

CHAPTER XII
ECHINODERMS

ECHINODERMS (OTHER THAN HOLOTHURIANS) OF THE GULF OF MEXICO

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The first definite record of an echinoderm from the Gulf of Mexico was published in 1758 when Albertus Seba described and figured *Stella marina polyactis* seu *Luna marina* (*Nemaster grandis*) from New Spain, presumably the eastern coast of Mexico. From time to time scattered notices of other species appeared, mostly from Mexico.

In 1867 investigation of the sea bottom in deep water was undertaken by the United States Coast Survey in the steamer *Corwin* under the direction of Count L. F. de Pourtalès. Four dredge hauls were made in from 96 to 350 fathoms off the Florida Keys and northern Cuba. In 1869 the U. S. C. S. S. *Bibb* made a number of deep hauls about the Florida Keys and off northern Cuba. In 1872 the *Bibb* dredged in from 17 to 1,164 fathoms in the Yucatán Channel and on the Yucatán Bank, with a few hauls among the Florida Keys, and in the same year the *Blake* made many dredge hauls about the Keys and off the west coast of Florida.

In 1877-78 the *Blake*, under the direction of Alexander Agassiz, continued work about the Florida Keys, north of Havana, and on and about the Yucatán Bank, with a few hauls off the mouth of the Mississippi. In 1880 the *Blake* made a single dredge haul east of Cape Catoche, Yucatán.

In 1884, 1885, and 1886 the U. S. Fish Commission steamer *Albatross* took a number of dredge hauls off Havana and in the Gulf of Mexico. Subsequently, the Bureau of Fisheries ships *Fish Hawk* and *Grampus* worked along the west coast of Florida.

The Bahama Expedition of the State University of Iowa made a few dredge hauls off Havana in 1893, and in 1938 and 1939 the *Atlantis* of the Woods Hole Oceanographic Institution made an intensive survey of the deeper waters about Cuba.

John B. Henderson, in his yacht *Eolis*, dredged extensively about the Florida Keys and on the Pourtalès Plateau, and Hubert Lyman Clark made intensive studies of the littoral species at Tortugas under the auspices of the Department

of Marine Biology of the Carnegie Institution of Washington. Waldo L. Schmitt also collected much interesting material in the same region.

It is most gratifying to be able to say that all the echinoderms from these collections, both governmental and private, have been studied and reports on them published. Furthermore, the material has been collected in comprehensive monographs by Mortensen (Echinoidea), H. L. Clark (Ophiuroidea), Döderlein (Euryalidae and Gorgonocephalidae), and A. H. Clark (Crinoidea), so that the relationships of the various species to others in different parts of the world may be readily appreciated.

But it is evident that by far the greatest part of our knowledge of the echinoderms of the Gulf of Mexico is confined to those species in the extreme southeast, about the Florida Keys and along the northern coast of Cuba. The remainder of the Gulf is largely a blank, and this is especially true of the zone between the shore line and 150 fathoms where undoubtedly many additional species remain to be discovered. Even among the Florida Keys, the most thoroughly worked of any comparable warm water area, there is still much to be found as is evident from the recent discovery of such conspicuous shallow water species as *Astropyga magnifica*, *Copidaster lymani*, *Ophidiaster bayeri*, and *Schizostella bifurcata*.

CRINOIDEA

Family COMASTERIDAE

- Nemaster grandis* A. H. Clark.
- Nemaster iowensis* (Springer).
- Nemaster rubiginosa* (Pourtalès).
- Nemaster discoidea* (P. H. Carpenter).
- Neocomatella pulchella* (Pourtalès).
- Neocomatella alata* (Pourtalès).
- Leptonemaster venustus* A. H. Clark.
- Comatonia cristata* (Hartlaub).
- Comactinia echinoptera* (J. Müller).

Family COLOBOMETRIDAE

- Analcidometra armata* (Pourtalès).

Family THALASSOMETRIDAE

- Stylometra spinifera* (P. H. Carpenter).
Horaeometra duplex (P. H. Carpenter).

Family CHARITOMETRIDAE

- Crinometra brevipinna* (Pourtalès).
Crinometra brevipinna var. *insculpta* A. H. Clark.
Crinometra brevipinna var. *coquinnia* A. H. Clark.
Crinometra brevipinna var. *margaritacea* A. H. Clark.
Crinometra brevipinna var. *diadema* (Hartlaub).
Crinometra brevipinna var. *brevipinna* (Pourtalès).
Crinometra brevipinna var. *gemmata* A. H. Clark.
Crinometra brevipinna var. *granulosa* (Hartlaub).
Crinometra brevipinna var. *granulifera* (Pourtalès).
Crinometra brevipinna var. *pulchra* A. H. Clark.

Family ANTEDONIDAE

- Compsometra nuttingi* A. H. Clark.
Coccometra hagenii (Pourtalès).
Coccometra nigrolineata A. H. Clark.
Coccometra guttata A. H. Clark.
Hypalometra defecta (P. H. Carpenter).
Zenometra columnaris (P. H. Carpenter).
Caryometra monilicirra A. H. Clark.
Caryometra atlantidis A. H. Clark.
Caryometra tenuipes (A. H. Clark).
Caryometra spinosa A. H. Clark.
Caryometra lisa A. H. Clark.
Caryometra alope A. H. Clark.
Trichometra cubensis (Pourtalès).

Family ATELECRINIDAE

- Atelecrinus balanoides* P. H. Carpenter.

Family ISOCRINIDAE

- Cenocrinus asteria* (Linné).
Neocrinus decorus Wyville Thomson.
Neocrinus blakei (P. H. Carpenter).
Endoxocrinus parrae (Gervais).
Endoxocrinus prionodes H. L. Clark.
Diplocrinus carolinae A. H. Clark.

Family HOLOPIDAE

- Holopus rangii* d'Orbigny.

Family BATHYCRINIDAE

- Monachocrinus caribbeus* (A. H. Clark).
Rhizocrinus lofotensis M. Sars.
Democrinus robustus (A. H. Clark).
Democrinus rawsonii (Pourtalès).¹

ECHINOIDEA**Family CIDARIDAE**

- Histocidaris sharreri* (A. Agassiz).
Histocidaris nuttingi Mortensen.

¹ An undersea photograph taken by D. M. Owen, Woods Hole Oceanographic Laboratory, in lat. 27°18' N., long. 85°30' W., west of Florida, in 1,200 fathoms, shows a 10-armed stalked crinoid that may be *Bathycrinus aldrichianus* Wyville Thomson. See Science News Letter, vol. 60, No. 15, October 13, 1951, p. 227.

- Stereocidaris ingolfiana* Mortensen.
Cidaris abyssicola (A. Agassiz).
Cidaris rugosa (H. L. Clark).
Cidaris blakei (A. Agassiz).
Calocidaris micans (Mortensen).
Stylocidaris affinis (Philippi).
Eucidaris tribuloides (Lamarck).

Family ECHINOTHURIDAE

- Phormosoma placenta* Wyville Thomson.
Hygrosoma petersii (A. Agassiz).
Araeosoma fenestratum (Wyville Thomson).
Araeosoma belli Mortensen.²

Family SALENIIDAE

- Salenocidaris varispina* A. Agassiz.
Salenia goëstiana Lovén.

Family ARBACIDAE

- Habrocidaris scutata* (A. Agassiz).
Podocidaris sculpta (A. Agassiz).
Arbacia punctulata (Lamarck).
Coelopleurus floridanus A. Agassiz.

Family ASPIDODIADEMATIDAE

- Plesiodiadema microtuberculatum* (A. Agassiz).
Plesiodiadema antillarum (A. Agassiz).
Aspidodiadema jacobyi A. Agassiz.

Family DIADEMATIDAE

- Astropyga magnifica* A. H. Clark.
Diadema antillarum (Philippi).
Centrostephanus rubricingulus H. L. Clark.

Family TEMNOPLEURIDAE

- Trigonocidaris albida* A. Agassiz.
Genocidaris maculata A. Agassiz.

Family TOXOPNEUSTIDAE

- Lytechinus variegatus* (Lamarck).
Lytechinus variegatus var. *variegatus* Lamarck.
Lytechinus variegatus var. *carolina* A. Agassiz.
Tripneustes ventricosus (Lamarck).

Family ECHINIDAE

- Echinus gracilis* A. Agassiz.

Family ECHINOMETRIDAE

- Echinometra lucunter* (Linné).³
Echinometra viridis A. Agassiz.

Family ECHINONEIDAE

- Echinoneus cyclostomus* Leske.

² Mortensen gives *Tromikosoma hispidum* from the Gulf of Mexico by error for the Gulf of California.

³ In the western part of the Gulf of Mexico this species is frequently circular, and is then easily mistaken for a species of *Heliocidaris*. Verrill in 1867 recorded (?) *Anthocidaris mexicana* A. Ag. from Vera Cruz. In the reprint of his article he says that Mr. Agassiz considers this his *Echinometra plana* (= *E. viridis*). It is probably the circular variety of *E. lucunter*.

Family ECHINOLAMPADIDAE

Echinolampas depressa Gray.
Conolampas sigsbei (A. Agassiz).

Family NEOLAMPADIDAE

Neolampas rostellata A. Agassiz.

Family CLYPEASTRIDAE

Clypeaster rosaceus (Linné).
Clypeaster euclastus H. L. Clark.
Clypeaster cyclopilus H. L. Clark.
Clypeaster ravenelii (A. Agassiz).
Clypeaster prostratus (Ravenel).

Family FIBULARIIDAE

Echinocyamus grandiporus Mortensen.
Echinocyamus macrostomus Mortensen.

Family SCUTELLIDAE

Mellita quinquiesperforata (Leske).
Mellita quinquiesperforata var. *quinquiesperforata* (Leske).
Mellita quinquiesperforata var. *tenuis* H. L. Clark.
Mellita quinquiesperforata var. *lata* H. L. Clark.
Mellita sexiesperforata (Leske).
Encope michelini L. Agassiz.

Family POURTALESIIDAE

Pourtalesia miranda A. Agassiz.

Family PALAEOPNEUSTIDAE

Palaeopneustes cristatus A. Agassiz.
Archaeopneustes hystriz (A. Agassiz).
Linopneustes longispinus (A. Agassiz).
Homolampas fragilis (A. Agassiz).
Palaeotropus josephinae Lovén.

Family AEROPSIDAE

Aceste bellidifera Wyville Thomson.

Family HEMIASTERIDAE

Hemiaster expergitus Lovén.

Family LOVENIIDAE

Echinocardium laevigaster A. Agassiz.

Family SCHIZASTERIDAE

Schizaster orbignyianus A. Agassiz.
Hypselaster limicolus (A. Agassiz).
Moiria atropos (Lamarck).
Agassizia excentrica A. Agassiz.

Family BRISSIDAE

Neopneustes micrasteroides (A. Agassiz).
Briassopsis alta Mortensen.
Briassopsis atlantica Mortensen.
Plethotaenia spatangoides (A. Agassiz).
Plagiobrissus grandis (Gmelin).
Brissus unicolor (Leske).
Meoma ventricosa (Lamarck).

ASTEROIDEA

Family GONIOPECTINIDAE

Goniopecten demonstrans Perrier.
Prionaster elegans Perrier.

Family ASTROPECTINIDAE

Astropecten articulatus (Say).
Astropecten articulatus var. *articulatus* (Say).
Astropecten articulatus var. *valenciennesi* Müller and Troschel.
Astropecten cingulatus Sladen.
Psilaster squameus H. L. Clark.
Plutonaster bifrons (Wyville Thomson).
Plutonaster intermedius (Perrier).
Persephonaster pulcher (Perrier).
Persephonaster echinulatus H. L. Clark.
Persephonaster spinulosus H. L. Clark.
Tethyaster grandis (Verrill).
Tethyaster vestita (Say).⁴

Family LUIDIIDAE

Luidia senegalensis Müller and Troschel.
Luidia barbadiensis Perrier.
Luidia variegata Perrier.
Luidia convexiuscula Perrier.
Luidia alternata (Say).
Luidia clathrata (Say).⁵

Family BENTHOPECTINIDAE

Benthopecten spinosus Verrill.
Cheiraster coronatus (Perrier).
Cheiraster mirabilis (Perrier).
Luidiaster mixtus (Verrill).

Family ODONTASTERIDAE

Odontaster hispidus Verrill.

Family GONIASTERIDAE

Pseudarchaster concinnus Verrill.
Pseudarchaster parelii (Düben and Koren).
Pseudarchaster ordinatus Verrill.
Paragonaster grandis H. L. Clark.
Mediaster pedicellaris (Perrier).
Tessellaster notabilis H. L. Clark.
Ceramaster grenadensis (Perrier).
Nymphaster ternalis (Perrier).
Nymphaster arenatus (Perrier).
Nymphaster subspinosus (Perrier).
Blakiaster conicus Perrier.
Rosaster alexandri (Perrier).
Peltaster hebes Verrill.
Goniaster cuspidatus Gray.
Plinthaster dentatus (Perrier).
Plinthaster productus A. H. Clark.
Litonaster intermedius (Perrier).
Astroceramis brachyactis H. L. Clark.

⁴ *Asterias vestita* Say, Jour. Acad. Nat. Sci. Philadelphia, vol. 5, p. 143 1825.

⁵ *Asterias clathrata* Say, 1825, is preoccupied by *Asterias clathrata* Pennant, 1777, but nothing would be gained by displacing this well established name.

Lydiaster americanus A. H. Clark.
Circeaster occidentalis H. L. Clark.
Anthenoides peircei Perrier.

Family OREASTERIDAE

Oreaster reticulatus (Linné).

Family LINCKIIDAE

Linckia bowieri Perrier.
Linckia guildingii Gray.
Linckia nodosa Perrier.
Copidaster lymani A. H. Clark.
Hacelia floridæ (Perrier).⁶
Ophidiaster guildingii Gray.
Ophidiaster bayeri A. H. Clark.

Family GANERIIDAE

Leilaster radians (Perrier).⁷

Family PORANIIDAE

Marginaster pectinatus Perrier.

Family ASTERINIDAE

Asterina folium Lütken.
Stegnaster wesseli (Perrier).

Family ECHINASTERIDAE

Thyraster serpentarius (Müller and Troschel).
Echinaster modestus Perrier.
Echinaster sentus (Say).
Henricia antillarum (Perrier).
Henricia microspina Verrill.
Henricia sexradiata (Perrier).

Family SOLASTERIDAE

Solaster caribbeus Verrill.
Lophaster furcifer (Düben and Koren).
Laetmaster spectabilis (Perrier).

Family PTERASTERIDAE

Pteraster caribbaeus Perrier.
Pteraster militarioides H. L. Clark.
Pteraster rugosus H. L. Clark.
Pteraster stoibe H. L. Clark.
Hymenaster regalis Verrill.

Family BRISINGIDAE

Odinia pandina Sladen.
Freyella mexicana A. H. Clark.

Family ZOROASTERIDAE

Zoroaster ackleyi Perrier.
Mammaster sigsbei (Perrier).

⁶ Includes *Ophidiaster floridæ* Perrier, 1881; *O. alexandri* Verrill, 1915; *O. pinguis* H. L. Clark, 1941; and *Hacelia superba* H. L. Clark, 1921.

⁷ Given by Perrier as *Korethraaster radians*, *Lophaster radians*, *Solaster radians*, and *Korethraaster hispidus*.

Family ASTERIIDAE

Pedicellaster pourtalesi Perrier.
Coronaster briareus (Verrill).
Asterias crassispina H. L. Clark.
Asterias forbesi (Desor).
Stephanasterias gracilis (Perrier).
Eustolasterias angulosa (Perrier).
Eustolasterias contorta (Perrier).

OPHIUROIDEA

Family OPHIOMYXIDAE

Ophiomyxa brevicauda Verrill.
Ophiomyxa flaccida (Say).
Ophiomyxa tumida Lyman.
Ophiobyrsa serpens Lyman.
Ophiobranchion uncinatus Lyman.
Ophiogeron granulatus (Lyman).
Ophiophrixus quadrispinosus (Koehler).
Ophiosciasma granulatum Lyman.
Ophioscolex disacanthus H. L. Clark.
Ophioscolex stimpsonii Lyman.
Ophioscolex tropicus Lyman.
Ophiopleptoplax atlanticus Koehler.

Family TRICHAETERIDAE

Asteroschema arenosum Lyman.
Asteroschema brachiatum Lyman.
Asteroschema elongatum Koehler.
Asteroschema intectum Lyman.
Asteroschema laeve (Lyman).
Asteroschema nuttingii Verrill.
Asteroschema oligactes (Pallas).
Asteroschema tenue Lyman.
Ophiocreas lumbricus Lyman.
Ophiocreas spinulosus Lyman.
Asteronyx lovéni Müller and Troschel.
Astrodia tenuispina (Verrill).

Family GORGONOCEPHALIDAE

Astrogomphus rudis Verrill.
Astrogomphus vallatus Lyman.
Asteroporpa annulata Lütken.
Asteroporpa lindneri A. H. Clark.
Asteroporpa pulchra H. L. Clark.
Schizostella bifurcata A. H. Clark.
Astrocnida isidis Lyman.
Astrospartus mucronatus (Lyman).
Astrophytum muricatum (Lamarck).
Astrocyclus caecilia (Lütken).
Astrocanemum herrerae (A. H. Clark).

Family HEMIEURYALIDAE

Ophiochondrus convolutus Lyman.
Ophiochondrus crassispinus Lyman.
Ophiochondrus gracilis Verrill.
Ophiochondrella squamosa (Lyman).
Sigsbeia conifera Koehler.
Sigsbeia murrhina Lyman.
Ophioplus tuberculosus (Lyman).

Family OPHIACANTHIDAE

Ophiolebes humilis (Lyman).
Ophiacantha affinis Koehler.
Ophiacantha aspera Lyman.
Ophiacantha curima H. L. Clark.
Ophiacantha echinulata Lyman.
Ophiacantha ensifer (Verrill).
Ophiacantha hirsuta Lyman.
Ophiacantha mesembria H. L. Clark.
Ophiacantha pentacrinus Lütken.
Ophiacantha robusta (Koehler).
Ophiacantha scutata Lyman.
Ophiacantha stellata Lyman.
Ophiacantha valenciennesi Lyman.
Ophiothamnus exiguus (Lyman).
Ophiothamnus minimus (Koehler).
Ophiothamnus vicarius Lyman.
Ophiomitrella laevipellis (Lyman).
Ophiomitra ornata Verrill.
Ophiomitra valida Lyman.
Ophioplinthaca dipsacos (Lyman).
Ophioplinthaca incisa (Lyman).
Ophiocamax austera Verrill.
Ophiocamax fasciculata Lyman.
Ophiocamax hystrix Lyman.
Ophioprium cervicorne (Lyman).
Ophiacanthella troscheli (Lyman).
Ophiotreta affinis Koehler.
Ophiotreta lineolata (Lyman).
Ophiotreta littoralis (Koehler).
Ophiotreta mixta (Lyman).
Ophiotreta sertata (Lyman).
Ophialcaea nuttingii Verrill.
Ophioconis miliaria Lyman.

FAMILY OPHIOMYCETIDAE

Ophiomyces fructosus Lyman.
Ophiomyces mirabilis Lyman.

Family AMPHIURIDAE

Amphiura diducta Koehler.
Amphiura duplicata Koehler.
Amphiura fibulata Koehler.
Amphiura grandisquama Lyman.
Amphiura kinbergiensis Koehler.
Amphiura küenthali Koehler.
Amphiura lunaris Lyman.
Amphiura otteri Ljungman.
Amphiura palmeri Lyman.
Amphiura semiermis Lyman.
Amphiura stimpsonii Lütken.
Hemipholis elongata (Say).
Ophiophragmus wurdemannii (Lyman).
Ophiophragmus brachyactis H. L. Clark.
Amphipholis abnormis (Lyman).
Amphipholis gracillima (Stimpson).
Amphipholis squamata (Delle Chiaje).
Ophio stigma isacanthum (Say).
Amphiodia pulchella (Lyman).
Amphiodia repens (Lyman).
Ophiocnida cubana A. H. Clark.

Ophiocnida filogranea Lyman.
Ophiocnida scabriuscula (Lütken).
Amphioplus abditus (Verrill).
Amphioplus cuneatus (Lyman).
Amphioplus tumidus (Lyman).
Amphilimna olivacea (Lyman).
Amphitarsus mirabilis H. L. Clark.

