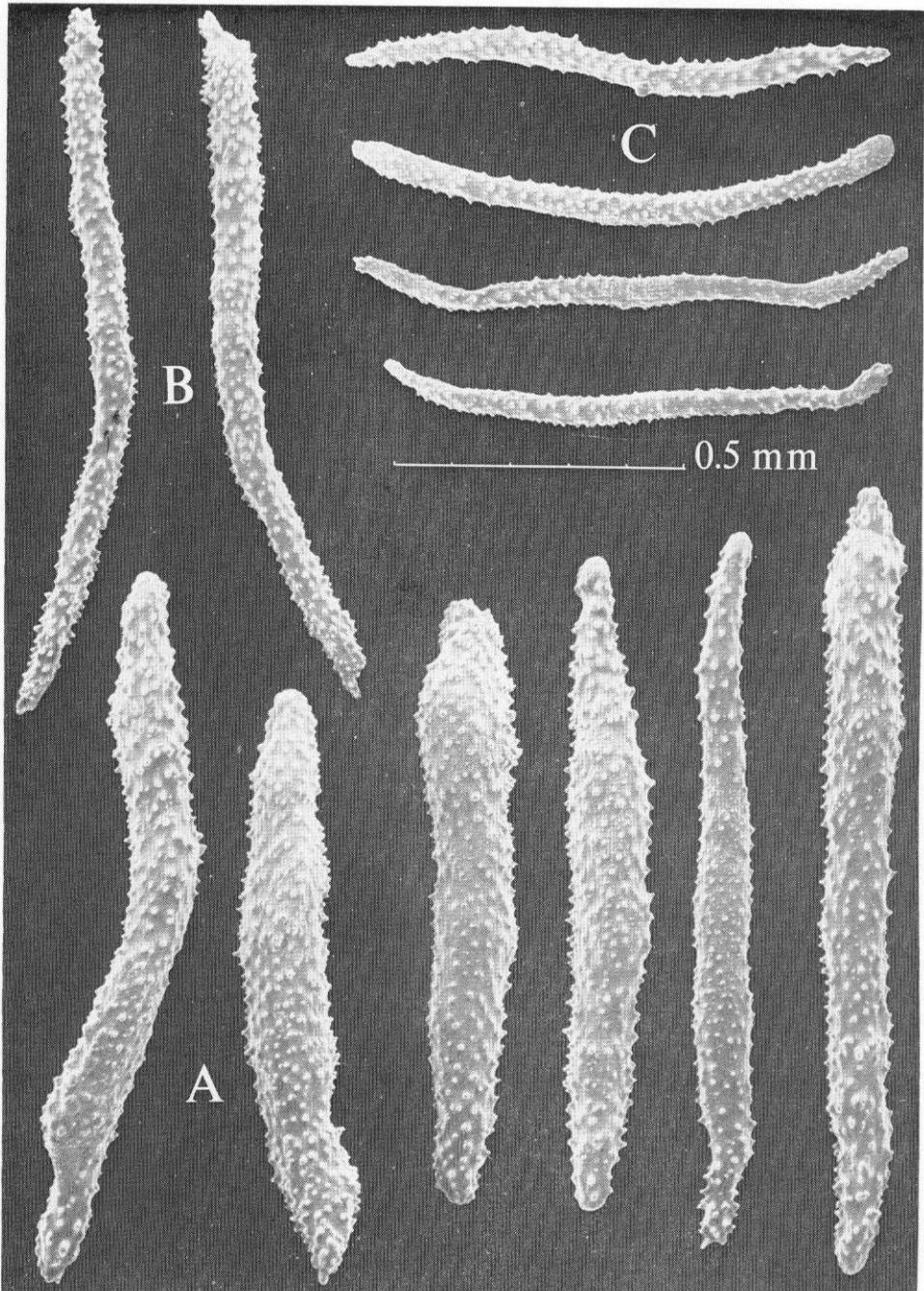


FIG. 3.—Sclerites of *Tiaroa tauhou*. A. Spindles from anthostele. B. Spindles from transitional region between tentacular points and transverse collaret. C. Transverse spindles and rods from introversible part of anthocodial wall.

