A Revision of the Ahermatypic Scleractinia of the Galápagos and Cocos Islands

STEPHEN D. CAIRNS

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Robert McC. Adams  
Secretary  
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A Revision of the Ahermatypic Scleractinia of the Galápagos and Cocos Islands

Stephen D. Cairns
ABSTRACT

Cairns, Stephen D. A Revision of the Ahermatypic Scleractinia of the Galápagos and Cocos Islands. Smithsonian Contributions to Zoology, number 504, 44 pages, 12 plates, 4 tables, 1 map, 1991.—The ahermatypic Scleractinia of the Galápagos and Cocos islands are revised based primarily on the collections of the 1986 expedition of the Johnson-Sea-Link I research submersible. A historical review of the previous work on ahermatypic Scleractinia from the Galápagos and Cocos islands is given. Forty-two ahermatypic species from the Galápagos and 12 ahermatypic species from Cocos Island, including nine and five new records, respectively, are described and illustrated—because of overlap in distribution, a total of 44 species. One genus, Pseudocyathyoceras, and nine species are described as new: Cladocora pacifica, Oculina profunda, Caryophyllia percula, C. solida, Concentrotheca vaughani, Crispatrochus galapagensis, Anomocora carinata, Polymyces wellsii, and Dendrophyllia johnsoni. Crispatrochus Tenison Woods, 1878, is resurrected and designated the senior synonym of Cyathoceras Moseley, 1881. In order to facilitate comparisons within the subgenus Caryophyllia (Caryophyllia), the 56 Recent species and subspecies are tabulated based on the nature of their base, septal symmetry, number of septa, and their distribution. The four species of Galapagian Tubastrea are also compared in a tabular key.

The zoogeographic affinities of both the Galapagan and Cocos Island ahermatypic Scleractinia are found to be consistent with other groups of marine invertebrates. The Galapagan fauna has a 41% endemic component, 21% Panamanian, 19% Indo-Pacific, 14% cosmopolitan, and 5% West Indian. The West Indian affinity is strengthened by the suggestion of two geminate species pairs: Cladocora pacifica-C. debilis and Oculina profunda-O. varicosa. The Cocos ahermatypic fauna has smaller endemic and larger Panamanian components, 17% and 33% respectively, the remaining species equally allied between the Indo-Pacific region and cosmopolitan species.

OFFICIAL PUBLICATION DATE is handstamped in a limited number of initial copies and is recorded in the Institution’s annual report, Smithsonian Year.

SERIES COVER DESIGN: The coral Montastrea cavernosa (Linnaeus).
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Appendix: Station List

Literature Cited

Plates
A Revision of the Ahermatypic Scleractinia of the Galápagos and Cocos Islands

Stephen D. Cairns

Introduction

HISTORICAL RESUMÉ.—The first ahermatypic coral to be reported from the Galápagos was *Flabellum galapagense* Milne Edwards and Haime (1848a,b), a fossilized specimen from an unspecified island within the Galápagos archipelago and an unknown geologic age. This specimen is lost (Wells, 1983) and the species has not subsequently been found in the Galápagos.

Pourtales (1875) reported seven scleractinians from the Galápagos collected on the beach during an expedition of the U.S.C.S. Steamer *Hassler* in 1872, including two shallow-water ahermatypes: *Oulangia bradleyi* and *Tubastrea coccinea*, the latter reported as *Astropsychia pedersenii*. Duncan (1876) also reported *T. coccinea* from the Galápagos as *Placopsammia darwini*, the specimen having been collected in 1835 by Charles Darwin.

Based on the dredging of the U.S.F.C. Steamer *Albatross* in 1891, Marenzeller (1904b) reported three deep-water corals from the Galápagos: *Madrepora oculata*, *D. cristagalli*, and *Oculina pacifica* (the latter reported as "Oculinidarium gen.? sp.?"") and three species from Cocos Island: *Cladocora profunda* (reported as *C. arbuscula*), *Caryophyllia diomedeae* (reported as *Caryophyllia sp.*), and *Javania cailleti* (reported as *Flabellum sp.*).

In a similar publication based on the deep-water dredging of the U.S.F.C. Steamer *Albatross* in 1904–1905, Vaughan (1906) reported three new deep-water species from the Galápagos: *Madrepora galapagensis* (= *M. oculata*), *Desmophyllum galapagensis* (= *Javania cailleti*), and *Balanophyllia galapagensis*. Only the last two species were new records for the Galápagos. Both Marenzeller's (1904b) and Vaughan's (1906) specimens are deposited at the USNM.

On the expedition to the South Pacific of the S.Y. St. George, Crossland (1927) reported yellow and pink *Dendrophyllia* from Tagus Cove, Isabela, believed by Wells (1983) to be the first record of *D. gracilis* from the Galápagos.

The greatest addition to the Galapagan ahermatypic fauna was that of Durham and Barnard (1952), who reported 19 shallow-water species from the Galápagos and three from off Cocos Island, 13 and 1 new records, respectively, for these islands. These specimens were collected on board the Velero III and Velero IV between 1932 and 1949 and are deposited at the AHF. The 13 new Galapagan records were *Madracis asperula*, *M. pharensis* (reported as *Madracis sp.*), *Cladocora pacifica* (reported as *C. debilis*), *Astrangia browni* (reported as *A. gardnerensis*), *A. equatorialis*, *Caryophyllia percula* (reported as *C. diomedeae*), *Polycyathus hondensis* (reported as *Astrangia hondensis*), *Phyllangia consagensis* (reported as *Lophosmilia wellsi*), *Sphenotrochus hancocki*, *Pseudocyathoceras avis* (reported as *Kionotrochus avis* and *K. hoodensis*), *Flabellum daphnense*, *Endopachys grayi* (reported as *E. vaughani*), and *Endopsammia pourtalesi*. The two new Cocos Island records were *Polycyathus hondensis* and *Endopachys grayi*. Durham and Barnard (1952, table 1) also listed the 98 species then known from the eastern Pacific, including a separate category for the Galápagos species, making this a benchmark paper for the study of the taxonomy and zoogeography of the eastern Pacific coral fauna.

Six ahermatypic species were collected at the Galápagos and Cocos islands on the Galápagos-Expedition 1953–1954 of the International Institute for Submersible Research (Durham, 1962). The collections were made on the *Xarifa* and are now deposited at the Hessisches Landsmuseum, Darmstadt, and Museum of Paleontology, University of California, Berkeley. None of the four shallow-water species from the Galápagos was a new record but all three from Cocos Island were previously...
unknown from that island: Astrangia dentata, Rhizopsammia verrilli (reported as Balanophyllia scheeri), and Tubastrea cucullata (reported as T. teniulamellosa). Durham (1962, table 3) also tabulated a comprehensive list of all Scleractinia known from the Galápagos and Cocos islands, but because he overlooked the papers by Milne Edwards and Haime (1848a), Pourtales (1875), Marenzeller (1904b), and Crossland (1927), the list was incomplete.

In a paper on the zoogeography of the eastern Pacific Scleractinia, Durham (1966, table 1) reiterated his lists of scleractinian species for the Galápagos and Cocos islands, this time including the paper by Pourtales (1875), but no additional species were reported for either island group. Durham (1966, table 2) also reiterated his list of all 103 species known from the eastern Pacific, extracted primarily from Durham and Barnard (1952), and presented a brief historical resume of the corals previously reported from the Galápagos and Cocos islands.

The next addition to the scleractinian fauna of the Galápagos was that of Wells (1982), who described six new shallow-water ahermatypes: Polymyces isabela, Balanophyllia eguchi, Rhizopsammia wellingtoni, Tubastrea faulkneri, T. tagusensis, and T. floreana. The most recent addition to the Galápagan fauna was the annotated and illustrated checklist of Wells (1983), who listed five new records for the Galápagos: Culicina rubroga, Caryophyllia solida (reported as C. diomedeae), Paracyathus humilis, Eunapopsammia rostrata (reported as E. amphioides), and Polymyces wellsi (reported as Javania pseudolabasta). As in his previous paper (Wells, 1982), most of the specimens on which this paper was based are deposited at the USNM, but some are also at the CAS and Charles Darwin Reserach Station, Santa Cruz.

Nine new records are reported herein from the Galápagos: Caryophyllia diomedeae, Concentrotheca vaughani, Crispatorus culpifera, Flabellum sp. A, Javanee sp. A, Dendrophyllia johnsoni, D. californica, and Rhizopsammia verrilli. This increases to 42 the number of ahermatypic species known from the Galápagos Islands (Table 1). Combined with the 13 hermatypic species known from the Galápagos (Wells, 1983:215), a total of 55 species are thus known from the archipelago, including one exclusively fossil species.

Four new records are reported herein for Cocos Island: Culicina rubroga, Desmophyllum cristagalli, Anomocora carinata, and Dendrophyllia californica. This increases to 12 the number of ahermatypic species known from Cocos Island (Table 1). Combined with the 12 hermatypic species known from Cocos Island (Durham, 1966:125), a total of 24 species are thus now known from this island.

ABBREVIATIONS.—The following abbreviations are used in the text, primarily in the context of the "Material Examined" sections.

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</tr>
<tr>
<td>AHF</td>
<td>Allan Hancock Foundation, Los Angeles</td>
</tr>
<tr>
<td>ALB</td>
<td>U.S. Fish Commission Steamer Albatross</td>
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ACKNOWLEDGMENTS.—I would like to thank the following people who have generously loaned me specimens used in this study: G. Bakus (AHF), D. Fautin (CAS), and W.D. Hartman (YPM). I am also, as always, grateful to H. Zibrowius (Station Marine d’Endoume) for his tireless efforts in reviewing my manuscripts.

The Johnson-Sea-Link I submersible expedition to the Galápagos and Cocos islands, which provided the bulk of the new material reported in this report, was co-sponsored by Harbor Branch Oceanographic Institution; SeaPharm, Inc.; and the National Cancer Institute, Natural Products Branch (contract NO1-CM-67919). I am grateful to co-chief scientists K.L. Rinehart and S.A. Pomponi for the opportunity to participate in this cruise, and to J.K. Reed and P.M. Mikkelsen for facilitating the loan of specimens.

The scanning electron photomicrographs were taken in the SEM Laboratory of the National Museum of Natural History, Smithsonian Institution.

Material and Methods

The new material on which this revision is based originated primarily from the Johnson-Sea-Link I submersible expedition to the Galápagos and Cocos islands in November to December of 1986. Ahermatypic Scleractinia were collected from 25 (see "Station List") of the 35 submersible dives, and 10 additional SCUBA dives in adjacent shallow waters. The use of a manned research submersible allowed selective collection of invertebrates and in situ observation and photography of living corals. Specimens were also examined from 14 Albatross stations, several Anton Bruun stations, several shallow-water stations made in 1974 by W.D. Hope in the Galápagos, and several shallow-water collections made by W.L. Schmitt in 1934 off Cocos Island. Much of the previously reported historical material from the Galápagos, Cocos Island, and eastern Pacific was also examined, including the specimens reported by Marenzeller (1904b), Vaughan (1906), Durham and Barnard (1952), and Wells (1982, 1983). Station data for the Velero stations reported by Durham and Barnard (1952) are found in volumes 1 and 6 of the Allan Hancock Pacific Expeditions.

Species synonymies are complete insofar as records from the Galápagos, Cocos Island, and eastern Pacific. If a species...
TABLE 1.—General distribution and depth ranges of ahermatypic Scleractinia from Galápagos and Cocos islands. (S) indicates that species was considered as a predominantly shallow-water species in the zoogeographic analysis.

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<th>West Indies</th>
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<td>x</td>
<td>315-316</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Lophelia prolifera</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>0-59 (S)</td>
</tr>
<tr>
<td>21. Phyllangia consagensis</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Anomocora carinata</td>
<td>x</td>
<td></td>
<td>614-785</td>
<td></td>
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</tr>
<tr>
<td>23. Sphenotrochus hancockii</td>
<td>x</td>
<td>x</td>
<td>18-273</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>24. Pseudocyathoceras avia</td>
<td>x</td>
<td></td>
<td>91-183</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Flabellum galapagense</td>
<td>x</td>
<td></td>
<td>fossil</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>26. Flabellum sp. A</td>
<td>x</td>
<td></td>
<td>441-717</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>27. Flabellum daphnense</td>
<td>x</td>
<td></td>
<td>101</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. Javania caillieti</td>
<td>x</td>
<td>x</td>
<td>245-576</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. Javania sp. A</td>
<td>x</td>
<td></td>
<td>143</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. Polymyces wellsi</td>
<td>x</td>
<td></td>
<td>391-813</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. Balanophyllia galapagensis</td>
<td>x</td>
<td></td>
<td>18-462</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. Balanophyllia eguchii</td>
<td>x</td>
<td>x</td>
<td>1-27</td>
<td>(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33. Dendrophyllia gracilis</td>
<td>x</td>
<td>x</td>
<td>0-12</td>
<td>(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34. Dendrophyllia californica</td>
<td>x</td>
<td>x</td>
<td>315-576</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. Dendrophyllia johnsonii</td>
<td>x</td>
<td></td>
<td>373-462</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. Endopachys grayi</td>
<td>x</td>
<td>x</td>
<td>20-183</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37. Rhizoparmella verrilli</td>
<td>x</td>
<td>x</td>
<td>6-20</td>
<td>(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38. Rhizoparmella wellingtoni</td>
<td>x</td>
<td></td>
<td>2-43</td>
<td>(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39. Endoparmella pourtalesi</td>
<td>x</td>
<td></td>
<td>7</td>
<td>(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40. Enalloparma rostrata</td>
<td>x</td>
<td>x</td>
<td>717</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41. Tubastra rusticana</td>
<td>x</td>
<td>x</td>
<td>1-5-183</td>
<td>(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42. Tubastra faunaensis</td>
<td>x</td>
<td>x</td>
<td>3-5</td>
<td>(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43. Tubastra tagasensis</td>
<td>x</td>
<td>x</td>
<td>1-43</td>
<td>(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44. Tubastra floreana</td>
<td>x</td>
<td></td>
<td>2-5</td>
<td>(S)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Totals | 42 | 12 | 20 | 14 | 8 | 20 | S |

Ranges beyond the eastern Pacific, one or more references are included in the synonymy that summarizes these records. Efforts were made to verify most of the historical records by personal observation, but when specimens were not available for study and the published account was unclear, the synonymy and corresponding distributional records are queried. Representatives of 43 of the 44 species known from the Galápagos and Cocos islands were examined and illustrated; only the fossil *Flabellum galapagense* was not seen and is presumed to be lost.
Descriptions are provided for most species; however, when no additional specimens were collected of a particular species, then only a discussion is provided including emendations or additions to the previously published description. Conventional scleractinian terminology is used in describing the coralla (see Wells, 1956; Cairns, 1981, 1989). In two cases (i.e., subgenus Caryophyllia and Crispatotrochus) supraspecific taxa are discussed in order to facilitate comparisons of described species or to resurrect an older taxon.

In the "Material Examined" sections, the number of specimens from a station (if solitary) is enclosed in parentheses following the station number, itself followed by the museum catalog number and previous publication citation, if any. Additional reference material examined, not conspecific with the species being discussed, follows. Types of all new species are deposited in USNM.

If the species is widespread, bathymetric ranges are given for the Galápagos-Cocos records distinct from the entire known range. Spanish names are used for the individual Galápagos Islands (see Glynn and Wellington, 1983:5-7) and in the "Distribution" sections listed in a counterclockwise order beginning with Fernandina.

The scanning electron photomicrographs were done by the author on a Cambridge Stero Scan 100. In many cases stereo pairs are published in order to give a better appreciation of the depth of fossa and relative exsertness of septal cycles. Some specimens were dyed with red food color in order to improve their contrast for conventional photography.

**Zoogeography**

Unlike the Galapagan stylasterid corals, which are all endemic to that archipelago (Cairns, 1986), the Galapagan ahermatypic Scleractinia have more traditional faunistic affini-
ties as described by Ekman (1953) and Briggs (1974), that is: a high endemic component, followed by affinities with the Panamanian, Indo-Pacific, and West Indian regions, in that order. The relative percentages of these categories are given in Table 2. It should be noted that the shared possession of a species between the Galápagos and Cocos Island is considered as an endemic. The West Indian affinity is not only inferred by the shared possession of two species of Madracis, but also by the occurrence of Oculina profunda and Cladocora pacifica, which are extremely similar (geminate pairs) to the West Indian Oculina varicosa and Cladocora debilis.

It must be remembered, however, that marine zoogeographic patterns are based primarily on shallow-water (continental shelf) organisms, whereas the ahermatypes are predominantly a deep-water (continental slope) ecological group. Therefore, a further breakdown of faunistic affinities based on depth range is also presented in Table 2. A high majority of the endemic and cosmopolitan species from the Galápagos are deep water species, whereas all West Indian, most Indo-Pacific, and a majority of the Panamanian species are shallow water in distribution. Another result of analyzing a predominantly deep-water group of organisms is a relatively higher percentage of cosmopolitan species.