Family OPHIACTIDAE

Ophiactis dispar Verrill.
Ophiactis duplicata (Lyman).
Ophiactis loricata Lyman.
Ophiactis mülleri Lütken.
Ophiactis plana Lyman.
Ophiactis savignyi (Müller and Troschel).

Family OPHIOTRICHIDAE

Ophiothrix angulata (Say).
Ophiothrix brachyactis H. L. Clark.
Ophiothrix lineata Lyman.
Ophiothrix ørstedii Lütken.
Ophiothrix suensonii Lütken.

Family OPHIOCHITONIDAE

Ophiochiton grandis Verrill.
Ophioplax ljungmani Lyman.
Ophioplax pardalis H. L. Clark.
Ophioplax reducta (Koehler).
Ophioplax spinulifera H. L. Clark.
Ophionereis reticulata (Say).

Family OPHIOCOMIDAE

Ophiocoma echinata (Lamarck).
Ophiocoma pumila Lütken.
Ophiocoma riisei Lütken.
Ophiopsila fulva Lyman.
Ophiopsila hartmeyeri Koehler.
Ophiopsila maculata (Verrill).
Ophiopsila riisei Lütken.

Family OPHIODERMATIDAE

Ophioderma appressum (Say).
Ophioderma brevicaudum Lütken.
Ophioderma brevispinum (Say).
Ophioderma cinereum Müller and Troschel.
Ophioderma pallidum (Verrill).
Ophioderma rubicundum Lütken.
Ophiarachnella angulata (Lyman).
Ophiarachnella petersi (Lyman).
Bathypsectinura lacertosa (Lyman).

Family OPHIOLEPIDAE

Ophiomastus secundus Lyman.
Amphiphora metabula H. L. Clark.
Amphiphora oedignatha H. L. Clark.
Amphiphora sculptilis (Lyman).
Ophiura acervata (Lyman).
Ophiura falcifera (Lyman).
Ophiura irrorata (Lyman).
Ophiura lepida (Lyman).
Ophiura ljungmani (Lyman).

Ophiomusium acuferum Lyman.
Ophiomusium armigerum Lyman.
Ophiomusium dyscritum (H. L. Clark.)
Ophiomusium eburneum Lyman.
Ophiomusium eburneum var. *eburneum* Lyman.
Ophiomusium eburneum var. *elegans* Verrill.
Ophiomusium leptobrachiium H. L. Clark.
Ophiomusium lymani Wyville Thomson.
Ophiomusium microporum H. L. Clark.
Ophiomusium moniliforme H. L. Clark.
Ophiomusium monoplas H. L. Clark.
Ophiomusium oligoplacum H. L. Clark.
Ophiomusium planum Lyman.
Ophiomusium rugosum Koehler.
Ophiomusium sculptum Verrill.
Ophiomusium serratum Lyman.
Ophiomusium stellatum Verrill.
Ophiomusium testudo Lyman.
Ophiomusium validum Ljungman.
Ophiolipus agassizii Lyman.
Ophiothyreus goësi Ljungman.
Ophioceramis rugosa H. L. Clark.
Ophiozona impressa (Lütken).
Ophiozonella clypeata (Lyman).
Ophiozonella granulifera H. L. Clark.
Ophiozonella marmorea Lyman.
Ophiozonella nivea (Lyman).
Ophiozonella nivea var. *compta* (Verrill).
Ophiozonella nivea var. *nivea* (Lyman).
Ophiozonella tessellata (Lyman).
Ophiomidas dubius (Lyman).
Ophiolepis elegans Lütken.
Ophiolepis paucispina (Say).

Family OPHIOLEUCIDAE

Ophiopaepale goësiana Ljungman.
Ophiopyren longispinus Lyman.
Ophiernus adspersus Lyman.

BIBLIOGRAPHY

AGASSIZ, ALEXANDER.

- 1872-1874. Revision of the Echini. Illus. Catalogue of the Mus. Comp. Zool., Harvard College, No. 7, 762 pp.
 1878. Echini. In: No. 9. Report on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico, by the United States Coast Survey steamer *Blake* . . . Bull. Mus. Comp. Zool. Harvard College, 5 (9): 181-195.

CASO, MARIA ELENA.

1951. Contribución al conocimiento de los ofiuroides de México. I. Algunas especies de ofiuroides litóralas. Anales del Instituto de Biología 22 (1): 219-312.

CLARK, AUSTIN H.

- 1915-50. A monograph of the existing crinoids. Bull. U. S. Nat. Mus. 82.
 1916. A new starfish (*Lydiaster americanus*) from the Gulf of Mexico, representing a section of the subfamily Goniasterinae hitherto known only from the Indo-Pacific region. Jour. Washington Acad. Sci. 6 (6): 141-144.

CLARK, AUSTIN H.—Continued

1917. Four new echinoderms from the West Indies. Proc. Biol. Soc. Washington 30: 63-70.
 1918. A new genus and species of multibrachiate ophiuran of the family Gorgonocephalidae from the Caribbean Sea. Proc. U. S. Nat. Mus. 54 (2257): 637-640.
 1923. The Danish Ingolf-Expedition. Crinoidea. Vol. 4, No. 5, pp. 1-60.
 1934. A new sea-urchin from Florida. Jour. Washington Acad. Sci. 24 (1): 52-53.
 1939. Echinoderms from the Smithsonian-Hartford Expedition, 1937, with other West Indian records. Proc. U. S. Nat. Mus. 86: 441-456.
 1940. The family Antedonidae in the west tropical Atlantic. Mem. Soc. Cubana Hist. Nat. 14 (2): 139-160.
 1948. Two new starfishes and a new brittle-star from Florida and Alabama. Proc. Biol. Soc. Washington 61: 55-66.
 1952. *Schizostella*, a new genus of brittle-stars (Gorgonocephalidae). Proc. U. S. Nat. Mus. 102: 441-444.

CLARK, HUBERT LYMAN.

1515. Catalogue of recent ophiurans. Mem. Mus. Comp. Zool., Harvard College, 25 (4): 165-376.
 1919. The distribution of the littoral echinoderms of the West Indies. Carnegie Inst. Washington, Pap. Dept. Mar. Biol. 13: 51-73.
 1925. A catalogue of the recent sea-urchins (Echinoidea) in the collection of the British Museum (Natural History). Pp. i-xxvii, 1-250.
 1933. A handbook of the littoral echinoderms of Porto Rico and other West Indian Islands. New York Acad. Sci., Scientific survey of Porto Rico and the Virgin Islands. Vol. 16, part 1, pp. 1-147.
 1940. A revision of the keyhole urchins. Proc. U. S. Nat. Mus. 89: 435-444.
 1941. Echinoderms (other than holothurians). Mem. Soc. Cubana Hist. Nat. 15 (1): 1-154.

DÖDERLEIN, LUDWIG.

1911. Über japanische und andere Euryalae. Abhandl. der math.-phys. Klasse der K. Bayer. Akademie der Wiss. II. Suppl. Bd. 5, Abhandig, pp. 3-126.
 1917. Die Asteriden der Siboga-Expedition. I. Die Gattung *Astropecten* und ihre Stammesgeschichte, pp. i-vi, 1-191.
 1920. Die Asteriden der Siboga-Expedition. II. Die Gattung *Luidia* und ihre Stammesgeschichte, pp. 1-293.
 1927. Indopacifische Euryalae. Abh. der Bayerischen Akad. d. Wiss., math.-naturwiss. Abt., vol. 31, Abt. 6.
 1936. Die Asteriden der Siboga-Expedition. III. Die Unterfamilie Oreasterinae, pp. 1-369.

IVES, J. E.

1889. Catalogue of the Asteroidea and Ophiuroidea in the collection of the Academy of Natural Sciences, Philadelphia. Proc. Acad. Nat. Sci., Philadelphia, for 1889, pp. 169-178.

- IVES, J. E.**
1890. Echinoderms from the north coast of Yucatán and the harbor of Vera Cruz. Proc. Acad. Nat. Sci., Philadelphia, for 1890, 42: 317-340.
- KOEHLER, RENÉ.**
1907. Revision de la collection des ophiures du Museum d'Histoire Naturelle de Paris. Bull. Scientifique de la France et de la Belgique 41: 279-351.
1914. A contribution to the study of ophiurans of the United States National Museum. U. S. Nat. Mus. Bull. 84: i-vii, 1-173.
- LYMAN, THEODORE.**
1865. Ophiuridae and Astrophytidae. Illus. Catalogue of the Mus. Comp. Zool., No. 1, pp. 1-200.
1878. Ophiurans and Astrophytons. In: No. 9. Report on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico, by the United States Coast Survey steamer *Blake* . . . Bull. Mus. Comp. Zool. 5 (9): 217-238.
- MORTENSEN, TH.**
1928-51. A monograph of the Echinoidea. Copenhagen.
- MÜLLER, JOHANNES, and TROSCHEL, FRANZ HERMAN.**
1842. System der Asteriden. Braunschweig.
- PERRIER, EDMOND.**
1881. Description sommaire des espèces nouvelles d'astéries. In: Report on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico, 1877-78, by the United States Coast Survey steamer *Blake* . . . Bull. Mus. Comp. Zool. 9 (1): 1-31.
- PERRIER, EDMOND.**
1884. Mémoire sur les étoiles de mer recueillies dans la mer des Antilles et la Golfe du Mexique durant les expéditions de dragage faites sous la direction de M. Alexandre Agassiz. Nouvelles Arch. Mus. d'Hist. Nat., Paris, ser. 2, 6: 127-276.
- POURTALÈS, L. F. de.**
1878. Crinoids and corals. In: No. 9. Report on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico, by the United States Coast Survey steamer *Blake* . . . Bull. Mus. Comp. Zool. 5 (9): 213-216.
- SAY, THOMAS.**
1825. On the species of the Linnaean genus *Asterias* inhabiting the coast of the United States. Jour. Acad. Nat. Sci., Philadelphia, 5 (part 1): 141-154.
- SEBA, ALBERTUS.**
1734-65. Locupletissimi rerum naturalium thesauri . . . 4 vols. Amsterdam.
- VERRILL, A. E.**
1867. Notes on the Radiata in the museum of Yale College, with descriptions of new genera and species. Trans. Connecticut Acad. Sci. 1: 247-274.
1899a. Revision of certain genera and species of starfishes, with descriptions of new forms. Trans. Connecticut Acad. Sci. 10: 145-234.
1899b. Report on the Ophiuroidea collected by the Bahama Expedition in 1893. Bull. Lab. Nat. Hist., State Univ. Iowa, 5 (1): 1-86.

THE HOLOTHURIANS OF THE GULF OF MEXICO

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The holothurians constitute one of the smaller groups of Recent echinoderms. They occur widespread in the sea, ranging from the shores of the Arctic to the greatest depths of the ocean and particularly abundant in the tropical shallow waters, especially in the coral reef zone. They are predominately bottom forms, though a few are adapted for an exclusive pelagic mode of life, and some have been observed actively swimming.

Except for the larger members of the order they are less likely to be noticed than other echinoderms. For one thing they have thoroughly masked their original five-rayed structure by developing a secondary bilaterality, with a strong muscular system and reduction—in most forms—of the calcareous skeleton; hence they can contract into shapeless lumps or seek shelter in narrow crevices or burrow in sand or mud. In addition, many species dissolve into slime when taken out of water, so it is certain that many specimens never reach the museum collections, even if a careful collector has succeeded in capturing them. It is sometimes difficult to give good description of these forms as their bodies so often are contorted when preserved; also, the number of tube feet frequently increases with age, and the spicules in the skin are apt to undergo profound changes during the animal's life. One finds, therefore, the older literature cluttered with worthless species, based on poorly preserved specimens or immature or aged individuals.

The West Indian region is considered one of the best explored in the world, but our knowledge of the distribution of the holothurians there is still incomplete, and this is particularly true of the northern section—the Gulf of Mexico. In some respects this is an advantage as the worker can begin with a clean slate, free from old records of species which impossibly could have been collected there.

During the last 20 years there has been an increasing interest in the biology of the Gulf area,

and material of holothurians has steadily been coming in to the Museum of Comparative Zoology, Harvard College, for identification. It may be worth noting that the only new shallow water dendrochirote added to the West Indian fauna since 1930 came from Louisiana; also, that the *Atlantis* expeditions around Cuba have added a number of new species (or species new to the region), and some of these extend their range into the Gulf area along the north coast of Cuba.

Biologically, one can roughly divide the area under consideration into two zones: the shallow water zone, from shore down to about 200 fathoms—about as deep as one possibly can dredge with a small boat—and the deep water zone which demands a specially equipped vessel with complicated collecting apparatus. The shallow water zone can again be divided into the southern part with coral reefs, that is, the southern part of Florida, the north coast of Cuba, and Yucatán—with a comparatively rich and diversified holothurian fauna—and the barren sandy or muddy stretches along the eastern shores of Mexico, the Gulf States, and most of the western coast of Florida. This region is characterized by an impoverished fauna of burrowing forms which in suitable sheltered localities may occur in large numbers. For the whole shallow water area one can predict that the fauna may change locally from year to year as it undoubtedly does in other parts of the West Indies. The hurricanes may play havoc with large areas both in the southern coral reef region and along the endless stretches of mud flats and sand bars which festoon the northern part of the Gulf, and it may take several years before larvae from individuals living at greater and more secure depths have been able to settle down and re-populate a denuded area again.

The deep water zone will probably prove to consist of two areas, the vast muddy expanses, mostly inhabited by *Elasipoda* which are adapted

to slide over the slimy bottom, or burrowing forms as the Molpadonia and deep water Apoda, and the ledges along the north coast of Cuba and Yucatán with a depth of 200 to 500 fathoms and inhabited by offshots of the shallow water fauna, mostly Aspidochirota and Synallactidae.

In 1930 an attempt was made to trace the origin of the West Indian holothurian fauna on the basis of what was then known. The following 20 years have added so much to our knowledge about the distribution of the holothurians of the American waters, the result of the Hancock expeditions along the west coast of Mexico and Central America and the Harvard-Havana expeditions around Cuba, that many of the statements set down then have had to be modified or entirely reversed.

The deep water forms, the Elaspodae, Synallactidae, and a few Holothuriidae, represent a selection of the Atlantic fauna. Most of them are typical mud dwellers which occur widespread in the Atlantic Ocean in deep water, but the *Atlantis* expeditions have added a number of forms hitherto known only from the eastern part of the Atlantic occurring close to the shore and from moderate depth, 200 to 500 fathoms or so. Some of these have been taken inside of the Gulf area along the northern coast of Cuba, and they may very likely prove to be a characteristic element in the southern part of the Gulf.

The order Molpadonia have a few representatives from moderate to great depth. With a single exception, the widespread *Molpadia musculus*, they all appear to be endemic, though one may expect that most of them have a parallel form in the Pacific. The single representative of the order Apoda is known from deeper water off the Atlantic Coast of North America, and in the end it may be united with a closely related species reported from the eastern Pacific.

Among the typical shallow water forms, which mostly are taken at low tide or a few fathoms depth though some go down to almost 200 fathoms, we find that the Aspidochirota have no affinities with the eastern Atlantic (*Holothuria impatiens* is a circumtropical form, while *H. mexicana* and *Stichopus badiotus*, though reported from the eastern Atlantic, appear not to belong there; it may be either wrong labeling, or they may have become accidentally introduced without being permanently established). The Aspidochirotes have their closest affinities with the Indo-Pacific

fauna; a few somewhat similar species occur also in the Panamic region, but we are not able to speak of truly parallel forms. On the other hand, the dendrochirotes which 20 years ago were considered endemic have now, thanks to the Hancock expeditions, been found to have in most cases a parallel form in the Panamic region but no close affinities with the remaining part of the Pacific Ocean nor with the eastern Atlantic. An exception is *Thyone inermis*, a Mediterranean form of which immature specimens have been taken, off and on, around Florida and at Tobago but not in the Gulf itself. Some dendrochirotes appear to be absent in the West Indies as a whole but occur in the northern part of the Gulf and along the Atlantic seaboard (*Thyone briareus* and *Thyonella gemmata*). There is only one true shallow water form of the order Molpadonia, though others have been taken in abnormally shallow water; this species, *Paracaudina obesacauda*, is, as far as known, restricted to the Gulf, and the genus is not otherwise known from the Atlantic Ocean. A number of closely related species in shallow water are found in the Pacific, ranging from Chile northward to Alaska, from Japan, China, Australia to New Zealand. When it comes to the order Apoda, our knowledge is still most unsatisfactory. The few, purely tropical species known from the West Indies will undoubtedly be found widespread in the southern part of the Gulf, on the reefs, while offshots from the forms found along the Atlantic seaboard may be expected in muddy and sandy localities between Florida and Texas and possibly farther south along the east coast of Mexico. Nothing can be said about the affinities with the Panamic fauna of Apoda as it is still almost unknown. Very likely it is almost nonexistent as much of the shoreline of the west coast of Mexico and Central America is ill-suited for these forms. With the fauna of Apoda from the eastern Atlantic and the Mediterranean there seem to be no close affinities.

TECHNIQUE

Holothurians may be anesthetized with chlore-tone or Epsom salt, or even stale sea water. By slowly adding alcohol one is often able to have them preserved in reasonably well-expanded condition. Large species may later have an incision made in the skin so that alcohol can penetrate

into the body cavity. As it often is impossible to bring back the large individuals one can make a note of their length and width, color, arrangement of tube feet, papillae, or other features, and preserve some pieces of the skin with a tag tied to it; one should take a skin sample from the dorsal side as well as from the ventrum as the spicules often are quite different in these two regions. Formalin must never be used as it dissolves the spicules and makes the tissue soft.

The gross anatomical features can be found listed in almost any zoological textbook. For examination of the spicules one places a small piece of skin on a slide, noting whether it is from dorsal or ventral side, or elsewhere, and after most of the alcohol has evaporated one adds a few drops of fresh chlorox or zonite or a similar chlorine bleaching compound. It pays to follow the disintegration of the tissue to estimate the position of the different types of spicules. Often one can get the outer spicules off by placing the skin with the outer side downward in the liquid for a short time. This is of special advantage when the external spicules are small or so few that they easily disappear among those of the deeper layer. Special preparations may often be made of the tube feet to ascertain whether an end plate or a trace of such is present, and how the walls are

armed; many times juvenile spicules are retained near the tip of papillae. In the dendrochirota the introvert, the retractile thin-skinned part behind the tentacles, contains usually characteristic spicules, as do also the tentacles. The size of the animal must be noted since there often is considerable difference in the size and shape of the spicules in the young and the aged individuals. In some forms the spicules are reduced with age and may become completely resorbed; in others, they grow heavier and more complex.

Extremely small individuals, a few millimeters long, are often difficult to identify. Sometimes they have still only simple perforated plates, and when the first typical spicules appear they are in many forms scaled down to the animal's size. In some forms there is a period during which the spicules are excessively large, and these spicules may be found preserved near the tip of the papillae when they have disappeared in other places.

Permanent slides can be made by rinsing off the chlorine solution with distilled water and letting the slide go through alcohol-xylo-balsam. Great care must be exercised not to have the slides contaminated with spicules from earlier preparations. With important specimens it is wise to use a new eye dropper and a fresh bottle of chlorine solution.

KEY TO THE ORDERS

- | | |
|--|--------------------------|
| 1. Animals with disk-shaped tentacles..... | 2 |
| 1. Animals not with disk-shaped tentacles..... | 3 |
| 2. No respiratory trees present. Exclusively deep water forms..... | 1. Elasi-poda, p. 383 |
| 2. Respiratory trees present. Shallow water to deep water forms..... | 2. Aspidochirota, p. 384 |
| 3. Tentacles dendritic, 10 to 20 in number; numerous tube feet. Plankton feeders. Clings to the substratum or buried in mud or sand, except for the tentacles and the anal end..... | 3. Dendrochirota, p. 394 |
| 3. Tentacles not dendritic, feather-shaped or with few lateral digits..... | 4 |
| 4. Tentacles 15, small, in a terminal circle, with few digits. Tube feet reduced to anal papillae. Body barrel-shaped with a shorter or longer "tail." Burrows in mud..... | 4. Molpadonia, p. 405 |
| 4. Tentacles 10 (or 12-13) with few to many digits, sometimes feather-shaped. Tube feet totally lacking. Body worm-like often able to contract transversely so the hind end drops off (may later be regenerated). Among coral fragments or burrowing in sand or mud..... | 5. Apoda, p. 406 |

Order 1 ELASIPODA

In the Gulf of Mexico only three representatives have so far been taken of this remarkable order which first became known when the *Challenger* explored the deepest parts of the oceans in the 1870's. On the whole, one can say that the deeper parts of the Gulf of Mexico represent a true

"Mediterranean" type of water body, with few species, but nevertheless one may expect almost any species known from the Atlantic Ocean. In case other species than those listed below should be found, it will be necessary to consult more extensive reports, such as Mortensen's, *The Echinoderms of the British Isles*, 1927, or Deichmann's 1930 and 1940 papers.

