The Shallow-Water Holothurians of Guam[1]

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Abstract—Thirty species of holothurians are now known from Guam; of these, six are new records. A key to the species is given along with illustrations of living specimens and their spicules. The distributional patterns of species across several of Guam's reef flats are discussed. A list is given of the commercially utilisable species of the island and the zoogeographical relationships of the Guamanian fauna are described. Methods of preservation and identification are also described.

Introduction

The earliest published record of a holothurian collected from Guam is that of *Holothuria guamensis* described by Quoy and Gaimard (1833). Brandt (1835) described a new species, *Holothuria* (*Microthele*) *maculata*, from "Insula Guahan," referring *H. guamensis* to the genus *Muelleria* Jaeger. Apart from these records, little attention has been given to the holothurian fauna of Guam until the present century.

Lindsey (1935) reported on the costs of the various kinds of Beche-de-Mer forms occurring around Guam and indicated that there was once a flourishing trade from the island. Frey (1951) reported the use made by local Guamanian fishermen of crude extracts from *Holothuria atra* to stun fish in reef pools. He also cited an earlier reference to this local custom (in Guam Recorder, May 1941; not seen by the authors). Janice Beaty (1964 and 1966), a local reporter, wrote two popular articles describing many interesting habits of the holothurians occurring on the reef flats of Guam and the uses to which the holothurians have been put. Yamaguchi (1975) described the mass mortality of reef flat organisms in Pago Bay (east coast of Guam), which occurred in 1972 after abnormal climatic conditions, and the recovery of the benthic communities by 1975. Included in his report were records of six species of holothurians. Randall and Eldredge (1974), Dickinson and Tsuda (1975) and Marsh and Doty (1975) have provided some data on holothurian distribution patterns across three reef flats on Guam in technical reports.

The only comprehensive taxonomic report published on the holothurians of Guam, however, is that of Domantay (1954). He records eighteen species, but only eleven are accompanied by any locality data. No indication is given of the habitats

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or depths in which the species were found.

At the invitation of Professor L. G. Eldredge, University of Guam, and supported by a Sea Grant Project, the senior author spent three weeks on Guam in April, 1975, in order to study and report on the holothurian fauna of the reef flats. Eleven locations around the island were visited and the holothurian populations were examined (Fig. 1). The holothurian collection at the University was also examined. The junior author assisted with the collection of holothurians and has subsequently added three further species records, prepared data on Piti reef flat and prepared the figures for the final draft of the paper.

In this paper, a method of preservation and identification of holothurians is described. A systematic key to the holothurian species is provided, which should

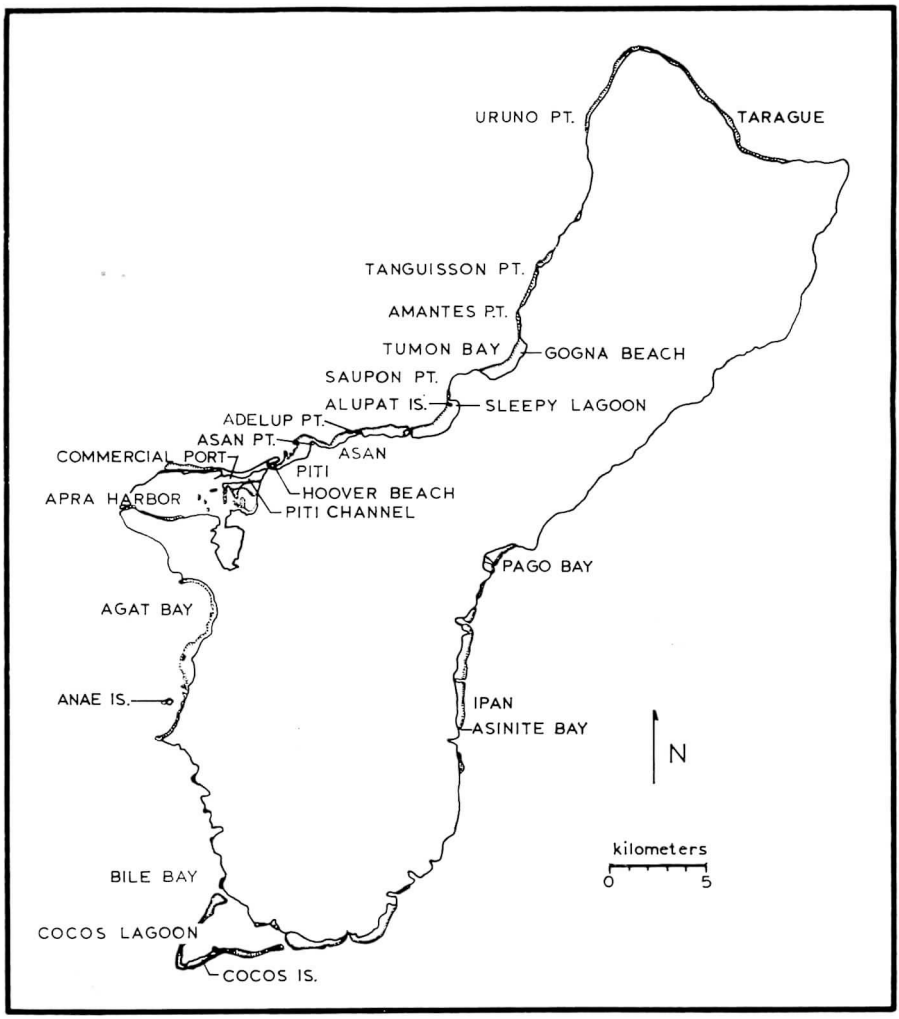


Fig. 1. Map of Guam showing locations referred to in the text.

allow the identification of fresh or preserved material. The key is conventionally arranged from a systematic point of view, but notes on color, form and habitat are added to assist the non-taxonomist. The species are then listed with locality and habitat data from Guam, their general distribution and any further relevant notes. The list of references under each species has been kept as short as possible but includes the original description, authors responsible for changes in nomenclature, and the most authoritative references to synonomy, distribution and currently accepted nomenclature. The distribution patterns of holothurians on several reef flats are discussed. A list is given of the commercially utilisable species of the island, and the zoogeographical relationships of the Guamanian holothurian fauna are described.