The only comparable analysis of the Galapagan ahermatypes was that of Wells (1983:217), based on 31 species. He listed a lower percentage (32%) of endemics, a slightly higher percentage of combined Indo-Pacific and cosmopolitan species (35%), a slightly lower percentage of Panamanian species (19%), and a much higher percentage of West Indian species (13%). These discrepancies can be explained by the higher number of species analyzed herein and the reidentification of several of Wells' species.

The affinities of the Galapagan ahermatypes differ from the affinities of the Galapagan hermatypes (Wells, 1983) by having a much higher percentage of endemic and cosmopolitan species and a much lower percentage of Indo-Pacific species.

The faunistic affinities of the relatively few (12 species) ahermatypes known from Cocos Island (Table 2) are also consistent with most other groups of marine invertebrates as summarized by Briggs (1974): a relatively low endemic component (17%), a high Panamanian component (33%), and lesser Indo-Pacific (25%) and cosmopolitan (25%) components. Cocos Island is therefore considered to be an outpost of the Panamanian Province. Ten of its 12 ahermatypic species are shared with the Galápagos.

### Table 2.—Zoogeographic affinities of Galápagos and Cocos islands ahermatypic Scleractinia, emphasizing depth ranges. Percentages of shallow and deep divisions are expressed as a percentage of total component.

<table>
<thead>
<tr>
<th>Component</th>
<th>Galápagos</th>
<th></th>
<th>Cocos</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Shallow</td>
<td>Deep</td>
<td>Total</td>
</tr>
<tr>
<td>Endemic</td>
<td>17 (41%)</td>
<td>5 (29%)</td>
<td>12 (71%)</td>
<td>2 (17%)</td>
</tr>
<tr>
<td>Panamanian</td>
<td>9 (21%)</td>
<td>5 (56%)</td>
<td>4 (44%)</td>
<td>4 (33%)</td>
</tr>
<tr>
<td>Indo-Pacific</td>
<td>8 (19%)</td>
<td>6 (75%)</td>
<td>2 (25%)</td>
<td>3 (25%)</td>
</tr>
<tr>
<td>Cosmopolitan</td>
<td>6 (14%)</td>
<td>1 (17%)</td>
<td>5 (83%)</td>
<td>3 (25%)</td>
</tr>
<tr>
<td>West Indian</td>
<td>2 (5%)</td>
<td>2 (100%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Totals</td>
<td>42 (100%)</td>
<td>19</td>
<td>23</td>
<td>12 (100%)</td>
</tr>
</tbody>
</table>

### Order SCLERACTINIA

**Suborder ASTROCOENIINA Vaughan and Wells, 1943**

**Family POCILLOPORIDAE Gray, 1842**

**Madracis Milne Edwards and Haime, 1848**


**PLATE 1a**


**DISCUSSION.**—A delicately branched decameral species of Madracis is known from one specimen from the Galápagos, a branch fragment 26.6 mm long reported by Durham and Barnard (1952). Nothing is added to their description of this specimen. Until a revision of the genus is made (as recommended by Zibrowius, 1980), based, perhaps, on a detailed morphometric analysis or a molecular taxonomic approach (e.g., electrophoresis), the taxonomy of Madracis and the range of variation and taxonomic value of various characters will remain poorly known. Until then, I prefer to follow Durham and Barnard's (1952) tentative identification of this specimen as *M. asperula* even though the gross morphological characters of the Galapagan specimen are identical to those of *M. asperula* from the Atlantic.

*Madracis asperula* differs from the other Pacific branching *Madracis* (i.e., *M. kauaiensis* Vaughan, 1907, and *M. asanoi* Yabe and Sugiyama, 1936) by having very slender, delicate branches.

**MATERIAL EXAMINED.**—Velero 201-34 (1) AHF 1.1 (Durham and Barnard, 1952), Plate 1a.

**DISTRIBUTION.**—Galápagos: off Gardner Bay, Española;
2. Madracis sp. cf. *M. pharensis* (Heller, 1868)  
**PLATES 1b-e, 11g**


**DESCRIPTION OF SPECIMEN FROM JSL-1920.—**Corallum small, colony consisting of five corallites encrusting the inner edges of several septa of a dead, heavily encrusted specimen of *Desmophyllum cristagalli*. Colony approximately 4.5 mm in diameter; individual corallites 1.5 mm in diameter; calices circular. Intercalary coenosteum narrow (0.2 mm) and spinose. Corallum white. Septa decamerally arranged in one cycle with traces of 10 secondary septa in several corallites (10–20 septa per corallite). Primary septa exsert and relatively narrow, each separated by a deep notch from a small paliform lobe. Ten paliform lobes highly granular, their inner edges fusing to the central massive styliform columella. Fossa moderately deep.

**DISCUSSION.—**The specimen reported by Wells (1983) from Gardner Island, Floreana, is a much larger colony of approximately 60 corallites, having very thin, nonspinose walls and polygonal (pentameral or hexameral) corallites. Nonetheless, that specimen, as well as *Madracis* sp. of Durham and Barnard (1952) and the JSL specimen, are considered to represent the same encrusting species, but its identity as *M. pharensis* is unsure. Based on the large variation in colony shape and calicular features found in the Atlantic populations of *M. pharensis*, the paucity of characters to analyze in the *M. pharensis*, and the paucity of specimens from the Galápagos, I share the reservations of Durham and Barnard (1952), Wells (1954), and Zibrowius (1980) in assigning the Galápagan specimens to *M. pharensis*, even though their gross morphological characters do match those of the Atlantic species.

The Galápagos specimens differ from the Pacific *M. kauaiensis* and *M. asanoi* in being encrusting, not branching. It differs from the encrusting *Madracis* sp. reported by Wells (1954) from the Marshall Islands in having poorly developed secondary septa and narrow primary septa; the secondary septa of the Marshall Islands specimen are well developed.

**MATERIAL EXAMINED.—**JSL-1920 (1) USNM 84775, Plate 1d.e; Velero bottom sample 453 (1) AHF 2.1 (*Madracis* sp. of Durham and Barnard, 1952); Gardner Island, Floreana, CAS 66645 (Wells, 1983), Plate 1b.c, 11g. Reference Specimens: *Madracis* sp. from Bikini Atoll (1) USNM 44407 (Wells, 1954).

**DISTRIBUTION.—**Galápagos: Gardner Island, Floreana (Wells, 1983); off Kicker Rock, San Cristóbal; Gardner Bay, Española (Durham and Barnard, 1952); 30–343 m. Elsewhere (if identified as *M. pharensis*): ?Gorgona Island, Colombia (Durham and Barnard, 1952); eastern Atlantic; Caribbean; 5–150 m.

### Suborder FAVIINA Vaughan and Wells, 1943

#### Family FAVIIDAE Gregory, 1900

*Cladocora* Ehrenberg, 1834

3. *Cladocora pacifica*, new species

**PLATE 1f-a**

*Cladocora arbuscula*—Marenzeller, 1904b:76-79, pl. 1: fig. 1a-e.


*Cladocora debilis*—Henlein, 1963:231.

**DESCRIPTION.—**Colonies consist of a scolecoid, cylindrical principal corallite, from which numerous extratentacular buds originate at right angles. Longest principal corallite 7 cm and 6.2 mm in diameter; secondary buds rarely exceed 1.5 cm in length; smaller tertiary buds not uncommon; quaternary buds rare. No attached coralla were found in the study material. Branches do not anastomose. Costae equal in width (about 0.35 mm), convex to slightly ridged, and coarsely granular. Intercostal striae narrow (about 0.10 mm) and shallow. Coralla light brown to white.

Septa hexamerally arranged in approximately four cycles, the number of septa increasing with increased calicular diameter. Corallites of 2.2–3.5 mm calicular diameter usually have 24 septa; 3.5–6.0 mm, 26–48 septa; and over 5.5 mm calicular diameter, 48–62 septa. Thirty-six septa is a common complement of septa for a corallite of average size, which includes one pair of S₁ in each system. S₁ larger and slightly more exsert (up to 1 mm) than other septa, having smooth, straight upper inner edges, but usually laciniate lower inner edges, the slender septal teeth merging with the columella. Larger paliform teeth or paliform lobes also present on lower inner edges of S₂, sometimes manifested as crispate fascicular laths. If S₃ flank S₂, paliform lobes also occur before the S₃ rising higher in the fossa than the P₂. Septal faces covered with fine pointed granules. Fossa relatively deep. Columella papilllose, consisting of a small field of irregularly shaped crispate laths, often merging indistinguishably with lower paliform lobes.

**DISCUSSION.—**Three valid Recent species of *Cladocora* are known: *C. caespitosa* (Linnaeus, 1767) (eastern Atlantic, 0–50 m); *C. arbuscula* (Lesueur, 1821) (western Atlantic, 0–50 m); and *C. debilis* Milne Edwards and Haime, 1849 (eastern and western Atlantic, 28–100 m). Other species have been described from the western Pacific but have subsequently been assigned to other genera (see Zibrowius, 1980:28), resulting in the Galápagos and Cocos islands specimens being the only known occurrences of the genus outside the Atlantic, a
zoogeographic pattern not unlike that of Oculina. The presumably ahermatypic *C. pacifica* is most easily distinguished from the hermatypic species *C. arbuscula* and *C. caespitosa* by growth form: the two shallow-water species have dense, bushy colonies with highly coalescent branches. *Cladocora pacifica* is clearly most similar to *C. debilis* in growth form, and the two might be considered as a geminate pair. *Cladocora pacifica* differs from *C. debilis* in corallite and branch size, number of septa, and number of growth forms, and the two might be considered as a geminate species pair. *Cladocora pacifica* has a typical calicular diameter of only 3.5 mm, only 24 septa per corallite, and only one crown of *P₂*, whereas *C. pacifica* has calicular diameters up to 7.0 mm, up to 62 septa per corallite, and caliform lobes before the *S₂* and *S₃*. Some specimens of *C. debilis* from the Gulf of Guinea (Zibrowius, 1980) and St. Peter and Paul Rocks (USNM 80814) have large corallites with correspondingly more septa, not unlike those corallites of *C. pacifica*. These equatorial Atlantic specimens should be more carefully compared to typical *C. debilis* and *C. pacifica* to ascertain their status.

**ETYMOLOGY.**—Named pacifica because it is the only species of *Cladocora* known thus far from the Pacific Ocean.

**MATERIAL EXAMINED.**—Holotype: ALB-3367, USNM 84776, Plate 1f-4. Paratypes: ALB-3367 (10) USNM 22103; ALB-3368 (over 100) USNM 22104 (*C. arbuscula* of Marenzeller, 1904b); JSL-1939 (1) USNM 84777; "Galápagos," 100 m (3) USNM 46967 and 79106 (S. Pacific; Wells, 1983). Other material: Velero 143-34 (4) AHF 22.1, 22.2, and 27.1.

**TYPE LOCALITY.**—5°31'30"N, 86°52'30"W (Cocos Island), 185 m.

**DISTRIBUTION.**—Galápagos: Gardner Bay, Española; Wolf. Cocos Island; 45–274 m.

**Family RHIZANGIIDAE** d'Orbigny, 1851

*Culicia* Dana, 1846

4. *Culicia* sp. cf. *C. rubeola* (Quoy and Gaimard, 1833)

**PLATE 1i,j**

*Culicia rubeola.*—Wells, 1954:464-465, pl. 185: figs. 3-6 (synonymy and discussion); 1983:232, pl. 11: figs. 1, 2.

**DESCRIPTION.**—Colonies increase by extratentacular budding from thin, encrusting stolons, each corallite originating only one or two stolons. Stolons often eroded or encrusted by other organisms, sometimes giving an impression that corallites are solitary. Because of the irregularities in the substrate and the lengths of stolons, corallites usually cover only about 50% of the substrate on which they occur. Corallites short (<2.0 mm tall) and cylindrical; irregular, concentric bands of epitheca encircle each corallite. Corallum white.

Septa hexamerally arranged in four cycles, the fourth cycle incomplete (*S₁> S₃> S₃> S₄*), the number of septa apparently a function of calicular diameter. Corallites 3.5–4.5 mm in diameter have 24–30 septa; a large corallite 5.0 mm in diameter may have 40 septa. Upper, outer edges of all septa join epitheca at same level, 0.3–0.5 mm below the calicular edge, which, in well-preserved corallites, produces a thin, nonseptate rim around the upper calice. Nevertheless, *S₁* are exsert, their upper edges usually rising well above the calice in a narrow septal lobe. Inner edges of *S₂* vertical and slightly dentate, laciniate near columella. All other septa nonexsert with laciniate inner edges that slope gradually toward the columella. In well-developed septal systems, pairs of *S₃* fuse to adjacent *S₃* and pairs of *S₄* fuse to adjacent *S₂* Fossa variable in depth, perhaps dependent on the turbulence of the environment, ranging from shallow to moderately deep. Columella papillose and large, consisting of a circular field of granular papillae, often indistinguishable in shape from the laciniate teeth of the higher cycle septa.

**DISCUSSION.**—As is the case with many of the shallow-water ahermatypic genera (e.g., *Madracis*, *Oculina*, *Astrangia*), the species of *Culicia* are in need of revision on a worldwide basis. Approximately 12 Recent species of *Culicia* have been described, probably only half of them valid. The genus was previously only known from shallow water of the Indo-West Pacific, especially common in the Australian and New Zealand temperate regions. In 1983, Wells reported *C. rubeola* from the Galápagos, which was the first record of the genus from the eastern Pacific. The genus is also known from off Hawaii (USNM 78497). Because I have not seen the types of *C. rubeola*, I share Wells' (1954) hesitation in assigning any specimen definitively to *C. rubeola*.

**MATERIAL EXAMINED.**—Onslow, USNM 78892-3 (Wells, 1983); Caleta Iguana, Isabela, USNM 79100 (Wells, 1983); Rábida, CAS 66643; Cousin's Rock, USNM 79101 (Wells, 1983); Santiago, CAS 66656; Genovesa, CAS 66649; Marchena, USNM 84779; Wolf, USNM 46954 (Wells, 1983). Cocos Island: JSL-30-XI-86-2, USNM 80849; JSL-1-XII-86-2, USNM 80850, Plate 1i,j: "Cocos Island," USNM 84780.

**DISTRIBUTION.**—Galápagos: off Isabela, Santiago, Cousin's Rock, Rábida, Santa Cruz, Onslow, Genovesa, Marchena, Wolf, and Darwin; 0–27 m. Cocos Island. Elsewhere (if identified as *C. rubeola*): widespread in central and South Pacific.

5. *Astrangia browni* Palmer, 1928

**PLATE 2a,b**


**DESCRIPTION.**—Colonies cerotid to slightly plocoid, individual corallites closely spaced and project less than 1.0 mm above common basal coenosteum. A large corallum (USNM 46958) measures 58 × 32 mm in size, consisting of about 50 corallites encrusting a volcanic rock. Calices circular to irregular in
shape, 3.0–5.1 mm in diameter. Costae indistinct, very short or absent, the latter condition present in short corallites. Costae, when present, are equal in width, slightly rounded, and relatively smooth. Coenosteum and corallites white; polyps when present, are equal in width, slightly rounded, and absent, the latter condition present in short corallites. Costae, shape, 3.0-5.1 mm in diameter. Costae indistinct, very short or 


corallites with 24 septa. Primary septa slightly exsert, their edges coarsely dentate on the vertical upper half, and more but never attain the columella. Fossa shallow. Columella quite laciniate inner edges that sometimes fuse to an adjacent septum the lower teeth merging indistinguishably with the columella. Fossa finely dentate to laciniate on the lower almost horizontal half, brown to reddish brown; polyps pink.

Septa arranged in two size classes: 12:12 (24 septa) to 21:21 (42 septa), hexameral symmetry apparent only in those corallites with 24 septa. Primary septa slightly exsert, their edges coarsely dentate on the vertical upper half, and more finely dentate to laciniate on the lower almost horizontal half, the lower teeth merging indistinguishably with the columella. Secondary septa much smaller, sometimes rudimentary, with laciniate inner edges that sometimes fuse to an adjacent septum but never attain the columella. Fossa shallow. Columella quite large, consisting of a circular field of numerous papillae.

**DISCUSSION.**—Although I have not examined the type of *A. browni*, its description and illustrations match the Galapagan specimen, except that the corallites of the Galapagan specimens are larger (those of the type are only 2.5-3.0 mm) and have correspondingly more septa (corallites of the type have only 28–30 septa).

Wells’ (1983) synonymy of *A. gardnerensis* with *A. browni* is difficult to understand and may represent an error of placement, because the type of *A. gardnerensis* is clearly more similar to *A. equatorialis* (in fact synonymous) than the Galapagan specimen he identified as *A. browni*.