Family PSYCHROPOTIDAE

KEY TO THE GENERA AND SPECIES TAKEN IN THE GULF OF MEXICO

1. Dorsal side with a "hump"-like appendage on the posterior part. Spicules dorsal crosses, with strongly curved arms and a central spine surrounded by four smaller ones. Color deep purplish. Genus 1. *Euphronides*.
Euphronides violacea Perrier, p. 384
1. Dorsal side without a posterior "hump." Genus 2. *Benthodytes*.....2
2. Flattened form, short, with a broad lateral swimming brim of papillae. Spicules simple spinous rods. Deep purple.
1. *Benthodytes typica* Théel, p. 384
2. More or less vaulted form, elongate, with narrow brim of papillae. Spicules large crosses with curved arms and one to three stout, spinous projections arising from the center. Color reddish to deep purple.
2. *Benthodytes lingua* Perrier, p. 384

Genus 1 EUPHRONIDES Théel, 1881

1 *Euphronides violacea* Perrier

Euphronides violacea Perrier, 1896, p. 102; 1902, p. 438, pl. 20, fig. 14; Deichmann, 1930, p. 128.

Diagnosis.—Flattened body with mouth and anus ventral, 10 to 20 tentacles, narrow lateral brim of small papillae. Dorsally four to six pairs of papillae placed anteriorly and an unpaired hump arising some distance from the posterior margin. Spicules, dorsally large, curved crosses with one large conical spine surrounded by four smaller ones; ventrally scattered delicate crosses, almost flat. Type: Paris. Type locality: Coast of Morocco. Distribution: Eastern Atlantic; in the western part from the Lesser Antilles and Gulf of Mexico, from 655 to 2,120 fathoms.

Genus 2 BENTHODYTES Théel, 1881

1 *Benthodytes typica* Théel

Benthodytes typica Théel, 1882, p. 103; 1886a, p. 2; Deichmann, 1930, p. 123.

Diagnosis.—Flat, short form (15 cm.) with wide swimming-brim of closely placed papillae. Double row of small pedicels in midventral ambulacrum. Deep purple in color. Spicules scattered, spinous rods. Type: British Museum.

Type locality: Off Gibraltar. Distribution: Eastern Atlantic; in the West Indies, common in the Gulf of Mexico, along the Lesser Antilles and also known from off the coast of New England, from 172 to 766 fathoms.

It is seldom that one gets more than a bunch of broad muscle bands and some shreds of skin. Nevertheless, it is usually possible to recognize the animal on account of the short body length and the simple spicules. It lives on soft mud bottom

2 *Benthodytes lingua* Perrier

Benthodytes lingua Perrier, 1896, p. 902; 1902, p. 466, pl. 12, figs. 1-2; pl. 21, figs. 1-9; Deichmann, 1930, p. 124; 1940, p. 200, pl. 35, figs. 3-4.

Diagnosis.—Large form, 30 cm., with 15 ventral tentacles, a narrow brim of small papillae and a double row of feet in the midventral radius. Dorsally, a few, insignificant papillae. Color pale reddish to deep purplish. Enormous crosses with curved spinous arms and one to three stout spinous projections from the center of the cross. Type: Paris. Type locality: Off Morocco. Distribution: Eastern Atlantic; in the western part known from the Gulf of Mexico and also off the coast of New England from 470 to 1,200 fathoms.

Order 2 ASPIDOCHIROTA Grube

KEY TO THE FAMILIES

1. No free tentacle ampullae. Deep water forms.....1. Synallactidae, p. 384
1. Free tentacle ampullae. Mostly shallow water forms.....2
2. Genital organs in two tufts. Large, thick-skinned forms.....2. Stichopodidae, p. 387
2. Genital organs in one tuft on left side of dorsal mesentery. Large to small forms.....3. Holothuriidae, p. 388

Family 1 SYNALLACTIDAE

KEY TO THE GENERA REPRESENTED IN THE GULF OF MEXICO

1. Spicules almost lacking. Anus often in a vertical furrow. Skin thick, gelatinous, often covered by sand or minute shells.....1. *Pseudostichopus* Théel, p. 395
1. Spicules present. Anus not in a vertical furrow.....2

- 2. Spicules large tables with disk developed as a cross; rarely arms of cross united so a complete disk is formed. Large, thick-skinned forms with ventral side set off as a sole with marginal papillae.....4. *Bathyploetes* Oestergren, p. 386
- 2. Spicules small to large tables; disk not cross-shaped.....3
- 3. Appendages large papillae and feet, all in distinct rows. Tables of varying size, often the large ones with spire reduced. 5. *Amphigygnas* Walsh, p. 387
- 3. Appendages small, scattered or marginal.....4
- 4. Numerous tube feet, resembling short threads, distributed over most of the sack-like body...2. *Mesothuria* Ludwig, p. 385
- 4. Few marginal feet, wart-like.....3. *Zygothuria* Perrier, p. 386

Genus 1 PSEUDOSTICHOPUS Théel, 1882

Of the seven incompletely known species reported from the Atlantic Ocean, one is listed from the Gulf of Mexico. For the others which very likely may belong to the fauna, see Mortensen, 1927, p. 367, or Deichmann, 1930, p. 86.

Pseudostichopus occultatus v. Marenzeller

Pseudostichopus occultatus v. Marenzeller, 1893a, p. 15, pl. 4, fig. 9; Deichmann, 1930, p. 89; 1940, p. 190.

Genus 2 MESOTHURIA Ludwig, 1894

KEY TO THE SPECIES REPORTED FROM THE GULF OF MEXICO

- 1. Deposits triradiate tables.....1. *Mesothuria maroccana* Perrier, p. 385
- 1. Deposits quadri radiate tables.....2
- 2. Feet of almost uniform size scattered over most of the upper and lower side....2. *Mesothuria verrilli* Théel, p. 385
- 2. Feet dorsally small, absent on most of the ventrum.....3
- 3. Tables of moderate size with one circle of about eight holes, sometime a few accessory ones 3. *Mesothuria intestinalis* (Ascanius and Rathke), p. 385
- 3. Tables with enormous disks with numerous holes in several circles.....4. *Mesothuria gargantua* Deichmann, p. 386

1 *Mesothuria maroccana* Perrier

Mesothuria maroccana Perrier, 1902, p. 312, pl. 16, figs. 32-35; Deichmann, 1930, p. 97, pl. 7, figs. 2-7; 1940, p. 191.

Diagnosis.—Small form, 4 to 8 cm. long, with feet largest along the flanks, well-developed on the dorsum and totally lacking on the ventrum. Spicules, regular tables mostly with six holes; margin smooth or undulating; spire composed of three rods and ending in three diverging arms with few teeth. Type: Paris. Type locality: Off Morocco, 2,105 meters. Distribution: Eastern Atlantic; also widespread in the West Indies; in the Gulf of Mexico reported from San Nicholas Channel, northern Cuba, 500 fathoms. From 500 to 1,350 fathoms.

2 *Mesothuria verrilli* (Théel)

Holothuria verrilli (partim) Théel, 1886b, p. 6. *Mesothuria verrilli* Deichmann, 1930, p. 93, pl. 6, figs. 1-8; 1940, p. 192.

Diagnosis.—Up to 30 cm. long. Feet small, thread-like, more or less uniformly scattered,

Diagnosis.—Small species, 4 to 6 cm., body normally covered with *Creseis*-shells, etc. Larger tube feet along sides of body. A few perforated plates usually found near anus; tentacles with curved rods; gonads with delicate crosses. Type: Possibly in Vienna. Type locality: Eastern Mediterranean. Distribution: Eastern Atlantic; northwest of Cuba. From 160 to 1,100 fathoms. The covering of Pteropod shells seems to be characteristic of this small species.

absent on anterior part of ventrum. Spicules tables with regular to irregular disk with about eight holes, sometimes reduced with age. Feet with small tables, often with disk completely resorbed. Type: Museum of Comparative Zoology. Type locality: Ambergris Key, British Honduras. Distribution: Eastern and western Atlantic, from 382 to 1,000 fathoms; in the West Indies common along the Lesser Antilles and recently secured by the *Atlantis* along the north coast of Cuba. The species may be expected off the shores of Yucatán.

3 *Mesothuria intestinalis* (Ascanius and Rathke)

Holothuria intestinalis Ascanius and Rathke, 1805, Fasc. 5, p. 5, pl. 45. *Mesothuria intestinalis* Deichmann, 1930, p. 94, pl. 6, figs. 9-10.

Diagnosis.—Elongate thin-skinned form with almost naked ventrum, large lateral feet and smaller dorsal ones. Spicules tables with eight oval holes; feet with end plate and tables of same size and shape as those in the skin. Type: Not

existing. Type locality: Coast of Norway. Distribution: From Murman coast, Norway to the Azores; also in the Mediterranean; in the western Atlantic taken off the Lesser Antilles and off Florida (*Fish Hawk*), 200 fathoms. According to Mortensen (1927), from 10 to 1,000 fathoms. The extreme low depth may refer to the most northern localities; usually the species lives at 200 fathoms or more. As far as the present records go the species is not common in the American waters, but it may very likely occur in numbers on the extensive areas of muddy bottom in the Gulf of Mexico.

4 *Mesothuria gargantua* Deichmann

Holothuria verrilli Théel (partim), 1886b, p. 6.

Mesothuria gargantua Deichmann, 1930, p. 95, pl. 7, fig. 1; 1940, p. 191.

Diagnosis.—Large robust form, 20 cm. long, with stout, cylindrical feet over entire surface except the anterior part of the ventrum; dorsal feet slightly smaller. Spicules tables with irregular disk with numerous holes and four-pillared spire with numerous spines on the top. Feet with vestige of end plate or none; tables as those in the skin. Type: Museum of Comparative Zoology. Type locality: Off Barbados, 394 fathoms.

Distribution: Off the Lesser Antilles (*Blake*); north of Cuba (*Atlantis*). From 394 to 500 fathoms. This robust species may possibly be common in deeper water of coasts of Cuba and Yucatán.

Genus 3 ZYGOTHURIA Perrier, 1898

Zygothuria lactea (Théel)

Holothuria lactea Théel, 1886, p. 183.

Zygothuria lactea Deichmann, 1930, p. 108, pl. 8, figs. 8-9; 1940, p. 190.

Diagnosis.—Large flattened forms, 15 cm. long, with few tube feet along the margin. Spicules, fragile tables with six large holes in the disk, and slender, three-pillared spire with either three long, diverging spines or a single pointed rod. Type: British Museum. Type locality: Off New Zealand. Distribution: Widespread in the Pacific and Atlantic Oceans; common along the coast of New England, in the West Indies and also taken in the Gulf of Mexico. From about 350 to 1,000 fathoms.

The *Albatross* collected it in various localities in the Gulf, while the *Atlantis* dredged it in San Nicholas Channel, northern Cuba. One would expect it to be one of the most common species in the muddy part of the Gulf.

Genus 4 BATHYLOTES Oestergren, 1896

KEY TO THE SPECIES FOUND IN THE GULF OF MEXICO

1. Disk of tables often forming a complete circle with a large number of large holes in each of the four sections. Dorsal side flattened; ventral side with small fungiform papillae in two bands...3. *Bathylotes bigelowi* Deichmann, p. 387
1. Disk of tables cross-formed.....2
2. Arms with few holes, often incomplete; spire smooth, without teeth. Dorsal side high, vaulted with large papillae; ventral side with large fungiform papillae.....2. *Bathylotes pourtalesi* (Théel), p. 386
2. Arms with numerous small holes; spire with teeth along the sides. Dorsal side flattened; no large fungiform papillae on the ventrum (if any are present they are quite small).....1. *Bathylotes natans* (M. Sars), p. 386

1 *Bathylotes natans* (M. Sars)

Holothuria natans M. Sars, 1868, p. 4.

Bathylotes natans Deichmann, 1930, p. 100, pl. 9, figs. 1-2, 8.

Diagnosis.—Flattened, large form with marginal row of papillae; dorsal side with few papillae in indistinct rows. Ventral side with lateral rows of appendages and sometimes some scattered on the ventral sole but none in the midventral ambulatorium. Spicules tables with cross-shaped disk with a large number of small holes. Type: Not existing. Type locality: Lofoten, Norway. Distribution: In the eastern Atlantic from Lofoten to Cape Verdes, from 100 to 800 fathoms; in the West

Indies reported from the Gulf of Mexico, 335 and 337 fathoms depth (*Albatross* station 2396 and 2398). The species is also reported from the Japanese waters (Mortensen, 1927, p. 385), but the latter record needs reinvestigation.

2 *Bathylotes pourtalesi* (Théel)

Stichopus pourtalesi Théel, 1886a, p. 4.

Bathylotes pourtalesi, Deichmann, 1930, p. 102, pl. 9, figs. 3-7; 1940, p. 186, pl. 31, figs. 3-4.

Diagnosis.—Large form, 20 cm. or more, with high, vaulted dorsal side, thick-skinned with large papillae (often thrown off in long strips); ventral side with large fungiform papillae. Spicules

tables with smooth four-pillared spire and few holes in the tip of the arms of the disk. Type: Museum of Comparative Zoology. Type locality: Off St. Kitts. Distribution: Known from off the Canaries, in the eastern part of the Atlantic, off the Lesser Antilles, Ambergris Key, British Honduras, and the northeast coast of Cuba. About 200 to 600 fathoms.

Although it has not been reported in the Gulf itself, it is most likely that the gap between north-east Cuba and Ambergris Key will be closed when more extensive dredging is undertaken in the Gulf. It is seldom that one gets a complete specimen, but the large fungiform papillae and the spicules should make it easy to recognize this species.

3 *Bathyplores bigelowi* Deichmann

Bathyplores bigelowi Deichmann, 1940, p. 187, pl. 31, figs. 1-2.

Diagnosis.—Large form, 25 cm. Resembles *B. natans* but has two bands of large fungiform papillae on the ventral side, and the spicules are large delicate tables usually with a circular disk with large holes in the ends of the four arms. Type: Museum of Comparative Zoology. Type locality: Bahia de Cochinos, southern Cuba. Distribution: Waters around Cuba. From 220 to 320 fathoms. So far it has been reported only in the Gulf, from the northwest coast of Cuba, but it will undoubtedly prove to belong to the fauna of the waters around Yucatán.

Genus 5 AMPHIGYMNAS Walsh, 1891 *Amphigymnas bahamensis* Deichmann

Amphigymnas bahamensis Deichmann, 1930, p. 107, pl. 9, fig. 9, pl. 10, figs. 1-6; 1940, p. 189, pl. 32, figs. 1-10.

Diagnosis.—Large species with skin rigid from spicules. Resembles a *Synallactes*, with four rows of conical papillae on the dorsum, a lateral row of stouter conical appendages and a midventral double row of smaller ones. Inner anatomy like that of *Synallactes* but muscle bands undivided.

Spicules large to small tables with mostly four central holes and smaller marginal ones; spire mostly with four pillars, often reduced, besides large perforated plates. Ventral appendages with or without end plate, with walls packed with supporting rods with dentate edge, and small tables with three to four short pillars in spire. Dorsal and lateral papillae with curved supporting rods and tables of varying size but apparently no trace of end plate. Color lavender, quickly reduced to pure white in alcohol. Type: United States National Museum. Type locality: Between Bahamas and Cape Fear, 270 fathoms. *Albatross* station 2666. Distribution: Known from the type locality and the waters around Cuba and Florida. In the Gulf taken south of the Mississippi Delta (*Oregon* station 384, 29°10' N., 88°00' W., 265 to 300 fathoms).

The largest specimen measures 33 cm. It was collected in June 1951 by the *Oregon* and showed four months later a beautiful lavender color which probably in a few years will have completely faded into a pure white. The spicules of the few specimens which have been examined show great variation, but there seems no doubt that they all belong to the same species. It has so far never been taken in the eastern Atlantic, but most likely it does occur there. The only other representative of the genus is found in the Indian Ocean (see Deichmann 1930, p. 107).

Family 2 STICHOPODIDAE

KEY TO THE GENERA KNOWN FROM THE GULF OF MEXICO

1. Large, thick-skinned forms with feet in crowded bands on the ventral side and large warts on the vaulted dorsal side. Spicules tables; C-shaped bodies present in some species.....1. *Stichopus* Brandt, p. 387
1. Large thick-skinned forms with numerous tube feet scattered all over the body but not forming a ventral sole, nor has the dorsal side distinct warts. Spicules minute grains, and C-shaped bodies.....2. *Astichopus* H. L. Clark, p. 388

Stichopus Brandt, 1835

1. Deep water form (200 fathoms). Prominent lateral brim of papillae. Spicules large tables with up to 50 holes in disk.....1. *Stichopus regalis* (Cuvier), p. 388
1. Shallow water (reef dweller, probably down to 25 to 30 fathoms depth). No prominent lateral brim of papillae. Spicules small tables with few holes in the disk; often also C-shaped bodies.....2. *Stichopus badionotus* Selenka, p. 388

Genus 1 *STICHOPUS* Brandt, 18351 *Stichopus regalis* (Cuvier)

Holothuria regalis Cuvier, 1817, p. 22.

Stichopus regalis Deichmann, 1940, p. 193, pl. 32, figs. 1-8.

Diagnosis.—Large form, up to 32 cm. long, with lateral row of papillae, ventrum with numerous cylindrical indistinct bands; dorsal side with papillae. Color brownish with white spots on the dorsal side, ventrum paler. Spicules large tables with numerous holes in the disk. Type: Possibly in Paris. Type locality: Mediterranean Sea. Distribution: In the eastern Atlantic from the west coast of Ireland to the Canaries. In the western Atlantic reported for the first time, by the *Atlantis*, west of Havana, at 200 fathoms depth. Lampert (1885, p. 101) reports that it is taken at 2 fathoms depth, but one wonders whether there is not some misunderstanding. Most specimens appear to have come from 50 to 200 fathoms depth, and Nobre (1931, p. 146) mentions that the animal has difficulty in surviving in aquaria.

This represents another of the east Atlantic species which the Harvard-Havana expeditions revealed also existed in the western part. It will probably be found to occur more widespread in the Gulf, at moderate depth, along the northern coast of Cuba and around Yucatán.

2 *Stichopus badionotus* Selenka

FIG. 66: 1-8

Stichopus badionotus Selenka, 1867, p. 316, pl. 18, fig. 26; Deichmann, 1930, p. 80, pl. 5, figs. 30-36; 1940, p. 195.

Diagnosis.—Large, thick-skinned form with cylindrical feet in crowded bands on the ventrum and flanks and dorsum with few large warts. Color varying from deep chocolate brown to almost black or spotted or striped on more yellow ground. Spicules a crowded layer of small tables with few holes in a circle around the low, squat spire; sometimes C-shaped bodies. Type: Museum of Comparative Zoology. Type locality: Florida. Distribution: Seems to be common all over the West Indies including Bermuda, wherever

there are suitable localities—quiet pools with eelgrass or sandy patches among coral reefs. It is known from the Florida reefs, the north coast of Cuba, and Yucatán, but it is doubtful whether it is able to live in the northern part of the Gulf.

Crozier (1918) has studied its biology and found that its consumption of sand is not unimportant in the sanitation of the reefs whenever it occurs in large numbers. The animals become easily transformed into slime and are apparently unsuitable for preparation of "trepang" as no animals seem to want to eat them. As in the case of many other marine animals mostly large individuals are known; the young ones must undoubtedly hide in inaccessible spots; they probably grow very fast as Mitsukuri has found in a related species in Japan.