A total of thirty species is now recorded from the reef flats and slopes of Guam.

Preservation

Holothurians should be relaxed before preservation so that tentacles, papillae and tube-feet remain extended. This may be achieved by narcotisation overnight (up to about 12 hours) using a strong solution (about 10%) of magnesium sulphate made up in sea water. The animal can be prodded to check for complete narcotisation. If no reaction is registered the holothurian can be preserved by injecting 95% methyl or ethyl alcohol into the body cavity and then submerging the whole animal in the alcohol. After about a week the specimen can be transferred to 70% alcohol for permanent storage. The initial storage of specimens in 95% alcohol should allow for dilution of the storage medium by body fluids. It cannot be stressed too strongly that holothurians should never be placed in formalin solution because the tiny spicules, which are vital for identification purposes, are particularly susceptible to dissolution by the formalin.

In storage, the specimens must be accompanied by a parchment paper label with information details (site of collection, locality, substrate, associations, life color, the name of the collector and date of collection) written in waterproof (insoluble) ink.

Identification

Identification of holothurians requires examination of various features, including: externally the form and number of tentacles and the distribution of tube-feet and papillae, and internally the shape of the calcareous ring around the front end of the gut, the presence or absence of respiratory trees and cuvierian organs in the posterior part of the body, and the form of calcareous spicules included in various parts of the body wall. Dissection of the animal, for examination of internal structures, is usually carried out in a waxed dish. The main incision is usually made longitudally along the middorsal line and the flaps of the body wall are pinned back to the wax.

Examination of spicules usually involves the preparation of a permanent micro-

slide. The procedure is easy. A very small vertical wedge of body wall is cut and placed in the center of the glass slide. The wedge is covered in a drop of domestic bleaching agent (active ingredient, sodium hypochloride 3.5%). This will dissolve the tissues leaving the calcareous spicules intact. The spicules can be spread, for better examination, using a dissecting needle. The bleach should be allowed to crystalise. The bleaching agent must then be removed by washing, i.e., by repeatedly adding drops of water to dissolve the crystals and drawing the solution off by the careful use of absorbant paper. This procedure is continued until no further crystals form when the area containing the spicules is dried. During this process, very few, if any, spicules will be lost as they stick to the glass slide. The spicules can now be covered by a mountant (e.g., Euparol) and protected by a cover slip and the slide can be properly labelled.

When preparing a large number of slides, the junior author has found it convenient to dissolve the tissued wedge in a 125 ml tapered glass centrifuge tube. Removal of the bleach solution is then accomplished by decanting the supernatant after centrifugation for ten minutes at 1500 rpm. The spicules were rinsed twice, first with tap water and then with distilled water, and then dehydrated with 95% ethanol. After decanting the final ethanol supernatant, the spicules were distributed with a pipette to glass slides and dried on a warming plate. After drying was complete (1–2 min) the slides were removed and cover glasses applied with the use of a mounting medium. Complete permeation of the spicules by the mounting medium was ensured by placing a droplet of the proper solvent (in this case, toluene) on the slide prior to application of the mounting medium.

Spicules are usually taken from the middorsal region of the holothurian, however, it may be necessary to examine spicules from specific areas such as the tentacles, introvert, tube-feet, papillae. When examining spicules from different parts of the same animal or from different parts of several animals of the same or different species, it is essential that the instruments used in obtaining skin samples, or in any dissection of the animals, be thoroughly cleansed before each sample is taken. It is too easy to transfer spicules from one specimen to slide preparation of another on a scalpel, dissecting scissors, dissecting needle or any other instrument. This may lead to the misidentification of the species under review.

Glossary

Anal "teeth" or papillae: radially placed calcareous papillae which encircle the anus.

Ambulacra and Interambulacra: the ambulacra run in 5 radial bands longitudinally between the anterior mouth and posterior anus. The tube-feet may be restricted to these areas or may be distributed also between these areas in the interambulacra.

Calcareous ring: an internal ring usually of 10 plates surrounding the anterior part of the gut (pharynx). The plates alternate in size, the larger being called radials (adjacent to the ambulacra), the smaller being called the interradials

(adjacent to the interambulacra). These plates may be short and ring-like or long, compound and tubular.

Dorsal mesentery: an internal mesentery from the middorsal interambulacral area which is attached to the gut.

Spicules: skeletal elements mainly in the body wall.

a. Anchors—anchor shaped spicules attached at posterior end, the stock, by tissue to the posterior "bridge" of the anchor plates.
b. Anchor plates—more or less rectangular, perforated plates in association with the anchors. The anterior end of the plate often wider than the posterior, the latter end usually with a well formed arched bar (bridge) with which the stock of the anchor articulates.
c. Buttons: elongate two-dimensional plates pierced by holes which are usually arranged in pairs. The surface of the button may be smooth or knobbed.
d. Fenestrated ellipsoids: modified and three-dimensional buttons forming elongate hollow fenestrated structures.
e. Fenestrated spheres: modified tables forming rounded hollow fenestrated structures.
f. Lenticulate plate: very thick, lens-shaped, perforated, plate.
g. Miliary granules: small solid, rounded or elongated bodies.
h. Pseudobuttons: imperfect buttons, often twisted or reduced to a simple row of holes.
i. Rods: bar-like spicules, variously developed and branched.
j. Rosettes: two-dimensional, perforated spicules formed from branched rods and often button-like. They differ in having holes of various sizes and often a terminal one at each end.
k. Tables: three-dimensional spicules with a more or less circular, perforated disc from which arise 2–4 vertical pillars which are linked by transverse bars (bridges) to form a spire. Measurements are made of the diameter of the disc and height of the spire. Tables occur above the two-dimensional buttons in the body wall.
l. Wheels: circular, wheel-liked spicules with six, or more, spokes.