**MATERIAL EXAMINED.**—Caleta Iguana, Isabela, USNM 46958 (Wells, 1983), Plate 2a,b. Reference Specimen: holotype of *A. gardnerensis*, AHF 30.1.

**DISTRIBUTION.**—Galápagos: Caleta Iguana, Isabela; 5 m. Elsewhere: west of Puerto Angel, Oaxaca, Mexico; intertidal (Palmer, 1928).

### 6. *Astrangia equatorialis* Durham and Barnard, 1952

**PLATE 2c-f**

*?Astrangia browni* Palmer, 1928:27–29, pl. 1: figs. 1, 2.


**DESCRIPTION.**—Colonies plocoid; corallites closely adjacent and united basally by a thick, encrusting, common coenosteum. Individual corallites usually project above coenosteum as much as 2.5 mm. Largest colony examined 65 x 41 mm in size (Wells, 1983) consists of about 120 corallites that encrust a volcanic rock. Calices circular, elliptical, or irregular in shape; calices 2.5-3.5 mm in greater calicular diameter. Costae equal (about 0.25 mm wide), low, and rounded, covered by a very coarse granulation that extends to basal coenosteum. Intercostal striae shallow and often indistinct. About 1 mm below calicular edge there is often an epithelial ridge below which the costae are either encrusted or eroded. Coenosteum and corallites light brown to reddish brown; polyps pink.

Septa hexameraly arranged in four incomplete cycles (24–36 septa), apparently dependent on calicular diameter. S₁ slightly exsert and narrow, with vertical, highly dentate to laciniate inner edges. S₂-₅ progressively less wide, but having laciniate inner edges. Septal faces covered by large, pointed granules up to 85 μ tall. Fossa moderately deep, dependent on height of corallite. Columella consists of a tangle of 5-10 elongate septal teeth (paliform lobes?) of the S₁ and sometimes the S₂.

**DISCUSSION.**—Despite Durham and Barnard’s (1952) separation of *A. equatorialis* and *A. gardnerensis* based on the characters of fossa depth and length of paliform lobes, a reexamination of the types (both from the same locality) and additional material from the Galápagos show these characters to be within the range of variation of one species. The synonymy of *A. gardnerensis* with *A. browni*, as implied by Wells (1983), is questioned. Although *A. browni* has calices of the same range of calicular diameters and a similar number of septa per corallite, its corallum is ceroïd (not plicoid) and its septa are of only two size classes (not three or four size classes as in *A. equatorialis*). The type of *A. browni* was not examined.

**MATERIAL EXAMINED.**—Holotype of *A. equatorialis*, Velero 31-33, AHF 29.1, Plate 2e; holotype of *A. gardnerensis*, Velero 31-33, AHF 30.1; Caleta Iguana, Isabela, USNM 46958 (Plate 2d) and 78891 (Wells, 1983); “Galápagos,” USNM 78890, Plate 2e, f.

**DISTRIBUTION.**—Galápagos: Caleta Iguana and Urvina Bay, Isabela; Onslow; Gardner Bay and Osborn Island, Española (Durham, 1962); Genovesa (Durham, 1962); Darwin (Wells, 1983); 0–15 m.

### 7. *Astrangia dentata* Verrill, 1866

**PLATE 2g**


**DISCUSSION.**—Durham (1962) reported *A. dentata* from Cocos Island, but did not include a description or illustration of the specimen. It is presumed to be deposited at the Hessisches Landesmuseum, Darmstadt, Germany; however, it was not examined. For this reason, and because there are so many nominal species of *Astrangia* described from the eastern Pacific (see Durham and Barnard, 1952), this record is queried. The original description of this species (Verrill, 1866) has been reproduced by Verrill (1870) and Durham (1947).

**MATERIAL EXAMINED.**—Syntypes of *A. dentata*, YPM 5376, Plate 2g.

**DISTRIBUTION.**—?Cocos Island; 8 m (Durham, 1962). Elsewhere: Panama, Pearl Islands, San Salvador, Acapulco, La Paz; 0–15 m (Verrill, 1866).
Oulangia Milne Edwards and Haime, 1848

8. Oulangia bradleyi Verrill, 1866

**PLATE 2A:i**

*Oulangia bradleyi* Verrill, 1866:333; 1870:534-535, pl. 9: fig. 10.—Pourtales, 1875:283.—Marenzeller, 1904b:75.


**DESCRIPTION.**—Colonies increase by extratentacular budding from stolons, but isolated corallites also common. Intratentacular budding also occurs. Corallites short (rarely over 8 mm tall), and cylindrical, usually slightly greater in diameter at base. Base polycyclic, having up to five concentric theca. Calices circular to elliptical, up to 15 x 13 mm in diameter. Theca usually heavily encrusted with bryozoans and calcareous algae up to calicular edge; however, theca, when visible, consists of broad, slightly convex granular costae, separated by very shallow, narrow intercostal striae. Coralla are circular, about 3.5 mm in diameter. This form is easily distinguished from the numerous other eastern Pacific rhizangiids by its relatively large size and higher number of septa.

Septa hexamerally arranged in five cycles, the fifth cycle usually incomplete, the number of septa dependent on corallum size. Small corallites of 3.5-5.0 mm have 48 septa; 5.0-12.5 mm, 48-70 septa; and over 14 mm calicular diameter, 90-96 septa. S1, exsert: their upper edges slightly dentate to smooth and project well into fossa; their inner edges vertical; their lower inner edges bearing laciniate teeth. S2 smaller than S1 and bear thickened laciniate septal teeth along most of their margins. S3 smaller still, bearing slender laciniate teeth along entire margin, pairs of S2s often joined to adjacent S2. S4s rudimentary, with laciniate inner edges. Inner edges of S3s, slope gradually toward columella and are sometimes porous. Septal faces bear sparse, pointed granules; granulation on septal teeth and columella slightly more prominent. Fossa moderately deep and evenly concave (bowl-shaped). Columella composed of a circular field of spiny papillae forming the concave base of the fossa.

**DISCUSSION.**—*Oulangia bradleyi* is easily distinguished from the other eastern Pacific rhizangiids by its relatively large size and number of septa.

**MATERIAL EXAMINED.**—Off Punta Almendares (8), Bahia Urvina (1), and Perry Isthmus (1), Isabela, USNM 46959 (Plate 2h,i), 78895, (Wells, 1983); Cowley Island, Isabela (1) CAS 66654; off Guy Fawkes Island, Santa Cruz (2) CAS 17911; unknown ALB-station (6) USNM 22075 (Marenzeller, 1904b); Velero 275-34 (1) AHF 39.1 (Durham and Barnard, 1952); Panama Canal, USNM 78841 (Wells, 1983); Playa Grande, Pearl Islands (1) USNM 81369; syntype of *O. bradleyi* from Pearl Islands (1) YPM 5374.

**DISTRIBUTION.**—Galápagos: off Isabela and Santa Cruz (see "Material Examined"); 0-14 m. Elsewhere: off Pacific Panama, Mexico (Durham and Barnard, 1952), and Ecuador (Wells, 1983); 0-64 m.

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Family OCULINIDAE Gray, 1847

9. Madrepora Linnaeus, 1758

**PLATES 2j, 3a-d**


**DISCUSSION.**—*Madrepora oculata* is an extremely variable species, some of its variation described and illustrated by Zibrowius (1974a) and Cairns (1979, 1982). Zibrowius (1974a) synonymized or implied the synonymy of most of the Recent nominal species of *Madrepora*, including *M. galapagensis*, as *M. oculata*, which results in one species with a worldwide distribution and a range of 80–1500 m. Although I (Cairns, 1979) previously maintained the distinction of *M. galapagensis*, after seeing additional specimens from the Galápagos and Subantarctic (Cairns, 1982), I now concur with Zibrowius in considering *M. galapagensis* a junior synonym of *M. oculata*. I can not offer a full resolution to the species problem in the genus *Madrepora*, but in the context of this revision note that there are four distinctive forms of *Madrepora* in the study material from the Galápagos. The forms are referred to as *M. oculata* forma *galapagensis* (Vaughan, 1906), forma *alpha* (including Marenzeller’s (1904b) specimens), and forma *gamma* (illustrated by Wells, 1983), and are briefly diagnosed below.

*Madrepora oculata* forma *galapagensis* is a bushy deep-water form (166–547 m) with dense brown coenosteum, bearing linear to reticulate intercostal striae. Calices are 3.6–4.0 mm in diameter. The septal formula is S1=S2=S3, the inner edges of the S1, reaching the columella and often greatly thickened (especially the S3), sometimes as paliform lobes. S2 are quite exert and S3 are small to rudimentary. The fossa is moderately deep and contains dense stereome and a rudimentary, crispate columella.

*Forma alpha* is similar to forma *galapagensis*, being a bushy to encrusting deep-water (545–806 m) form with dense brown coenosteum. However, its C1–2 are slightly ridged and its corallites are much smaller (<2.5 mm in diameter). Septa are arranged S1>S2>S3, both S1–2 reaching the columella but without inner paliform lobes. S2 are well developed. The fossa is very shallow, with a massive columella.

*Forma beta* is an openly branching, flabellate, deep-water (545–806 m) growth form with dense, brown coenosteum. The coenosteum is relatively smooth, with no raised costae. Calices are circular, about 3.5 mm in diameter. This form is distinguished by its septal arrangement: all septa are nonexsert; only the six S1 reach the center of the fossa; S2–4 are very reduced or missing. The lower, inner edges of the S1 join to...
form a rudimentary columella deep in the fossa, but there is no thickening of their inner edges. The fossa is deep and straight.

Forma gamma is the most distinctive of the forms, being a delicate, bushy, shallow-water (15–24 m) phenotype with a low-density corallum. The white coenosteum is highly granular and bears ridged C1–2; Calices are 3.5–4.0 mm in diameter but often irregular in shape. Septal formula: S1 > S2 > S3; S1 exsert; S3 rudimentary or missing. Inner edges of S1–2 not thickened, only the S1, meeting at the base of the fossa. Fossa extremely deep and usually curved, obscuring base of fossa. Columella rudimentary or absent.

MATERIAL EXAMINED.—Forma galapagensis: ALB-4642 (types) USNM 68276 (Plate 2j) and 77275; JSL-1911, USNM 84782; JSL-1914, USNM 84783, Plate 3b; JSL-1924, USNM 84781; JSL-1926, USNM 84784; JSL-1935, USNM 84785.

Forma alpha: JSL-1916, USNM 84786, Plate 3a; JSL-1929, USNM 84787.

Forma beta: ALB-2818, USNM 36377, Plate 3c; ALB-3401, USNM 22085 (Marenzeller, 1904b); JSL-1915, USNM 84789; JSL-1916, USNM 84791; JSL-1921, USNM 84790; JSL-1929, USNM 84788.

Forma gamma: Tagus Cove, Isabela, USNM 46961 (Wells, 1983), Plate 3d; off Española, USNM 79099 (Wells, 1983).

DISCUSSION.—Forma galapagensis: off Fernandina, Santiago, Santa Cruz, Floreana, and Española; 166–547 m. Forma alpha: west of Española and Roca Redonda; 545–806 m. Forma beta: off Santa Cruz, San Cristóbal, Españaola, Genovesa, and Roca Redonda; 545–806 m. Forma gamma: Tagus Cove, Isabela and off Española; 15–24 m. Elsewhere: cosmopolitan except for off continental Antarctica (Cairns, 1982); 80–1500 m.

Oculina Lamarck, 1816

10. Oculina profunda, new species

PLATES 3e–g, 4a,b

“Oculinidarum gen.? sp.?”—Marenzeller, 1904b:79.


DESCRIPTION.—Colony openly branched, with infrequent branch anastomosis. Colony size and attachment unknown; species known only from broken branch fragments, the largest (holotype) 7 cm long and 6 mm in greater branch diameter. Corallites distributed uniformly on branch, spaced 1.0–3.5 mm apart, being more crowded toward branch tips. Occasionally corallites at branch tips arranged in alternating, symподial fashion. Corallites circular to elliptical, elliptical corallites more common at branch tips, about 2.6 x 3.7 mm in diameter, the greater diameter aligned with branch axis. Circular corallites 2.0–3.0 mm in diameter. Corallites slightly exsert (up to 1.0 mm), oriented at a right angle to larger-diameter branches but oriented apically on lesser-diameter branch tips. Coenos-
California; 119-578 m. ?Pleistocene of Mexico (Palmer, 1928).

Suborder CARYOPHYLLINA Vaughan and Wells, 1943
Family CARYOPHYLLIDAE Gray, 1847

Caryophyllia Lamarck, 1801

DIAGNOSIS.—Corallum solitary, attached or free: if attached, corallum cylindrical, trochoid, or ceratoid; if free, corallum usually cornute with a nonreinforced pedicel. Calice circular, elliptical, or compressed; thecal edge spines or crests present on species having compressed coralla. Septal symmetry quite variable, including hexameral, octameral, decameral, and various multiples of 12-20; however, hexameral symmetry with four cycles of septa most common pattern. One crown of pali present before penultimate cycle of septa (usually S3); pali rarely present before antepenultimate cycle. Columella fascicular, usually composed of one to several tightly twisted laths, but may also be composed of a field of rod-like papillae.

TYPE SPECIES.—Madrepora cyathus Ellis and Solander, 1786, by subsequent designation (Broderip, 1828).

Subgenus Caryophyllia (Caryophyllia) Lamarck, 1801

DIAGNOSIS.—Caryophyllia in which the calice is circular to elliptical (not compressed) and does not bear thecal edge spines or crests.

DISCUSSION.—Wells (1956) listed three subgenera of Caryophyllia: nominate, Acanthocyathus, and Premocyathus. The latter is now considered as a separate genus and Acanthocyathus is easily distinguished by its edge spines or crests. Despite this parsing of the genus, the remaining nominate subgenus contains the greatest number of species of any ahermatypic genus: 56 valid Recent species and subspecies (Table 3) and approximately 185 nominal fossil species, many of the latter described as Ceratocyathus and undoubtedly including many junior synonyms. In view of the large number of Recent species of Caryophyllia and because three species of Caryophyllia are described from the Galápagos (two of them as new species), it was thought appropriate to examine the descriptions and reference specimens (if possible) of all Recent species and to devise a method of subdividing this subgenus in order to facilitate comparisons.

An easily observable and ecologically and morphologically fundamental difference among the species of Caryophyllia concerns whether or not the pedicel of the corallum is subsequently reinforced with stereome. If reinforced, the corallum is invariably attached to a substrate and stands upright in relation to the substrate. If the pedicel is not reinforced, the original attachment is usually broken, the corallum becomes free, and often (perhaps in an attempt to right itself) becomes cornute in shape. This character can be used to separate the Recent species into 41 “attached” species and subspecies and 15 “unattached” species and subspecies. Some authors (e.g., Chevalier, 1961) have employed the subgenus Ceratocyathus Seguenza, 1863, for the unattached, free species. Squires (1958) used this distinction to help characterize his five “groups” of Indo-West Pacific Caryophyllia. However, Zibrowius (1980) cautioned against using this character at the subgeneric level because of the intermediate nature of some species, the variation found within some species, and the difficulty of diagnosing this character in poorly preserved fossil species.

Another useful level of discrimination that usually represents a valid species-level character in the genus is that of septal symmetry. Sometimes the number of septa and apparent septal symmetry changes as the corallum increases in size, but usually the adult symmetry is fixed and can be determined. Septal symmetry varies greatly among the species of Caryophyllia; among the 41 attached taxa, 24 have hexameral symmetry, 4 octameral, 7 decameral, and 6 have symmetry that appears to change with calicular diameter. The same criterion can be applied to the unattached species (Table 3).

Among the 24 attached species and subspecies with hexameral symmetry, a third criterion, that of number of adult septal cycles, can be applied: 19 have four cycles (48 septa) and 5 have five cycles (96 septa). Squires (1958) also used this character in concert with the state of the corallum base to distinguish his five species groups. To further discriminate among the 19 attached hexameral species with four cycles of septa, characters such as relative septal exsertness and size, septal sinuosity, development of the columella, and corallum size and shape must be considered.

DISTRIBUTION.—Upper Jurassic to Recent, cosmopolitan, 0-3200 m (Keller, 1981).

11. Caryophyllia diomedeae Marenzeller, 1904

PLATE 4c-e

Caryophyllia diomedeae Marenzeller, 1904b:79-80, pl. 1: fig. 2.
Not Caryophyllia diomedeae.—Durham and Barnard, 1952:82, pl. 9: fig. 43
[= C. solida].

DESCRIPTION.—Corallum tall (up to 30 mm) and ceratoïd, attached by a narrow pedicel 30%-40% diameter of calice. Calice elliptical: GCD:LCD ranging from 1.1-1.3; largest corallum (JSL-1933) 13.1 mm in greater calicular diameter. Costae alternate in width and expression: C4 flat and broad (0.6-0.8 mm wide), C1-3 slightly ridged and often narrower (0.6 mm). Theca porcellaneous and milky white, not granular.