Genus 2 *ASTICHOPUS* H. L. Clark, 1922*Astichopus multifidus* (Sluiter)

Stichopus multifidus Sluiter, 1910, p. 334, text figs. a-b.

Astichopus multifidus Clark, 1922, p. 48; Deichmann, 1930, p. 84, pl. 5, figs. 44-47.

Diagnosis.—Large species, 45 cm. long; body blunt, cylindrical, with tube feet scattered over the entire surface, cylindrical on the ventrum, smaller, more papilliform on the dorsum. Spicules numerous minute grains, collected in heaps, and besides scattered C, S, or O-shaped bodies. The feet have an end plate composed of smaller plates, and the walls contain C-shaped bodies. Type: Hamburg Museum. Type locality: Tortugas. Distribution: Taken at the type locality, also Port Antonio, Jamaica, and the Campeche Bank. Few fathoms depth, down to 8 to 10 fathoms.

While it is easy to recognize this species it is still uncertain whether it belongs in the family Stichopodidae. Although large specimens have been available, the gonads have not been well preserved so it is not certain whether they are in one or two tufts.

Up to recently only few specimens have been observed, but now (1951) H. Hildebrand informed me that the species is "very conspicuous if not abundant in trawl hauls on the Campeche Bank."

Family 3 *HOLOTHURIIDAE* Ludwig, 1894

KEY TO THE GENERA FOUND IN THE GULF OF MEXICO

1. Anus surrounded by five conspicuous calcified "teeth." Large, clumsy forms with spicules as simple rosettes and short blunt rods; no tables 1. *Actinopyga* Bronn, p. 390
1. Anus not surrounded by five conspicuous calcified teeth. Varying sizes. Spicules of different types. If simple rosettes, no short blunt rods, but tables also present 2. *Holothuria* Linnaeus, p. 390

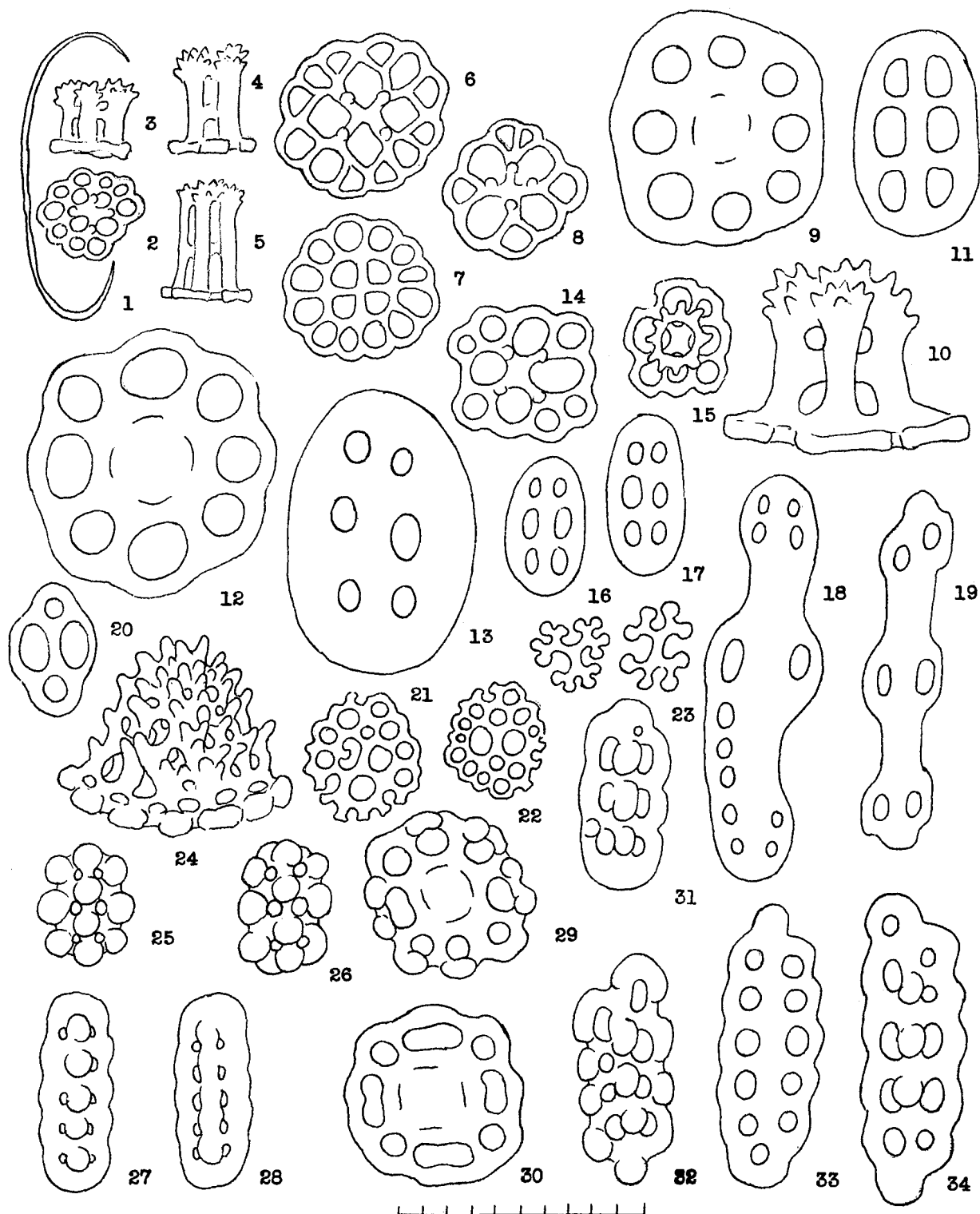


FIGURE 66: 1-34.—*Stichopus badionotus*, p. 388. 1, C-shaped spicules; 2-3, table from body of adult; 4-5, tables from young lateral view; 6-8, disk of tables from young. *Holothuria impatiens* (Forskål), p. 393. 9-10, table, disk and side view; 11, button. *Holothuria parvula* Selenka, p. 392. 12, disk of table; 13, button. *Holothuria arenicola* Semper, p. 393. 14-15, tables; 16-17, buttons; 18-19, long rods or buttons from feet. *Holothuria mexicana* Ludwig, p. 391. 20-22, buttons and plates. *Holothuria floridana* Pourtales, p. 392. 23, typical rosettes. *Holothuria cubana* Ludwig. 24, table, lateral view; 25-28, knobbed buttons, short and long. *Holothuria pseudofossor* Deichmann, p. 394. 29-30, disk of tables; 31-34, knobbed to smooth buttons. Magnification: $\times 400$ Divisions 1/100 mm. 389

Genus 1 ACTINOPYGA Bronn, 1860

Actinopyga agassizii (Selenka)

Mülleria agassizii Selenka, 1867, p. 311.

Actinopyga agassizii Deichmann, 1930, p. 78, pl. 5, figs. 21-29.

Diagnosis.—Large, stout form, preserved and contracted 20 cm. long, but may very well be almost twice as long when alive. Mouth ventral with 25 to 29 large tentacles; anus with five large anal teeth. Ventral side with numerous cylindrical feet in three bands; dorsal side with small papillae and minute cylindrical feet. Color varying shades of brown, mottled; pedicels and tentacles yellowish. Spicules simple rosettes and

short blunt rods. Type: Museum of Comparative Zoology. Type locality: Florida. Distribution: Known from Barbados to Florida; once taken in Bermuda but appear not to be a constant element in that island's fauna (Crozier, 1917d).

As far as known it lives exposed in the sheltered pools of the West Indian reefs. It will most likely turn out to be found also in shallow water around Yucatán.

Genus 2. HOLOTHURIA Linnaeus, 1757

Remarks.—A little more than a dozen species are known from the West Indian region, and although not all have definitely been found inside the Gulf area they are all included in the key.

KEY TO THE SPECIES FOUND IN THE GULF OF MEXICO OR LIKELY TO OCCUR THERE

1. Deep water forms, about 200 fathoms depth..... 2
1. Shallow water forms, exposed at low tide or down to less than 50 fathoms depth..... 3
2. Large, soft-skinned form, up to 46 cm. long, color light brown with tips of appendages darker, often a lighter spot around base. Spicules tables and smooth buttons, twisted, incomplete, rarely with one or two knobs on the surface..... 1. *Holothuria lentiginosa* v. Marenzeller, p. 391
2. Medium-sized forms, up to 15 cm. long; skin stiffened with spicules. Ventrally cylindrical tube feet; dorsally and laterally conical papillae. Spicules small tables with blunt dentate margin and often partly resorbed spire; buttons deformed, knobbed, sometimes with holes obliterated..... 2. *Holothuria occidentalis* Ludwig, p. 391
3. Dark, blackish or brownish forms, soft-skinned, with numerous cylindrical feet on ventrum. Spicules few, curved rods in the skin. Clings to rocks in the surf zone..... 3. *Holothuria glaberrima* Selenka, p. 391
3. Not blackish, soft-skinned; not clinging to rocks in the surf zone..... 4
4. Free-living forms, usually exposed in the tide pools, sometimes with a few bits of seaweeds or sand covering the dorsum..... 5
4. Normally buried in sand or mud or hiding under rocks or among corallines, etc..... 7
5. Large, smooth-skinned, form blunt, cylindrical, usually dark above and pinkish below. Spicules small tables and minute perforated plates, mostly with small holes..... 4. *Holothuria mexicana* Ludwig, p. 391
5. Medium sized forms, not particularly thick-skinned..... 6
6. Usually brownish in color, sometimes spotted; not strongly warted dorsal side. Spicules tables and simple rosettes. (Young individuals concealed among mangrove.)..... 5. *Holothuria floridana* Pourtales, p. 392
6. Colors mixed gray (living animals with specks of yellow red, black, etc.). Dorsal side with distinct rows of low warts. Spicules tables and small plates with two to four large central holes, some small terminal ones and a blunt dentate margin..... [6. *Holothuria grisea* Selenka, p. 392]
7. Animals normally concealed under rocks or among corallines..... 8
7. Animals normally buried in sand or mud..... 10
8. Flattened, yellowish-brownish forms with ventral circle of large tentacles; ventral feet crowded; dorsal side with papillae. Spicules a crowded layer of tables and large oval smooth buttons with comparatively small holes..... 7. *Holothuria parvula* Selenka, p. 392
8. Elongate, cylindrical or flask-shaped forms with small terminal tentacles; feet scattered, more papilliform on dorsal side..... 9
9. Chocolate colored with yellow tentacles. Spicules a crowded layer of tables with tall spire ending in few spines which form a Maltese cross; disk resorbed, except in very small specimens; a few large flat bars beneath the tables, most numerous near the tube feet..... 8. *Holothuria surinamensis* Ludwig, p. 393
9. Mottled gray, warty, rough to the touch. Spicules a crowded layer of squat tables with squarish disk and numerous small spines on the top; an inner layer of smooth, six-holed buttons, with large holes..... 9. *Holothuria impatiens* (Forskål), p. 393
10. Elongate, cigar-shaped body, with small terminal tentacles. No strong warts; skin fairly smooth to the touch. Spicules few delicate tables and small, smooth buttons with six holes, usually small..... 10. *Holothuria arenicola* Semper, p. 393
10. Not elongate, cigar-shaped body. Skin rigid with spicules..... 11

11. More or less barrel-shaped with large appendages, mostly with conical base; color dark brown and yellowish, mixed. Spicules reduced tables of different size; in base of feet often enormous tables with tapering conical spire.
11. *Holothuria princeps* Selenka, p. 393
11. Flattened forms with blunt ends and small appendages; color grayish or whitish..... 12
12. Crowded layer of complicated tables, often with spire transformed into a hemispherical reticulum. Buttons in dorsal layer short, knobbed buttons with three pairs of holes; in ventral layer mostly longer ones with four to six pairs of holes and surface knobbed to almost smooth..... 12. *Holothuria cubana* Ludwig, p. 394
12. Tables fairly simple; disk often partly reduced, as also the spire may be. Buttons of varying length, intermingled, with three to seven pairs of holes, with knobbed to undulating surface, often the middle bar projecting.
13. *Holothuria pseudofossor* Deichmann, p. 394

1 *Holothuria lentiginosa* v. Marenzeller

Holothuria lentiginosa v. Marenzeller, 1893a, p. 6, pl. 1, fig. 1; Deichmann, 1940, p. 196, pl. 33, figs. 1-7.

Diagnosis.—Up to 46 cm. long in life; cylindrical with 20 ventral tentacles; feet ventrally scattered, cylindrical, retractile, dorsally as contractile papillae. Color light brown, paler ventrally; tip of appendages darker, often with a paler area around the base of the papillae. Spicules tables of varying size and narrow buttons often twisted and incomplete, smooth with an occasional knob. Type: Monaco. Type locality: Off the Azores. Distribution: Eastern Atlantic, 67 to 180 fathoms and recently reported by the *Atlantis* from the south and north coast of Cuba, 175 to 255 fathoms. As a single large specimen has been taken along the northern coast of Cuba the chances are that the species belongs to the fauna of the southern part of the Gulf.

2 *Holothuria occidentalis* Ludwig

Holothuria occidentalis Ludwig, 1875, p. 104, fig. 35; Deichmann, 1930, p. 60, pl. 2, figs. 9-17; 1940, p. 197, pl. 33, figs. 8-13.

Diagnosis.—Preserved specimens up to 15 cm. long; 20 small ventral tentacles, feet tapering but with cylindrical tips on ventrum; laterally and dorsally as conical papillae. Color light brown, paler beneath, dorsal papillae almost white. Spicules small tables often with partly resorbed spire; inner layer of knobbed buttons often with holes obliterated. Type: Hamburg. Type locality: "West Indies." Distribution: Known from deeper water in the West Indies; Virgin Islands (Th. Mortensen); Old Bahamas Channel and Santarin Channel, northern Cuba (*Atlantis*). From 180 to 250 fathoms. So far the species has been reported just on the edge of the Gulf, but the chances are that it will prove to extend farther in along the northern coast of Cuba and probably along the coast of Yucatán.

3 *Holothuria glaberrima* Selenka

Holothuria glaberrima Selenka, 1867, p. 328, pl. 18, figs. 57-58; Deichmann, 1930, p. 69, pl. 4, figs. 10-13.

Diagnosis.—Up to 10 to 15 cm. long, short barrel-shaped, with large, unusually branched tentacles; numerous ventral feet; dorsally scattered papillae; soft-skinned; color black or brownish. Spicules few curved or straight rods with branched ends. Type: Museum of Comparative Zoology. Type locality: Bahamas. Distribution: Widespread in the West Indies but no definite record of its occurrence in the Gulf. The only observation about its mode of life is that of W. K. Fisher who notes "it clings to the outer side of the surf-washed rocks, usually where a tough kelp is growing." The almost dendritic, bushy tentacles indicate an adaptation for plankton feeding similar to that which characterizes the dendrochirotes.

4 *Holothuria mexicana* Ludwig

FIG. 66:20-22

Holothuria mexicana Ludwig, 1875, p. 101; Deichmann, 1926, p. 16; 1930, p. 74, pl. 5, figs. 15-20.

Diagnosis.—Huge form, 50 cm. or more when alive, thick-skinned, cylindrical, with blunt ends, ventral feet cylindrical, often completely retracted, dorsal side with insignificant papillae. Spicules scattered small tables and an inner layer of minute plates, mostly with several minute holes, resembling crackers. Color normally a dark brown or black upper side with pinkish under side; sometimes spotted, with ventral dark spots and paler dorsum, etc. Type: Hamburg (immature specimen). Type locality: Gulf of Mexico. Distribution: Common in shallow water along the lagoons of northern Cuba, also taken at Jamaica and Puerto Rico, Barbados, and as far west as Curacao. Not reported in the western part of the Caribbean nor in the Gulf. Taken occasionally in "Florida" and in the Bahamas.

Prefers sheltered eelgrass patches and similar localities.

As so often the case the young ones are seldom collected so we may assume that they live in deeper water or in crevices until they suddenly appear, almost full-grown, at a few feet of depth.

Edwards considers it the mature stage of *H. floridana* which has a similar anatomy and somewhat simpler spicules of about the same size. If he is right the name must of course be withdrawn under Pourtalès' older name, but in my opinion it has a different distribution which only overlaps that of *floridana* in Florida, and there we do not know whether specimens with different types of spicules have been collected in the same spots.

5 *Holothuria floridana* Pourtalès

FIG. 66: 23

Holothuria floridana Pourtalès, 1851, p. 8; Deichmann, 1930, p. 72, pl. 5, figs. 5-9.

Diagnosis.—Medium-sized form; preserved specimens 15 cm. long; mouth slightly ventral bent with 20 large tentacles; numerous cylindrical feet on ventrum; dorsal side with low conical warts ending in small papillae. Spicules tables and numerous simple rosettes which never seem to form plates with complete holes. Color dirty white, with darker spots, sometimes uniformly dark. Type: Probably not preserved. Type locality: Florida reefs. Distribution: Extremely common in Florida as well as around Yucatán from where it was described under different names by Ives in 1890. Also reported from Swan Island and as far south as Colon, Panama, but has apparently never been taken in the waters of the Lesser Antilles or South America. A single record from northern Cuba. The adult lives freely exposed in tide pools, at utmost with a few algae or a little sand attached to the back, while the young individuals conceal themselves among mangroves or under rocks, as Pourtalès observed.

Edwards (1905, 1908) studied the early development of this form and made an attempt to correlate the growth of the animals with the changes of the spicules. He considered *H. mexicana* the aged stage of this species, but from study of his material in the United States National Museum I am inclined to disagree, although it would be tempting to take the easy course and lump the two forms. As far as I can see they have a dif-

ferent range which only overlaps in few places and even there we do not know whether they live in exactly the same environment. It is a question which should be attacked on the basis of freshly collected material by a modern worker, without the use of old material which possibly may have been wrongly labeled.

[6 *Holothuria grisea* Selenka

Holothuria grisea Selenka, 1867, p. 328, pl. 18, figs. 52-56; Deichmann, 1926, p. 15; 1930, p. 76, pl. 5, figs. 1-4.

Diagnosis.—Up to 25 cm. long with 20 to 25 tentacles which are downward directed; ventrally numerous soft feet, dorsally 4 to 6 rows of distinct warts, ending in papillae. Spicules, scattered tables and heaps of small plates with 2 to 4 large central holes, a few small holes in the ends and a margin with blunt teeth. Color in alcohol, salt and pepper gray; in life, with specks of bright yellow, red and black. Type: Museum of Comparative Zoology. Type locality: Haiti. Distribution: Known from Haiti, Puerto Rico, and southward along the Lesser Antilles to Rio de Janeiro, Brazil. Also reaching Colon, Panama. A single doubtful record from Florida (*Sluiter's grisea* from that region is at least partly *floridana*). Most likely this species will not be found in the Gulf although it may have been able to penetrate from south along the coasts of Central America and Mexico. It is chiefly included here to prevent misidentification.]

7 *Holothuria parvula* (Selenka)

FIG. 66: 12-13

Mülleria parvula Selenka, 1867, p. 314, pl. 38, figs. 17-18.

Holothuria parvula Deichmann, 1930, p. 70, pl. 4, figs. 14-22.

Diagnosis.—Small form, 6 to 7 cm. long, flattened with 20 large ventral tentacles, numerous ventral feet and low warts with papillae on the dorsum. Color yellowish brown, contains a greenish pigment, extracted in alcohol. Spicules a uniform layer of tables with rounded disk and squat spire and inner layer of thin, smooth elliptical buttons with two rows of small holes. Type: Museum of Comparative Zoology. Type locality: Florida. Distribution: Seems widespread in the West Indies and Bermuda, but the exact range is not known. The species occurs often in large numbers under flat rocks in tide pools. Transversal fission seems to be a normal occurrence.

As it is not uncommon in Florida it will probably also be found in Yucatán.

8 *Holothuria surinamensis* Ludwig

Holothuria surinamensis Ludwig, 1875, p. 111, fig. 37; Deichmann, 1930, p. 63, pl. 3, figs. 12-15, 19.