Tentacles: modified tube-feet forming a single or double circle around the mouth.

Tube-feet: cylindrical projections of the body wall, their lumen continuous with the internal water vascular system of the animal. Tube-feet may be restricted to the ambulacral area or scattered over the whole body. When dorsoventral specialization occurs, those on the ventral surface remain unspecialized and are called pedicels, while the nonlocomotory dorsal ones are called papillae.

KEY TO THE SPECIES

1 Body rather stout, sausage-shaped; tube-feet present (usually as ventral pedicels and dorsal papillae); body wall sometimes thick and muscular, not sticky to

touch; tentacles leaf- or bush-shaped; spicules in body wall may include tables, rods or plates (Figs. 2, 3, 4a–g). No wheels, anchors or anchor plates ..... Dendrochirotida and Aspidochirotida 2

1′ Body worm-like; tube-feet absent, though body may appear warty; body wall thin and sticky to touch; tentacles pinnate; spicules in body wall as wheels and small C-shaped rods or anchors and plates (Figs. 4h, 5a–d)..... Apodida 26

2 Tentacles always richly branched and bushy; small forms (<25 mm long), body curved (U-shaped)..... Dendrochirotida 3

2′ Tentacles leaf-shaped (peltate), rarely bushy [*H.* (*Semperothuria*) *cinerascens*]; larger forms (>25 mm long) body not curved (U-shaped) ..... Aspidochirotida 4

3 Ten tentacles; calcareous ring wide, tubular; tube feet scattered all over body; spicules only a circular, perforated plate in disc of each tube-foot; color brown (Fig. 8a) ..... *Thyone okeni*

3′ Twenty tentacles; calcareous ring not wide and tubular; tube-feet in two rows along each ambulacrum; spicules in body wall mainly circular, lenticulate, perforated plates (Fig. 2a); color purplish black..... *Afrocucumis africana*

4 Gonads in two tufts, one on either side of the dorsal mesentery; body squarish in cross section with large dorsal papillae; spicules include C-shaped and branched rods with three-dimensional tables, or slender dichotomously branched rods..... Stichopodidae 5

4′ Gonads in a single tuft to the left of the dorsal mesentery; body usually with flat "sole" and arched dorsally, not squarish in cross section; dorsal papillae smaller and numerous; spicules comprise two-dimensional buttons and/or dichotomously branched rods, three-dimensional tables but never C-shaped rods ..... Holothuriidae 8

5 Spicules are slender, dichotomously branched rods and grains only (Fig. 2b) ..... *Thelenota* 6

5′ Spicules are three-dimensional tables with C- or S-shaped rods and rosettes ..... *Stichopus* 7

6 Dorsal papillae large, trilobed, leafy (Fig. 5e); color brick-red ..... *Thelenota ananas*

6′ Dorsal papillae not large or leafy; color mottled mainly creams and browns (Fig. 5f) ..... *Thelenota anax*

7 Spicules are tables and C- or S-shaped rods only (Fig. 2c); dorsal papillae restricted to a double row along the dorsal/lateral edges; color dark green with papillae tipped with red (Fig. 6a); exposed on reef flat ..... *Stichopus chloronotus*

7′ Spicules are tables, including tack-like forms with a large disc and pointed spire (Fig. 2d), with C- or S-shaped rods and dichotomously branched rosettes; color mottled green-black-cream (Fig. 6b); found under rocks ..... *Stichopus horrens*

8 Spicules are branched rods only, never any three-dimensional tables;

large, stout thick-walled forms 9

8′ Spicules always include tables with or without two-dimensional elongate perforated plates (buttons), branched rods or rosettes.....13

9 Anus guarded by five calcified anal teeth.....*Actinopyga* 10

9′ No calcified teeth but five groups of anal papillae.....*Bohadschia* 11

10 Spicules are complex branched rods, including larger spiny branched rods (Fig. 2e); numerous dorsal papillae, usually with covering layer of sand dorsally; color mottled brown and black (Fig. 6c) .....*Actinopyga echinites*

10′ Spicules are elongate rods with lateral projections, and branched rods (Fig. 2f); never covered with sand dorsally, smooth to touch; color rich brown-chestnut with or without white mottling (Fig. 6d) .....*Actinopyga mauritiana*

11 Spicules include raquet-shaped forms with rosettes (Fig. 2g); three distinct bands of tube-feet ventrally, but feet scattered dorsally; color generally light tan with brown patches and spots (Fig. 6e); tube-feet white tipped, tentacles grey/black, ventrally mottled black bands separate rows of tube-feet .....*Bohadschia graeffei*

11′ Spicules do not include raquet-shaped forms; tube-feet scattered dorsally and ventrally; color not as above 12

12 Spicules, simple branched rods (Fig. 2h); color light brown-grey with distinctive brown or black-ringed darker patches (Fig. 6f); rarely covered by sand, exposed .....*Bohadschia argus*

12′ Spicules, simple to very complex branched rods (Fig. 3a); color variable, smaller individual (up to 130 mm), cream with irregular chocolate-brown areas, larger forms uniformly cream, with or without an anteriorly placed and a posteriorly placed transverse yellow-brown band, or mainly brown with black or lighter spots (Fig. 6g–h); usually buried in sand, the smaller individuals being deeper (50–100 mm) in the substrate .....*Bohadschia marmorata*