Septal formula: S1>S2>S3>S4, 48 being the typical complement of septa regardless of corallum size. Inner margins of S1,2,4 straight; those of S3 quite sinuous. P3 broad (up to 1.4 mm wide), each separated by a deep and narrow notch from corresponding S3. Septal face granules 0.2 mm tall; those of
TABLE 3.—Tabulation of 56 species and subspecies of Recent Caryophyllia (Caryophyllia) based on nature of attachment (A = attached; U = unattached), septal symmetry, number of septa, and geographic distribution (1 = Western Atlantic, 2 = Eastern Atlantic, 3 = Antarctic/Subantarctic, 4 = Eastern Pacific, 5 = Central Pacific, 6 = Australia/New Zealand Region, and 7 = Indo-West Pacific).

<table>
<thead>
<tr>
<th>Species</th>
<th>Attachment</th>
<th>Septal symmetry</th>
<th>Number of septa</th>
<th>Geographic distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. berteriana</em> Duchassaing, 1850</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><em>C. formosa</em> Pourtalès, 1867</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><em>C. polyopa</em> Pourtalès, 1878</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><em>C. horologium</em> Cairns, 1977</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><em>C. corrugata</em> Cairns, 1979</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><em>C. parva</em> Cairns, 1979</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><em>C. calveri</em> Duncan, 1873</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>C. sarsiae</em> Zibrowius, 1974</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>C. alaskana</em> Vaughan, 1900</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>C. arnoldi</em> Marenzeller, 1904</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>C. abscondita</em> Marenzeller, 1904</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>C. alcocki</em> Moseley, 1881</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>C. angelina</em> Moseley, 1881</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>C. antarclica</em> Marenzeller, 1888</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>C. barbadensis</em> Alcock, 1891</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>C. paraoctopali</em> Alcock, 1902</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>C. smithii</em> Stokes and Broderip, 1828</td>
<td>A</td>
<td>x6</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Generic attribution of *C. gigas* van der Horst, 1931, uncertain, but thought to be a parasmiliid.

pali 0.3 mm tall. No carinae on septal or palar faces. Fossa moderately deep. Fascicular columella consists of 5–8 slender twisted laths recessed below level of pali.

DISCUSSION.—Durham and Barnard’s (1952) records of *C. diomedeae* from the Galapagos and off Panama do not pertain to this species, as Wells (1983:235) implied for the Galapagan record. The specimen reported by Wells (1983) from ALB-2808 is too small and poorly preserved to accurately identify, but its costal granulation suggests an identity of *C. solida*.

The three specimens from Cocos Island are only tentatively identified as *C. diomedeae*. Two of the three specimens (Marenzeller’s (1904b) Caryophyllia sp. and JSL-1983) are seemingly identical to *C. diomedeae* but are queried because of their poor preservation. The third specimen (JSL-1983) is well preserved and very similar to *C. diomedeae*, differing only in having granular and a much better developed costae. The skeletal variation of this species, known from less than a dozen specimens, is not yet adequate to determine accurate species limits.

In comparing *C. diomedeae* to the other 18 attached, hexamerally symmetrical species of Caryophyllia with four cycles of septa, it was found to be remarkably similar to *C. sarsiae* Zibrowius, 1974 (eastern Atlantic and Bermuda, 520–2200 m). The only differences noted were that the coralla of *C. sarsiae* attained a larger size and were more robust, and lacked the G1–3 costal ridges (Plate 4f).

Likewise, judging from the description and figures of Alcock
junior synonym of C. Marenzeller, 1888. 

Marenzeller’s (1904b) original description of C. diomedeae was apparently based on two specimens from ALB-3358, which must be considered as syntypes. His figured specimen is deposited at the USNM (22083); the deposition of the other syntype was not traced.

**MATERIAL EXAMINED.**—JSL-1916 (2) USNM 84793; JSL-1929 (1) USNM 84794; JSL-1933 (2) USNM 84795; JSL-1938 (1) USNM 84796, Plate 4c; JSL-1942 (1) USNM 84787; ALB-3358 (syntype) USNM 22083, Plate 4c,d; ALB-3370 (1) USNM 22082 (C. sp. of Marenzeller, 1904b). Reference Specimens: Velero 948-39 (1) AHF 43.2 (C. diomedeae of Durham and Barnard, 1952); ALB-2808 (1) USNM 36429 (C. diomedeae of Wells, 1973).

**DISTRIBUTION.**—Galápagos: off Fernandina, Españaola, Roca Redonda, Cocos Island; 245–806 m. Elsewhere: off Panama; 1043 m (Marenzeller 1904b).

### 12. Caryophyllia percula, new species

**PLATE** 5a,b,d

*Caryophyllia diomedeae*—Durham and Barnard, 1952:82 [part: Velero 948-39], pl. 9 fig. 43.

**DESCRIPTION.**—Corallum ceratoid, with a circular to slightly elliptical calice. Holotype 7.6 mm in calicular diameter (circular) and 12.6 mm tall; however, its slightly bent pedicel is broken above the point of attachment. Only upper 0.5–1.0 mm of theca covered by coenosarc, the lower part highly eroded, a yellowish brown in color. Nonetheless, faint intercostal striae can sometimes be seen on the theca, delimiting equal costae about 0.5 mm wide, uniformly covered by low, rounded granules 0.10–0.12 mm in diameter. Upper, intact thecal glisteny white, that of holotype displaying concentric epithecal bands.

Septa decamerally arranged in three cycles (10 : 10 : 20=40 septa), even a specimen only 4.0 mm in calicular diameter having 40 septa and 10 pali. Ten primary septa moderately exert (1.5 mm above calicular edge), with vertical, only slightly sinuous inner edges that attain about 85% distance to columella. Ten secondary septa less exert (0.8 mm) and about 2/3 width of primary septa (or extending about 57% distance to columella). Twenty tertiary septa, although less exert than secondaries (0.5 mm), extend an equal or greater distance toward the columella (57%–67% of distance). Septal faces covered by blunt granules about 0.10 mm tall, the granulation replaced by long (up to 0.8 mm), low (0.1 mm), obliquely oriented carinae on the lower inner septal edges. A ring of 10 wide (0.75 mm) pali occurs before the secondary septa, each palus separated from its corresponding septum by a narrow gap of about 0.07 mm, i.e., 1/10 the palar width. Palar edges highly sinuous, the palar faces bearing tall (0.25 mm) obliquely oriented carinae that completely traverse the pali, giving the pali the appearance of even greater sinuosity. Upper edges of pali terminate about 1 mm below calicular edge. Fossa relatively deep, the pali crown 1 mm deep and the columella about 2 mm deep within the fossa. Fascicular columella composed of up to six orally twisted laths.

**DISCUSSION.**—Durham and Barnard’s (1952) C. diomedeae from Bahia Honda, Panama, is clearly C. percula. The other two specimens reported by Durham and Barnard as C. diomedeae from the Galápagos (Velero 170-34) were not examined.

Among the six other species of decamerally symmetrical attached Caryophyllia, C. percula is most similar to C. hawaiiensis Vaughan, 1907, both species having coralla of about the same size and shape, and tertiary septa that are wider than the secondary. Caryophyllia percula is distinguished by its orally carinate septal and palar faces and lack of thecal granulation. Caryophyllia percula also seems to be similar to C. quadrageneria Alcock, 1902 (East Indies, 112–281 m), based on the description; however, as in the case of C. hawaiiensis, C. percula differs in its septal and palar ornamentation and lack of thecal granulation. Furthermore, both C. hawaiiensis and C. quadrageneria have a purplish brown upper thecal margin, an unusual character not shared with C. percula and one that indicates a possible synonymy of the Hawaiian and East Indian species. Several other species of Caryophyllia have orally carinate septal and palar faces, such as C. vaughani; C. alberti Zibrowius, 1980; C. antarctica Marenzeller, 1904a; and C. rugosa Moseley, 1881; however, the septal symmetry of these species is not decameral.

**ETYMOLOGY.**—The species name is from the Latin *percula* (highly adorned), alluding to its ornately carinate septal and palar faces and twisted columnellar laths.


**TYPE LOCALITY.**—0°59.8’S, 91°27.1’W (off Caleta Iguana, Isabela), 315–316 m.

**DISTRIBUTION.**—Galápagos: off Caleta Iguana and Tagus Cove, western Isabela; Floreana. Cocos Island; 105–316 m. Elsewhere: Medidor Island, Bahia Honda, Panama; 54–64 m (Durham and Barnard, 1952).

### 13. Caryophyllia solida, new species

**PLATE** 5c,e, f


**DESCRIPTION.**—Corallum subcylindrical and short, firmly attached to substrate through a thick pedicel and thin encrusting base. Largest specimen (JSL-1926) 12.3 × 12.2 mm in calicular diameter and 19.8 mm tall; holotype 11.3 × 11.0 mm in
The species name is from the Latin _solida_ (solid), alluding to the solid, robust nature of the corallum.

**Material Examined.**—Holotype: JSL-1924, USNM 84804, Plate 5e,f. Paratypes: JSL-1924 (8) USNM 84805; JSL-1926 (1) USNM 84806, Plate 5c; JSL-1935 (1) USNM 84807; ALB-2808 (1) USNM 36429 (C. _diomedeae_ of Wells, 1983).

**Type Locality.**—0°03.9'N, 90°19.2'W (seamount north of Santiago), 373-430 m.

**Distribution.**—Galápagos: southeast of Fernandina; north of San Cristóbal (Wells, 1983); north of Santiago; 373-488-71160 m.

**Concentrotheca Cairns, 1979**

**14. Concentrotheca vaughani, new species**

**Plate 4g-i**

**Description.**—Corallum cylindrical, tapering little, if any, toward polycyclic base. Corallum firmly attached, having, in addition to the thick pedicel, a thin peripheral expansive base. Three of the seven coralla examined (including the holotype) show signs of rejuvenescence from a parent corallum of larger diameter. Calices circular to slightly elliptical. Holotype (largest specimen) 6.7 mm in calicular diameter and 9.9 mm tall; however, its pedicel is broken above point of attachment. Only upper theca covered by coenosarc, the lower theca eroded. Theca uniformly covered by small, low granules with no evidence of costae. Upper theca and septa light brown.

Septa hexamerally arranged in four cycles, the fourth incomplete: the largest specimen lacking one pair of _S_4 (46 septa); a specimen with a greater calicular diameter of 5.8 mm lacks two pairs of _S_4 (44 septa); and other specimens 3.4-4.3 mm in calicular diameter have 36-42 septa. Six _S_1 moderately exsert (up to 1 mm), having vertical, straight to slightly sinusous inner edges. Upper edges of _S_1 project deeply into fossa, creating a well-defined hexameral symmetry for each corallum; lower inner septal edges attain the columella. _S_2 equally exsert as _S_1 but their inner edges are not vertical; they slope slightly toward the columella and only attain 0.9 the distance to columella. _S_3-4 progressively less exsert and wide. Septal faces covered by small granules about 0.08 mm tall and, on higher cycle septa _S_2-4, low carinae are obliquely oriented on the lower inner septal edges (Plate 4i). Small _P_3 (0.4-0.6 mm wide) occur deep in the fossa, forming an indistinct crown just above the colunella. In half-systems lacking pairs of _S_4, a palus is usually present before the _S_2, maintaining the penultimate palar position. Owing to the great depth of the fossa of the holotype, the small _P_3 are barely visible, appearing as small appendages to the extreme lower, inner septal edges, but, nonetheless, are well differentiated from the colunellar elements. Pali highly sinusous and also covered with thick, elongate carinae. Fossa deep, approximately 4 mm in the holotype. Colunella papillose, composed of a circular field of 10-15 irregularly-shaped rods, each 0.2-0.3 mm in diameter.

**Discussion.**—The genus _Concentrotheca_ is very similar to _Caryophyllia_, but differs primarily in having a polycyclic base and a papillose colunella. Only one other species is known in the genus, the type species _C. laevigatus_ (Pourtalès, 1871), which is known only from the western Atlantic and Azores (183-800 m). _Caryophyllia vaughani_ differs from the type species in having consistently hexameral symmetry, a relatively thin thecal wall, carinate septal faces, and narrow notches separating pali from their corresponding septa.


**Crispatrochus Tenison Woods, 1878**


*Cythoceras* Moseley, 1881:156.

**DIAGNOSIS.**—Corallum solitary, ceratoid to turbinate, and firmly attached through a robust pedicel. Theca costate or porcellaneous, Septal symmetry hexameral (48–96 septa) or decameral (40 septa). Pali absent. Columella fascicular and usually robust, composed of 2–30 twisted laths.

**DISCUSSION.**—Crispatrochus, as described by Tenison Woods (1878) and defined by the holotype of its type species (*C. inornatus*, off Port Stephens, N.S.W., Australia), clearly belongs to the same genus as those species subsequently described as *Caythoceras*. Because *Crispatrochus* has nomenclatural priority by three years, those species formerly placed in *Caythoceras* must be transferred to *Crispatrochus*. It should be noted that Chevalier (1987) considered *Crispatrochus* as a subgenus of *Edwardstrochos* Chevalier, 1961, separate from *Caythoceras* but a senior synonym of *Labyrinthocyathus* Cairns, 1979.

A review of the literature reveals that 12 species can be assigned to *Crispatrochus*, and, as with *Caryophyllia*, they may be grouped based on septal symmetry. Eight species have hexameral symmetry: *Crispatrochus inornatus* Tenison Woods, 1878; *C. cornu* (Moseley, 1881); *C. rubescens* (Moseley, 1881) (= *Caythoceras diomedeae* Vaughan, 1907); *C. tydnani* (Alcock, 1902) (? = *C. rubescens*); *C. niiioi* (Yabe and Eguchi, 1942); *C. foxi* (Durham and Barnard, 1952); *C. irregularis* (Cairns, 1982); and *C. galapagensis*, new species, and four species have decameral symmetry: *C. woodsi* (Wells, 1964); *C. squirei* (Cairns, 1979); *C. sp. cf. C. cornu* (Cairns, 1979); and *C. sp. A* (Cairns, 1982). Four other species previously assigned to *Caythoceras* have been transferred to other genera: *C. quaylei* Durham, 1947, and *C. kondoi* Wells, 1977, to *Labyrinthocyathus*; and *C. avis* and *C. hoodensis* (Durham and Barnard, 1952) to *Pseudocyathoceras*, a new turbinoloid genus described herein. In addition to septal symmetry, other characters of systematic value include number of septal cycles, relative exsertness of septal cycles, corallum size, and columella size.


**ETYMOLOGY.**—Named in honor of T.W. Vaughan (1870–1952) for his many contributions to scleractinian taxonomy (see Thompson, 1958), including the description of new species from the Galápagos (Vaughan, 1906).

**MATERIAL EXAMINED.**—Holotype: JSL-1937, USNM 84802, Plate 4h. Paratypes: JSL-1932 (6) USNM 84803, Plate 4g.i.

**TYPE LOCALITY.**—0°59.8’S, 91°27.1’W (off Caleta Iguana, Isabela), 315–316 m.

**DISTRIBUTION.**—Galápagos: off Tagus Cove and Caleta Iguana, Isabela; 313–316 m.

**Crispatrochus galapagensis**, new species

**PLATE 5g,a**


**DESCRIPTION OF HOLOTYPE.**—Corallum ceratoid: 7.6 x 7.1 mm in calicular diameter, 11.0 mm tall, and firmly attached to substrate through a pedicle 3.8 mm in diameter, which expands into an encrusting base approximately 6.5 mm in diameter. Costae indistinct, slightly incised only near calicular edge. Theca smooth, porcellaneous, and white, masking an underlying granulation.

Septa hexameral arranged in four complete cycles (48 septa). S1,2 equal in size and highly exsert (up to 1.6 mm), with extremely sinuous, vertical inner edges that fuse to the columella at their lower edges. S3 less exsert (up to 1.2 mm), with slightly less sinuous inner edges, extending about 0.8 distance to columella. S4 quite small, extending only about one third distance to columella, and have slightly sinuous inner margins. Septal face granulation consists of sparse, low granules about 0.10 mm tall. Fossa nonextant, being entirely filled with a fascicular columella consisting of 6 or 7 broad, loosely twisted laths interconnected among themselves. Tips of columellar laths extend slightly above calicular edge.

**DISCUSSION.**—The three paratypes from JSL-1929 differ from the holotype in several characters, all of which are considered to fall within the range of variation for this species. These specimens have better-defined costae and tangible thecal granules about 0.08 mm in diameter. Their S4 are slightly larger than the S2 and their septal face granules are approximately twice the height (0.2 mm) as those of the holotype. Their columellae are not exsert, but recessed about 1 mm within the fossa.

Among the eight species of hexameral symmetrical *Crispatrochus*, most have in excess of four cycles of septa: either an incomplete fifth cycle (e.g., 2–60 septa) or a complete fifth cycle (96 septa). Only two species, the Australian *C. inornatus* and *C. galapagensis* have only four cycles of septa.