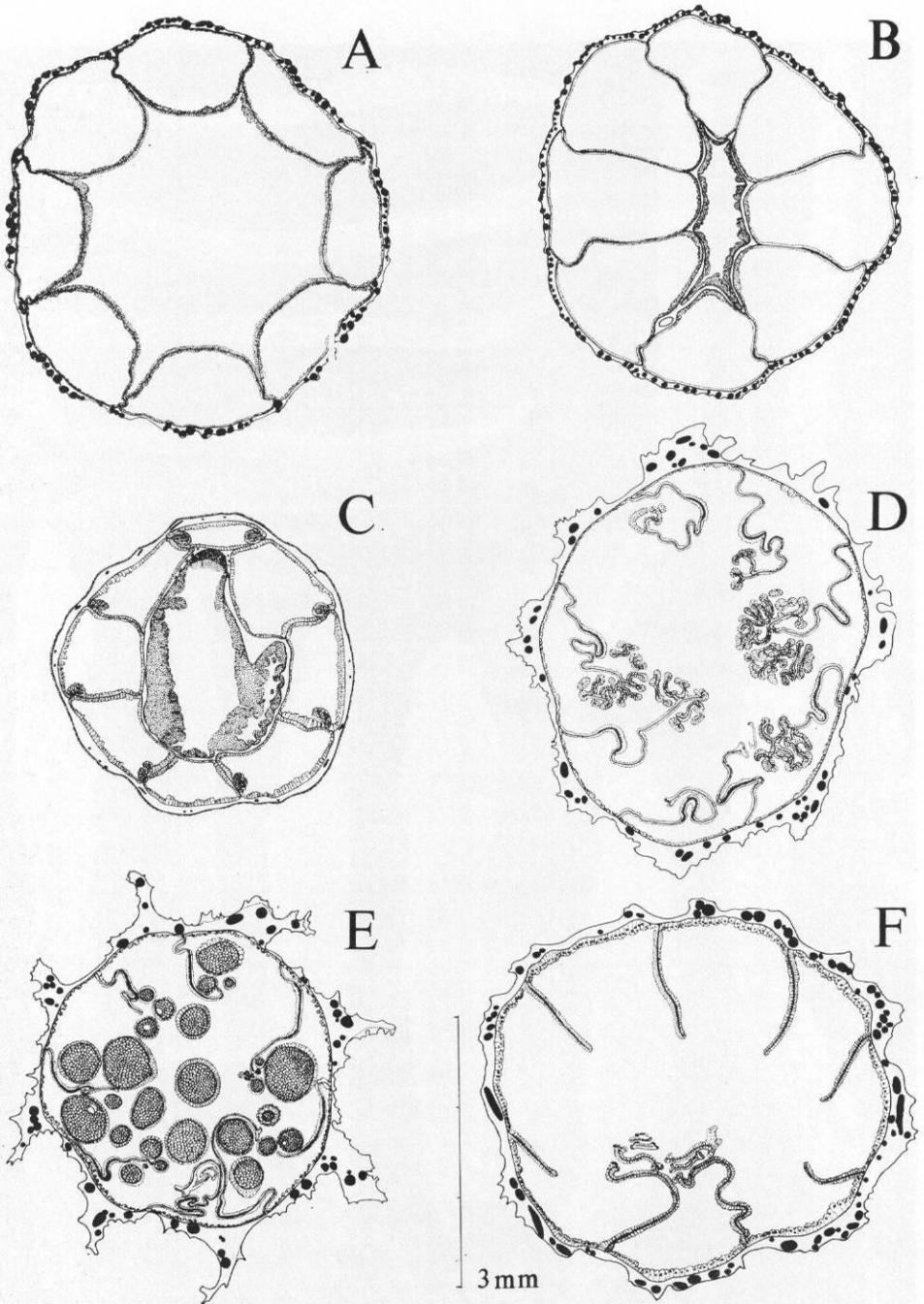


FIG. 4.—Cross section of polyp of *Taiaaroa tauhou*. A, At origin of tentacles. — B, Just below level of mouth opening. — C, Through pharyngeal region. — D, Below hypopharynx but above gonads. — E, Through fertile region. — F, near base. Lower-case letters in Fig. 2D indicate approximate levels of these sections.

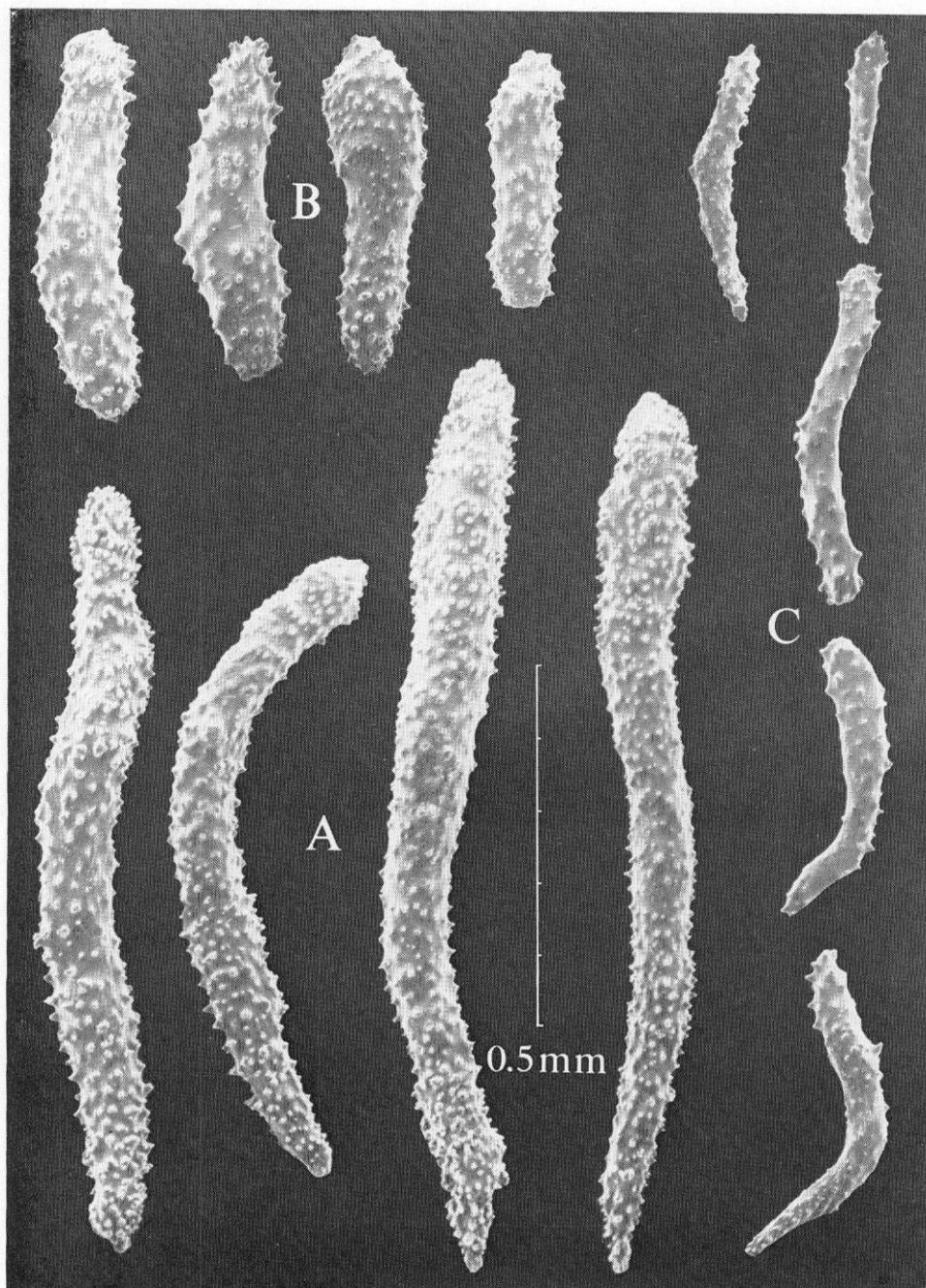


FIG. 5.—Sclerites of *Tiaroa tauhou*. A. Blunt spindles from the subtentacular crown. B. Rods from aboral side of tentacles. C. Bent rods from pinnules.

proximal sediment-encrusted anthostele commonly having eight strong longitudinal ridges, and distal anthocodia capable of complete retraction within the anthostele (Fig. 1). Average height of 34 extended preserved specimens, excluding tentacles, is 22.9 mm. Tallest polyp 36.5 mm; the shortest 11.2 mm. Most individuals are preserved partially contracted, tentacles folded inward, but with the anthocodia exsert (Fig. 1C). In a fully retracted animal, only the anthostele is visible, often forming a cylinder with a slight median bulge.