Diagnosis.—Up to 20 cm. long, cylindrical or slightly broader posteriorly, with 20 small terminal tentacles and few, scattered tube feet, more papilliform on the dorsal side. Color chocolate brown, often faded; tentacles yellow; skin contains a greenish pigment, soluble in alcohol. Spicules a close layer of tables with reduced disk (except in young individuals); spire with four slender rods, ending in four erect spines and four double pairs, forming a Maltese cross. Large flattened bars with dentate or perforated margin below the tables, especially numerous near the appendages. Type: Würzburg. Type locality: Surinam. Distribution: Ranges from Surinam southward to Port Seguro, Brazil, and northward to Barbados and Jamaica; common in Bermuda. Also taken at Cape Florida and other localities in "Florida," including Biscayne Bay. Like *H. parvula* it occurs in large numbers under flat rocks, and it divides also quite normally by transverse fission.

9 *Holothuria impatiens* (Forskål)

FIG. 66: 9-11

Fistularia impatiens Forskål, 1775, p. 121, pl. 39, fig. B.
Holothuria impatiens Deichmann, 1930, p. 64, pl. 3, figs. 17-18.

Diagnosis.—Up to 15 to 20 cm. long; shape similar to that of *H. surinamensis* but more warty and rougher to the touch; color various shades of gray and brown. Spicules, a uniform layer of tables with almost squarish disk with eight large marginal holes and squat spire with numerous teeth on top, and an inner layer of buttons with three pairs of large holes. Type: Undoubtedly lost. Type locality: Suez. Distribution: Almost circumtropical. Common in the West Indies and recently reported from Bermuda (Clark, 1942). A few specimens taken at low tide but apparently most specimens live concealed among rocks a little deeper than most collectors are able to reach. There are few records from Florida probably due to the difficulty in earlier times to collect below low tide. One would, however, expect that it does occur in the Gulf, especially in the part where there are coral reefs.

10 *Holothuria arenicola* Semper

FIG. 66: 14-17

Holothuria arenicola Semper, 1868, p. 61, pl. 20, pl. 30, fig. 13, pl. 31, fig. 4; Deichmann, 1930, p. 66, pl. 4, figs. 1-9.

Diagnosis.—Up to 20 cm. long, cigar-shaped or curved, with 20 small terminal tentacles and scattered small cylindrical tube feet, dorsally and ventrally. Color variable, mostly grayish with two dorsal rows of dark patches; occasionally uniformly colored or dark rusty or blackish, possibly due to external conditions. Spicules, a scattered layer of small tables and an inner layer of small oval buttons with six holes, usually small. Type: Possibly in Germany. Type locality: Bohol, Philippines. Distribution: Almost circumtropical; in the western Atlantic it ranges from Bahia, Brazil, to Bermuda, including the Lesser Antilles and Jamaica. From Florida it is known from Cape Florida and Tortugas. Normally, this species is found buried in sand or mud, but it may possibly also hide among stones. With the modern, more intensive methods of collecting with digging and sifting, it will probably prove to be much more common than hitherto assumed.

11 *Holothuria princeps* Selenka

Holothuria princeps Selenka, 1867, p. 332, pl. 18, figs. 67-69; Deichmann, 1930, p. 58, pl. 2, figs. 1-8.

Holothuria imperator Deichmann, 1930, p. 62, pl. 3, figs. 1-11.

Diagnosis.—Large forms, 20 to 30 cm. or more, often contracted to short thick-skinned barrels. Tentacles small, terminal; tube feet scattered over the entire surface, often with a conical base and ventrally ending in a cylindrical part, dorsally in a papilla. Color different shades of brown and dark yellow, often with a lighter ring around the base of the appendage. Spicules small tables more or less defect and in some individuals a few huge tables in the base of the appendages with conical spire which projects through the skin. An inner layer of irregular buttons, often incomplete with three or more pairs of holes and irregularly knobbed surface. Type: Museum of Comparative Zoology. Type locality: Florida. Distribution: As far as known only reported from the western coast of Florida and San Domingo and Yucatán; from the latter region described as *H. imperator*. The six specimens from Yucatán upon which *H. imperator* was established were only slightly larger than the types of *princeps* so a com-

parison seemed justified, but having learned how unreliable are such striking characters as the huge tack-like tables in the skin, I feel that the Yucatán species must be withdrawn as a possibly slightly older stage of Selenka's *princeps*, one in which the large, tack-like spicules have completely disappeared.

12 *Holothuria cubana* Ludwig

FIG. 66: 24-28

Holothuria cubana Ludwig, 1875, p. 104, pl. 7, fig. 34; Deichmann, 1930, p. 54, pl. 1, figs. 1-8.

Diagnosis.—Up to 15 cm. long, flattened with blunt ends, ventral mouth with 20 small tentacles. Tube feet ventrally small and scattered, often retracted into pits, dorsally few and papilliform. Color white or gray. Spicules a crowded layer of tables with knobbed disk and spire gradually transformed into a reticulated hemisphere. Inner layer of knobbed buttons, short, strongly knobbed with three pairs of holes on the dorsal side; ventrally mostly larger with four to six pairs of holes and less strongly knobbed, sometimes almost

smooth. Type: Vienna. Type locality: Off Cuba. Distribution: Reported from the West Indies from Florida, Curaçao, Barbados, and Bermuda. This burrowing form should find excellent conditions in the sandy flats in the Gulf of Mexico.

13 *Holothuria pseudofossor* Deichmann

FIG. 66: 29-30

Holothuria pseudofossor Deichmann, 1930, p. 57, pl. 1 figs. 9-14.

Diagnosis.—Resembles *H. cubana* but has larger appendages and these are more inclined to remain expanded. The spicules are regular tables with eight marginal holes, more or less knobbed edge and low spire with numerous teeth. The buttons have three to seven pairs of holes and large and small ones are found intermingled; the surface is knobbed to smooth. Type: Museum of Comparative Zoology. Type locality: Montego Bay, Jamaica. Distribution: So far known only from the type locality where it is fairly common, buried in sand under slabs of coral rocks.

Order 3 DENDROCHIROTA Grube

KEY TO THE FAMILIES KNOWN FROM THE GULF OF MEXICO

1. Part of the ventral side developed as a sole, while the remaining part of the body is covered by scales...2. Psolidae, p. 401
1. Part of the ventral side not set off as a sole.....2
2. Tentacles 10, often the 2 ventral smaller. (In some deep water forms the number reduced to 8, and the tentacles almost unbranched.).....1. Cucumariidae, p. 394
2. Tentacles 20, in 2 more or less distinct circles.....3. Phyllophoridae, p. 402

1 Cucumariidae

KEY TO THE GENERA KNOWN FROM THE GULF OF MEXICO

1. Shallow water forms.....2
1. Deep water forms (at least around 100 fathoms depth). Body covered by large circular scales.....8
2. Calcareous ring tubular, with distinct tails.....3
2. Calcareous ring simple, or with short posterior prolongation.....6
3. Spicules predominantly elongate plates with a varying number of holes, usually in two rows. Feet scattered over the entire surface in the adult animals.....4. *Thyoneria* nom. nov., p. 398
3. Spicules not predominantly elongate plates.....4
4. Spicules four-holed buttons, forming a crowded layer in the skin.....3. *Neothyone* Deichmann, p. 397
4. Spicules tables with four to eight holes in disk and two to four-pillared spire; spicules in some forms reduced with age.....5
5. Tube feet in five crowded bands.....1. *Pentamera* Ayres, p. 395
5. Tube feet scattered over entire surface of body, except in very young individuals.....2. *Thyone* Oken s. str., p. 395
6. Dorsal side with large warts; ventral tube feet in three broad bands; short, box-like form, chocolate brown.....7. *Pentacta* Goldfuss, p. 399
6. Dorsal side not with large warts.....7
7. Ring low, simple. Spicules regularly knobbed buttons and an outer layer of deep baskets with a wreath of short spines along the rim. Stout, barrel-shaped or lemon-shaped form with thick skin, large oral valves and tube feet scattered over the body.....6. *Euthyonacta* nom. nov., p. 399
7. Ring simple or with short posterior prolongations. Spicules mostly knobbed buttons, irregular or regular.....5. *Thyonella* Verrill, p. 399
8. Plates with excentric spire.....8. *Echinocucumis* Sars, p. 400
8. Plates with centrally placed spire or spine.....9. *Sphaerothuria* Ludwig, p. 400

Genus 1 PENTAMERA Ayres 1852

Pentamera pulcherrima Ayres

Pentamera pulcherrima Ayres, 1854, p. 200; Deichmann, 1941, p. 84.

Diagnosis.—Small species, at utmost 10 cm. long. Ovoid, with oral and anal ends upward curved. Feet in five crowded bands. Color white or dirty brown with tentacles dotted with dark pigment. Spicules two-pillared tables with oval disk with four holes. Feet with large end plate and curved supporting tables with two-pillared spire, sometimes reduced. Type: Undoubtedly

lost. Type locality: Charleston, S. C. Distribution: Common along the Atlantic seaboard, occasionally reaching the coasts of New England. Taken at Sabanilla, Columbia (U. S. National Museum), and once reported from the coast of Texas (J. Hedgpeth, letter). In the South it is taken in shallow water where it lives buried in the mud. In the northern waters it lives in deeper water and is either washed up after storms or dredged. Grave (1905) has reared it from eggs taken with free swimming larvae in the plankton around Beaufort, N. C. Some of these specimens were kept alive for 3 years.

Genus 2 THYONE Oken 1815

KEY TO THE SPECIES KNOWN FROM THE GULF OF MEXICO

1. Spicules in skin tables with large disk; supporting tables in feet with enormous, reticulated spire. Apparently spicules preserved throughout the animal's life.....1. *Thyone mexicana* Deichmann, p. 395
1. Spicules in skin tables with disk of normal size; supporting tables with normal spire, or a low reticulum.....2
2. Disk of tables thick, oval, with four small holes; spire two-pillared with two large clusters of spines; sometimes a handle is present on the other side of the disk making a transition to the buttons found in other genera.
 2. *Thyone pseudofusus* Deichmann, p. 395
2. Disk of tables of normal thickness, with four large and up to four smaller marginal holes. Spire often delicate with feeble spines.....3
3. Tables usually with squarish disk, and tendency to have four pillars in the spire; supporting tables with complex, low spire. Large species, 12 cm. or more; greenish or brownish.....3. *Thyone briareus* (LeSueur), p. 395
3. Tables oval or squarish, with weakly developed two-pillared spire. Supporting tables delicate. Seems never to attain its full size in American waters. Possibly a guest from the eastern Atlantic.....4. *Thyone inermis* Heller, p. 397

1 *Thyone mexicana* Deichmann

FIG. 67: 1-3

Thyone mexicana Deichmann, 1946, p. 1, text fig. 1.

Diagnosis.—Large form 10 cm. or more; resembles the type species *T. fusus* from the north-eastern Atlantic, but the spicules appear to be retained throughout life and the feet are more clumsy on account of the tall, thimble-shaped spire on the supporting tables. Color mottled brown. Spicules tables with several circles of holes and knobbed edge; spire with two pillars and occasionally three to four. Feet with end plate and numerous supporting tables with huge, reticulated spire. Type: U. S. National Museum. Type locality: Sugarhouse Bend, Barataria Bay, Grand Isle, Louisiana. Distribution: So far known from the coast of Louisiana and Texas, in tidepools, down to few fathoms.

2 *Thyone pseudofusus* Deichmann

Thyone pseudofusus Deichmann, 1930, p. 168, pl. 14, figs. 6-9; 1941, p. 107.

Diagnosis.—Small species 4 to 5 cm. long. Spicules tables with oval disk with thick rim, two-

pillared spire with clusters of spines on top and frequently a handle on the inner side. Type: U. S. National Museum. Type locality: Yucatán, 25 fathoms. Distribution: Known from Yucatán, Florida, Tobago, British West Indies, and coast of Brazil. In Yucatán 18 specimens were taken in the same haul so the species may possibly have direct development with the larvae settling down close to the parents.

3 *Thyone briareus* (LeSueur)

Holothuria briareus LeSueur, 1824, p. 161.

Thyone briareus Deichmann, 1930, p. 165, pl. 13, figs. 5-7; 1938, p. 134; 1946, p. 3.

Diagnosis.—Large robust form, 12 cm. or more, with numerous tube feet which give an almost hairy aspect to the animal. Skin soft due to the scarcity of spicules; color dark greenish or brown; sometimes faded in alcohol. Spicules scattered tables with mostly squarish disk; often three to four pillars in spire; feet with large end plate and elongate supporting tables with low irregular spire composed of several rods. Type: Lost. Type locality: Florida. Distribution: From

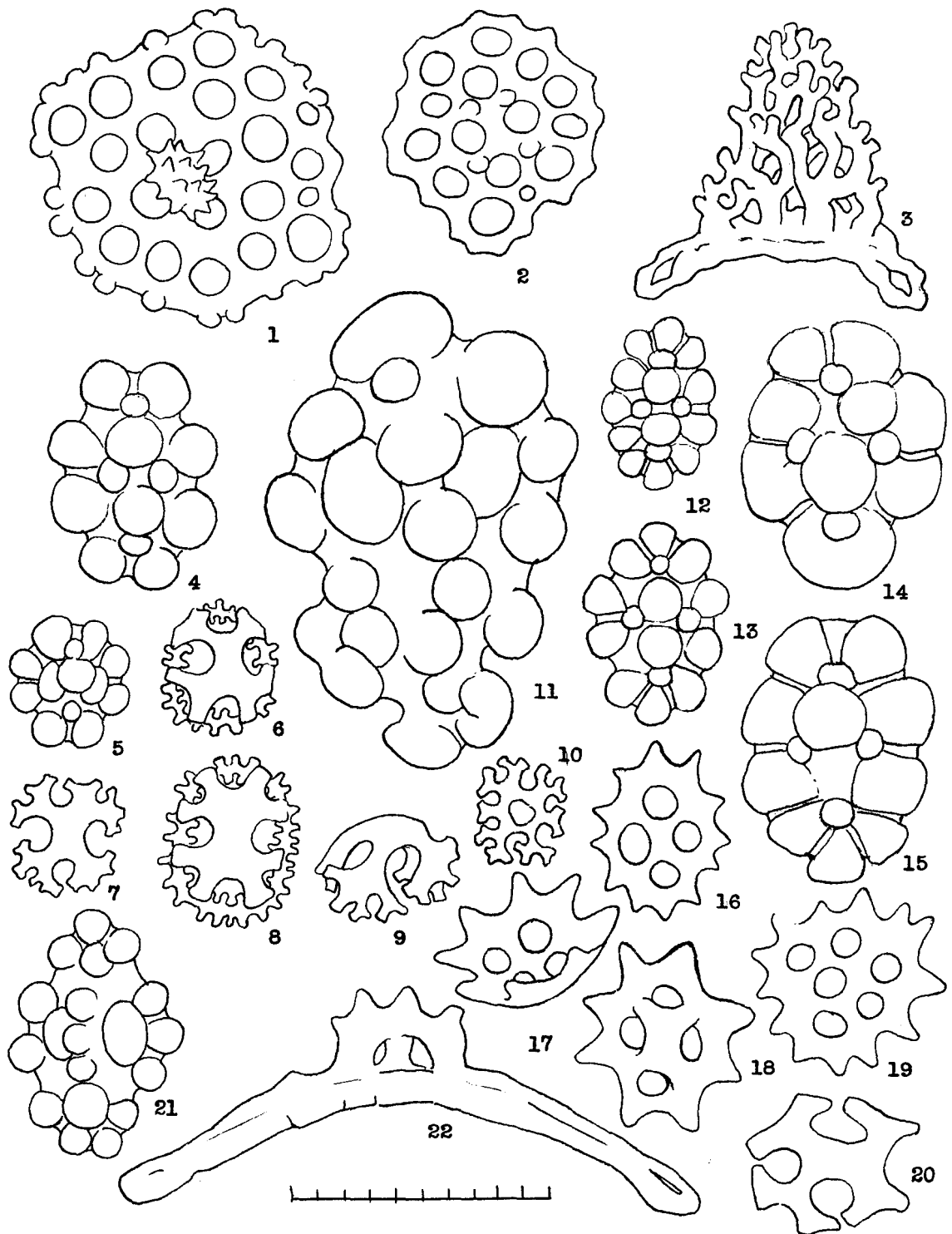


FIGURE 67: 1-20.—*Thyone mexicana* Deichmann, p. 395. 1-2, disk of tables from body wall; 3, supporting table from tube foot, side view. *Pentacta pygmaeus* (Théel), p. 399. 4-5, knobbed buttons; 6-9, baskets from outer layer of skin; 10, perforated plate; 11, knobbed plate. *Thyonella pervicax* (Théel), p. 399. 12-15, knobbed buttons; 16-20, baskets from outer layer of skin. *Neothyone belli* (Ludwig), p. 397. 21, knobbed button with knobbed handle; 22, supporting table from tube foot. Magnification: $\times 400$ Division 1/100 mm.

Texas to Florida and northward along the Atlantic seaboard to Woods Hole, Mass. Shore to few fathoms depth, in muddy localities, often attached to eelgrass in muddy sheltered localities. At Cocoplum Beach in Biscayne Bay, H. L. Clark dug it out of the mud in the same localities as *Leptosynapta micropatina* while in Woods Hole the year-old individuals were picked off the eelgrass.

The species has been extensively used for experimental work at Woods Hole and may possibly be even more useful in the South where many animals are more tolerant to warm water than they are in the North.

In Woods Hole, *T. briareus* breeds in June-July but very likely the season is earlier in the Gulf and around Florida. The eggs are small and develop in 3½ days (Ohshima 1925) into a creeping larva which soon acquires tentacles and after 3 months is completely equipped with spicules of the same type as in the adult though naturally scaled down to the size of the few millimeter long specimens. In June, the following year, the smallest individuals found measure 2 cm. in length with no trace of genital organs. In specimens 3 to 4 cm. long gonads are present and increase the following years in length and number of the tubes. After 5 years the animals are ready to spawn, but whether they die after the spawning or regenerate the gonads is not known. The spawning has been studied by Colwin (1948).

Kille has studied the regeneration of the tentacles which is accomplished in 3 weeks. Extirpated gonads regenerate very fast if small pockets of germ cells are left; if completely removed it will take several months before the glands stage a comeback.

It is one of the few species which as far as known has no parallel form in the Panamic region. Troschel had apparently some mislabeled *Thyone briareus* which he described as *Anaperus peruviana* (Lesson), a deep purple form with simple calcareous ring. As the Panamic region recently has been rather thoroughly explored by the Hancock Expeditions it seems rather unlikely that so large a species as one resembling *T. briareus* could have escaped attention.

Thyone inermis Heller

Thyone inermis Heller, 1868, p. 78; Deichmann, 1947, p. 84, pl. 1, figs. 7-13; pl. 2, figs. 1-17.

From Tobago, British West Indies, and Florida has occasionally been reported a small species

which, with some doubt, has been referred to *T. fusus* (O. F. Müller), the well-known type species from the northeastern Atlantic. It appears, however, that one has been dealing with a southern species typical of the Mediterranean and the waters around Portugal, the Azores, as far north as Roscoff, France.

As the American material always has been immature, few centimeters long, it seems likely that the species appears intermittently only and has been unable to be established in the western Atlantic. It is included here because a somewhat similar form is known from the Panamic region, and if it has a parallel form in the Caribbean and the Gulf one might be inclined to identify it with the European invader which most likely does not extend its range into the Gulf.

Genus 3 NEOTHYONE Deichmann

Neothyone Deichmann, 1941, p. 106; new name for Selenka's *Stolus gibber*, 1867, p. 356 and allied forms.

Remarks.—In the Panamic region three species have been referred to this genus. In the West Indian region only one species is known, previously listed under three different names.

Neothyone belli (Ludwig)

FIG. 67: 21-22

Thyone belli Ludwig, 1887, p. 21, pl. 1, figs. 10-13; Deichmann, 1930, p. 176, pl. 14, figs. 10-13.

Thyone micropunctata Sluiter, 1910, p. 338, text fig. D a-c; Deichmann, 1930, p. 171, pl. 14, figs. 14-18.

Cucumaria argillacea Sluiter, 1910, p. 336, text fig. B a-c; Deichmann, 1930, p. 160 (not examined).

Diagnosis.—Small form, 5 cm. long, with skin rigid from the numerous spicules. Color dirty gray, sprinkled with dark spots. Spicules knobbed buttons with six marginal knobs and two central, often fused to a handle. Type: Würzburg; Sluiter's type may be in Germany. Type locality: Abrolhos Reefs, Bahia, Brazil; Sluiter's types came from Tortugas, Florida. Distribution: From Abrolhos Reef, Brazil, to Colon Harbor, Panama, including Trinidad and Tobago. Also taken at Tortugas. Shore to 12 fathoms.