They are differentiated on the basis of relative septal exsertness (S1,2 less exsert in *C. inornatus*), sinuosity of inner septal edges (straight in *C. inornatus*), and nature of the columella (over 30 narrow twisted laths in *C. inornatus* vs. 6–7 broad laths in *C. galapagensis*). Disregarding symmetry, *C. galapagensis* is remarkably similar to the western Atlantic decameral species *C. sp. cf. C. cornu* described by Cairns (1979).

**ETYMOLOGY.**—Named for the archipelago from which it was discovered, the Galápagos Islands.

**MATERIAL EXAMINED.**—Holotype: JSL-1931, USNM 84808. Paratypes: JSL-1911 (1) USNM 85222; JSL-1913 (1) USNM 84809; JSL-1929 (3) USNM 84810; JSL-1935 (1)
USNM 84811. Reference Specimen: holotype of C. inornatus, Macleay Museum, University of Sydney.

TYPE LOCALITY.—0°10.3'S, 91°24.7'W (off Tagus Cove, Isabela), 441–525 m.

DISTRIBUTION.—Galápagos: southwest of Fernandina; off Tagus Cove, Isabela; north of Floreana; off Santa Cruz; and off Roca Redonda; 84–806 m.

Paracyathus Milne Edwards and Haime, 1848

16. Paracyathus humilis Verrill, 1870

PLATE 6a,b

Paracyathus humilis Verrill, 1870:538.—Durham and Barnard, 1952:92, pl. 12, fig. 54a,b.—Wells, 1983:235–236, pl. 13: figs. 5, 6.

DESCRIPTION OF GALAPAGAN SPECIMENS.—Corallum ceratoid and firmly attached through a thick pedicel and polycyclic base. Illustrated specimen (Plate 6a) 5.5 mm in calicular diameter and 10.2 mm tall, with a pedicel diameter of 3.7 mm. Theca and all calicular elements light brown. Costae equal, rounded, and slightly granular; lower theca encrusted.

Septa hexamerally arranged in four incomplete cycles according to the formula $S_1>S_2>S_3>S_4$, the largest specimen missing one pair of $S_4$ (46 septa). Inner edges of all septa straight. $P_1$ variable in width but usually slender yet still lamellar, forming the innermost palar crown directly adjacent to columella. Crown of six $P_2$ also slender, slightly recessed from columella, and rises higher in fossa than $P_3$. $P_3$ sometimes quite broad, rise higher in fossa and recessed farther from columella than $P_2$. $P_3$ sometimes have 2 or 3 very slender accessory paliform lobes on inner margins. Palar granulation much coarser than that of septa, but not carinate. Fossa shallow. Papillose columella composed of a field of 15–20 slender, irregularly shaped rods recessed within the palar crowns.

DISCUSSION.—Five species of Paracyathus are known from the eastern Pacific: P. clathra Verrill, 1869; P. stearnsi Verrill, 1869 (= P. pedroensis Verrill, 1903); P. humilis Verrill, 1870; P. montereyensis Durham, 1947; and P. tiburonensis Durham, 1947. Another undescribed species was alluded to by Durham (1957) from Clipperton Island. Only two of these species have four cycles or less of septa in the adult stage: P. montereyensis and P. humilis. Paracyathus humilis appears to differ from P. montereyensis in having brown theca and thinner pali.

MATERIAL EXAMINED.—Syntype of P. humilis (1) YPM 5377; Velero 137-34 (1) AHF 54.1 (Durham and Barnard, 1952), Plate 6b; Darwin Bay, Genovesa (4) USNM 46966 (Wells, 1983), Plate 6a.

DISTRIBUTION.—Galápagos: Darwin Bay, Genovesa; 23 m. Elsewhere: Sulphur Bay, Clarion Island, Pearl Islands (Durham and Barnard, 1952); 104 m.

Polycyathus Duncan, 1876

17. Polycyathus isabela Wells, 1982

PLATE 6c–e


DESCRIPTION.—Corallum colonial, cylindrical corallites arising from thin basal encrustation, often directly adjacent to base of parent corallite. Largest corallite of holotypic colony 6.5 mm in calicular diameter and 8.1 mm tall; calice elliptical. Costae equal and slightly convex, about 0.32 mm wide, and separated by distinct intercostal striae about 0.08 mm wide. Coenosteum light brown to white; costae covered by low, coarse granules.

Septa hexamerally arranged in four incomplete cycles according to the formula $S_1>S_2>S_3>S_4$; a corallite with a greater calicular diameter of 2.0 mm has only 24 septa; 2.8 mm, 32 septa; 3.0 mm, 36 septa; and 3.7–6.5 mm, 42 septa. Inner edges of $S_1$–$S_2$ straight; edges of $S_3$ slightly sinuous; edges of $S_4$ lacerate. Six slender, crispate, twisted $P_1$ form a palar crown deep in fossa adjacent to columella. A second crown of six $P_2$, each palus equal in size to a $P_1$, occurs slightly higher in the fossa. A third crown of 12 $P_3$, each palus twice the size of a $P_1$ but equally crispate, occurs still higher in fossa. Fossa moderately deep. Columella papillose, composed of 15–20 slender, irregularly shaped rods.

DISCUSSION.—According to Wells (1982), only two species of Polycyathus are known from the eastern Pacific, both known from the Galápagos. Polycyathus isabela differs from P. hondaeensis (Durham and Barnard, 1952) by having larger corallites with an additional incomplete cycle of septa.

MATERIAL EXAMINED.—Holotype, USNM 49964, Plate 6c–e; no additional specimens are known of this species.

DISTRIBUTION.—Known only from the type locality: west of Punta Albemarle, Isabela; 14–23 m.

18. Polycyathus hondaeensis (Durham and Barnard, 1952)

PLATE 6f


DESCRIPTION.—Corallum colonial, cylindrical to slightly ceratoid corallites arising from a basal coenosteal encrustation. Corallites up to 3.1 mm in greater calicular diameter and 3–9 mm tall; calices circular to elliptical. Granular costae equal and flat, separated by narrow intercostal striae.

Septa hexamerally arranged in three cycles (20–24 septa) according to the formula $S_1>S_2>S_4$. Inner edges of $S_1$–$S_2$ straight, those of $S_3$ dentate. Twelve robust, crispate $P_1$ occur in a tight crown before first two septal cycles. Septal and palar granulation ornate, composed of large, multi-tipped
Desmophyllum Ehrenberg, 1834

19. Desmophyllum cristagalli Milne Edwards and Haime, 1848

PLATE 6p-i


DESCRIPTION.—Corallum solitary and variable in shape, ranging from subcylindrical to ceratoid to trochoid. Large corallites have flared calices. Corallum firmly attached through a thick pedicel and a thin expansive basal encrustation. Largest Galapagos corallite 43 x 28 mm in calicular diameter and 50 mm tall, with a pedicel diameter of 7.2 mm. Theca and septa yellowish brown to white. Theca variable in expression: usually finely granular with no evidence of costae except for thin, white striae corresponding to C1-3; however, some specimens bear thin ridged C1-3 that extend to the base.

Septa hexamerally arranged in five complete cycles (96 septa), the fifth cycle completed between 14-17 mm calicular diameter. Relative sizes of septa: S1>S2>S3>S4=S5, all septa being highly exsert, up to 12 mm in the case of the S1-2. Inner edges of all septa straight and vertical, the inner edges of opposing S1-2 coming within 1 mm of each other. S3 extend about 2/3 distance to center of fossa; S4 extend about half distance to center of fossa; and S5 about 1/2 that distance. Although S5 are clearly less wide than S4, they are more exsert than the S4, fusing to the exsert outer faces of adjacent S1-3. Septal granulation inconspicuous, giving the appearance of smooth septal faces. Fossa extremely deep, not encumbered with pali or columella; however, observable in some small corallite are 1-4 slender, twisted columellar laths, similar to those of Crispatrochus.

DISCUSSION.—Although cosmopolitan in distribution and common in collections, D. cristagalli was previously known from only five “dead” specimens dredged from two Albatross stations (Marenzeller, 1904b; Wells, 1983). Durham and Barnard’s (1952) records of specimens from 12 fathoms (22 m) from off Cartago Bay, Isabela are queried based on their unusually shallow depth.

Desmophyllum cristagalli was the most commonly observed and collected ahermatypic coral on the JSL expedition, often found growing downward on the underside of overhangs or within cavities, a growth habit also observed for this species in the deep-water canyons off New York (B. Hecker, pers. comm.). This may explain why, despite their abundance, they were rarely collected by a surface vessel in the Galápagos.

MATERIAL EXAMINED.—JSL-1911, USNM 84814, Plate 6p-i; JSL-1915 (1) USNM 84815; JSL-1916 (6) USNM 84816; JSL-1922 (1) USNM 84817; JSL-1924 (4) USNM 84818; JSL-1927 (3) USNM 84819; JSL-1929 (46) USNM 84820; JSL-1938 (1) USNM 84821; JSL-1942 (4) USNM 84822; ALB-2818 (2) USNM 19146 (Wells, 1983); ALB-3401 (3) USNM 22086 (Marenzeller, 1904b).

DISTRIBUTION.—Galápagos: off Isabela, Santiago, Santa Cruz, San Cristóbal, Española, Marchena. Cocos Island; 300-606 m. Elsewhere: cosmopolitan except off continental Antarctica (Cairns, 1982); 35-2460 m.

Lophelia Milne Edwards and Haime, 1849

20. Lophelia prolifera (Pallas, 1766)

PLATE 6j

Lophelia californica Durham, 1947:36, pl. 1: figs. 13, 16, pl. 2: fig. 11.


DIAGNOSIS OF GALAPAGAN SPECIMENS.—Corallum increases by intratentacular budding. Corallites long and slender, the largest 4.3 x 3.8 mm in diameter and 14.0 mm long. C1-2 slightly ridged near calice; otherwise, theca uniformly granular and white. Three of four branch fragments possess irregularly shaped lateral thecal extensions, some of which adhere to an adjacent serrulid worm tube. Septal symmetry variable, the largest corallite having 11 primary and 11 secondary septa (22 septa), but septa of other corallites hexamerally arranged (S1>S2>S3 = 24 septa). S1 (or primary septa) exsert but not
Phyllangia Milne Edwards and Haime, 1848

21. Phyllangia consagensis (Durham and Barnard, 1952)

DESCRIPTION.—Corallum quasicolonial, larger corallites intratentacularly budding one or more smaller corallites at right angle to parent corallum, the daughter corallites breaking free of the parent before a third generation bud appears. Corallum ceratoid when young, becoming cylindrical with growth. Holotype consists of a corallite 5.8×4.7 mm in calicular diameter and 18.5 mm long, sporting six buds: one 8.5 mm long, the other five only represented by scars, the buds either previously detached or aborted early in ontogeny. Costae of primary septa carinate, sometimes ridged almost to base, and up to 1 mm tall near calicular edge. Secondary costae flat and slightly broader than primary costae. All costae covered by a fine granulation, the pointed granules about 0.10 mm in diameter. Theca pale brown. Irregularly shaped lateral thecal extensions, like those described for Lophelia from the Galápagos, also present on some specimens, linking adjacent thecal extensions (buds) on one corallum or fusing a corallite to a serpulid worm tube.

Septa symmetry irregular, but 28 septa per corallite is most common: arranged 11:11:6 in the holotype, 9:9:10 in a
paralifera, both species having intratentacular budding, endothecal dissepiments common, especially in longer cylindrical coralla, spaced about every 1.0–1.5 mm, resulting in a corallum of low density. Fossa variable in depth depending on recency of dissepiment formation. Invariably a complete dissepiment or one in the process of formation can be seen from a calicular view. A columella was not noted in any specimen.

**Discussion.**—Only one other species of *Anomocora* has been previously described, the type species *A. fecunda* (Pourtales, 1871), known from the Atlantic Ocean from 73–567 m (Cairns, 1979). Reports of *Anomocora* are also known from the Red Sea (Gardiner and Waugh, 1939), off Sumatra (Marenzeller, 1904a), off Japan (Eguchi, 1968), and off the Hawaiian Islands (Cairns, 1984), the Pacific records representing (an) undescribed species. *A. carinata* differs from all previously reported specimens in this genus by having highly carinate primary costae. In the study area, it might be confused with small branch fragments of *Lophelia prolifera*, both species having intratentacular budding, endothecal dissepiments, and thecal extensions. *Anomocora carinata* is distinguished by its prominent costae, taller costal spines, wider septa, and more conspicuous dissepiments.

**Etymology.**—The species name is from the Latin *carinata* (keeled), alluding to the distinctively ridged primary costae.

**Material Examined.**—Holotype: JSL-1938, USNM 84824, Plate 7a, b. Paratypes: JSL-1938 (12) USNM 84825.

**Type Locality.**—5°24.5'N, 87°09.8'W (off Cocos Island), 614–785 m.

**Distribution.**—Known only from the type locality.

### Sphenotrochus Milne Edwards and Haime, 1848

#### 23. Sphenotrochus hancocki Durham and Barnard, 1952

**PLATE 7c-a-g**


**Description of the Holotype.**—Corallum solitary, cuneiiform, and highly compressed: 2.3 x 1.25 mm in calicular diameter and 4.0 mm tall. Costae equal in width (0.16–0.18 mm), separated by broad, shallow intercostal furrows. Costae rounded and smooth, lacking granulation. Costae continuous for most of thecal face but degenerating into isolated fragments in lower 1/2 to 1/4 of corallum face. Septa hexamerally arranged in three cycles according to the formula: $S_1$, $S_2$, $S_3$. Twelve $S_{1,2}$ highly exsert and extend about 0.6 distance to columella, the 10 lateral $S_{1,2}$ fusing with the columella low in fossa. $S_3$ rudimentary. Septal faces smooth. Columella lamellar and exsert, rising above calicular edge.

**Discussion.**—This species was described and illustrated recently by Cairns (1989), where its affinities to other species were also discussed.

**Material Examined.**—Holotype and paratype of *S. hancocki*, Velerio 170-34, AHF 57.2, Plate 7c. Other Material Examined: ALB-5311 (Philippines), USNM 81897 (Plate 7e–g).

**Distribution.**—Galápagos: Stephen’s Bay, San Cristóbal; Wolf, 18–273 m. Elsewhere: Miocene of Costa Rica; Recent: Philippines, South China Sea, Lower California.

### Pseudocyathoceras, new genus


#### Cyathoceras—Cairns, 1982:22 [in part: *K.avis* and *K. hoodensis*]

**Diagnosis.**—Corallum conical (ceratoid to trochoid), with a pointed base that invariably shows a scar of previous attachment; transverse division lacking. Wall imperforate; costae rounded and finely granular; intercostal grooves do not extend to epicenter. Septa decamerally arranged in three highly exsert cycles (40 septa). Pali absent. Columella fascicular, composed of numerous twisted laths.

**Discussion.**—Durham and Barnard (1952) tentatively placed two Galapagan species in the genus *Kionotrochus* based on the characters of their corallum shape and nature of their costae. They also noted their resemblance to *Cyathoceras*, but argued against this placement. After seeing the types of these two species in 1979, I (Cairns, 1982) listed them, without explanation, as *Cyathoceras*. Wells (1983) followed suit and furthermore synonymized *C. hoodensis* with *C. avis*. After having recently reviewed and keyed the turbinoliid genera (Cairns, 1989), I now consider this species to represent a new genus of turbinoliid, *Pseudocyathoceras*, not *Kionotrochus*, as suggested by Durham and Barnard (1952). Although similar to *K. suteri* in costal shape and granulation, *Pseudocyathoceras* differs in having a fascicular columella, shorter intercostal grooves, a more conical corallum, and in lacking pali. *Pseudocyathoceras* is considered to be a turbinoliid based on its unattached corallum with costae extending to the epicenter, and relatively deep intercostal furrows (at least in the upper corallum). Among the 23 known turbinoliid genera (Cairns, 1989), it belongs to the group of seven imperforate, nonpaliferous genera. It is distinguished from these genera both by its conical corallum and fascicular columella.

**Etymology.**—Although *Cyathoceras* is herein synonymized with *Crispatotrochus*, for a time (e.g., Cairns, 1982) *P. avis* was placed in *Cyathoceras*. Thus, *Pseudocyathoceras* is an allusion to its superficial similarity to *Cyathoceras*. Gender: neuter.

**Type Species.**—*Kionotrochus avis* Durham and Barnard, 1952, herein designated.

**Distribution.**—Galápagos: 91–183 m.
24. *Pseudocythoceras avis* (Durham and Barnard, 1952), new combination

**PLATE 7h,i**

*Kionotrochus (?) avis* Durham and Barnard, 1952:88-89, pl. 11: fig. 50a,b, pl. 12: fig. 50a.—Durham, 1962:46; 1966:125.