Many slender, flexible holdfasts grow from the basal 5 mm of the animal. These rootlets, studded with particles from the sediment, are up to 1 cm long. They are cellular and are covered by a cuticle.

Anthostele typically forms more than half the total height of the polyp, measuring 22 m in the 36.5 mm specimen. Diameter at beginning of the rootlets is 7 mm; at distal limit of anthostele 6.5 mm. Average diameter of 36 specimens is 4.2 mm at the beginning of the holdfasts and 3.8 mm at the distal limit of the anthostele. Body wall, excluding sedimentary encrustation, is from 0.1 mm to 0.2 mm thick, beige in colour, and nearly opaque. It may be up to 1 mm thick in the interseptal ridges, or as little as 0.05 mm between them. Interseptal ridges extend the length of the anthostele (Fig. 2C) and may be quite prominent in fully-expanded specimens. In some individuals, particularly those preserved in a retracted condition, the ridges may be less prominent or absent, perhaps because of stretching of the body wall brought on by increase in volume of the anthostele when the animal retracts (Fig. 1A). However, with no dynamic evidence, it is not possible to say with certainty if differences in the prominence of ridges are due to individual variation or are correlated with changes in shape and volume.

Sclerites of the anthostele mostly confined to the longitudinal ridges or, in the absence of ridges, to the interseptal regions, in rows from two to eight sclerites wide (Figs. 1; 2B, C). They are long spindles, straight or slightly bent, arranged longitudinally, from 0.5 to 1.25 mm long and 0.05 to 0.2 mm wide, colourless and sculptured with small, bluntly conical projections (Fig. 3A).

In specimens preserved exsert, the anthocodia usually comprises less than half the total height of the animal, measuring 14.5 mm in a 36.5 mm polyp, and averaging 10 mm in 34 individuals measured. Anthocodia cylindrical, with a body wall rather uniform

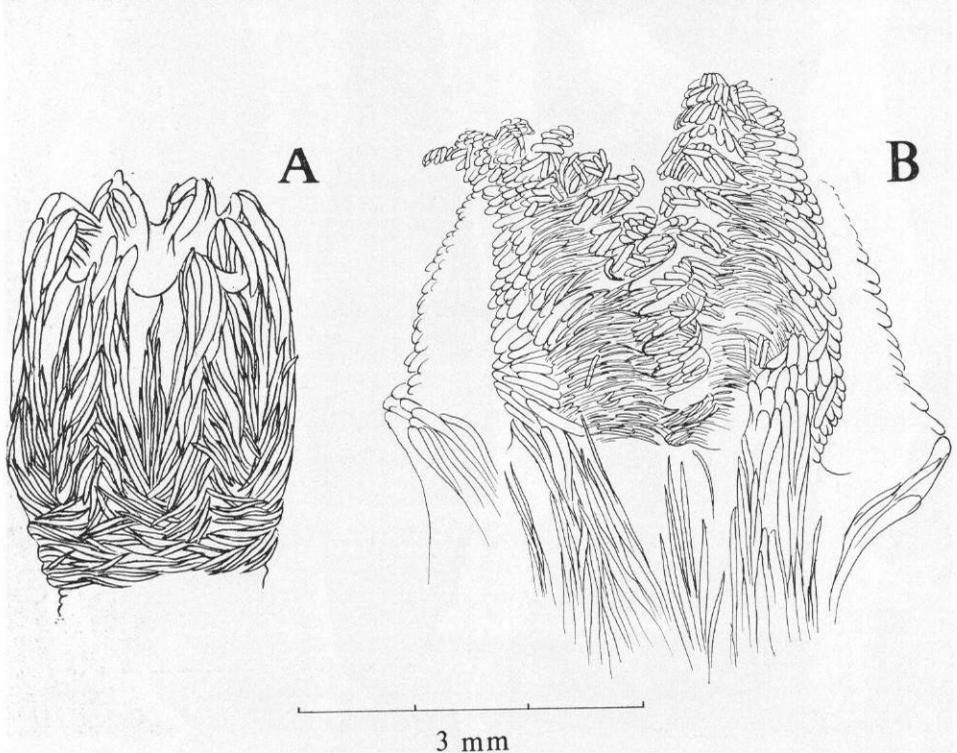


FIG. 6.—A, Distal part of anthocodia with tentacles folded inward, showing arrangement of sclerites to form crown and points. — B, Distal part of anthocodia with tentacles extended, showing arrangement of sclerites on aboral surface of two tentacles.