13 Spicules are reduced tables with characteristic disc not developed (Fig. 3b), and minute rods; calcareous ring ribbon-like with radial plates shorter than broad and interradial plates similar but tending to be curved; tube-feet in three double rows ventrally, papillae small, scattered dorsally; color, body translucent pinkish white, dark brown around anus, tentacles yellowish (Fig. 5g) .....*Labidodemas semperianum*

13′ Spicules are variously developed, usually well developed tables and buttons, or rosettes or branched or knobbed rods; calcareous ring not ribbon-like but stout and relatively strong, radial plates either as long as or longer than broad, interradial plates usually half as long as broad, not curved; tube feet and papillae variously arranged, though tube-feet usually crowded ventrally; color varied, not white .....*Holothuria* (sensu extenso) 14

14 Spicules are tables in combination with rosettes or rods (Figs. 3c–e);

never buttons 15

14′ Spicules are tables in combination with buttons (e.g., Figs. 3g–h), the buttons may be reduced to knobbed bars; rosettes may be present in addition to buttons 17

15 Spicules are tables with reduced disc accompanied by thorny, usually curved rods (Fig. 3c); color mottled black and orange-red (Fig. 7h); cryptic form, found attached under rocks or buried in underlying rubble ..... *Holothuria* (*Semperothuria*) *cinerascens*

15′ Spicules are tables with reduced disc and rosettes only; color, wholly black or gray-black dorsally and bright pink ventrally..... *H.* (*Halodeima*) spp. 16

16 Spicules are tables with reduced disc and rosettes (Fig. 3d); color uniformly black; exposed on sandy areas, body usually covered with a layer of sand but with 4–5 pairs of bare patches dorsally (Fig. 7a).. *H.* (*H.*) *atra*

16′ Spicules are tables without disc and rosettes (Fig. 3e); color gray-black dorsally, bright pink ventrally (Fig. 7b); exposed forms, not covered by layer of sand ..... *H.* (*H.*) *edulis*

17 Spicules are tables always well developed, usually with a smooth rim to the disc, buttons smooth or knobbed or developed into elongate ellipsoidal bodies; body size 2–60 cm; colors various; cryptic or exposed..... 18

17′ Spicules are tables variously developed, disc with spinous rim, occasionally a few tall spired, smooth rimmed tables may be present, buttons smooth or twisted in pseudobutton form, or reduced to knobbed rods; body size up to ca. 30 cm long; colors various; usually cryptic..... 23

18 Massive, thick-walled forms, up to 60 cm long; black or brown; spicules include elongated, fenestrated ellipsoids and well developed tables (Figs. 3f–g) ..... *H.* (*Microthele*) 19

18′ Small-moderate sized forms, up to about 25 cm long; colors various; spicules do not include fenestrated ellipsoids..... 20

19 Spicules are tables with smooth rim to disc and top of spire crowded with small spines (Fig. 3f); massive form, covered with a sand layer, dorsally arched, smooth but with 3–4 prominent lobes along the ventral-lateral edge, ventrally a distinct sole with crowded tube feet; color black or mottled with white (can be white) (Fig. 7d); exposed on sandy areas ..... *H.* (*Microthele*) *nobilis*

19′ Spicules are tables with slightly spinous rim to disc and few spines at top of spire (Fig. 3g); color light brown with darker transverse markings (Fig. 7c); uncommon ..... *H.* (*Microthele*) *axiologa*

20 Spicules are tables and flat, thin, oval buttons which have a distinct median optical discontinuity present (Fig. 3h); body small, up to 3 cm long; color uniformly brown; cryptic form, found attached under rocks or amongst dead coral heads ..... *H.* (*Platyperona*) *difficilis*

20′ Spicules are variously developed, but buttons not flat and thin as above; color, variously spotted or striped, not uniformly brown 21

21 Spicules are small tables and buttons, table disc diameter up to 60 μm, buttons

up to 50 μm and with small perforations (Fig. 4a); color uniformly cream with about 6 pairs of dorsal purplish brown spots; found buried in sand and rubble ..... *H. (Thymiosycia) arenicola*

21′ Spicules are larger tables and buttons, perforations of buttons relatively large; color not as above 22

22 Spicules are moderate size tables with disc diameter 65–75 μm and buttons up to 70 μm long with 3–5 pairs of holes (Fig. 4b); color, dorsally light to rich brown with bright yellowish or green papillae (Fig. 8b); found under rocks ..... *H. (T.) hilla*

22′ Spicules are tables with large, squarish disc up to 80–90 μm diameter and buttons up to 75 μm long with three pairs of holes (Fig. 4c); color yellow-brown background with 12 or more transverse black bands along the dorsal side (Fig. 7e); found under rocks..... *H. (T.) impatiens*

23 Spicules are stout tables, some of which may have developed into fenestrated spheres, and buttons with usually three pairs of holes, but these may be obscured by the large knobs on the buttons (Fig. 4d); color cream (Fig. 7f); found under dead coral heads and boulders in sand zone.. *H. (Cystipus) rigida*

23′ Spicules are variously developed but not as above; color not uniformly cream but variously mottled or uniformly blackish 24

24 Spicules are very spinose tables, rarely tall-spired smooth rimmed tables present, and smooth buttons but mainly twisted pseudobuttons (Fig. 4e); color grayish mottled form with several pairs of darker spots along the dorsal surface ..... *H. (Lessonothuria) pardalis*

24′ Spicules and color not as above..... 25

25 Spicules are tables with characteristic ring of 8–12 spines at top of spire, and smooth buttons, irregular in shape with three pairs of holes, small two holed rosettes also present (Fig. 4f); color uniformly purplish black or dark brownish red (Fig. 7g); found under rocks or exposed, if exposed then with a covering of pieces of algae, small stones, and shells.... *H. (Mertensiothuria) leucospilota*