**DESCRIPTION.**—Corallum ceratoid to trochoid; free; calice elliptical. Corallum up to 10.3 × 8.4 mm in calicular diameter and 11.4 mm tall (USNM 46962). Costae continuous to epicentral scar, but separated by deep intercostal grooves in upper corallum only. Costae covered by fine, low, rounded granules.

Septa decamerally arranged in three cycles (i.e., 40 septa). Septa well spaced, separated from one another by 2-3 times thickness of a primary septum. Primary septa highly exert (up to 1.7 mm), with sinuous vertical inner edges that attain the caliculum. Secondary septa also highly exert (up to 1.2 mm), with sinuous vertical inner edges that extend about 1/3 distance to caliculum. Tertiary septa extend about 0.9 mm above calicular edge and about 1/4 distance to caliculum; they have relatively straight inner edges. Pointed granules 0.08-0.10 mm tall cover septal faces. Fossa shallow. Columella composed of several S1 in upper calice of largest specimen, suggesting an adult complement of four cycles. Inner edges of S1 slightly sinuous, extending about 0.8 distance to center of fossa. S2 only slightly smaller than S1, S3 quite small, extending only 0.3 distance to center of fossa. Relative exsertness of septal cycles unknown because calicular edges of all specimens damaged. Septa as thin and delicate as theca, approximately 0.11 mm thick and widely separated from one another by as much as 0.70 mm, producing a very spacious fossa. Fossa deep. Rudimentary columella formed from contorted lower inner edges of S3.

**DISCUSSION.**—The three juvenile specimens from ALB-2818 reported by Wells (1983) as *J. cailleti* are clearly a species of *Flabellum*, not *Javania*. Ontogenetic sequences of *J. cailleti* from the Galápagos show that at a greater calicular diameter as low as 5.7 mm, it has 48 thick septa, a straight corallum, and a nonreinforced pedicel. Corallia of *Flabellum* sp. A of an equivalent calicular diameter have only 24 very delicate septa, and a bent, nonreinforced pedicel.

Among the 28 Recent species of *Flabellum* (F.) listed by Cairns, 1989, *Flabellum* sp. A most closely resembles two species with scolecoid coralla: *F. gracile* Studer, 1878, and *F. flexuosum* Cairns, 1982.

**MATERIAL EXAMINED.**—Holotype and 2 paratypes of *K. avis*, AHF 50.1; holotype and paratype of *K. hoodensis*, AHF 51.1-2; “Galápagos,” 100 m, V. and T. Williams (11) USNM 46962 (Wells, 1983), Plate 7h,i.

**DISTRIBUTION.**—Galápagos: off Floreana and Española; 91-183 m.

25. *Flabellum (F.) galapagense* Milne Edwards and Haine, 1848

*Flabellum galapagense* Milne Edwards and Haine, 1848a, pl. 4: fig. 3; 1848b:264.—Wells, 1983:237.

**DISCUSSION.**—Little can be added to the description and figure of Milne Edwards and Haine (1848a,b) and the comments by Wells (1983). This species is known from only one fossil (?)Pliocene) specimen that is now thought to be lost (Wells, 1983:237). As Wells suggested, the figure of the holotype looks very much like *F. thouarsii* Milne Edwards and Haine, 1848 (see Cairns, 1982:34-35); however, it should be remembered that *Flabellum* is a very speciose genus (Cairns, 1989), the nominate subspecies having 28 valid Recent species and the genus having an additional 144 nominal fossil species, none of which have been reported from the eastern Pacific. Even if the original specimen were available, comparisons to other species would be difficult.

The spelling of the species name is herein emended to *F. galapagensis* in accordance with Article 32c of the *International Code of Zoological Nomenclature*, the original intention of the authors clearly being to name the species for the Galápagos Islands.

**DISTRIBUTION.**—Known only from the ?Pliocene of the Galápagos, specific locality unknown.

26. *Flabellum (Ulocyathus) daphnense* Durham and Barnard, 1952

**PLATE 8a,b**

DISCUSSION.—*Flabellum daphnense* is known from only one specimen, the holotype; its original description can be augmented accordingly. The finely "cobble" theca is reddish brown in color. The specimen has an incomplete fourth cycle of septa, lacking pairs of S4 from four lateral half-systems (40 septa). The upper calicular edge, although highly damaged, appears to be moderately jagged, the S1-2 forming exert apices, which places this species in the subgenus *Ulocyathus*. The fossa is relatively shallow.

Of the 23 Recent and fossil species attributed to the subgenus *Ulocyathus*, Cairns (1989) placed *F. daphnense* in a subgroup of nine species characterized by having laterally compressed coralla. As Wells (1983) suggested, *F. daphnense* is similar to *F. aoteaoroa* Squires, 1964, in thecal granulation, as well as thecal color and having a moderately jagged calicular edge; however, *F. aoteaoroa* has a greater edge angle, edge crests, and five cycles of septa. No other species of *F. (Ulocyathus)* is known from the eastern Pacific.

MATERIAL EXAMINED.—Holotype of *F. daphnense*, AHF 58.1, Plate 8a-b; one worn specimen of *Flabellum* is reported (ALB-2808, USNM 36437), which, based on its fragmentary nature, could be *F. galapagense*, *F. daphnense*, or another species.

DISTRIBUTION.—Galápagos: known only from the type locality: southeast of Daphne Mayor (north of Santa Cruz); 101 m.

29. *Javania* Duncan, 1876

28. *Javania cailleti* (Duchassaing and Michelotti, 1864)

**PLATE 8c-e**

*Flabellum* sp.—Marenzeller, 1904b:81.


*Javania cailleti*.—Cairns, 1979:153–156, pl. 28: figs. 8–12, pl. 30: figs. 1, 4 [synonymy and discussion]; 1982:46–48, pl. 14: figs. 9–12 [discussion and distribution].

Not *Javania cailleti*.—Wells, 1983:238 [= *Flabellum* sp. A and *Javania* sp. A].

DESCRIPTION.—Corallum solitary, ceratoid, and firmly attached through a robust, stereome-reinforced pedicel and thin, expansive basal layer. Largest Galapagan specimen 16.2×14.1 mm in calicular diameter, 25.7 mm tall, and 5.3 mm in pedicel diameter, these specimens, in general, being smaller than those of Atlantic populations. Lower third of corallum, corresponding to area of pedicel reinforcement, dull white and smooth. C1-3 sometimes slightly ridged, C3 more than others, but only near calicular edge.

Septa hexamerally arranged in four complete cycles (48 septa) even at a calicular diameter as small as 5.7 mm, according to the formula S1>S2=S3>S4, S1-2 highly exerted, with straight, vertical inner edges that extend 0.8–0.9 distance to center of fossa. S3 much less exert, extending about half distance to center of fossa. S4 only slightly exert, thin and rudimentary, extending up to 0.2 distance to center of fossa. Exsert septa produce a jagged calicular margin. Septal granules pointed, up to 0.2 mm tall. Fossa deep and narrow. Columella an elongate, solid, smooth calcareous mass joined by the lower inner edges of the S1-2.

DISCUSSION.—Zibrowius (1974b) was the first to realize that Vaughan’s *Desmophyllum galapagense* was a *Javania*. Although previously reported from the Cocos and Galápagos islands by Marenzeller (1904b) and Vaughan (1906) as *Flabellum* sp. and *Desmophyllum galapagense*, respectively, *J. cailleti* was first verified as such from these localities by Cairns (1979). The new Galapagan specimens reported by Wells (1983) from ALB-2816 and 2818 pertain to a different species of *Javania* and *Flabellum*.

MATERIAL EXAMINED.—JSL-1911 (2) USNM 84827; JSL-1916 (6) USNM 84828; JSL-1924 (6) USNM 84829; JSL-1926 (2) USNM 84830; JSL-1931 (1) USNM 84831, Plate 8c-e; JSL-1932 (4) USNM 84852; JSL-1935 (3) USNM 84832; JSL-1941 (1) USNM 84833; JSL-1943 (6) USNM 84834, Plate 8d: JSL-1944 (2) USNM 84835; ALB-3370 (1) USNM 22084 (*Flabellum* sp. of Marenzeller, 1904b); ALB-4642 (1) holotype of *Desmophyllum galapagense*, USNM 68275.

DISTRIBUTION.—Galápagos: off Fernandina; off Tagus Cove, Isabela; Santiago; Santa Cruz; Española. Cosoc Island; 245–576 m. Elsewhere: cosmopolitan, except for continental Antarctic and eastern Pacific (Cairns, 1982); 86–2165 m.
Polymyces Cairns, 1979

30. Polymyces wellsi, new species

PLATES 8/7, 9a-b


DESCRIPTION.—Corallum solitary, ceratoid to trochoïd, and firmly attached through a pedicel reinforced with pairs of contiguous hollow rootlets. Rootlets usually asymmetrical in development, first appearing as 2–4 contiguous hollow chambers near base of corallum, each chamber corresponding to one septum. Slightly higher on corallum each chamber subdivides into two smaller chambers, one corresponding to each half-system. Each of these smaller chambers (rootlets) communicates with the remainder of the polyp through a small compartmentalized contiguous ring encircling or partially encircling the lower pedicel. In larger specimens the chambers that constitute the 2–4 pairs of rootlets rise 6–7 mm from the base on one side of the corallum, but only 0–2 mm on the other side. Holotype 29.7 x 24.7 mm in calicular diameter and 32.6 mm tall, with an original pedicel diameter of 2.1 mm augmented to 5.3 mm by the rootlets. C1–2 slightly ridged for most of theca; C3 ridged only near calice. Theca smooth and porcellaneous, streaked with reddish brown stripes corresponding to the C1–2 and upper C3. This coloration also continues to the septal faces adjacent to theca.

Septa hexamerally arranged in four complete cycles, the fourth cycle already complete at a greater calicular diameter of 6.5 mm. Septal formula: S1–2 > S3 > S4. S1–2 highly exsert (up to 5.0 mm), with slightly inclined straight inner edges extending about 0.8 distance to center of fossa. S3 also exsert (up to 3.1 mm) and similar to the S1–2, reaching about 0.6 distance to center of fossa. S4 up to 1.5 mm exsert and reach about 0.4 distance to center. Exsertness of septa produces a jagged calicular edge. Septal granules blunt and tall, up to 0.25 mm in height. Fossa deep. Columella composed of an elongate, solid to porous, smooth mass of calcium carbonate joined to the lower inner edges of the S1–2.

DISCUSSION.—Three previously described species belong to Polymyces: P. fragilis (Pourtallé, 1868), the type species; P. montereyensis (Durham, 1947); and P. tannerensis (Durham and Barnard, 1952). Polymyces wellsi is similar in thecal pigmentation and septal number to the tulipa form of P. fragilis, a species known only from the western Atlantic from 75–796 m (see Cairns, 1979), but differs in having irregular development of rootlets, straight septal edges, and much more exsert septa. Polymyces montereyensis, known only from off California from 82–110 m, differs in having five cycles of septa, 12 symmetrically arranged rootlets, and relatively nonexsert septa, resulting in a smooth calicular margin. Polymyces tannerensis, known only from the holotype from Tanner Bank, California at 82–84 m, is perhaps the most similar to P. wellsi, the two species having 48 highly exsert septa and straight inner septal edges. Polymyces tannerensis differs, however, in having S4 more exsert than S3 (in P. wellsi the S3 are more exsert than the S4), 12 symmetrically arranged rootlets, and a white corallum.

ETYMOLOGY.—Named in honor of John W. Wells, author of numerous papers on scleractinian taxonomy, including a revision of the Galapagan fauna (Wells, 1983).

MATERIAL EXAMINED.—Holotype: JSL-1916, USNM 84836, Plate 9a-b. Paratypes: JSL-1916 (5) USNM 84837, Plate 8f; JSL-1921 (2) USNM 84838; JSL-1928 (1) IRCZM; JSL-1935 (1) USNM 84839; ALB-2818 (2) USNM 77273 (J. pseudoalabastra of Wells, 1983), Plate 8i. Reference Specimens: holotype and paratype of F. tannerensis, AHF 59.1; holotype of F. montereyensis, USNM 547406.

TYPE LOCALITY.—1°18.7'S, 89°48.8'W (northwest of Española), 545–562 m.

DISTRIBUTION.—Galápagos: off Fernandina; east of Isabela; Santa Cruz; Española; Genovesa; 391–813 m.

Suborder DENDROPHYLLIINA Vaughan and Wells, 1943

Family DENDROPHYLLIIDAE Gray, 1847

Balanophyllia S.V. Wood, 1844

31. Balanophyllia galapagensis Vaughan, 1906

PLATE 9c-g


DESCRIPTION.—Corallum solitary, ceratoid, and firmly attached through a thick pedicel. Largest specimen examined (USNM 77277) 8.45 x 7.2 mm in calicular diameter, 12.3 mm tall, and 4.7 mm in pedicel diameter. C1–3 usually slightly broader than C4, 0.36 mm vs. 0.25 mm, respectively. Costae slightly convex and granular, separated by deep, thin (0.11 mm) intercostal striae. A very thin epitheca masks the synaptycotheca for a variable percentage (5–85) of the corallum, most extensively developed on the holotype of B. galapagensis.

Septa hexamerally arranged in four complete cycles, the largest specimen having an additional pair of S8 (50 septa) and the holotype of B. osburni, virtually the same size, having two pairs of S8 (52 septa). S1–2 of approximately the same size, slightly exsert (up to 1.2 mm), and extend to columella. S3 rudimentary, only about 0.4 mm exsert, and extend 0.2–0.3 distance to columella. S4 more exsert (0.8 mm) and broader than S3, fusing before the S5 in a broad (1/3 calicular radius) paliform lobe, which projects slightly into the columella. Septa and pali covered with prominent pointed granules up to 0.08 mm tall. Fossa usually very shallow, containing a large compact elliptical columella composed of fused fascicular elements.

DISCUSSION.—Balanophyllia galapagensis and B. osburni...
are both known from the Galápagos from approximately the same depth range. Durham and Barnard (1952) distinguished *B. osburni* by its deeper fossa, smaller columella, thinner septa, and smaller septal granules. In examining the types of both species it was found that the columellar and septal granules of both species are virtually identical. The fossa of *B. osburni* may be deeper and its septa thinner, but these characters are considered to be within the range of variation of *B. galapagensis*.

**MATERIAL EXAMINED.**—JSL-1911 (2) USNM 84840; JSL-1914 (5) USNM 84841; JSL-1936 (3) USNM 84842; ALB-4643 (1) holotype of *B. galapagensis*, USNM 68278, Plate 9c, f; holotype (Plate 9e) and paratype of *B. osburni*, AHF 63.2; AB 18-795 (4) USNM 77277, Plate 9d, g; off Onslow, USNM 46965 (Wells, 1983); west of Wolf (3) CAS 66655.

**DISTRIBUTION.**—Galápagos: off Isabela; Santa Cruz; Floreana; Onslow; Española; and Wolf; 18-462 m.

**32. Balanophyllia eguchii** Wells, 1982

**PLATE 9a-j**

*Balanophyllia eguchii* Wells, 1982:211-213, pl. 1: figs. 4-6 [synonymy]; 1983:239, pl. 14: figs. 6-8.

**DESCRIPTION.**—Corallum colonial, small clusters of corallites formed by extratentacular budding from basal coenosteum and directly from corallite theca, augmented by settlement of sexually produced planulae on the colonial coenosteum. Second generation buds not uncommon but third generation buds rare. Corallites cylindrical; calices elliptical to greatly elongate (e.g., 13.5 × 6.5 mm for one on holotylo colony). Theca of corallites covered by thin epitheca for 50%-95% of its depth range. Calices circular to irregularly elliptical in shape. Costae thin (about 0.14 mm) and "vermiculate," bearing small triangular teeth. Intercostal striae of equal width to costae and relatively deep. Theca porous and relatively thin, never epithecate.

Septa irregular in symmetry. Small corallites hexameral: S₁ > S₂ > S₃ > S₄ > S₅; however, with increase in calicular diameter (e.g., 8-11 mm), pairs of S₂ are gradually added and concurrently the S₂ increase to a size equal to the S₁. Ultimately, a full five cycles are present at a calicular diameter of 13-14 mm, the higher cycle septa arranged in the Pourtales Plan. Corallites with 8, 9, 10, and 11 primary septa (with a corresponding number of 64, 72, 80, and 88 septa) are therefore not unusual. Septa nonexsert or only slightly so, the higher cycle septa having laciniate inner edges. Inner edges of S₄ do not bear palfiform lobes. Fossa extremely deep, containing an irregularly shaped spongy columella of variable size, ranging from quite small to massive.