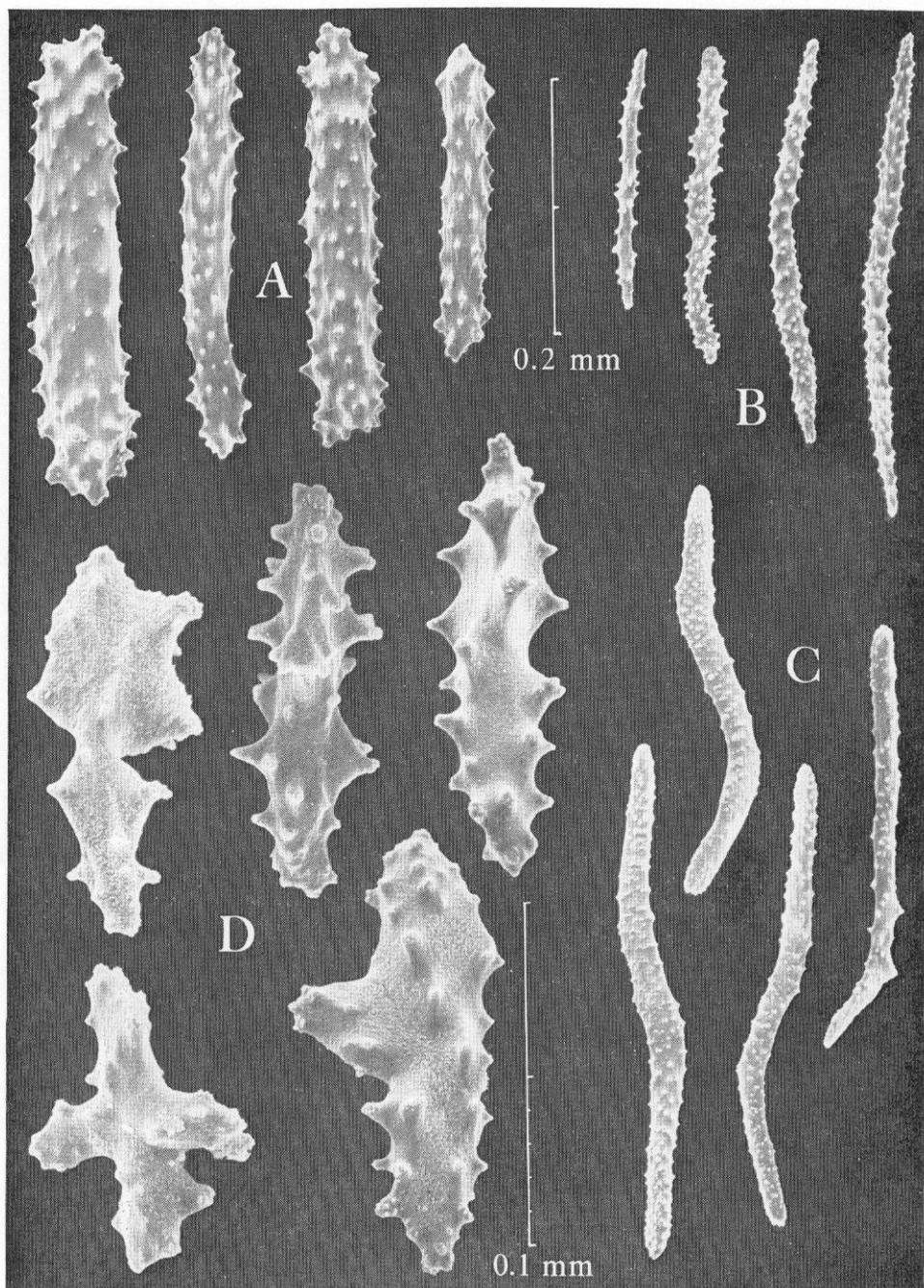


FIG. 7.—Sclerites of *Tairaoa tauhou*. A. Blunt rods from proximal part of anthocodial wall. B. Spiny spindles and rods from oral disk. C. Bent rods from pharyngeal wall. D. Spiny rods from sulco-lateral septal filaments. 0.1 mm scale applies to D; 0.2 mm scale applies to all others.

in thickness, about 0.1 mm, and semi-translucent, with the septal insertions visible through it as opaque longitudinal lines. Sclerites lying in the anthocodial wall are numerous and change both in shape and in orientation proceeding distally. All sclerites are colourless.

The sclerites of the distal part of the anthocodia are arranged to form a crown and points beneath the tentacles (Fig. 4A). Beneath each tentacle is a group of distally converging spindles, more or less bent and commonly blunter at the upper end than at the lower (Fig. 5A), up to 1 mm long and 0.15 mm wide, together forming eight points of the crown. At the apex of the points, where the tentacles begin and where infolding occurs upon contraction, the sclerites abruptly change in size and shape. Distad from this point, the aboral side of the tentacles is filled with short, blunt rods often thicker at one end, with spinulose sculpture (Fig. 5B), proximally up to 0.6 mm long and 0.2 mm wide, becoming smaller and narrower distad, where there are spinulose spindles up to 0.4 mm long, and nearly smooth rods up to 0.15 mm long. The pinnules contain many sparsely thorny rods more or less curved or bent (Fig. 5C).

Alternating with the eight large, interseptal points are eight narrower longitudinal tracts of spindles lying along the septal insertions (Figs. 1B, C, D; 2B, C; 6). These sclerites are similar to those of the main points except for length and stoutness.

Beneath the points, the sclerites assume a progressively more nearly horizontal arrangement until they form a transverse collaret, which is most distinct in the more strongly contracted specimens (Fig. 6A). Proximad, in the introversible part of the anthocodial wall, the sclerites are more sparsely distributed and mostly placed transversely (Figs. 1C, D; 2B, C). In the upper and middle parts of the introvert they are slender, curved or bent spinulose rods, mostly pointed but occasionally flattened at one end (Fig. 3C), which lie transversely in two irregular longitudinal tracts in each interseptal area and which converge distad toward the tentacle bases. In the proximal part of the introvert they are short, blunt, spinulose rods up to 0.35 mm long (Fig. 7A), which converge basad in the interseptal areas and merge with the sclerites of the anthostele (Fig. 1B, C).

The oral disk is furnished with slender, spiny rods and spindles reaching 0.4 mm in length (Fig. 7B), but their orientation could not be determined in any of the dissections that we performed.

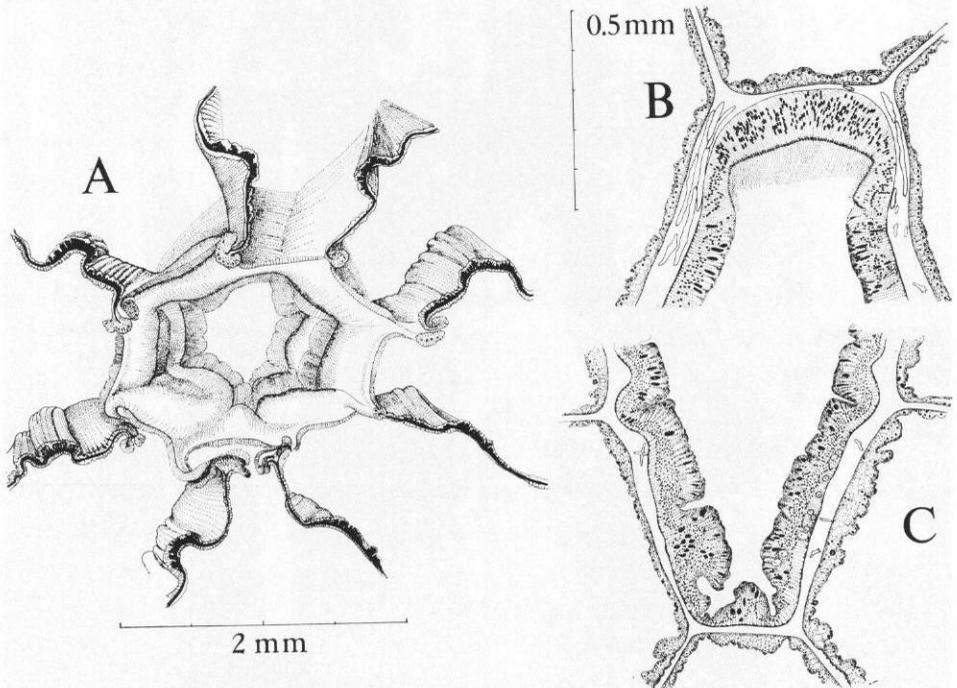


FIG. 3.—Anatomy of *Taiaroa tauhou*. A, Hypopharynx seen from below in thick epoxy cross section; sulcal side at top; mesogloea black. — B, Siphonoglyph, showing sclerites in mesogloea of pharynx; epoxy section. — C, Asulcal side of pharynx; epoxy section. Scale at B applies to B and C.