Reexamination of the available material of *T. belli* and *T. micropunctata* has convinced me that the two species cannot be kept separate, and undoubtedly Sluiter's 8 mm. long *C. argillacea*, taken at the same locality as his *micropunctata* is the young of the latter. The differences in the calcareous ring which his figures indicate are such

as is often observed in material of different age. More surprising is his statement that *argillacea* possessed small gonads, but he may have mistaken some lobes of the respiratory trees for these organs.

Genus 4 THYONERIA nom. nov.

New name for *Semperia cognata* Lampert 1885.

***Thyoneria cognata* (Lampert)**

Semperia cognata Lampert, 1885, p. 67.

Thyone cognita Deichmann, 1930, p. 169, pl. 15, figs. 1-4.

Thyone cognata H. L. Clark, 1933, p. 115. Deichmann, 1938c, p. 134.

Diagnosis.—Large form, 14 cm. long, fairly delicate, spindle-shaped, often oral and anal ends turned up. Tentacles 10, of equal size. Feet in double rows and scattered interambulacraly. Calcareous ring tubular, with distinct tails and tall, narrow interradians. Spicules numerous elongate plates with mostly two rows of holes and a varying number of smaller, button-like holes with up to four holes. End plate in feet small, almost rudimentary except in young individuals;

walls of feet with perforated rods, with or without a third arm. Introvert with rosettes; tentacles with heavy rods in stem and delicate ones in the terminal branches. Type: Possibly in Germany. Type locality: Fernando do Noronhas, Cuba. Distribution: Cuba, Yucatán, Tortugas, and Biscayne Bay, Florida. Shallow water down to few fathoms depth. H. L. Clark reports it at Biscayne Bay, from soft bottom in patches of eelgrass.

Genus 5 THYONELLA Verrill 1872

Remarks.—The genus was established, rather casually, by Verrill for Pourtalès' *Colochirus gemmata*. The name has been discarded by most authors, but it seems to be the only one suitable for *gemmata*. The diagnosis has been enlarged so it takes in the members of *Thyonacta* Deichmann and provisionally Théel's *Thyone pervicax* which has become homeless after the name *Thyone* has been restricted to the species with delicate tables in the skin.

KEY TO THE SPECIES OF THYONELLA KNOWN FROM THE GULF OF MEXICO

1. Tube feet numerous, covering the entire body as slightly conical warts. Small form, 7 cm. long; curved, rigid body. Color white with brown spots, or light brown..... 3. *Thyonella pervicax* (Théel), p. 399
1. Tube feet in distinct double rows along the ambulacra, and scattered in the interambulacra but not covering the surface uniformly. Large forms, 15 cm. long. Color mottled gray or brown..... 2
2. Cups in outer layer star-shaped, with four central holes and eight large marginal teeth. Mottled gray
1. *Thyonella gemmata* (Pourtalès), p. 398
2. Cups in outer layer ring-shaped, with four small marginal holes in the corners; marginal teeth small and blunt. Uniformly grayish brown..... 2. *Thyonella sabanillensis* (Deichmann), p. 399

1 *Thyonella gemmata* (Pourtalès)

Colochirus gemmata Pourtalès, 1851, p. 11.

Thyone gemmata Deichmann, 1930, p. 177, pl. 17, figs. 1-3.

Diagnosis.—Large species, 15 cm., spindle-shaped, often somewhat curved; feet in double rows along the ambulacra and scattered in the interambulacra, cylindrical except toward the ends where they tend to become papilliform. Color brownish-grayish mottled. Spicules externally flattened baskets with eight broad teeth and four central holes; an inner layer of four-holed buttons more or less regular and knobbed, with tendency to become more irregular with age, with holes reduced and surface undulated. Feet apparently without end plate; walls stiffened by thick perforated rods; in papillae triangular plates or short tri-armed rods. Introvert with rosettes, and small spectacle-shaped rods. Tentacles with

heavy rods with small holes. Type: Undoubtedly lost. Type locality: Sullivan Island, S. C. Distribution: Like *Thyone briareus* it seems to be one of these species which is restricted to the Gulf of Mexico and the Atlantic seaboard. It is known from Yucatán, Texas, Florida, and South Carolina. Also reported from near Woods Hole but seems not to be permanently established so far north. As far as known, always dredged from a few fathoms depth.

The records from Maine and Barbados are omitted as they undoubtedly refer to individuals which have been mislabeled. The species appears to live buried in mud, and it is apparently one of the most common species in the Gulf. Like so many other of the larger species it is practically unknown as young. The smallest individuals I have seen measured 4 cm. in length but in strongly contracted condition.

2 *Thyonella sabanillensis* (Deichmann)

Thyone sabanillensis Deichmann, 1930, p. 178, pl. 17, figs. 4-19.

Thyonacta sabanillensis Deichmann, 1941, p. 101.

Diagnosis.—Large form, 15 cm. Resembles a somewhat more delicate *T. gemmata*, with stronger tendency to papillae toward the ends of the body and dorsally. Color uniformly grayish brown. Spicules an external layer of flattened baskets with uneven margin with blunt teeth and four small accessory holes besides the four central ones. Inner layer buttons with strongly knobbed surface and irregular plates with undulating to smooth surface. Feet without end plate, walls with curved thick supporting rods with small holes. In papillae often triangular plates, more or less strongly bent. Introvert with rosettes; tentacles with perforated rods which decrease in size toward the tips. Type: United States National Museum. Type locality: Sabanilla, Columbia, shallow water. Distribution: So far known only from the type locality and the western part of the Gulf of Mexico, coast of Texas (Hedgpeth). Few fathoms depth.

3 *Thyonella pervicax* (Théel)

FIG. 67: 12-20

Thyone pervicax Théel, 1886a, p. 93, pl. 5, fig. 9; pl. 2, fig. 3; Deichmann, 1930, p. 175, pl. 16, figs. 9-12.

Diagnosis.—Medium sized form, 7 cm. long, with rigid skin; ventral tentacles small; tube feet with conical base, covering the surface completely even in small individuals, at utmost with a faint indication of serial arrangement along the ambulacra. Color white or pale brown, sometimes with brown spots. Spicules an external layer of flattened cups with large marginal spines; an inner layer of four-holed, strongly knobbed buttons of two sizes. Feet with small end plate or none and walls stiffened by slightly curved rods, spectacle-shaped with one or more holes in each end. Type: British Museum. Type locality: Bahia, Brazil. Distribution: Reported from the type locality, Tortugas, and other localities on the Gulf side of Florida. Occasionally dredged in Vineyard Sound. Seems always to be taken at some fathoms depth. Although the species has spicules somewhat similar to *gemmata* they are nevertheless sufficiently different to prevent misidentification. Aside from the differences in the calcareous ring *pervicax* has more feet even at an early stage than has *gemmata*

and the latter is also more darkly colored. It is evidently one of the most common species off the west coast of Florida.

Genus 6 EUTHYONACTA nom. nov.

New name for *Thyone solida* (Deichmann).

Euthyonacta solida Deichmann

Thyone solida Deichmann, 1930, p. 172, pl. 15, figs. 11-17, pl. 16, figs. 1-2.

Diagnosis.—Heavily built, thick-skinned form with barrel-shaped body, five heavy oral valves and tube feet scattered uniformly over the body, more papilliform on the dorsum and at the ends. Color in alcohol yellowish brown. Simple ring. Spicules an outer layer of deep baskets with a wreath of teeth along the rim and an inner layer of regularly knobbed buttons of varying size. Feet apparently without end plate, though a number of branched rods may substitute for such one; walls packed with heavy rods, often with a third arm. Introvert with rosettes and small buttons with almost smooth surface. Tentacles with strong, perforated rods, decreasing in size toward the tips. Type: United States National Museum. Type locality: Gulf of Mexico, *Albatross* station 2369. Distribution: So far known only from the Gulf of Mexico from 26 to 30 fathoms depth. The largest individuals examined were about 6 cm. long with the tentacles retracted. From the size of the gonads I judge that the species may reach a much larger size, 15 to 20 cm. or thereabout. It was taken from coarse gray sand and broken corals in which it most likely lives concealed.

Genus 7 PENTACTA Goldfuss 1820

Pentacta pygmaea (Théel)

FIG. 67: 4-11

Colochirus pygmaeus Théel, 1886, p. 92, pl. 4, fig. 9.

Pentacta pygmaea, Deichmann, 1930, p. 180, pl. 21, figs. 10-16.

Diagnosis.—Medium-sized form, 7 cm. long, with short, box-like body, with cylindrical feet in three bands on the ventrum; dorsal side with blunt papillae along the ambulacra with some tendency to spread out into the interambulacra. Strong oral valves with papillae. Color chocolate brown, paler below. Spicules an external layer of deep baskets often with rim incomplete; an inner layer of strongly knobbed four-holed buttons with 10 knobs besides a varying number of much

smaller buttons with a larger number of knobs. Also scattered perforated plates with flat to knobbed surface. Feet with or without a small end plate; walls with stout supporting rods, often with a third arm. In the papillae the supporting rods are modified into plates, bent or flat. Introvert with rosettes; tentacles with heavy perforated rods. Type: British Museum. Type locality: Bahia, Brazil. Distribution: Ranges from Brazil, Trinidad to Florida and South Carolina. From tide mark down to 20 fathoms. In the Mexican Gulf known from Sanibel Island, Florida. The strong development of the ventral feet indicates that the animals live, limpet-like, attached to hard bottom, and this was observed to be the case of a specimen collected at Maguerepe Bay, Trinidad. It seems to be one of the more common species along the west coast of Florida.

Genus 8 ECHINOCUCUMIS Sars 1859

Echinocucumis hispida (Barrett)

Eupyrgus hispidus Barrett, 1856, p. 46, pl. 4, figs. 1a-6.
Echinocucumis hispida, Deichmann, 1930, p. 150, pl. 18, fig. 9.

Diagnosis.—Few cm. long, globular, with anterior and posterior end drawn out into short tubes; tentacles 10, almost finger-shaped. Spicules plates with large holes, smaller toward the margin, and spire, if present, reticulated and excentric in position. The feet pass out between the plates which often are indented for their passage. Type: Probably lost. Type locality: Coast of Norway. Distribution: From North Cape to Discaya, 100 to 250 fathoms. In the western Atlantic taken by Pourtalès near Florida and also by the *Albatross* between Bahamas and Cuba at 85 to 193 fathoms depth. Apparently the species is not common in the western Atlantic.

Echinocucumis hispida (Barrett) var. *atypica* Deichmann

Echinocucumis typicus Théel, 1886a, p. 9 (partim).
Echinocucumis hispida (Barrett) var. *atypica* Deichmann, 1930, p. 152, pl. 18, figs. 10-11.

Diagnosis.—As the typical form, except the spire is solid. Type: Museum of Comparative Zoology. Type locality: Off St. Kitts, 116 fathoms. Distribution: Taken from the type locality and off Havana, 100 fathoms depth.

Genus 9 SPHAEROTHURIA Ludwig 1894

KEY TO THE SPECIES KNOWN FROM THE GULF OF MEXICO

Scales coarsely reticulated; reticulation appears late. Tentacles with perforated, oblong plates.

Sphaerothuria asperrima (Théel), p. 400

Scales finely reticulated; reticulation appears early. Tentacles with cylindrical rods.

Sphaerothuria talismani (Perrier), p. 400

Sphaerothuria asperrima (Théel)

Echinocucumis asperrima Théel, 1886a, p. 10.
Sphaerothuria asperrima Deichmann, 1930, p. 152, pl. 19, figs. 1-2.

Diagnosis.—Large species, body 2 cm. in diameter; oral and anal tubes 2 cm. (together). Scales up to 2 mm. in diameter; spire centrally placed and with several pillars. Type: Museum of Comparative Zoology. Type locality: Islas de Pinos, Cuba, 158 fathoms. Distribution: Also taken off Kingston, Jamaica, Virgin Islands, and off Morro Light, Cuba. From 24 to 400 fathoms. In the smallest specimen, from off Morro Light, the plates lack almost all reticulation, but the feet pass through the plates and the scales are also larger than in *E. hispida* which is the species one might be inclined to refer it to.

Sphaerothuria talismani (Perrier)

Ypsilothuria talismani Perrier, 1902, p. 318, pl. 12, figs. 9-10, text fig. 12.

Sphaerothuria talismani Deichmann, 1930, p. 154, pl. 19, fig. 3.

Diagnosis.—Small form with finely reticulated plates, with central spire with numerous crossbars. Tentacles with cylindrical rods with perforated ends. Type: Paris. Type locality: Cape Finis Terre, Spain. Distribution: From Biscaya to west coast of Africa, 300 to 1,000 fathoms. In the western Atlantic taken along the Lesser Antilles and north of Havana and along the coast of New England. In the eastern Atlantic taken from 300 to 1,000 fathoms (if all Perrier's material refers to the same species); in the American waters taken from 339 to 1,491 fathoms.

Family 2 PSOLIDAE

KEY TO THE GENERA KNOWN FROM THE GULF OF MEXICO OR LIKELY TO OCCUR THERE

1. Dorsal side with numerous tube feet and scales covered by a layer of complex spicules, hour-glasses, towers, curved plates, etc.....1. *Thyonepsolus* H. L. Clark, p. 401
 1. Dorsal side without tube feet; scales naked or covered by a varying number of grains or cups, or both 2. *Psolus* Oken, p. 401

Genus 1 THYONEPSOLUS H. L. Clark 1901

Thyonepsolus braziliensis Théel

Thyone braziliensis Théel, 1886a, p. 15, fig. 7.

Thyonepsolus braziliensis Deichmann, 1930, p. 192, pl. 21, figs. 1-6; 1937, p. 173.

Diagnosis.—Small species, few cm. long, with 7 to 10 scales between oral and anal scales. Plates in outer layer of dorsal side small, incomplete; hour-glass shaped bodies relatively simple; towers present in varying numbers, obviously a juvenile character. Plates in sole with almost smooth even margin; tentacles with delicate rods and rosettes. Type: Museum of Comparative Zoology. Type locality: Porto Seguro, Brazil. Distribution: As far as known only taken at the

type locality and Tobago, British West Indies, but as it is a small inconspicuous species it may occur much more widespread. In shallow water, attached to rocks or seaweeds. Nothing is known about its life; even the color is not known though it most likely is bright red just as the closely related form known from the Panamic region. In Tobago several small individuals were taken from the same spot indicating that the development is direct, but it is doubtful whether the eggs are carried around in depressions on the mother's back as is the case in *T. nutriens* H. L. Clark, from the Californian waters.

The genus with its three species is restricted to the American waters, and the chances are that *T. braziliensis* also exists in the Gulf of Mexico.

Genus 2 PSOLUS Oken 1915

KEY TO THE SPECIES KNOWN FROM THE GULF OF MEXICO OR LIKELY TO OCCUR THERE

1. Dorsal scales covered by grains and small, regular cups.....[3. *P. complicatus* Deichmann, p. 402]
 1. Dorsal scales covered by grains but no cups.....2
 2. Few scales (2-4) between oral and anal scales. Grains few, large and ultimately fused with the scales, forming large protuberances.....1. *P. tuberculosus* Théel, p. 401
 2. Several scales (up to 6-7 scales) between oral and anal scales. Grains of moderate size.
 2. *P. operculatus* Pourtalès, p. 401

1 *Psolus tuberculosus* Théel

Psolus tuberculosus Théel, 1886a, p. 13, pl. 1, fig. 5; Deichmann, 1930, p. 186, pl. 20, fig. 3.

Diagnosis.—Small form, sole up to 3 cm. long; huge oral valves; anus surrounded by two circles of small scales; up to four scales between oral and anal scales. Feet restricted to the lateral ambulacra on the ventral sole. Spicules dorsally grains which increase enormously and finally fuse with the scales forming huge, blunt protuberances. Sole with perforated plates often two holes larger than the rest. Type: Museum of Comparative Zoology. Type locality: Sand Key, 500 fathoms. Distribution: The waters around Florida, Tortugas, and Campeche Bank, Mexico. Usually about 100 fathoms (95-135 fathoms); the type appears to have come from exceptionally deep water. The species is closely related to Fisher's *P. macrolepis* from Hawaii and Ludwig's *P.*

diomedea from Gulf of California to Ecuador and the Galapagos Islands. (See Deichmann, 1941, p. 149.)

2 *Psolus operculatus* (Portalès)

Cuviera operculata Portalès, 1868, p. 127; 1869, p. 359, 361.

Psolus operculatus Deichmann, 1930, p. 187, pl. 20, figs. 1-2.

Diagnosis.—Small form, sole up to 4 cm. long. Resembles *P. squamata* (D. & K.) with thin, imbricating scales, distinct oral valves, and up to seven scales between oral valves and anal scales; feet along margin of sole with a few at the ends of the odd ambulacrum. Spicules dorsally grains, lacking in very young individuals. Sole with heavy, four-holed buttons, with knobbed margin, increasing in number with age. Type: Museum of Comparative Zoology. Type locality: Sand Key, Florida, 120 to 125 fathoms. Distribution:

Known from the waters around Florida and Barbados. From about 100 fathoms (103-137).

[3 *Psolus complicatus* Deichmann

Psolus operculatus Théel, 1886a, p. 9 (partim).

Psolus complicatus Deichmann, 1930, p. 185, pl. 19, figs. 6-9.

Diagnosis.—Resembles *P. operculatus* but has in addition to grains on the dorsum, deep baskets;

deposits in the sole are larger knobbed buttons, often with a secondary reticulum. Type: Museum of Comparative Zoology. Type locality—Off Barbados, 137 fathoms. The species is known from the type locality only, taken in the same haul as material of *operculatus*. One almost expects that a larger series will prove that the two species must be merged.]

Family 3 PHYLLOPHORIDAE

KEY TO THE GENERA KNOWN FROM THE GULF OF MEXICO

- | | |
|--|---|
| 1. Deep water forms (100-200 fathoms or more). Skin paper-thin, stiff from numerous four-pillared tables | 6. <i>Benthophyllophorus</i> nov. nom., p. 405 |
| ----- | ----- |
| 1. Shallow water forms; tide pools to few fathoms depth | 2 |
| 2. Spicules perforated, knobbed plates | 5. <i>Phyllophorus</i> Grube, ¹ p. 405 |
| 2. Spicules tables | ----- |
| 3. Tables with distinctly dentate margin and low, two-pillared spire | 1. <i>Trachylthyonidium</i> nov. nom., p. 405 |
| 3. Tables with smooth margin or slightly uneven, at utmost blunt dentate | ----- |
| 4. Tables with four large holes, alternating with four small ones | 3. <i>Neophyllophorus</i> nom. nov., p. 404 |
| 4. Tables with 8 to 10 or more holes, in a circle or oval | ----- |
| 5. Disk oval with smooth margin | 2. <i>Paraphyllophorus</i> nov. nom., p. 402 |
| 5. Disk circular with uneven edge, sometimes blunt dentate | 4. <i>Lipotrapeza</i> H. L. Clark, p. 404 |

Genus 1 TRACHYTHYONIDIUM nov. nom.

New name for *Thyonidium occidentale* Ludwig.²

Trachylthyonidium occidentale (Ludwig)

FIG. 68: 1-5

Thyonidium occidentale Ludwig, 1875, p. 119.

Phyllophorus occidentale Deichmann, 1930, p. 148, pl. 18, figs. 1-2.

Euthyonidium occidentale Deichmann, 1938, p. 380; 1941, p. 124.

Thyonidium constituta Sluiter, 1910, p. 340, text fig. E; Deichmann, 1926, p. 124.

Diagnosis.—Up to 10 cm. long, with five pairs of large and five pairs of small tentacles. Color dark brown to yellow. Calcareous ring short tubular, with short tails which may become almost completely reduced. Spicules tables with dentate margin on the disk and four to eight holes, and two-pillared spire with few spines, sometimes reduced to four basal teeth. Type: Possibly in Germany. Type locality: Surinam. Distribution: From Porto Seguro, Brazil, Surinam, Trinidad, Antigua to the waters around Florida. The

species has been taken at Tortugas where it occurs in 3 feet of water in eelgrass patches. A closely related species is known from the Panamic region (Deichmann, 1941).