**MATERIAL EXAMINED.**—JSL-20-XI-86-2, IRCZM; JSL-21-XI-86-5, IRCZM; off Cousin’s Rock and Sullivan’s Bay, Santiago, USNM 46971 (Plate 10a,b), 79103 (Wells, 1983); off Rábida, CAS 18925 (Wells, 1983); 7-12 m; off Palau, USNM 47223-47230, 46972, 78644; off Australia, USNM 78537; off Singapore, USNM 78531-2; Malaysia, USNM 78533, 78535.

**DISTRIBUTION.**—Galápagos: off Isabela (Crossland, 1927); Santa Cruz; Rábida; Española (Wells, 1983); 0-12 m. Elsewhere: common throughout Indo-West Pacific, and off eastern Australia; 0-45 m (Wells, 1983).

**34. Dendrophyllia californica** Durham, 1947

**PLATE 10c-e**

*Dendrophyllia californica* Durham, 1947:37-38, pl. 10: figs. 2, 6.—Durham and Barnard, 1952:101-102, pl. 15: fig. 65a,b.—Bythell, 1986:21, pl. 12: figs. e,f.

**DESCRIPTION.**—Corallum colonial; increase by regular (usu-
ally sympodial) extratentacular budding resulting in large, often uniplanar branches and colonies up to 1 meter tall. Large colonies supported by dense, thick basal branches up to 5 cm in diameter. Calices elliptical, up to 14 x 12 mm in diameter. Costae equal in width and height (approximately 0.6 mm wide), evenly convex and separated by thin intercostal striae. Costae and intercostae solid on branches; however, in vicinity of corallites, costae are vermiculate and intercostae are porous. Costae covered by tiny pointed granules about 0.10 mm in diameter and 0.15 mm tall, arranged in an irregular pattern 2-4 across corallite width, producing a rough “sandpaper” texture to branch. Corallum white; coenosarc yellow.

Septa hexamerally arranged in five incomplete cycles, a common arrangement being one pair of S2 in each half-system, resulting in 72 septa. S1,2 approximately equal in size, thin, and solid, their inner edges straight and entire or coarsely dentate. S3 rudimentary, porous, and dentate. S4 and S5, depending on the half-system, also porous, pairs of septa meeting before adjacent lower cycle septa and extending to columbia. Inner edges of S4,5 laciniate, occasionally having a caliform lobe. Fossa moderately deep (4-5 mm), containing a massive columbia composed of an elliptical field of numerous small, swirled elements.

**DISCUSSION.**—Three nominal species of *Dendrophyllia* are known from the eastern Pacific: *D. oldroydi* Faustino, 1931; *D. californica* Durham, 1947; and *D. cortezi* Durham and Barnard, 1952. A comparison of topotypic specimens of *D. oldroydi* (USNM 38114) to the types of *D. cortezi* (AHF 66.1) show that they are identical, supposed differences cited by Durham and Barnard (1952) and Bythell (1986) notwithstanding. The character of having dentate or smooth S4 inner edges (for fused S3) is variable. *Dendrophyllia californica*, as figured by Durham and Barnard (1952), differs in having less exsert corallites (usually less than 5 mm), which project perpendicular to the main branch, a larger columbia, and a more robust corallum. The Galapagan specimens are most similar to *D. californica*, differing only in having larger corallites.

**MATERIAL EXAMINED.**—JSL-1911, USNM 84844, Plate 10c-e; JSL-1932, USNM 84845; JSL-1937, USNM 84846; JSL-1943, IRCZM; JSL-1944, IRCZM. Reference Specimens: toptotypes of *D. oldroydi*, USNM 38114; types of *D. cortezi*, AHF 66.1; *Velerio* 1254-41, AHF 65.6 (*D. californica* of Durham and Barnard, 1952).

**DISTRIBUTION.**—Galápagos: off Isabela, Santa Cruz; Cocos Island; 315-576 m. Elsewhere: off Lower California (26°-32°N), 100-228 m.

### 35. *Dendrophyllia johnsoni*, new species

**Plate 10f-a**

**DESCRIPTION.**—Corallum colonial; increase by regular sympodial extratentacular budding. Colony size and pedicel diameter unknown: largest branch (holotype) 8.1 cm long, with 14 corallites. Branches thin and delicate, about 5.8-6.0 mm in diameter; calices round to slightly elliptical, about 6.5 mm in greater calicular diameter and standing 3.0-4.5 mm from main branch. Costae unequal in width and height: primary costae about 0.54 mm in width, others about 0.32 mm wide. Eight primary costae ridged on corallites, the two opposing, transversely oriented primary costae usually more exsert than other six. All costae convex, separated by deep, thin intercostal striae. Costae covered with small pointed granules, giving the coenosarc a rough texture. Costae and intercostal areas of branches solid; however, costae of corallite walls vermiculate, and intercostal areas quite porous. Corallum white.

Septa octamerally arranged in three complete cycles (32 septa). Primary septa slightly exsert, complementing the ridged primary costae: thin in the upper half of the fossa (e.g., 0.6 mm wide) but gradually or abruptly widening to about 1.6 mm halfway down the fossa. Secondary septa not exsert and also very narrow in upper fossa (e.g., 0.4 mm) but also broadening in lower fossa. Inner edges of primary and secondary septa reach the columbia. Inner edges of primary septa entire to finely dentate; secondaries coarsely dentate to laciniate; and secondaries laciniate. Tertiary septa rudimentary in upper fossa, but broadening and joining in pairs to adjacent secondary septa through a porous connection lower in fossa. Fossa relatively deep. Columbia rudimentary, composed of several crispate processes fused to the lower inner edges of the primary and secondary septa.

**ETYMOLOGY.**—Named in honor of Mr. Seward Johnson, Jr., chief executive officer of Harbor Branch Oceanographic Institution and cosponsor of the JSL Galápagos expedition.

**MATERIAL EXAMINED.**—Holotype: JSL-1911, USNM 84847, Plate 10f-h. Paratypes: JSL-1924 (5 branches) USNM 84848.

**TYPE LOCALITY.**—0°32.7'S, 90°07'W (northeast of Santa Cruz), 426-462 m.

**DISTRIBUTION.**—Galápagos: seamount north of Santiago, off Santa Cruz; 373-462 m.

### Endopachys Lonsdale, 1845

#### 36. *Endopachys graysi* Milne Edwards and Haime, 1848

**Plates 10i,j, 11a,b**

**Endopachys graysi.**—Umbgrove, 1950:648-650, pl. 82: figs. 1-10, pl. 83: fig. 7 [synonymy and discussion].—Wells, 1983:241.


**DESCRIPTION.**—Corallum cuneiform and free, the original
scar of attachment usually overgrown by costae. Thecal faces gently rounded, meeting at acute angle at thecal edges, producing a calice lenticular in cross section. Thecal edges bear continuous crests up to 3.0 mm tall. Largest specimen examined (Velero 816-38) 40.2 x 16.5 mm in calicular diameter and 38.9 mm tall. Angle of thecal faces about 27°; edge angle, exclusive of crests, 55°-70°. Costae composed of one or two rows of short spines; costae of large coralla up to 0.45 mm wide and separated by shallow furrows about 0.35 mm wide. Thecal porosity only evident in intercostal furrows and exert portions of S
1-2. Corallum white.

Septa hexamerally arranged in four or five cycles (48 or 96 septa) depending on size of calice. S
1-2 equal in size, slightly exert, and quite thick (up to 1 mm) at calicular edge. Inner edges of S
1-2 vertical and entire, merging with corolla. S
3 about half as thick and \( \frac{3}{4} \) as wide as S
1-2, also meeting the corolla. In large specimens having five cycles of septa, S
4 are the smallest septa, each flanked by pairs of S
5 that are more exert and wider than the S
4, often fused together before the S
4. The S
4 of each pair that is adjacent to each S
3 and S
2 is more highly exert and strongly fused to its adjacent lower cycle septum above the calicular edge. Only these S
4 bear paliform lobes lower in fossa, the lobes not separated by notches from their septa. Inner edges of P
3 are covered by corallum. In smaller specimens having only four cycles of septa, pairs of S
4 merge before the S
3. Fossa deep and elongate. Columella rudimentary.

**MATERIAL EXAMINED.** Velero 816-38 (1) AHF 67.4 (Durham and Barnard, 1952), Plate 10 j; off Rábida (1) CAS 66652, Plate 11a, b; “Galápagos” (1) CAS 66651.

**DISTRIBUTION.** Galápagos: Tagus Cove, Isabela; off Rábida; north of Española; 20–183 m; Cocos Island (Durham and Barnard, 1952). Elsewhere: throughout Indo-Pacific, including off California, Hawaii, Indonesia, Philippines, Japan, and Persian Gulf (Umbgrove, 1950); 36–658 m.

**Rhizopsammia Verrill, 1870**

**37. Rhizopsammia verrilli** van der Horst, 1922

**PLATE 11c-e**


**DESCRIPTION.** Corallites ceratoid to cylindrical; largest specimen examined (USNM 77410) 10.8 x 9.6 mm in calicular diameter, 15.2 mm tall, and 8.3 x 8.1 mm in pedicel diameter. Corallites well separated from one another, interconnected by cylindrical costate stolons 2.5–3.5 mm in diameter, 3 or 4 originating from the base of each corallite. Costae equal in width and coarsely granular; intercostae porous and almost as wide as costae.

Septa hexamerally arranged in five complete cycles, pairs of S
5 consistently developed only in half-systems adjacent to S
1 (well illustrated by Durham, 1962, fig. 2c), resulting in 72 septa per corallite. S
1 large and solid septa, with straight inner edges that project well into fossa and reach columella. S
2 much smaller, but also reach columella lower in fossa. Higher cycle septa arranged according to an exaggerated Pourtalès Plan, their inner edges dentate to laciniate (see Durham, 1962, fig. 2b). Septal faces covered by low pointed granules. Fossa moderately deep. Columella an elongate spongy mass.

**DISCUSSION.** Although the type of *R. verrilli* was not examined, a specimen from Cocos Island (USNM 77410) closely matches the description and figures of the type, even to the dimensions of the calices. It is not surprising that Durham (1962) described this species as a *Balanophyllia*. As van der Horst (1922:65) noted, disassociated corallites are “not to be recognized from a *Balanophyllia*;” however, if the corallite base is intact, radiating stolons can usually be seen.

*Rhizopsammia verrilli* differs from *R. wellingtoni* in having larger and taller corallites, more septa per corallite (72 vs. 48), and isolated corallites united by stolons (vs. clumped corallites united by a basal coenosteum). The specimens of *R. verrilli* reported by Wells (1983) from the Galápagos have numerous pairs of S
5, characteristic of *R. verrilli* but the colonial habit of *R. wellingtoni*. They are tentatively identified as *R. verrilli*.

**MATERIAL EXAMINED.** JSL-21-XI-86-3, USNM 84849; “Cocos Island,” USNM 77410, Plate 11 c, d; Marchena, USNM 46968 (Wells, 1983); Wolf, USNM 46933 (Wells, 1983); Floreana, USNM 78889 (Wells, 1983).

**DISTRIBUTION.** Galápagos: off Santiago, Floreana, Marchena, Wolf; 6–20 m. Cocos Island; 7–10 m (Durham, 1962). Elsewhere: off Timor, Indonesia; 27–278 m.

**38. Rhizopsammia wellingtoni** Wells, 1982

**PLATE 11f-h**


**DISCUSSION.** No additional specimens of *R. wellingtoni* have been collected since its original description; however, examination of the type specimens allows several additional observations. Much of the extratentacular budding occurs from the lower edges of the corallites as well as from the basal coenosteum. Intratentacular budding also occurs but is rare. Intercostal striae are almost half the width of the costae and are only occasionally porous, the theca otherwise being imperforate. Epithecal bands are present only on lower corallite bases, if at all. Inner edges of S
3, S
4 entire and vertical; septal faces smooth. Inner edges of S
5 laciniate; S
6 rudimentary, S
7 larger and porous.

Wells (1982) listed the other seven Recent species of *Rhizopsammia*, stating that *R. wellingtoni* is most similar to *R. chamissoi* Wells, 1954, from the Marshall Islands. Comparison of the types of these two species show that although they are similar in size, shape, and Columellal structure, *R. chamissoi*
differs in having larger, thicker, and more exsert S₁ (which are perforate near the thecal edge) and coarsely granular costae. Large corallites of R. chamisoi have pairs of S₂ in some half-systems, but larger corallites of R. wellingtoni probably also have additional septa, the largest paratype corallite (greater calicular diameter = 9 mm) having two pairs of S₂.

MATERIAL EXAMINED.—Holotype (USNM 46969) and paratypes (USNM 46970, Plate 11f-h) of R. wellingtoni; Gardner Island, CAS 18851 (Wells, 1982), Plate 11g. Reference Specimens: types of R. chamissoi (USNM 45104-5); syntype of R. pulchra Verrill, 1869, YPM 5375.

DISTRIBUTION.—Galápagos: Tagus Cove, Isabela; off Floreana; Onslow; 2-43 m.

**Endopsammia Milne Edwards and Haime, 1848**

39. *Endopsammia poutareli* (Durham and Barnard, 1952)


**DISCUSSION.**—No additional specimens of E. poutareli have been collected since its original description; however, based on an examination of the type specimens, two observations can be made. Durham and Barnard (1952) reported that the species had four cycles of septa with traces of a fifth; however, the type specimens clearly have only three cycles of septa with traces of a fourth. They also remarked that the S₁ were prominently exsert, but all septa of the types are nonexsert.

Wells (1983), who transferred this species to *Endopsammia*, suggested that it might prove to be a junior synonym of the widespread Indo-West Pacific species *E. philippinensis* Milne Edwards and Haime, 1848. Comparisons to typical *E. philippinensis* (see “Material Examined”) show it to be quite different. *Endopsammia poutareli* forms quasicolonial coralla consisting of slender (4-6 mm calicular diameter), elongate (up to 2 cm) corallites, infilled with endothecal dissepiments. Coralla of *E. philippinensis* are solitary, relatively squat, and broader (calicular diameters to 8 mm), without endothecal dissepiments. Furthermore, *E. poutareli* has only three cycles of nonexsert septa, all about the same size, whereas *E. philippinensis* has up to four cycles of septa, the S₁ exsert and larger than the others.

MATERIAL EXAMINED.—Holotype (Plates 11i, 12a) and four paratypes of *T. poutareli*, AHF 68.1; topotypic specimens from Velero 12-32 (1) CAS 29319. Reference Specimens: *E. philippinensis* from Queensland (USNM 78574, 83006) and New Caledonia (USNM 78559).

**DISTRIBUTION.**—Known only from the type locality west of Baltra, Galápagos; depth unknown.

**Enallopsammia Michelotti, 1871**

40. *Enallopsammia rostrata* (Pourtales, 1878)

*Thecosammia rostrata*—Cairns, 1982:57, pl. 18: figs. 1-4 [synonymy and discussion].


**DESCRIPTION.**—Only one small branch fragment of this species is known from the Galápagos, reported by Wells (1983) as *E. amphelioides*. This terminal branch fragment consists of two corallites, the larger 2.93 mm in calicular diameter, the branch 6.48 mm long. Costae are equal (about 0.32 mm wide) and vermiculate, separated by thin (about 0.11 mm wide), porous intercostal striae. Corallites not rostrate. Septa hexamerically arranged in three cycles according to the formula S₁>S₂=S₃. S₁ not exsert and very thin, extending to base of fossa. S₂ and S₃ about same width in upper fossa, pairs of S₂ fusing with adjacent S₂ within system lower in fossa. Septal faces, especially lower inner edges, highly granular. Fossa deep and curved; columella rudimentary.

**DISCUSSION.**—*Enallopsammia rostrata* differs from the other three species in the genus (see Zibrowius, 1973) by having calices on only one side of the colony. Cairns (1982) synonymized *E. amphelioides* Alcock, 1902, with *E. rostrata* based on the wide range of variation of rostral development found in Subantarctic populations, a decision upheld based on a later examination of Hawaiian populations (Cairns, 1984). The small specimen from the Galápagos belongs to the nonrostrate (“amphelioides”) form of the species.

MATERIAL EXAMINED.—ALB-2818 (1) USNM 36465 (E. amphelioides of Wells, 1983), Plate 12b.

**DISTRIBUTION.**—Galápagos: northeast of Santa Cruz; 717 m. Elsewhere: Atlantic, Indo-West Pacific, Subantarctic, Hawaiian Islands (Cairns, 1984); 229-2165 m.

**Tubastraea Lesson, 1829**

41. *Tubastraea coccinea* Lesson, 1829

*Placopsammia darwini* Duncan, 1876:411.

*Placopsammia darwini* Duncan, 1876:411.

**DESCRIPTION.**—Colonies roughly spherical, up to 12 cm in diameter, and firmly attached to substrate. Corallites closely spaced, for the most part originating extratentacularly from
Table 4.—Comparison of Galápagos Tubastrea.