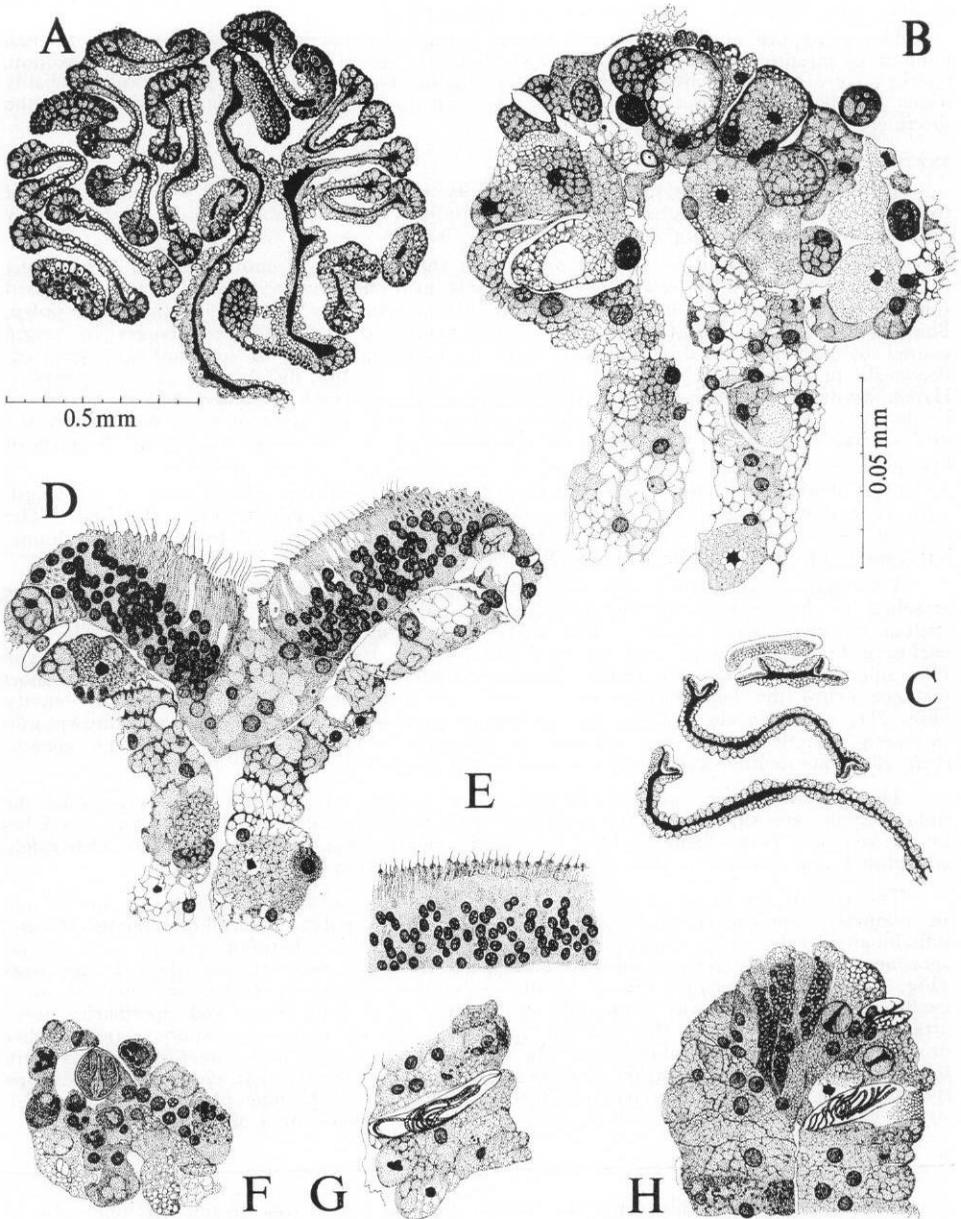


FIG. 9.—Anatomy and histology of *Taiaroa tauhou*. A, Cross section of edge of sulco-lateral septum showing convoluted filament; mesogloea black, sclerites in mesogloea white; epoxy section. — B, Sulco-lateral filament at higher magnification; epoxy section. — C, Cross section of edge of asulcal septum showing marginal folds with filament; mesogloea black; epoxy section. — D, Asulcal filament at higher magnification; epoxy section. — E, part of flagellated tract of asulcal filament in longitudinal section, showing villous surface and flagella; epoxy section. — F, Gastrodermis of sulco-lateral septum near filament, with stenotele; paraffin section. — G, Gastrodermis of sulco-lateral septum showing macrobasal amastigophore; paraffin section. — H, Sulco-lateral filament showing atrichous isorhizas, stenoteles and macrobasal amastigophore; paraffin section. Scale at A applies also to C; scale at B applies also to D-H.

The pharyngeal wall contains transversely placed, slender, weakly spinulose bent rods up to 0.42 mm long (Fig. 7C) concentrated in the sulcal side of the pharynx (Fig. 8B), possibly as a stiffening or support for the siphonoglyph.

The mesogloea of the sulcal and lateral septal filaments was found to contain a small number of minute, spinous rods (Fig. 9A; Fig. 7D) about 0.13 mm long. On dissection, sclerites were found in five of the six sulco-lateral filaments in one polyp, and probably occur in all. No evidence of sclerites was seen in the asulcal filaments of any of the specimens dissected or sectioned.