25′ Spicules are reduced tables and buttons, the latter often as knobbed bars (Fig. 4g); color, brightly mottled cream and brown or gray with some yellow, base of dorsal papillae with red ring (Fig. 8c); found under rocks ..... *H. (M.) pervicax*

26 Spicules are wheels clustered in papillae in the interambulacra and small C-shaped rods (Fig. 4h); color reddish brown, with white papillae (Fig. 8d) ..... *Chiridota rigida*

26′ Spicules are scattered anchors and plates and rosettes..... 27

27 Spicules are anchors with stock unbranched 28

27′ Spicules are anchors with stock branched 29

28 Spicules are massive anchors (up to 1100 μm long), plates (up to 750 μm long) and granules (Fig. 5a); color mottled grayish with transverse darker bands or blotches; found under rocks and among algae and seaweeds (Fig. 8e) ..... *Synapta maculata*

28′ Spicules are anchors and plates, not massive (up to 220–280 μm and 190–220 μm long, respectively), with miliary granules irregularly and dichotomously branched (Fig. 5b); color purplish brown (Fig. 8f) ..... *Polyplectana kefersteini*

29 Spicules with anchor plates abruptly contracted posteriorly, lacking a large smooth hole on each side (Fig. 5d); color variable, typically more or less annulated with broad brownish green and narrow cream transverse bands, darker dorsally than ventrally (Fig. 8g)..... *Opheodesoma grisea*

29′ Spicules with anchor plates not abruptly contracted posteriorly but with a large hole on each side (Fig. 5c); color dorsally creamy white and yellow with spaced transverse solid or broken dark brownish green bands, radii picked out as double thin lines ventrally uniformly creamy white (Fig. 8h) ..... *Euapta godeffroyi*

Systematic Account

1. *Thyone okeni* Bell

Fig. 8a

Thyone okeni Bell, 1884: 149, Pl. 1, fig. D; Clark, 1921: 167; 1946: 402; Clark and Rowe, 1971: 182 (distribution).

GUAM: Bile Boat Channel, Merizo, about 5 m depth.

HABITAT: Cryptic, found under rock fragments.

GENERAL DISTRIBUTION: Port Jackson, New South Wales, Australia; Torres Strait, Queensland, Australia.

REMARKS

The discovery of a small specimen (5 mm long) of this species in Guam by C. Carlson and P. J. Hoff in April, 1975, indicates that *T. okeni* is probably distributed throughout the western Pacific area.

2. *Afrocucumis africana* (Semper)

Fig. 2a

Cucumaria africana Semper, 1868: 53, Pl. XV, fig. 16.

Afrocucumis africana: Heding and Panning, 1954: 109 (synonymy); Clark and Rowe, 1971: 182 (distribution), Pl. 30, fig. 3.

GUAM: Bile Bay, Merizo; Tumon Bay (Gogna or San Vitores Beach); Tanguisson; Agat.

HABITAT: Clinging under stones or in dead shells and crevices, reef flat.

GENERAL DISTRIBUTION: Throughout the Indian Ocean, Indonesia, and western Pacific Islands but not yet recorded from Philippines or Hawaiian Islands.

3. *Thelenota ananas* (Jaeger)

Fig. 2b, 5e

Trepang ananas Jaeger, 1833: 24, Pl. 3, fig. 1.

Thelenota ananas: Clark, 1921: 184; 1946: 420; Clark and Rowe, 1971: 178 (distribution), Pl. 27, fig. 17.

GUAM: Ritidian Point; Uruno Point; Anae Island; Tumon Bay (Gogna Beach Sector).

HABITAT: Exposed, usually beyond reef fringe, 30–50 m depth.

GENERAL DISTRIBUTION: Mascarene and Maldive Islands, Indian Ocean, Indonesia, North Australia, islands of western Pacific, Japan, but not yet recorded from Philippine or Hawaiian Islands.

4. *Thelenota anax* H. L. Clark

Fig. 5f

Thelenota anax H. L. Clark, 1921: 185, Pl. 18, fig. 3; Yamanouti, 1939: 633 (table 17); Liao Yulin, 1975: 205, fig. 6.

GUAM: Tanguisson Point.

HABITAT: Exposed at 13–16 m on seaward reef slope.

GENERAL DISTRIBUTION: Northeast Australia northward to Guam. The species is also reported from Enewetak (Mrs. J. Lamberson, pers. comm.).

5. *Stichopus chloronotus* Brandt

Fig. 2c, 6a

Stichopus (*Perideris*) *chloronotos* Brandt, 1835: 50.

Stichopus chloronotus: Clark, 1922: 53, Pl. 2, figs. 1–10 (synonymy); Domantay, 1954: 351; Clark and Rowe, 1971: 178 (distribution), Pl. 27, fig. 18.

GUAM: Asan Point; Tumon Bay; Adelup Point; Cocos Lagoon; Uruno Point; Hoover Beach; Agat.

HABITAT: Exposed on rock or sand to about 30 m depth.

GENERAL DISTRIBUTION: Throughout the tropical Indo-West Pacific Ocean from East Africa to Hawaii.

6. *Stichopus horrens* Selenka

Fig. 2d, 6b

Stichopus horrens Selenka, 1867: 316, Pl. 18, figs. 27–29; Clark, 1922: 64, Pl. 2, figs. 19–23 (synonymy); Clark and Rowe, 1971: 178 (distribution), Pl. 27, fig. 19.

? *Stichopus badionatus*: Domantay, 1954: 350 (non *S. badionotus* Selenka, 1867).

GUAM: Asan; Hoover Beach; Adelup Point; Tumon Bay; Merizo; Agat; Pago Bay.

HABITAT: Normally under rocks or dead coral heads during the day, exposed at night.

GENERAL DISTRIBUTION: From the Maldive Islands in Indian Ocean, through Indonesia to the Hawaiian Islands.

7. *Actinopyga echinites* (Jaeger)

Fig. 2e, 6c

Muelleria echinites Jaeger, 1833: 17.