<table>
<thead>
<tr>
<th>Character</th>
<th>T. coccinea</th>
<th>T. tagusensis</th>
<th>T. floreana</th>
<th>T. faulkneri</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septal number and relative exsertness; fusion of septa</td>
<td>$S_1$=$S_2$=$S_3$ ($48$ septa); in well-developed corallites, pairs of porous $S_4$ unite before $S_3$</td>
<td>$S_1$=$S_2$=$S_3$ ($48$ septa); all septa straight</td>
<td>$S_1$=$S_2$=$S_3$ ($48$ septa); all septa straight</td>
<td>$S_1$=$S_2$=$S_3$ ($48$+ septa); pairs of $S_2$ join to $S_3$ in large corallites</td>
</tr>
<tr>
<td>Corallites: range of adult calicular diameter; exsertness from coenosteum; spacing</td>
<td>10-13 mm; up to 12 mm; closely spaced</td>
<td>7-10 mm; 3-20 mm; closely spaced</td>
<td>4-6 mm; 2-10 mm; variably spaced: close or widely separated</td>
<td>8-13 mm; 3-8 mm; widely spaced</td>
</tr>
<tr>
<td>Inner edges of larger septa</td>
<td>vertical and entire; 12 reach columella</td>
<td>vertical and entire, but with horizontal paliform lobes near columella; 12-24 septa attain columella</td>
<td>vertical, entire, or laciniate; 12 reach columella</td>
<td>vertical, slightly exsert and entire; 12-24 reach columella</td>
</tr>
<tr>
<td>Columella</td>
<td>large, spongy</td>
<td>variable in size; usually rudimentary but may be quite large</td>
<td>rudimentary</td>
<td>large</td>
</tr>
<tr>
<td>Fossa</td>
<td>moderately deep</td>
<td>deep</td>
<td>moderately deep</td>
<td>shallow</td>
</tr>
</tbody>
</table>

42. Tubastrea faulkneri Wells, 1982

**PLATE 12j**


**DISCUSSION.**—Little can be added to the original description of Wells (1982) concerning this species, as no additional specimens have been collected. It is distinguished from the other Galápagan species (Table 4) by its larger corallites and its prominent, slightly exsert $S_1$.

**MATERIAL EXAMINED.**—Only one specimen of this species has been reported from the Galápagos (Wells, 1982), from 3-5 m in Tagus Cove, Isabela. This specimen was later illustrated by Wells (1983, pl. 19: fig. 4), as an in situ underwater photograph. The deposition of this specimen, if it was collected, is unknown and therefore confirmation of this species from the Galápagos is still needed. Other Material Examined: holotype (USNM 47145) from Palau and other specimens of *T. faulkneri* reported by Wells (1982) USNM 62570, Plate 12j.

**DISTRIBUTION.**—Galápagos: Tagus Cove, Isabela; Pleistocene (Hertlein, 1939) and Recent of Santiago; Bartolomé; Santa Cruz; Baltra; Daphne Menor; Santa Fe; Floreana; Española; Wolf; Darwin; Cocos Island; 1.5-54 m. Elsewhere: circumtropical; 2-110 m (see Wells, 1983:243).
43. *Tubastraea tagusensis* Wells, 1982

PLATE 12f,g


*Tubastraea floreana* Wells, 1982:218 [part: specimen from Pinzón].

**DESCRIPTION.**—Colonies roughly spherical in shape, up to 13 cm in diameter, and firmly attached to substrate. Corallites relatively closely spaced; intratentacular budding from intercorallite coenosteum. Large corallites 7-10 mm in greater calicular diameter and project up to 20 mm above coenosteum; however, some colonies have uniformly short (2-3 mm) corallites. Calices circular to slightly elliptical. Costae equal in width (C, sometimes slightly ridged) and usually finely granular, separated by relatively thin, porous intercostal grooves.

Septa of smaller corallites arranged according to the formula $S_1 > S_3 > S_4$, the $S_{2,3}$ having laciniate inner edges. $S_3$ of larger corallites accelerated to size of $S_{1,2}$, i.e., $S_{1,3} > S_4$, the $S_4$ having laciniate inner edges. Inner edges of $S_{1,3}$ entire and vertical, except near columella where they expand into irregular horizontal paliform lobes. Inner edges of all septa straight; no fusion of higher cycle septa occurs. Fossa deep. Columella variable in size: usually rudimentary, composed of lower, inner edges of $S_{1,3}$, but occasionally robust.

**DISCUSSION.**—*Tubastraea tagusensis* is distinguished from the other Galapagan species by having four cycles of straight septa, irregular paliform lobes on the lower cycle septa, and corallites of intermediate calicular diameter (Table 4).

**MATERIAL EXAMINED.**—Holotype and paratype of *T. tagusensis*, USNM 46977 and 46979; numerous specimens from Tagus Cove, Isabela (USNM 77268-69, 78877-78, 80-84, 86, CAS 18996 (Wells, 1983), Plate 12f,g; Daphne Menor, USNM 77256 (Wells, 1982); Pinzón, USNM 19151 (T. *floreana* of Wells, 1982).

**DISTRIBUTION.**—Galápagos: Tagus Cove, Isabela; Santiago; Pinzón; Daphne Menor; 1-43 m. Elsewhere: Nicobar; Palau (Wells, 1982).

44. *Tubastraea floreana* Wells, 1982

PLATE 12h,i

*Tubastraea floreana* Wells, 1982:218, pl. 4: figs. 5, 6 [not specimen from Pinzón]; 1983:245, pl. 18: figs. 3-6.

**DESCRIPTION.**—Colonies irregular in shape, up to 10 cm in width, and firmly attached. Corallites closely spaced; intratentacular budding from basal coenosteum and, not infrequently, from sides of other corallites. Corallites 4-6 mm in greater calicular diameter and project 2-10 mm above coenosteum. Calices circular to slightly elliptical. Costae equal in width, separated by thin, porous intercostal furrows. Costae and coenosteum distinctly granular. Corallum white; polyps bright pink.

Septa hexameraly arranged in three cycles: $S_{1,2} > S_3$. Inner edges of $S_{1,2}$ vertical, entire or laciniate, and straight, attaining the columella. $S_3$ rudimentary, with laciniate inner edges. Fossa moderately deep. Columella rudimentary.

**DISCUSSION.**—*Tubastraea floreana* is distinguished from the other Galapagan *Tubastraea* by having only three cycles of septa and relatively small corallites (Table 4).

**MATERIAL EXAMINED.**—Holotype of *T. floreana*, USNM 46974; Gardner Island, Españaola, USNM 78885, Plate 12h,i; off Floreana, USNM 46975; off Caleta Iguana, USNM 46976 and 78879 (all Wells, 1982); Buccaneer Cove, Santiago, USNM 77261.

**DISTRIBUTION.**—Galápagos: Caleta Iguana, Isabela; Santiago; Pinzón; Floreana; Españaola; 2-5 m.
## Appendix

### Station List

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<th>Station</th>
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<th>Date</th>
<th>Bottom temp. (°C)</th>
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### U.S.F.C.S. Albatross (ALB)—continued.

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*Anton Bruun (AB)*

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Alcock, A.

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Crossland, C.

Duncan, P.M.

Durham, J.W.

Durham, J.W.


Durham, J.W., and J.L. Barnard

Eguchi, M.

Ekman, S.

Gardiner, J.S., and P. Waugh

Glynn, P.W., and G.M. Wellington

Hertlein, L.G.

Hertlein, L.G., and A.M. Strong

Keith, M.L., and J.N. Weber

Keller, N.B.

Lessson, R.P.

Marenzeller, E. von


Milne Edwards, H., and J. Haime


Moseley, H.N.


Palmer, R.H.


Pourtales, L.F.


Vaughan, T.W.


Verrill, A.E.


PLATE 1.—a, Madracis sp. cf. M. asperula, Velero 201-34, AHF 1.1 (see Durham and Barnard, 1952), terminal branch, x2.2. Madracis sp. cf. M. pharensis (b,c, Gardner Island, Floreana, CAS 66645 (see Wells, 1983); d,e, JSL-1920, USNM 84775): b,c, enlargements of same colony, x2.8, x5.9, respectively; d,e, enlargements of same small colony, x21, x34, respectively (e is a stereo pair). f-h, holotype of Cladocora pacifica, new species (C. arbuscula of Marenzeller, 1904b), ALB-3367, USNM 84776, x1.1, x2.2, x8.0, respectively. i,j, Culicia sp. cf. C. rubeola, JSL-1-x11-86-2, USNM 80850, lateral and stereo calicular views, x18, x15.5, respectively.
PLATE 1—Astrangia browni, Caleta Iguana, USNM 46958 (see Wells, 1983), enlargements of same colony, x2.9, x4.1, respectively.

Astrangia equitorialis (c, holotype of A. equitorialis, Velero 31-33, AHF 29.1; d, Caleta Iguana, also USNM 46958 (see Wells, 1983); e, f, “Galapagos,” USNM 78890); c, d, corallites, x2.2, x3.0, respectively; e, stereo calicular view, x17; f, border of lower epithea with upper costae, x87. g, Astrangia dentata, stereo view of syntypes, YPM 5376, x7.3. h, i, Oulangia bradleyi, west of Punta Alhemarle (see Wells, 1983), USNM 46959, x3.6, x2.8, respectively. j, syntype of Madrepora galapagensis (= M. oculata forma galapagensis), ALB-4642, USNM 68276, x0.62.
PLATE 3.—a, Madrepora oculata forma alpha, JSL-1916, USNM 84786, x0.65. b, M. oculata forma galapagensis, JSL-1914, USNM 84783, broken calice revealing ornate P2, stereo pair, x21.3. c, M. oculata forma beta, ALB-2818, USNM 36377, x0.45. d, M. oculata forma gamma, Tagus Cove (M. galapagensis of Wells, 1983), USNM 46961, stereo pair, x1.0. Oculina profunda, new species (e, holotype, ALB-3170, USNM 84792; f.g, paratype, ALB-3188, USNM 36372): e, holotype, x0.87; f.g, calicular views, x29, x23, respectively.
PLATE 4.—a,b, Oculina profunda, new species, paratype, ALB-3188, USNM 36372, stereo calicular view and granular costae, respectively, ×13.7, ×55. Caryophyllia diomedea (c,d, originally figured syntype, ALB-3358, USNM 22083; e, JSL-1938, USNM 84790): c,d, stereo calicular and lateral views, ×3.7, ×3.1, respectively; e, calicular view, ×3.7. f, Caryophyllia sarsiae. Thalassa Z435 (48°39'N, 9°53'W, 1050 m), USNM 45743, ×2.25. Concentrotheca vaughani (g,i, paratype, JSL-1932, USNM 84803; h, holotype, JSL-1937, USNM 84802): g, granular theca, ×18.9; h, stereo calicular view, ×6.4; i, broken corallum revealing carinate septal and palar faces, ×17.5.
PLATE 5.—Caryophyllia percula, new species (a, d, holotype, JSL-1937, USNM 84798; b, paratype, JSL-1914, USNM 84799): a, d, lateral and stereo calicular views, ×3.7, ×4.1, respectively; b, stereo view of broken corallum revealing carinate septal and palar faces, ×15.5. Caryophyllia solida, new species (c, paratype, JSL-1926, USNM 84806; e, f, holotype, JSL-1924, USNM 84804): c, calice, ×3.5; e, f, lateral and stereo calicular views of holotype, ×2.9, ×3.7, respectively. g, h, holotype of Crispatotrochus galapagensis, new species, JSL-1931, USNM 84808, lateral and stereo calicular views, ×5.0, ×5.2, respectively.
PLATE 6.—Paracyathus humilis (a, Darwin Bay, Genovesa (see Wells, 1983), USNM 46963; b, Velero 137-34 (see Durham and Barnard, 1952), AHF 54.1); a, b, calicular views, x6.3, x5.6, respectively. c-e, Polycyathus isabela, USNM 49964, lateral and calicular views of holotype, x5.3, x6.1, x6.5, respectively (d is a stereo pair). f, holotype of Polycyathus hondaensis, Velero 948-39, AHF 33.1, stereo view, x2.5. g-i, Desmophyllum cristagalli, JSL-1911, USNM 84814, lateral, calicular, and oblique calicular views, x0.85, x1.0, x1.0, respectively. j, Lophelia prolifera, JSL-1937, USNM 84813, x3.6.
PLATE 7.—a,b, Anomocora carinata, new species, holotype, JSL-1938, USNM 84824, calicular and lateral stereo views, x3.5, x2.2, respectively. Sphenostrochus hancocki (c, holotype, Velero 170-34, AHF 57.2; e-g, ALB-5311 (see Cairns, 1989), Philippines, USNM 81897): lateral, edge, and calicular views, x17.5, x18.5, x25, respectively.

d, Phyllangia consagensis, Darwin Bay, Genovesa (see Wells, 1983), USNM 79105, stereo view of corallites interconnected by stolons, x1.6. h,i, Pseudocyathoceras avis, “Galapagos” (see Wells, 1983), USNM 46962, lateral and stereo calicular views, x4.5, x5.5, respectively.
PLATE 8.—a, b. *Flabellum daphnense*, holotype, Velero 788-38, AHF 58.1, stereo calicular and lateral views, x4.1, x3.7, respectively. *Javania cailleti* (c-e, JSL-1931, USNM 84831; d, JSL-1943, USNM 84834): c-e, calicular and lateral views, x3.1, x3.2, x2.0, respectively. *Polymyces wellsi*, new species (f, paratype, JSL-1916, USNM 84837; i, paratype, ALB-2818, USNM 77273 (*Javania pseudoalabastra* of Wells, 1983)): f, broken corallum revealing upper region of rootlets, x5.7; i, broken basal region of corallum revealing asymmetrical development of rootlets, x7.9. g, h, *Javania* sp. A, ALB-2816, USNM 19142 (*Javania cailleti* of Wells, 1983), calicular and lateral views, x2.1, x1.5, respectively. j, k, *Flabellum* sp. A, ALB-2818, USNM 77274 (*Javania cailleti* of Wells, 1983), calicular and lateral views, x7.9, x6.1, respectively.
PLATE 9.—a,b, Polymyces wellsi, new species, holotype, JSL-1916, USNM 84836, lateral and stereo calicular views, x1.25, x1.3, respectively. Balanophyllia galapagensis (c, f, holotype of B. galapagensis, ALB-4643, USNM 68278; d, g, Anton Bruun 795, USNM 77277; e, holotype of B. osburni, AIIF-63.2); c-e, lateral views of coralla, x2.7, x3.3, x2.3, respectively; f, g, calicular views, x6.4, x6.0, respectively. Balanophyllia eguchii (h, j, holotype, USNM 46966; i, JSL-16-x1-86-2, USNM 84843); h, elongate corallites, x2.3; i, j, two colonies, x1.6, x0.95, respectively.
PLATE 10.—a,b, Dendrophyllia gracilis, Galapagos (see Wells, 1983), USNM 46971, stereo calicular and calicular views, ×0.85, ×3.5, respectively. c-e, Dendrophyllia californica, JSL-1911, USNM 84844, lateral and calicular views, ×0.85, ×2.2, ×2.9, respectively. f-h, Dendrophyllia johnsoni, new species, holotype, JSL-1911, USNM 84847, lateral and edge views of corallum, ×0.7, ×2.1, ×2.1, respectively. i,j, Endopachys grayi, Velero 816-38, AHF 67.4 (E. vaughani of Durham and Barnard, 1952), stereo calicular and lateral views, ×1.25, ×1.3, respectively.
PLATE 11.—a, b, Endopachys grayi, Raabida, CAS 66652, calicular and lateral views, both x1.7. Rhizopsammia verrilli, Cocos L., USNM 77410: c, d, calicular and lateral views of a corallite, x4.0, x2.5, respectively; e, stereo view of a corallite with several stolons, x2.8. Rhizopsammia wellingtoni (f, h, paratype, Tagus Cove, USNM 46970 (see Wells, 1983); g, Floreana, CAS 18851 (see Wells, 1983)): f, h, various coralla, x1.7, x1.5, x3.4, respectively, figure g a stereo pair and includes Madracis sp. cf. M. pharensis on base. i, Endopsammia pourtalesi, holotype, Velero 12-32, AHF 68.1, stereo view of colony, x1.7.
PLATE 12.—a. *Endopora pourtalesi*, holotype, Velero 12-32, AHF 68.1, stereo view of largest calice, ×8.0.
c-e. *Tubastraea coccinea*, Anton Bruun 66132, USNM 77264, calicular and whole corallum views, ×2.1, ×1.5, ×0.65, respectively.
f-g. *Tubastraea tagusensis*, Tagus Cove, USNM 7883 (see Wells, 1983), stereo calicular and calicular views, ×1.7, ×0.70, respectively.
h-i. *Tubastraea floreana*, Gardner Island, Española, USNM 78885 (see Wells, 1983), ×1.9, ×0.68, respectively.
j. *Tubastraea faulkneri*, Goenoeng, Api, Banda Islands, USNM 62570 (see Wells, 1982), ×0.80.
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