ANATOMY AND HISTOLOGY

The gastrovascular cavity is partitioned by eight septa which, in the distal 1/3 of the polyp, join with the pharynx and thus produce eight chambers which extend distally into the eight tentacles (Fig. 4).

Mouth an elongated or slit-like opening in the oral disk, 1 mm wide and 3 mm long in a polyp embedded in epoxy resin. It leads into the pharynx, which is a compressed tube occupying the distal half of the anthocodia or about 1/3 of the height of the polyp. Pharynx transversely plicate (Fig. 2D), presumably to accommodate changes in length caused by expansion and contraction, and its epithelial lining is longitudinally grooved. Brownish papillae about 0.1 mm high are visible in the distal part of the pharynx. Hypopharynx (Fig. 8A), or proximal opening of the pharynx, is flared and its margin is bordered by a ciliated band that extends outward onto the edge of each septum, on the asulcal pair continuous with the two ciliated lobes of the sepal filaments. Surface of hypopharynx smooth, not papillated as in the distal part of the pharynx.

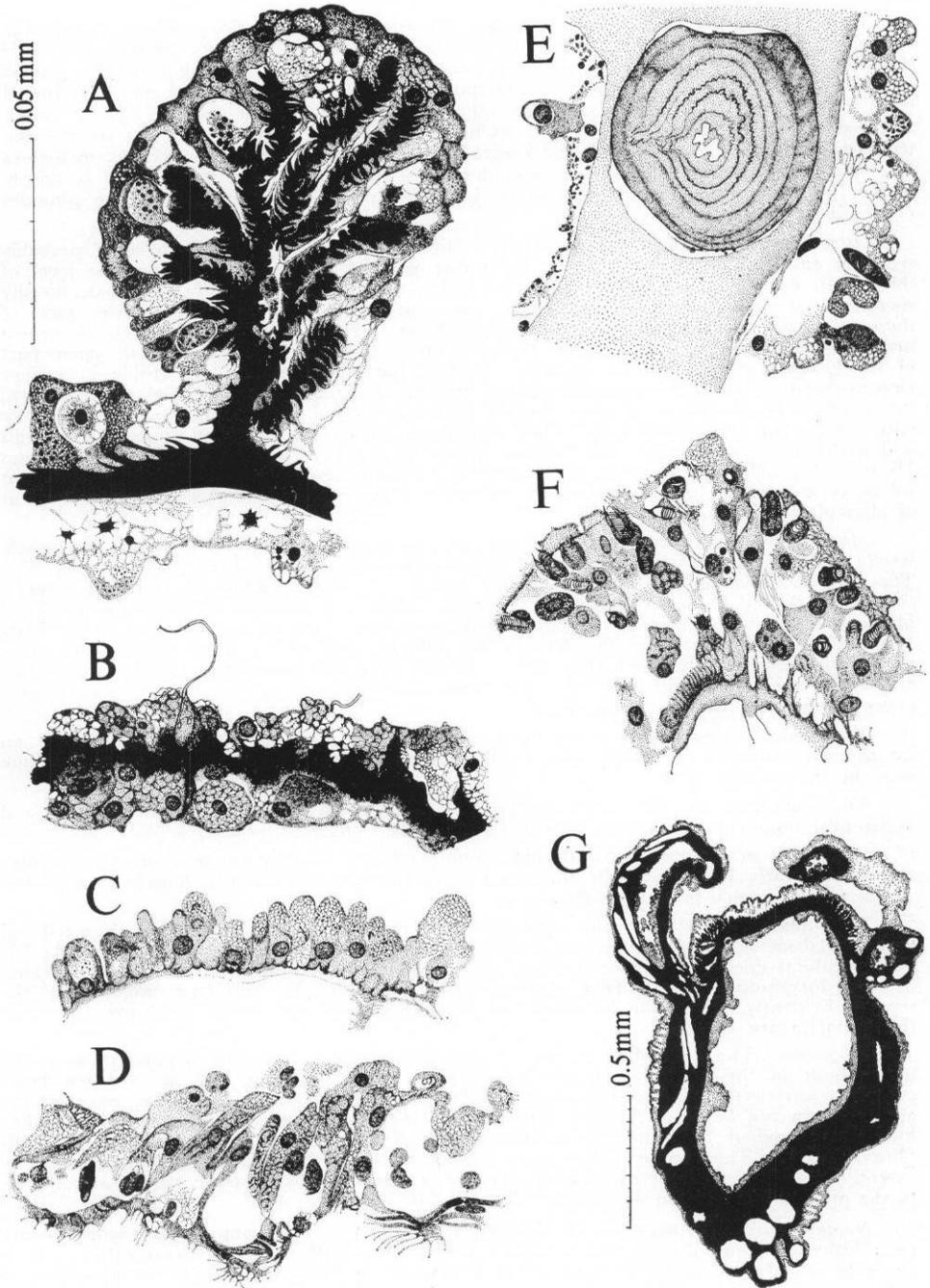
One of the two narrow sides of the pharynx is lined throughout most of its length with very thick, flagellated epithelium, the siphonoglyph or sulcus (Figs. 4C, 8B). The opposite side is narrower and lined with epithelium like the rest of the pharyngeal lining, but raised into a longitudinal ridge (Figs. 4C, 8C).

The eight septa, 0.3-0.5 mm thick, dividing the body cavity into eight chambers, are attached to the pharynx for its entire length and then descend, with free edges, to the bottom of the gastric cavity. The septa are morphologically of two sorts. The pair enclosing the siphonoglyph and the two pairs joining the two broad sides of the pharynx (the sulco-lateral septa) are fertile, bearing gonads along their free margins from a short distance below the hypopharynx to a point just above the bottom of the gastric cavity (Fig. 2D). Above the gonads, the thickened margins of these six septa are thrown into extremely complex folds, the sulco-lateral filaments (Figs. 2D, 4D); below the gonads, their edges are neither thickened nor convoluted (Fig. 4F).

The two remaining septa, which enclose the narrow edge of the pharynx opposite the siphonoglyph, are sterile and are furnished with thickened margins divided into two lobes by a groove. These margins, the asulcal filaments (Fig. 4D-F), are also elaborately convoluted and extend to the bottom of the gastric cavity (Fig. 2D).