Actinopyga echinites: Clark, 1921: 188; Rowe, 1969: 130, fig. 3; Clark and Rowe, 1971: 176 (distribution), Pl. 27, fig. 1.

GUAM: Asan; Amantes Point; Adelup Point; Pago Bay; Ipan; Uruno Point; Tumon Bay; Tarague; Hoover Beach; Agat; Cocos Island.

HABITAT: Exposed on sandy areas, always with a thin covering mantle of sand.

GENERAL DISTRIBUTION: Known from scattered localities throughout the tropical Indo-West Pacific area but not recorded from Hawaii.

8. *Actinopyga mauritiana* (Quoy and Gaimard)

Fig. 2f, 6d

Holothuria guamensis Quoy and Gaimard, 1833: 137.

Holothuria mauritiana Quoy and Gaimard, 1833: 138.

Microthele guamensis: Cherbonnier, 1952: 40, Pl. II, fig. 1.

Actinopyga mauritiana: Panning, 1944: 55, fig. 24 (synonymy); Cherbonnier, 1952: 41, figs. 16a–o; Domantay, 1954: 349; Rowe, 1969: 131; Clark and Rowe, 1971: 176 (distribution), Pl. 27, fig. 3.

GUAM: Tumon Bay; Saupon Point; Pago Bay; Amantes Point; Adelup Point; Uruno Point; Tanguisson Pt.; Hoover Beach; Agat.

HABITAT: Exposed on outer reef flat on rock and amongst *Sargassum* and *Turbinaria*. This species is smooth and "glossy" dorsally, without a covering of sand.

GENERAL DISTRIBUTION: Throughout the tropical Indo-West Pacific area.

REMARKS

Cherbonnier (1952) examined the remaining type specimens of Quoy and Gaimard. Unfortunately, those of *H. guamensis* were lost but Cherbonnier concluded, from Quoy and Gaimard's description, and from the fact that Brandt's *H.* (*Microthele*) *maculata* [homonym=*H.* (*M.*) *nobilis* Selenka] originated from Guam, that the two species were conspecific. If this is so, then *H. guamensis* would be the first available name to replace *H.* (*M.*) *maculata* instead of *H.* (*M.*) *nobilis*. However, the senior author (F.W.E.R.) cannot agree with Cherbonnier's conclusion. The description of the color pattern of *H. guamensis* together with the number of tentacles and anal teeth, agrees well with the color and other features of the more common species *H.* (=*Actinopyga*) *mauritiana* Quoy and Gaimard, specimens of which we have examined, both alive and preserved, on Guam. Brandt (1835) was therefore correct to consider Quoy and Gaimard's *H. guamensis* (*H. lineolata, H. mauritiana* and *H. miliaris*) to be congeneric with *Muelleria echinites* and *M. lecanora* Jaeger [*Muelleria* a homonym=*Actinopyga* Bronn (1860)]. In the absence of type specimens of the former and the existence of type specimens of the latter, and the common use of the name *A. mauritiana*, we conclude that *H. guamensis*

should be considered a synonym of *A. mauritiana* to prevent any confusion over the revival of a little-used species name.

9. ***Bohadschia graeffei*** (Semper)

Fig. 2g, 6e

Holothuria Graeffei Semper, 1868: 78, Pl. 30, fig. 3.

Bohadschia graeffei: Pearson, 1914: 170; Panning, 1944: 44, fig. 13; Rowe, 1969: 130; Clark and Rowe, 1971: 176 (distribution), Pl. 27, fig. 7.

Holothuria (*Bohadschia*) *graeffei* Panning 1929: 124, fig. 6 (synonymy).

GUAM: Piti Bay; Saupon Pt.; Tanguisson Pt.

HABITAT: Exposed but well hidden by cryptic coloration on rocky surfaces on the reef front.

GENERAL DISTRIBUTION: Indo-West Pacific including Red Sea and North Australia.

10. ***Bohadschia argus*** Jaeger

Fig. 2h, 6f

Bohadschia argus Jaeger, 1833: 19, Pl. 2, fig. 1; Panning, 1944: 36, fig. 7–8 (synonymy); Rowe, 1969: 130; Clark and Rowe, 1971: 176; (distribution), Pl. 27, fig. 6.

Holothuria argus: Domantay, 1954: 338.

GUAM: Tumon Beach; Asan; Piti; Alupat Island; Pago Bay; Uruno Point; Hoover Beach; Cocos Island; Cocos Lagoon; Agat.

HABITAT: Usually exposed on reef flat or covered with pieces of algae and stones rarely almost buried in sand.

GENERAL DISTRIBUTION: A common tropical Pacific species recorded only from the islands of the western Indian Ocean, Ceylon and Bay of Bengal in the Indian Ocean area.

11. ***Bohadschia marmorata*** Jaeger

Fig. 3a, 6g–h

Bohadschia marmorata Jaeger, 1833: 18, Pl. 3, fig. 9; Rowe, 1969: 129, fig. 2; Clark and Rowe, 1971: 176 (distribution), Pl. 27, fig. 8.

Holothuria (*Bohadschia*) *vitiensis*: Panning, 1929: 122, fig. 3 (with synonymy).

Bohadschia marmorata marmorata (and subspp.): Panning, 1944: 39, fig. 9–10.

GUAM: Adelup Point; Uruno Point; Sleepy Lagoon; Pago Bay; Hoover Beach; Piti; Tumon Bay; Cocos Lagoon; Agat.

HABITAT: Smaller specimens buried up to 50–100 mm in sand, larger specimens just subsurface or covered by a mound of sand, rarely exposed, but if so, then with a covering of sand.

GENERAL DISTRIBUTION: Throughout the tropical Indo-West Pacific area, except Hawaii.