Genus 2 PARAPHYLLOPHORUS nov. nom.

New name for *Thyonidium parvum* Ludwig and related forms.

Paraphyllophorus parvum (Ludwig)

FIG. 68: 12-13

Thyonidium parvum Ludwig, 1881, p. 54, pl. 3, figs. 16-18; Deichmann, 1930, p. 149; 1938, p. 133, pl. 1, figs. 19-21; H. L. Clark, 1933, p. 113.

Diagnosis.—Up to 5 to 7 cm. long in preserved condition. Tentacles 20, of uneven size; the two circles not well separated. Color in life brilliant red with red or purplish tentacles; in alcohol yellowish white. Spicules numerous tables with oval to circular disk and 8 to 10 marginal holes and spire with two to four pillars ending in a cluster or wreath of spines. Type: Possibly in Germany. Type locality: Coast of Brazil. Distribution: According to Ludwig it is not uncommon along the coasts of Brazil in shallow water. It has been reported once from Antigua, British West Indies and recently from Biscayne Bay, Florida, in grassy flats. Although not yet re-

¹ The key here refers only to the West Indian representative. The type species, *P. urna* Grube, from the Mediterranean Sea, and related forms, have tables which disappear early in life. Possible the young of the West Indian species may have tables (or it may prove to be erroneously referred to the West Indian fauna).

² The name *Euthyonidium* Deichmann, 1938, has been withdrawn as a complete synonym of *Pentadactyla* Hutton, which has been reinstated.

ported from the Gulf, it seems most likely that it will prove to live there also.

A closely related form is known from the Panamic region (Deichmann, 1941).

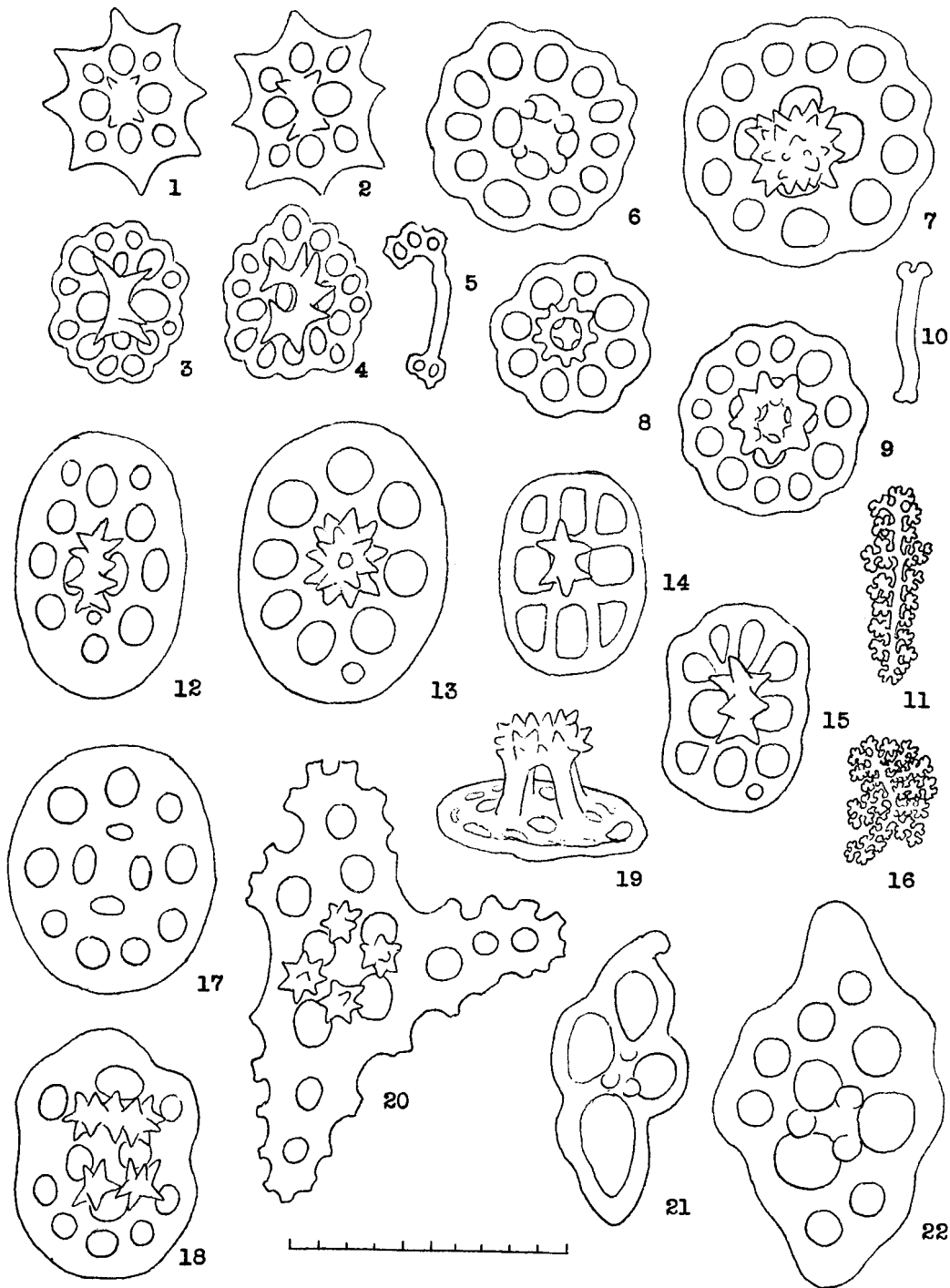


FIGURE 68: 1-22.—*Trachythyonidium occidentale* (Ludwig), p. 402. 1-2, tables from skin; 3-4, tables from introvert; 5, rod from tentacle. *Lipotrapeza seguroensis* Deichmann, p. 404. 6-9, tables from skin; 10, rod from tentacle; 11, rosette from introvert. *Paraphyllophorus parvus* (Ludwig), p. 402. 12-13, tables from skin. *Neophyllophorus desticatus*, (Deichmann), p. 405. 14-15, tables from skin; 16, rosette from introvert. *Benthophyllophorus conchilegum* (Pourtalès) p. 405. 17-19, tables from skin; 20, table from introvert. *Molpadia cubana* Deichmann, p. 405. 21, table from skin; 22, table from tail. Magnification: $\times 400$ Divisions 1/100 mm.

Genus 3 NEOPHYLLOPHORUS nov. nom.

New name for *Phyllophorus zacaë* Deichmann and related species.

KEY TO THE SPECIES OF NEOPHYLLOPHORUS

Tables with oral disk, with smooth edge and four squarish holes and four smaller wedge-shaped ones. Spire with two pillars and few teeth..... 1. *Neophyllophorus destichadus* (Deichmann)

Tables with oval to rectangular disk with four large holes and four smaller ones. Spire sometimes reduced to two knobs..... 2. *Neophyllophorus tritus* (Sluiter)

1 *Neophyllophorus destic*

FIG. 68: 14-16

Phyllophorus destichadus Deichmann, 1930, p. 146, pl. 18, fig. 3; 1938, p. 135, pl. 1, figs. 15-18; 1941, p. 135 (passim); H. L. Clark, 1933, p. 112.

Diagnosis.—Up to 6 to 7 cm. long, in preserved condition, with 15 to 20 tentacles, of different size, in two indistinctly separated circles. Color brownish purplish. Spicules tables with delicate, oval disk with four large, squarish holes and four smaller wedge-shaped ones; spire two-pillared, with 8 to 12 spines on top. Type: Museum of Comparative Zoology. Type locality: Tortugas. Distribution: Known from Tortugas and Biscayne Bay, Florida, collected at low tide. Both the Tortugas and Biscayne Bay specimens were collected by H. L. Clark who dug them out from eelgrass roots in firm mud.

A closely related form is known from the Panamic region (Deichmann, 1941).

2 *Neophyllophorus tritus* (Sluiter)

Thyone trita Sluiter, 1910, p. 339, text figs. E, a-e.

Phyllophorus tritus Deichmann, 1930, p. 147, pl. 18, figs. 4-8; H. L. Clark, 1933, p. 113.

Diagnosis.—Few cm. long in preserved condition; tentacles 18, probably 20 in mature specimens. Color grayish violet to deep purplish. Spicules tables with four large holes and four smaller ones in the oval to rectangular disk; spire with two pillars, sometimes reduced to knobs. Type: Possibly in Germany. Type locality: Bird Key Reef, Tortugas, Florida. Distribution: Taken at Tortugas, Florida, and Antigua, British West Indies. The small size may indicate that the species is based on immature individuals. It may be that it is the young of *destichadus* in which the spicules are less characteristic and for some

reason have been partly resorbed, something I have never seen in typical specimens in which the edge of the tables always is firm and even.

Genus 4 LIPOTRAPEZA H. L. Clark, 1938

Genus established for *Phyllophorus vestitiens* Joshua, and two other Pacific forms; the latter have, however, proven to belong in other genera. For the present one West Indian species has been included.

Lipotrapeza seguroensis (Deichmann)

FIG. 68: 6-11

Phyllophorus seguroensis Deichmann, 1930, p. 141, pl. 17, figs. 10-13.

Euthyonidium seguroensis Deichmann, 1938c, p. 132, figs. 9-14 (with field note by H. L. Clark).

Diagnosis.—Small forms 5 to 6 cm. in preserved condition, with flexible, soft skin, though rough to the touch. Feet scattered over entire body; tentacles 20 in two circles with five large pairs and five small inner pairs. Color mottled brown. Calcareous ring short, tubular, with insignificant posterior prolongations. Spicules numerous regular tables with four central holes and about 12 marginal ones; margin undulated to blunt dentate. Spire with four pillars and a number of spines on the top. Feet with end plate but no supporting rods. Introvert with tables and rosettes; tentacles with small perforated rods and rosettes in the distal part. Type: Museum of Comparative Zoology. Type locality: Porto Seguro, Brazil. Distribution: Known from Brazil, Jamaica, and Tortugas and Cape Florida in Florida. Taken near low tide mark. Near Cape Florida H. L. Clark dug it out of sandy mud in grassy flats. It may very likely be found widespread in suitable localities in the southern part of the Gulf.

Genus 5 PHYLLOPHORUS Grube, 1840*Phyllophorus dobsoni* Bell

Phyllophorus dobsoni Bell, 1883, p. 60, pl. 5, figs. 5, 5a-b; Deichmann, 1930, p. 141.

Diagnosis.—Type 8 cm. long, barrel-shaped, with conical feet scattered over the entire body. Color brownish. Calcareous ring short, tubular with short posterior tails. Spicules small disks, with four or more small holes and a few scattered knobs. Type: British Museum. Type locality: Bay of Honduras. So far no other specimens have ever been recorded, but one would naturally expect that the species would also occur in the Gulf of Mexico.

How the spicules are in young individuals is unknown, and the only other phyllophorid with similar spicules is Sluiter's *P. transvectus* from the East Indies known from the type and one other specimen. The similarity between the two species is so great that one wonders whether there possibly may be a mistake in the geographic location. Thus Domantay (1933) mentions a "Honduras Bay" in the Philippines, so there is the possibility that Bell's species might have come from that locality and not Central America.

Genus 6 BENTHOPHYLLOPHORUS nom. nov.

New name for *Thyonidium conchilegum* Pourtalès.

Benthophyllophorus conchilegum (Portalès), 1868

FIG. 68: 17-20

Thyonidium conchilegum Portalès, 1868, p. 128; 1869, pp. 359, 361.

Phyllophorus conchilegum Deichmann, 1930, p. 142, pl. 17, figs. 14-15.

Diagnosis.—Small form, 4 to 5 cm. long, with 20 tentacles of unequal size in 2 indistinct circles. Feet few large, scattered. Skin stiff, rough from spicules. Color in alcohol whitish. Spicules tables with circular disk with about eight marginal holes, four pillars and spire ending in numerous small teeth. Introvert with large tables with irregular disk. Type: Museum of Comparative Zoology. Type locality: Off Sand Key. Distribution: Known only from the waters around Florida, from 100 to 189 fathoms depth. Lives undoubtedly in soft mud, judging from the content of the intestine. It is a typical deep water form with no affinities to any other known phyllophorid.

Order 4 MOLPADONIA

The West Atlantic members of this order were treated by Deichmann, 1940, and no changes have been made since that time.

KEY TO THE GENERA AND SPECIES OF MOLPADONIA KNOWN FROM THE GULF OF MEXICO

1. Thick-skinned forms with barrel-shaped body which tapers off into a long stout tail. Tentacles 15 with 2 pairs of lateral digits (and no terminal digit). Color dirty white. Spicules numerous, small disk-shaped bodies ("cross-cups"). Few fathoms depth.....2. *Paracaudina* Heding. One species.
Paracaudina obesacauda (H. L. Clark), p. 406
1. Thin-skinned forms with barrel-shaped body which quickly contracts to a short thin tail. Tentacles 15 with a terminal digit and a few pairs of lateral digits. Spicules derived from tables or developed as huge rods or plates; in some species skin red from phosphatic bodies. 1. *Molpadia* Cuvier.....2
2. Spicules chiefly one-pillared tables with three to six holes in disk; in older individuals fusiform rods or thromboid plates dominate. Usually numerous phosphatic bodies.....1. *Molpadia musculus* (Risso), p. 405
2. Spicules chiefly three-pillared tables.....3
3. Tables large, with numerous holes; phosphatic bodies seem to be totally lacking..2. *Molpadia barbouri* Deichmann, p. 406
3. Phosphatic bodies present in varying amount. Tables small with three to six holes in disk; numerous holes in disk of tables in tail.....3. *Molpadia cubana* Deichmann, p. 406

Genus 1 MOLPADIA Cuvier, 1817**1 *Molpadia musculus* (Risso)**

See Clark, 1907, p. 165, pl. 23, figs. 4-7 (complete list of references); also Deichmann 1940, p. 225, pl. 40, figs. 1-15.

Diagnosis.—Large species up to 16 cm. long with varying amounts of phosphatic bodies.

Spicules one-pillared tables with three to six holes often one to three marginal projections. In older individuals these spicules are superseded by huge fusiform rods or rhomboid plates. Tail with fusiform rods, with or without a small spire. Type: Lost. Type locality: Mediterranean Sea, undoubtedly from less than 200 fathoms. Distribu-

tion: Circumtropical, in some regions reaching Arctic or Antarctic waters. From less than 200 to more than 1,000 fathoms. The Museum of Comparative Zoology has one record from the Gulf of Mexico at about 28° latitude and 87° longitude, 1,560 fathoms depth, but all the *Atlantis* records are from outside the Gulf area so apparently the species is not common there.

2 *Molpadia cubana* Deichmann

FIG. 68: 21-22.

Trochostoma antarcticum Théel, 1886a, p. 16.

Nec *T. antarcticum* Théel, 1886a, p. 44, pl. 2, fig. 7.

Molpadia cubana Deichmann, 1940, p. 220, pl. 37, figs. 1-3.

Diagnosis.—Small species, less than 10 cm. long, with numerous phosphatic bodies and three-pillared tables with three large holes and a varying number of smaller holes. Tail with small tables with round to oblong disk with numerous holes. Type: Museum of Comparative Zoology. Type locality: Off Havana, 175-210 fathoms. Distribution: So far reported only from the waters around Cuba, off Yucatán and the coast of Texas. From about 200 fathoms (*Atlantis*); a single record from 1,440 fathoms may possibly be omitted as erroneous. Along the coast of Texas and on the shrimp grounds off Yucatán the species has been taken in less than 50 fathoms depth (13 to 37 fathoms, Hildebrand, letter).

3 *Molpadia barbouri* Deichmann

Molpadia barbouri Deichmann, 1940, p. 222, pl. 39, figs. 1-6.

Diagnosis.—Medium sized, 8 cm. long, with snow-white skin (in alcohol). Rigid from the numerous spicules which consist of three-pillared tables with disk varying from large with several circles of holes to smaller with few holes. Sometimes the spire is reduced so large plates result.

Tail with small tables with elongate disk and minute spire. Type: Museum of Comparative Zoology. Type locality: Nicholas Channel, north of Cuba. Distribution: Waters around Cuba, from 390 to 605 fathoms.

The majority of the *Atlantis* records are definitely outside the Gulf region, but nevertheless, one may expect the species around the Yucatán peninsula.

Genus 2 PARACAUDINA Heding, 1931

Caudina (partim) *Auctores*.

Pseudocaudina Heding, 1931, p. 283 (preoccupied).

Paracaudina Heding, 1931, p. 455.

1 *Paracaudina obesacauda* (H. L. Clark)

Caudina obesacauda H. L. Clark, 1907, pp. 38, 176, pl. 9, figs. 1-5; Deichmann, 1930, p. 201, pl. 24, figs. 6-8.

Paracaudina obesacauda H. L. Clark, 1935, p. 284; 1940, p. 215.

Diagnosis.—Up to 15 cm. long with the barrel-shaped body gradually tapering off into the stout tail. Spicules in skin numerous cross-cups, mostly with bluntly rounded lateral projections, similar to those found in the New Zealand species, *P. coriacea*, and also common in the individuals of *P. chilensis* from off the tropical west coast of Central America and Mexico. Type: Museum of Comparative Zoology. Type locality: Marco, Florida. Distribution: Known from Key West and Tortugas, Florida, westward to Galveston, Texas. Few fathoms depth.

Usually large numbers are dredged from the same spot. More intensive collections will probably show that it is one of the most common forms in the Gulf in suitable localities. Its biology is completely unknown, but it will undoubtedly prove to be similar to that of the well studied Japanese form, usually called *P. ransonnetti* (v. Marenzeller) or *P. chilensis* (J. Müller).

Order 5 APODA Brandt, 1835

KEY TO THE FAMILIES KNOWN FROM THE GULF OF MEXICO

- Spicules anchors and anchor plates; tentacles with slender digits.....1. *Synaptidae*, p. 406
 Spicules wheels and sigmoid or bracket-shaped bodies; tentacles with broad stem with short, flat digits
 ..2. *Chiritotidae*, p. 408

Family 1 SYNAPTIDAE Oestergren, 1898

KEY TO THE GENERA AND SPECIES FOUND IN THE GULF OF MEXICO

1. Deep water form with large anchors with teeth on the arms; anchor plates with numerous dentate holes. Tentacles with one to two digits on each side. 4. *Protankyra* Oestergren.....*Protankyra brychia* (Verrill), p. 408
 1. Shallow water forms.....2

2. Large species, up to 100 cm. long, with plume-like tentacles; reef dweller. 1. *Euapta* Oestergren. *Euapta lappa* (J. Müller), p. 407
2. Small species, 10 cm. or less; tentacles with few digits. Lives in seaweed or burrows in sand or mud.....3
3. No teeth on flukes; anchor plates with large central holes surrounded by six large holes, all dentate; complete transverse bridge. 2. *Synaptula* Oersted.....*Synaptula hydriformis* (LeSueur), p. 407
3. A few teeth on flukes; anchor plates elongate, with large central holes, surrounded by six holes, more or less well equipped with teeth; incomplete transversal bridge. 3. *Leptosynapta* Verrill.....4
4. Large anchors, 0.3 to 0.5 mm. long; miliary grains as C-shaped bodies, numerous everywhere
1. *Leptosynapta multigranula* H. L. Clark, p. 407
4. Small anchors, 0.2 mm. long or less; miliary grains not numerous, often in groups of three to five, developed as delicate curved rods with expanded or branching tips.....2. *Leptosynapta crassipatina* H. L. Clark, p. 407

Genus 1 EUAPTA Oestergren, 1898

1 *Euapta lappa* (J. Müller)

Synapta lappa J. Müller, 1850, p. 134.

Euapta lappa H. L. Clark, 1907, p. 73, pl. 4, figs. 23-25; Deichmann, 1930, p. 205.

Diagnosis.—Up to 100 cm. long, silvery gray, sometimes longitudinally striped. Stock of anchor branched or deeply cleft; vertex with minute knobs; anchor plates with distinct bridge. Type: Possibly in Germany. Type locality: "West India." Distribution: Widespread in the West Indies but not known from Bermuda. It is reported from the waters around Tortugas and may therefore be expected in Yucatán and along the north coast of Cuba. Théel lists it from Tenerife but that may be a case of erroneous labeling.