The gonads are beige or yellowish spheres, sometimes with brown flecks, up to 0.8 mm in diameter, numbering more than 100 in a single polyp. Paraffin sections of one individual revealed it to contain both eggs and spermaries. Paraffin sections of a second specimen, and epoxy sections of two others, all from the same station, showed only eggs (Fig. 4E). Two specimens from another station, sectioned by the epoxy method, were exclusively male. It was impossible to determine if both eggs and spermaries were attached to the septa in the bisexual specimen, and therefore we cannot state whether or not it really is hermaphroditic. The fact that both eggs and intact spermaries were found detached in the pharynx of sectioned specimens suggests that males may eject ripe spermaries to be ingested by females, where fertilization could take place internally. This would explain the presence of both male and female gonads in a single individual.

Fig. 10.—Anatomy and histology of *Taiaroa tauhou*. A, Cross section of one lobe of circumscript retractor muscle of septum in pharyngeal region of polyp; mesogloea black; epoxy section. — B, Cross section of septum in pharyngeal region showing mesogloea ridges and muscle insertions on both faces; mesogloea black; epoxy section. — C, Entoderm of tentacle, longitudinal section, showing low mesogloea ridges and insertions of circular muscles; mesogloea unstippled; epoxy section. — D, Ectoderm of tentacle, longitudinal section, showing insertions of longitudinal muscles; mesogloea unstippled; epoxy section. — E, Cross section of anthocodial wall containing sclerite; entoderm with atrichous isorhiza on right; mesogloea lightly stippled; epoxy section. — F, Cross section of ectoderm of pinnule showing atrichous isorhizas; mesogloea lightly stippled, parts of sclerites unstippled; epoxy section. — G, Cross-section of tentacle, showing adoral ridges of mesogloea for insertion of longitudinal muscles; sclerites unstippled, mesogloea black; epoxy section. Scale at G applies to G only; scale at A applies to all others.



Epidermis: The anthostele is covered by a distinct cuticle to which are attached abundant grains of sediment, including foraminiferan tests and fragments of molluscan shells. Between the cuticle and the mesogloea, shreds of tissue can be found in some sections, but a continuous epidermis has not been seen and either does not exist or has deteriorated in preserved material.

The epidermis is very much damaged on the anthocodia also. Even though the anthocodia is not protected by a cuticle that might inhibit satisfactory preservation, it is commonly preserved exsert and therefore has been subjected to abrasion in the process of collection. Relatively undamaged epidermis can most readily be found on the infolded parts of the tentacles, and consists of tall, tapered cells similar to the "cover cells" reported in various groups of octocorals (Chester 1913: 747; Bayer 1974: 70) interspersed with cnidoblasts and nematocysts, and contractile cells anchored to the underlying mesogloea by long processes (Fig. 10D). The epidermis of the rachis of the tentacles is deeply folded, apparently because of contraction, but this is not so conspicuous in the pinnules (Fig. 10F).

Gastrodermis: The entire gastric cavity is lined with a tall, highly vacuolated, probably syncytial endoderm. It is shortest in the upper part of the anthocodia from the level of the mouth upward (Fig. 10E). In the tentacles, the cells are distinctly columnar, distally rounded and proximally anchored to the mesogloea (Fig. 10C). In the lower part of the gastric cavity, it becomes taller, and that of the body wall between the septa is thrown into conspicuous folds and papillae that are most conspicuous in the basal, open part of the gastric cavity below the gonads. In that part, the papillae are visible in surface view even with relatively low magnification of the dissecting microscope. At high magnification, the papillae are found to contain slender, vertically placed, sinuous fibres staining darkly with eosin with chromotrope II. They closely resemble fibres observed in both epidermis and gastrodermis of *Plexaura homomalla*, where they were interpreted as contractile fibres (Bayer 1974: 89). Several types of cells can be distinguished in the gastrodermis, but we make no attempt to interpret them. There is clear evidence of phagocytosis as well as of glandular secretion.

Muscle system: Although we have not been able to investigate it in detail, the muscle system generally conforms with that of other octocorals, e.g. *Alcyonium* (Hickson 1895). The most conspicuous components of this system are the longitudinal retractor muscles situated on the sulcal faces of the septa (Fig. 4). These are inserted on complex longitudinal plates of mesogloea that are very high and circumscribed in the pharyngeal part of the body (Figs. 4C, 10A), where they lie close to the column wall in the distal portion but more toward the pharynx proximad (Fig. 8A). In the uppermost, oral part of the septa, they are low, broad and diffuse (Fig. 4B), and below the hypopharynx they become progressively lower and broader proximad (Fig. 4D, F).

The asulcal faces of the septa have weak transverse or oblique muscles inserted on inconspicuous mesogloea ridges (Fig. 10B), which may be absent altogether below the level of the hypopharynx.

The endoderm of the tentacles is inserted on transverse mesogloea ridges and apparently represents a circular muscle system (Fig. 10C).

Embedded in the mesogloea of the column wall immediately beneath the gastrodermis are some greatly elongated cells that may constitute a weak circular muscle system, but we have been unable to confirm this.

The innermost cells of the epidermis of tentacles and pinnules are inserted on longitudinal mesogloea ridges by means of long, sometimes branching, processes (Fig. 10D, F). On the adoral side of the tentacles, these mesogloea ridges become very tall and complicated in two longitudinal tracts (Fig. 10G), which resemble the retractor muscles of the septa. Evidently, these muscle tracts are responsible for the strong infolding of which the tentacles are capable.

Filaments: The free edges of the six sulco-lateral septa from the hypopharynx to the upper limit of the gonads form the sulco-lateral septal filaments and are covered by a complex gastrodermis composed of several kinds of cells (Fig. 9A, B). The free edges of the asulcal septa are bordered by two parallel bands of flagellated cells histologically similar to the siphonoglyph, separated by a narrow tract of highly vacuolated, non-flagellated cells (Fig. 9C, D). These edges, also much convoluted, are the asulcal filaments, and they extend from the hypopharynx through the fertile region of the gastric cavity and almost to the proximal end of the septa (Fig. 2D).