REMARKS

Examination of a collection of 16 specimens of this species collected from within an area of about 10 m^2 in Piti channel has clarified the relationships between at least six species of *Bohadschia*. Panning (1929) was right to consider *B. similis* (Semper), *B. tenuissima* (Semper), *B. koellikeri* (Semper), and *B. vitiensis* (Semper) to be conspecific. Later (1944) he considered *B. vitiensis, B. koellikeri, B. tenuissima,* and *B. bivittata* Mitsukuri to be subspecies of *B. marmorata*, clearly showing in his descriptions, that the complexity of the branched rods more or less increased with the size of the animal, a fact we can verify from the study of the collection on hand. Rowe, 1971 (in Clark and Rowe, 1971, p. 194, notes on holothurian table), followed Cherbonnier (1954, 1955b) in recognizing the validity of each of the species cited above. We can no longer justify that action. We therefore concur with Panning but go further in considering *B. similis, B. koellikeri, B. tenuissima, B. vitiensis* and *B. bivittata* to be synonyms of *B. marmorata*, which is a species exhibiting a wide range of color patterns (see Fig. 6g–h) and increased spicule complexity with growth.

12. ***Labidodemas semperianum*** (Selenka)

Fig. 3b, 5g

Labidodemas semperianum Selenka, 1867: 309, Pl. 17, figs. 1–3; Deichmann, 1958: 286; Rowe, 1969: 132, fig. 4; Cherbonnier, 1970: 566, fig. A-P (synonmy); Clark and Rowe, 1971: 176, Pl. 28, fig. 12 (distribution).

GUAM: Pago Bay; Agat.

HABITAT: Outer reef flat, under rocks.

GENERAL DISTRIBUTION: Maldive Island to Haweii

13. ***Holothuria (Semperothuria) cinerascens*** (Brandt)

Fig. 3c, 7h

Stichopus (Gymnochirota) cinerascens, Brandt, 1835: 51.

Holothuria cinerascens: Panning, 1934: 37, fig. 32 (synonymy); Domantay, 1954: 340.

Holothuria (Semperothuria) cinerascens: Rowe, 1969: 135; Clark and Rowe, 1971: 178 (distribution), Pl. 27, fig. 12.

GUAM: Adelup Point; Uruno Point; Pago Bay; Asan; Hoover Beach.

HABITAT: Under rocks or in crevices or buried with tentacles exposed. This species is probably a suspension feeder, unlike the majority of species of *Holothuria.*

GENERAL DISTRIBUTION: Throughout the tropical Indo-West Pacific area.

14. ***Holothuria (Halodeima) atra*** Jaeger

Fig. 3d, 7a

Holothuria atra Jaeger, 1833: 22; Domantay, 1954: 339.

Holothuria (Halodeima) atra: Pearson, 1914: 170; Rowe, 1969: 137, fig. 7; Clark

and Rowe, 1971: 176 (distribution), Pl. 27, fig. 11.
Holothuria (*Holothuria*) *atra*: Panning, 1934: 30, fig. 22 (synonymy).
Halodeima atra: Panning 1944: 61, fig. 29; Cherbonnier 1955a: 77.
Ludwigothuria atra: Deichmann, 1958: 312, Pl. II, figs. 18–23.
GUAM: On all shores, very common.
HABITAT: Exposed on sandy areas of reef flats, particularly on inner reef flat platform. This species characteristically has a sand covering except for six or more pairs of bare patches along the dorsal surface.
GENERAL DISTRIBUTION: Throughout the tropical Indo-Pacific Oceans.

15. ***Holothuria* (*Halodeima*) *edulis*** Lesson

Fig. 3e, 7b

Holothuria edulis Lesson, 1830: 125, Pl. 46, fig. 2; Domantay, 1954: 342.
Holothuria (*Holothuria*) *edulis*: Panning, 1934: 43, fig. 36 (synonymy).
Halodeima edulis: Panning, 1944: 65, fig. 32; Cherbonnier, 1955a: 81.
Holothuria (*Halodeima*) *edulis*: Rowe, 1969: 138; Clark and Rowe, 1971: 176 (distribution), Pl. 27, fig. 14.
GUAM: Asan; Piti; Cocos Lagoon; Agat.
HABITAT: Exposed on sand, or under rocks or among seaweeds; not covered with a "cloak" of sand.
GENERAL DISTRIBUTION: Throughout the tropical Indo-West Pacific area except Hawaii.

16. ***Holothuria* (*Microthele*) *nobilis*** (Selenka)

Fig. 3f, 7d

Muelleria nobilis Selenka, 1867: 313, Pl. 7, fig. 13–15.
Holothuria (*Microthele*) *nobilis*: Panning, 1929: 131, fig. 15 (synonymy); Rowe, 1969: 162, fig. 21; Clark and Rowe, 1971: 178 (distribution), Pl. 27, fig. 10, Pl. 28, fig. 20.
GUAM: Umatac Bay; Ipan; Uruno Point; Agat; Cocos Island.
HABITAT: Exposed on sand with a covering "cloak" of sand.
GENERAL DISTRIBUTION: Throughout the tropical Indo-West Pacific area.

17. ***Holothuria* (*Microthele*) *axiologa*** H. L. Clark

Fig. 3g, 7c

Holothuria axiologa H. L. Clark, 1921.
Holothuria (*Microthele*) *axiologa*: Rowe, 1969: 166; Clark and Rowe, 1971: 192 (distribution).
GUAM: Cocos Lagoon, Anae Island.
HABITAT: Clean sand bottoms of lagoon slopes.
GENERAL DISTRIBUTION: North Australia; Palau; Mariana Islands.

REMARKS

Specimens were found on Guam and Pagan (northern Mariana Islands). This species looks much like *Bohadschia marmorata* and therefore may have been overlooked elsewhere. The examination of spicules from the Guamanian and Palauan specimens has confirmed the senior author's previous view (Rowe, 1969) that the species is consubgeneric with *H.* (*M.*) *nobilis*, type of subgenus *Microthele*.