According to W. K. Fisher the animal is quite active, crawling around among coral rocks or on sand and to a limited extent able to swim (Deichmann, 1926, p. 27).

The species differ very little from the Indo-Pacific form, *E. godeffroy* (Semper). The latter is supposed to have the base of the digits of the tentacles united by a web, while the anchors often are deformed. Possibly a study of large series of spicules may show definite size differences.

Genus 2 SYNAPTULA Oersted, 1849

Synaptula hydriformis (LeSueur)

Holothuria hydriformis LeSueur, 1823, p. 162.

Synaptula hydriformis H. L. Clark, 1907, pp. 23, 82, pl. 6; Deichmann, 1930, p. 206.

Diagnosis.—Few cm. long, at utmost 10 cm. in life when expanded. Tentacles 10 to 15, with 5 digits on each side. Stock of anchors finely toothed; arms smooth, vertex with few knobs. Anchor plates with large central hole, surrounded by six large holes all more or less dentate; two large smooth holes at the posterior end and a distinct arched bridge across these holes. Miliary

granules distributed in patches, visible with the naked eye. Viviparous; lives among algae. Type: Undoubtedly lost. Distribution: Common from Brazil to Bermuda, also around Tortugas and the southern Florida coast.

Two color phases exist, a brown and a green; the former is found among red or brown algae, the latter among green ones. Its life history has been worked out by H. L. Clark (1898) who found up to 179 young individuals escaping from a single female.

Genus 3 LEPTOSYNAPTA Verrill, 1867

1 *Leptosynapta multigranula* H. L. Clark

Leptosynapta multigranula H. L. Clark, 1924, p. 486, pl. 8, figs. 3-7; Deichmann, 1938, p. 135.

Leptosynapta multigranulata Deichmann, 1930, p. 207 (typographical error).

Diagnosis.—Up to 7.5 cm. in length in preserved condition. Tentacles 12, with 5 to 6 pairs of lateral digits, 2 to 9 sensory cups on the oral side of each tentacle. Spicules large anchors, 0.19 to 0.45 mm. long; anchor plates 0.2 to 0.29 mm. long. Miliary grains as C-shaped or ring-shaped bodies, scattered everywhere. Type: Museum of Comparative Zoology. Type locality: Tortugas, in sandy mud. Distribution: So far known only from Tortugas and Biscayne Bay.

The species seems to live in eelgrass covered flats and may very well have a much wider distribution than the present few records show.

2 *Leptosynapta crassipatina* H. L. Clark

Leptosynapta crassipatina H. L. Clark, 1924, p. 47, pl. 6, figs. 1-4; Deichmann, 1930, p. 208.

Diagnosis.—Few cm. long (types, 4 cm.) with 12 tentacles with 4 to 5 pairs of digits and 4 to 10 large sensory cups on the oral side of the tentacles. Spicules small anchors, 0.117 to 0.183 mm. long, with 3 to 7 teeth on each arm; anchor plates 0.11 to 0.14 mm. long. Miliary grains scarce, often in groups of 3 to 5, as delicate

curved rods with expanded or branching ends. Type: Museum of Comparative Zoology. Type locality: Near Key West, Florida. Distribution: From Key West northward and westward to Horn Island, Mississippi. The type specimens were dug out in a sandy mud flat in a mangrove key. The other specimens found in the Gulf have unfortunately all been preserved in formalin so the spicules are partly destroyed. A large series of this species and the foregoing is most desirable as they appear to me to be rather closely related and possibly represent different age stages.

Genus 4 PROTANKYRA Oestergren, 1898

Protankyra brychia (Verrill)

Synapta brychia Verrill, 1885, p. 539.

Protankyra brychia Oestergren, 1898, p. 116; Deichmann, 1940, p. 229, pl. 41, figs. 1-3.

Synapta abyssicola Théel, 1886, p. 14, pl. 1, fig. 11; Deichmann, 1930, p. 210.

Diagnosis.—Medium-sized form, 10 cm. long up to 1 cm. in diameter. Tentacles 12, with 2 pairs of digits. Color dark yellowish with reddish pigment on oral side of tentacle base. Spicules large anchors, 0.7 to 1.0 mm. long with branched handle. Anchor plates with numerous dentate holes and a bridge or an irregular network. No accessory miliary grains. Type: United States National Museum. Type locality: Off Cape Hatteras, at 938 fathoms. Distribution: Eastern and western Atlantic, including Gulf of Mexico. From 800 to 1,000 fathoms.

Usually, fragments are all that one gets of this mud-loving species. Although it is rather incompletely known it seems certain that the differences listed between Verrill's and Théel's species are within the limit of a variation which one must expect.

Lugwig's variety of *abyssicola* from the Pacific Ocean which H. L. Clark gave specific rank can undoubtedly be withdrawn as the presence or absence of teeth on the anchors is the result of age and not a constant character.

Family 2 CHIRIDOTIDAE

Genus 1 CHIRIDOTA Eschscholtz, 1829

Chiridota rotifera (Pourtalès)

Synapta rotifera Pourtalès, 1851, p. 15.

Chiridota rotifera, H. L. Clark, 1907, p. 115; Deichmann, 1930, p. 212; 1938, p. 136.

Diagnosis.—About 5 cm. long, occasionally 10 cm. with 12 (13-14) tentacles with 4 to 7 pairs of

digits; numerous wheel papillae with wheels of varying size diameter, 0.1 to 0.2 mm.; curved rods thinly scattered. Viviparous. Type: Lost. Type locality: Biscayne Bay, Florida. Distribution: Known to range from Brazil, Trinidad to Bermuda, and also Tortugas, Florida.

According to Pourtalès it occurs "among interstices of the branches of a coral which occurs on shoals in Biscayne Bay," and from the findings in Bermuda and Tortugas, etc., one can expect it wherever broken corals and sand occur. Usually, many specimens are found in one spot, and as *S. hydriformis*, it is viviparous which Ludwig was the first to notice (1881), while H. L. Clark (1910) wrote an extensive report on its development.

BIBLIOGRAPHY

- ASCANIUS, P. and RATHKE, J.
1805. *Icones rerum naturalium*. Fasc. 1-5, pls. 1-50. Copenhagen.
- AYRES, W. O.
1854. Observation upon the holothurians of our coast. Boston Soc. Nat. Hist. 4, p. 200.
- BARRETT, L.
1857. Description of four new species of Echinodermata. Ann. Mag. Nat. Hist., ser. 2, 20: 46-48, pl. 4.
- BELL, F. J.
1883. Studies in the Holothuroidea. II. Proc. Zool Soc. London, pp. 58-62, pl. 15.
- BRANDT, T. F.
1835. *Prodromus descriptionis animalium ab H. Mertensio in orbus terrarum circumnavigatione observatum*. Fasc. 1, pp. 42-61. Petropolis.
- BRONN, J.
1860. Die Klassen und Ordnung. d. Thierreichs. Strahlenthiere, pp. I-XVI, 1-434.
- CLARK, H. L.
1898. *Synapta vivipara*. Mem. Biol. Lab. Johns Hopkins Univ. 4 (2): 53-88, pls. 11-15.
1907. The apodous holothurians. Smithsonian Contr. 35: 12-231, pls. 1-13.
1910. The development of an apodous holothurian (*Chiridota rotifera*). Jour. Exp. Zool. 9 (3): 496-516, 6 figs.
1919. Distribution of the littoral echinoderms of the West Indies. Carnegie Inst. Washington Pub. 281: 49-74, pls. 1-3.
1922. The holothurians of the genus *Stichopus*. Bull. Mus. Comp. Zool. 65 (3): 39-74, pls. 1-2.
1924. The Synaptinae. Bull. Mus. Comp. Zool. 65 (13): 457-501, pls. 1-12.
1933. A handbook of the littoral echinoderms of Porto Rico and the other West Indian Islands. Scientific Survey of Porto Rico and the Virgin Islands, 16, Part 1, New York Acad. Sci., pp. 1-147, pls. 1-17.
1935. The Holothurians of the genus *Caudina*. Ann. Mag. Nat. Hist. (10) 15: 267-284.

- CLARK, H. L.—Continued
 1942. The Echinoderm Fauna of Bermuda. Bull. Mus. Comp. Zool., 89: 367-394, 1 pl.
- COLWIN, L. H.
 1948. Note on spawning of the holothurian *Thyone briareus* (LeSueur). Biol. Bull., Woods Hole, 95: 296-306.
- CROZIER, W. J.
 1914. The orientation of a holothurian by light. Am. Jour. Physiol. 36 (1): 8-20.
 1916. The rhythmic pulsation of the cloaca of holothurians. Jour. Exp. Zool. 20 (3): 297-356.
 1917a. The behavior of holothurians in balanced illumination. Am. Jour. Physiol. 43: 510-513.
 1917b. Multiplication by fission in holothurians. Am. Naturalist 61 (609): 560-566, text figs. 1-2.
 1917c. The sensory reaction of *H. surinamensis*. Zool. Jahrb. Abt. Allg. Zool. u. physiol. 35 (33): 577-584, text figs.
 1917d. Occurrence of a holothurian new to the fauna of Bermuda. Am. Mag. Nat. Hist. 19: 405-406.
 1918. The amount of bottom material ingested by holothurians (*Stichopus*). Jour. Exp. Zool. 26 (2): 379-389.
 1920. On the role of an integumentary pigment in photoreception in *Holothuria*. Jour. Gen. Phys. 3 (1): 57-59.
- CUVIER, G.
 1817. Le Règne animal. 4 vols., pp. 22-23.
- DEICHMANN, E.
 1926. Report on the holothurians collected by the Barbados-Antigua Expedition. Univ. Iowa; Studies in Nat. Hist. 9 (7): 9-31, pls. 1-3.
 1930. The holothurians of the western part of the Atlantic Ocean. Bull. Mus. Comp. Zool. 71: 41-226, pls. 1-24.
 1937. Holothurians from the Gulf of California. The Templeton Crocker Expedition, 9. Zoologica, New York Zool. Soc. 22: 161-176, text figs. 1-3.
 1938a. Holothurians from the western coast of Lower California and Central America, and from the Galapagos Islands; Eastern Pacific Expeditions of the New York Zool. Soc., 16, Zoologica, New York Zool. Soc. 23: 361-387, text figs. 1-15.
 1938b. New holothurians from the western coast of North America and some remarks on the genus *Caudina*. Proc. New England Zool. Club 16: 103-115, text figs.
 1938c. Holothurians from Biscayne Bay, Florida. Proc. Florida Acad. Sci. 3: 128-136, text figs. 1-25.
 1940. Report on the holothurians collected by the Harvard-Havana Expeditions, 1938 and 1939, with a revision of the *Molpadonia* of the Atlantic Ocean. Contr. 248, Woods Hole Oceanog. Inst., pp. 183-240, pls. 31-41.
 1941. The Holothurioidea collected by the *Velero III* during the years 1932-1938, Part 1, *Dendrochirota*. Allan Hancock Pacific Expeditions 3 (83): 61-194, pls. 10-30.
1946. A new species of *Thyone* ss. from the Gulf of Mexico. Occas. Pap. Mar. Lab., Louisiana State Univ., Baton Rouge, La., No. 4, pp. 1-4, text fig.
 1947. The fusus-like *Thyone* from the West Indian waters. Proc. New England Zool. Club 24: 83-90, pls. 1-2.
- DOMANTAY, J. S.
 1933. Littoral Holothurioidea of Port Galera Bay and adjacent waters. Univ. Philippines Nat. and Appl. Sci. Bull. 3 (1): 41-101.
- EDWARDS, C. L.
 1905. A quantitative study of *H. atra* Jaeger and the re-establishment of *H. floridana*. Pourtales (*H. mexicana* Ludwig). Science, N. S., 21: 383-384.
 1908. Variation, development and growth in *H. floridana* Pourtales. Biometrika 6: 238-301, pls. 1-5.
 1909. The development of *Holothuria floridana* Pourtales with special reference to the ambulacral appendages. Jour. Morph. 20: 211-230 (*H. mexicana* Ludwig).
- FORSKÅL, P.
 1775. Descriptiones animalium. Pp. 1-19, i-xxxiv, 1-164. Atlas (1776), pls. 1-43.
- GRAVE, C.
 1905. The tentacle reflex in a holothurian *Cucumaria pulcherrima*. John Hopkins Univ., Circular 178, pp. 24-27.
- HEDING, S. G.
 1931. On the classification of the *Molpadido*. Vid. Med. Nat. For., 92: 275-284. Correction, pp. 455-456.
- GRUBE, G. A.
 1840. Actinien, Echinodermen und Würmer des Adriatischen und Mittelmeers, pp. 1-92, pl. 1.
- HELLER, C.
 1868. Zoophyten und Echinodermen des Adriatischen Meeres. Pp. 1-88, pls. 1-3.
- IVES, J. E.
 1890. Echinoderms from the northern coast of Yucatán and the Harbor of Vera Cruz. Proc. Acad. Nat. Sci. Philadelphia 42: 317-340, pl. 8.
- KILLE, F. R.
 1935. Regeneration in *Thyone briareus* (LeSueur). Biol. Bull., Woods Hole, 69 (1): 82-108.
 1936. Regeneration in holothurians. Yearbook Carnegie Inst. Washington 35: 85-86.
 1937. Regeneration in the genus *Holothuria*. Yearbook Carnegie Inst. Washington 36: 93-94.
 1939. Regeneration of gonad tubules following extirpation in the sea-cucumber, *Thyone briareus* (LeSueur). Biol. Bull., Woods Hole, 76 (1): 70-79, figs. 1-3.
 1942. Regeneration of the reproductive system following binary fission in the sea-cucumber *Holothuria parvula* (Selenka). Biol. Bull., Woods Hole, 83: 55-66, pl. 1.
- LAMPERT, K.
 1885. Die Seewalzen. Pp. 1-212, pl. 1.
- LESUEUR, C. A.
 1823. Descriptions of several new species of *Holothuria*. Jour. Acad. Nat. Sci. Philadelphia 4: 155-163.

LINNAEUS, C. V.

1757. *Systema Naturae*. 10th edition.

LUDWIG, H.

1875. Beiträge zur Kenntniss der Holothurien. Arbeit. Zool. Zoot. Inst. Würzburg, 2 Heft 2, pp. 77-120, pls. 6-7.

1881. Ueber eine lebendige gebärende Synaptide und zwei andere neue Holothuriarten der Brazilianischen Küste. Arch. Biol. 2: 41-58, pl. 3.

1887. Die von G. Chierchia auf der Fahrt der Kgl. Corvette Vettor Pisani gesammelten Holothurien. Zool. Jahrb. 2: 1-36, pls. 1-2.

1892. Die Seewalzen. Bronn's Klass. & Ordn. d. Thierreichs, 2, Abt. 3, pp. I-IV, 1-460, pls. 1-17.

1894. The Holothurioida. Reports of an exploration of the west coast of Mexico, etc., by the *Albatross* during 1891. Mem. Mus. Comp. Zool. 17 (3): 1-183, pls. 1-19.

MARENZELLER, E. V.

1893a. Contribution a l'étude des Holothuries de l'Atlantique du Nord, Golf de Gascogne. Res. Comp. Sci. Prince de Monaco. Fasc. pp. 1-22, pls. 1-2.

1893b. Zool. Ergebnisse. Echinodermen. Ber. d. Commission f. Erforschung des Ostl. Mittelmeere, 5, Denkschrift. Akad. Wiss. Wien, 60, pp. 1-24, pls. 1-4.

1895. Zool. Ergebnisse 5, Echinodermen. Ber. d. Commission f. Erforschung des Ostl. Mittelmeere, 5, Denkschrift. Akad. Wiss. Wien, 62, pp. 1-26, pl. 1.

MÜLLER, J.

1850. Anatomische Studien über die Echinodermen. Muller's Archiv: 129-147.

MITSUKURI, K.

1897. On changes which are found with advancing age in the calcareous deposits of *Stichopus japonicus* Selenka. Annot. Zool. Jap., 1: 31-42, text figs.

MORTENSEN, T.

1927. Echinoderms of the British Isles. Pp. I-Viii, 1-471, text figs. 1-269.

NOBRE, A.

1931. Echinodermes de Portugal. Instituto de Zoologia da Universidade de Porto, pp. 1-76, pls. 1-14, text figs. 1-74.

OHSHIMA, H.

1925. Notes on the development of the seacucumber *Thyone briareus*. Science 41 (1591): 420-421.

OESTERGRÉN, H.

1896. Zur Kenntniss der Subfamilie Synallactinae unter die Aspidochiroten. Festschrift f. Liljeborg, pp. 345-360, pl. 18.

1898. Das System der Synaptiden. Oversigt Kgl. Svensk. Akad. Forhandl. 55, pp. 111-120.

PANNING, A.

1929-35. Die Gattung *Holothuria* I-V. Mitt. Zool. Staatsinstitut u. Zool. Museum, Hamburg, 44, pp. 91-135; 45, pp. 24-50, 65-107; 46, pp. 1-18, text figs. 1-121.

PERRIER, R.

1896. Sur les Elasiopodes recueilles par le Travailleur et le Talisman. Comptes rendus de l'Acad. des Sciences 123: 900-903.

1902. Holothuries. Exped. Sci. du Travailleur et du Talisman, pp. 273-554, pls. 12-22, 14 text figs.

POURTALÈS L. F. DE.

1851. On the Holothuriae of the Atlantic coast of the United States. Proc. Am. Assoc. Adv. Sci., 5th meeting, pp. 8-16.

1868. Contributions to the fauna of the Gulf Stream at great depths. Bull. Mus. Comp. Zool. 1: 121-142.

1869. List of Holothuriidae from the deep sea dredgings of the U. S. Coast Survey. Bull. Mus. Comp. Zool. 1: 359-361.

SARS, M.

1857. Bidrag til Kundskaben om Middelhavets Littoral Fauna. Nyt. Mag. f. Naturvidenskab, pp. 57-155, pls. 1-2.

1858. Om tre nye Holothurider af hvilke den ene danner Typus for en ny Slægt. Videnskabs Selskabets Forhandling for 1858, pp. 170-179.

1868. Om nogle Echinodermer og Coelenterater fra Lofoten. Videnskabs Selskabets Forhandling for 1867, pp. 1-7.

SELENKA, E.

1867. Beiträge zur Anatomie und Systematik der Holothurien. Zeitschr. Wiss. Zool. 17: 291-375, pls. 17-20.

1868. Nachtrage. Zeitschr. Wiss. Zool. 18: 109-119, pl. 8.

SEMPER, C.

1868. Reisen im Archipel der Philippinen, II. Vol. 1, Holothurien, pp. 1-282, pls. 1-40.

SLUITER, C. P.

1895. Die Holothurien Sammlung des Museum im Amsterdam. Bijdr. Dierk. 17: 75-82.

1901. Die Holothurien der *Siboga* Expedition. Uitkomst H. M. *Siboga*. Uitgeven van Max Weber. Monograph 44, pp. 1-141, pls. 1-11.

1910. Westindischen Holothurien. Zool. Jahrb. f. Anat. & Syst., Suppl. 11, Heft 2, pp. 331-341, text figs.

1914. Die von Dr. P. N. van Kampen während seiner Fahrt mit der Regierungsdampfer *Gier* 1906-1909 im Indischen Archipel gesammelten Holothurien-Buitensorg Contrib. Faune Indes Neerlandaises, 1, pp. 1-28, pl. 1.

THÉEL, H.

1882. Report on the Holothurioidea, Part I. Elasiopoda, Report on the scientific results of the voyage of H. M. S. *Challenger*, during 1873-1878. Zool. 4: 1-76, pls. 1-46.

1886. Report on the Holothurioidea, Part II. Elasiopoda, Report on the scientific results of the voyage of H. M. S. *Challenger*, during 1873-1878. Zool. 39: 1-290, pls. 1-16.

1886a. Report on the Holothurioidea of the *Blake* expeditions 1877-1880. Bull. Mus. Comp. Zool. 13(1): 1-21, pl. 1-2.

VERRILL, A. E.

1872. Radiata from the coast of N. Carolina. Am. Jour. Sci. & Arts, Ser. 3, 3 (18): 432-438.

1885. Results of the explorations made by the steamer *Albatross* off the northern coast of the United States in 1883. Rept. Commissioner of Fish., 1883: 503-601, pls. 1-44.