Nematocysts: The nematocysts observed in sections of these animals are more diverse than hitherto reported from any octocoral and present difficulties in identification. It is generally stated that octocorals have but a single type of nematocyst, basitrichs according to Cutress (1955: 127), atrichous isorhizas according to Mariscal (1974: 142). Nematocysts of this type certainly are common in *Taiaroa tauhou*. In addition to atrichous isorhizas, two other types of nematocysts can be observed more or less abundantly. Although their exact identification cannot be confirmed because none is exploded and structural details

are not sufficiently clear in the unexploded capsules, they conform most closely with stenoteles and macrobasic amastigophores. Neither of these categories has been reported from octocorals and it is possible that they were acquired by polyps of *Taiaroa* from some prey animal. Nevertheless, we have seen no proof that they are of foreign origin, as they are located in gastrodermis and often associated with atrichous isorhizas (Fig. 9H), so it will remain for future studies in New Zealand to answer this question.

Atrichous isorhizas (or basitrichs) are extremely abundant in the epidermis of tentacles and pinnules (Fig. 10F) and present in the epidermis elsewhere in the anthocodia. They occur sparsely in the gastrodermis lining the septa (Fig. 10B) and body wall (Fig. 10E), and more abundantly in the sulco-lateral filaments (Fig. 9B) and in the ciliated tracts of the asulcal filaments (Fig. 9D). They are very resistant to the stains we have used, and undischarged capsules commonly have not taken up any stain. Exploded nematocysts stain with Harris' haematoxylin (in paraffin sections) and with crystal violet (in epoxy sections). Nematocysts of the tentacles and pinnules are so crowded that no reliable measurements were made, but those of the sulco-lateral filaments and other gastrodermis are from 11 to 17 μm long and 4 to 5 μm wide.

Unexploded capsules agreeing closely with published figures of stenoteles (Mariscal 1974: 133, fig. 4 (24)) are present and sometimes abundant in the sulco-lateral septal filaments (Fig. 6F, H). Some are 14 μm long and others are 8-9 μm . In sections stained with Gomori's trichrome stain (Humason 1967: 169), the contents of the capsule appear pale greenish except for the shaft, which is red. As stenoteles are reported only from hydrozoans, it seems probable that individuals of *Taiaroa* had been feeding upon hydromedusae armed with this kind of nematocyst.

Nematocysts tentatively identified as macrobasic amastigophores (Carlgren, 1949: pl. 4, fig. 9) or macrobasic p-mastigophores (Cutress 1955: 133) are also present in the gastrodermis of the sulco-lateral filaments, sometimes in close proximity to the stenoteles and the atrichous isorhizas (Fig. 6G, H). In Gomori trichrome preparations, the contents of these capsules stain faintly greenish except for the shaft, which is red. They range in length from 30 to 38 μm . Nematocysts of this type have been reported from the Anthozoa (e.g., *Alicia*, Carlgren 1949). If the identification of macrobasic amastigophores in *Taiaroa* is correct it is possible they too are of foreign origin. Their presence may be explained through some intermediary such as a nudibranch that might have browsed on actinians and in turn been eaten by *Taiaroa*.

METHODS: Because of the unusual interest that attaches to this animal, we wished to make an introductory study of its anatomy and histology for comparison with other octocorals. Towards this end, Mrs Fay Mucha, histologist at the Rosenstiel School of Marine and Atmospheric Science, attempted to make serial sections through two specimens. As the proximal part of the polyps was encrusted with particles of sediment, desilicification was necessary in addition to decalcification. Treatment with hydrofluoric acid and EDTA produced dramatic shrinkage, fifty percent or more, with attendant distortion of tissues.

In order to study the anatomy and general histology without distortion and with the mineral component intact, five specimens were embedded in epoxy resin by Donald Dean of the Smithsonian Institution according to the procedures described by Nye, Dean and Hinds (1972). One embedded specimen was cut transversely into seven pieces, and the cut surfaces were polished for observation. Gross anatomical features could readily be observed this way, and finer details could be studied from acetate peels made from the polished surfaces. Because different types of structure result in different degrees of hardness of the cured epoxy, the polished surfaces contain minute relief, which is accurately reproduced in the acetate peels. Such peels can be studied under the compound microscope with low-level conventional illumination (i.e., with condenser diaphragm stopped down), with phase contrast optics, and with Nomarski interference optics.

Another embedded specimen was cut transversely into six pieces and the polished surfaces were replicated in acetate as described above. The blocks were then cemented to glass specimen-slides with epoxy and the greater part of each sawed off with a diamond saw. The coarse sections remaining on the slides were ground thin by hand, polished, and stained with crystal violet.

Epoxy sections so produced compare favourably in quality with sections cut by the paraffin method and have the added advantage of retaining calcareous structures in virtually their natural relationship with the soft parts.

Acetate replicas of the polished cut surfaces when viewed with phase contrast equipment compare favourably with unstained paraffin sections viewed with the same optics, and likewise show the calcareous structures in natural position. Moreover, by etching the polished block with dilute acetic acid prior to replication, the fine structure of the calcareous sclerites can be observed by scanning electron microscopy.

This epoxy method of sections may not be an unalloyed blessing, as some sections upon aging have developed minute cracks, which commonly appear between mesogloea and epithelium, and around cell bodies. Such cracking appears to be the result of differential shrinkage as curing of the epoxy continues after sectioning, and perhaps may be avoided by thorough elimination of propylene oxide followed by slow, thorough curing of the epoxy prior to sectioning. We have not had sufficient time to verify this supposition, and suggest only that epoxy blocks be thoroughly cured before cutting, in the hope of precluding this difficulty.

CONCLUSIONS

Although the status of the solitary octocorals previously described (*Haimea funebris* Milne Edwards and Haime, *Hartea elegans* E. P. Wright, *Monoxenia darwini* Haeckel, and *Psuchastes glacialis* T. S. Wright) was so much in doubt that Hickson (1930) dropped from his classification the major taxon that he himself had erected for them, there is no doubt that the solitary animals described in this paper are permanently solitary octocorals which reproduce exclusively by sexual means. Specimens have been collected on five occasions, twice in quantities that indicate the presence of substantial populations in suitable substrates in depths of 300 to 600 m. Likewise, there is no doubt that these animals conform exactly to Hickson's original concept of Protoalcyonaria, which he proposed for those forms that never reproduce vegetatively to form colonies. Therefore, that taxon is here reinstated at the ordinal level to contain the family Haimeidae E. Perceval Wright, 1865, which provisionally comprises the genera *Haimea*, *Hartea*, *Monoxenia* and *Psuchastes*, and the new family Taiaroidae, which as yet contains only *Taiaroa tauhou*, gen. et sp. nov.

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