18. ***Holothuria* (*Platyperona*) *difficilis*** Semper

Fig. 3h

Holothuria difficilis Semper, 1868: 92, Pl. 30, fig. 21.

Microthele difficilis: Deichmann, 1958: 288, Pl. 1, figs. 6–9 (synonymy).

Holothuria (*Platyperona*) *difficilis*: Rowe, 1969: 143, fig. 12; Clark and Rowe, 1971: 178 (distribution), Pl. 27, fig. 9.

Holothuria sanctori: Domantay, 1954: 348 (non *H. sanctori* Delle Chiaje).

GUAM: Uruno Point; Pago Bay; Agat.

HABITAT: Clinging amongst dead coral heads and under stones on reef flat.

GENERAL DISTRIBUTION: Throughout the tropical Indo-Pacific area.

19. ***Holothuria* (*Thymiosycia*) *arenicola*** Semper

Fig. 4a.

Holothuria arenicola Semper, 1868: 81, Pl. 20, Pl. 30, fig. 13, Pl. 35, fig. 4; Domantay, 1954: 346.

Holothuria (*Holothuria*) *arenicola*: Panning, 1935: 88, fig. 73 (synonymy).

Brandtothuria arenicola: Deichmann, 1958: 291, Pl. 1, figs. 10–13.

Holothuria (*Thymiosycia*) *arenicola*: Rowe, 1969: 147; Clark and Rowe, 1971: 178 (distribution), Pl. 28, fig. 3.

GUAM: Adelup Point; Pago Bay.

HABITAT: In burrows in rubble and sand or under stones and rocks.

GENERAL DISTRIBUTION: Throughout the tropical Indo-Pacific area.

20. ***Holothuria* (*Thymiosycia*) *hilla*** Lesson

Fig. 4b, 8b

Holothuria hilla Lesson, 1830: 226, Pl. 79; Cherbonnier, 1951: 532, fig. 1.

Holothuria monacaria (sensu Theel, 1886, non Lesson, 1830): Panning, 1934: 69, fig. 47 (synonymy).

Holothuria gyrifer: Domantay, 1954: 343.

Brandtothuria gyrifer: Deichmann, 1958: 294, Pl. 1, figs. 16–18.

Holothuria (*Thymiosycia*) *hilla*: Rowe, 1969: 147; Clark and Rowe, 1971: 178 (distribution), Pl. 28, fig. 9.

GUAM: Hoover Beach; Alupat Island; Piti; Adelup Point; Pago Bay; Asan; Tanguisson; Asinite Beach; Uruno Point; Tumon Bay; Cocos Lagoon; Agat; Cocos Island.

HABITAT: Found under rocks and boulders or amongst coral.
GENERAL DISTRIBUTION: Throughout the tropical Indo-Pacific area.

21. *Holothuria (Thymiosycia) impatiens* (Forskal)

Fig. 4c, 7e

Fistularia impatiens Forskal, 1775: 121, Pl. 39, fig. B.
Holothuria (Holothuria) impatiens: Panning, 1935: 86, fig. 72 (synonymy).
Holothuria impatiens: Domantay, 1954: 344.
Holothuria (Thymiosycia) impatiens Pearson, 1914: 171; Rowe, 1969: 145, fig. 13; Clark and Rowe, 1971: 178 (distribution), Pl. 28, fig. 8.
GUAM: Hoover Beach; Adelup Point; Alupat Island; Pago Bay; Agat; Cocos Island; Uruno Point.
HABITAT: Usually concealed under rocks or amongst coral or algae.
GENERAL DISTRIBUTION: Throughout the tropical Indo-Pacific and Atlantic Oceans, and Mediterranean.

22. *Holothuria (Cystipus) rigida* (Selenka)

Fig. 4d, 7f

Stichopus rigida Selenka, 1867: 317, Pl. 18, figs. 30–31.
Fossothuria rigida: Deichmann, 1958: 321, Pl. 8, figs. 1–13 (synonymy).
Holothuria (Cystipus) rigida: Rowe, 1969: 155, fig. 18; Clark and Rowe, 1971: 176 (distribution), Pl. 28, fig. 13.
GUAM: Gogna Beach (Tumon Bay); Hoover Beach.
HABITAT: Buried under rocks and dead coral heads.
GENERAL DISTRIBUTION: From East Africa to Hawaii, the Galapagos, the west coast of North America, to the Panamanic region and to the West Indies.

23. *Holothuria (Lessonothuria) pardalis* Selenka

Fig. 4e

Holothuria pardalis Selenka, 1867: 336, Pl. 19, fig. 85.
Holothuria (Holothuria) pardalis: Panning, 1935: 3, fig. 106 (synonymy).
Lessonothuria pardalis: Deichmann, 1958: 295, Pl. 2, figs. 1–17.
Holothuria (Lessonothuria) pardalis: Rowe, 1969: 149, fig. 15; Clark and Rowe, 1971: 176 (distribution), Pl. 28, fig. 11.
? *Holothuria pulla*: Domantay, 1954: 347 (non *Holothuria pulla* Selenka).
GUAM: Inarajan; Hoover Beach.
HABITAT: Under rocks on reef flat.
GENERAL DISTRIBUTION: Throughout the tropical Indo-Pacific area.

24. *Holothuria (Mertensiothuria) leucospilota* (Brandt)

Fig. 4f, 7g

Stichopus (Gymnochirota) leucospilota Brandt, 1835: 51.

Mertensiothuria leucospilota: Deichmann, 1958: 297, Pl. 3, figs. 1–9 (synonymy).
Holothuria (*Mertensiothuria*) *leucospilota*: Rowe, 1969: 148, fig. 14; Clark and Rowe, 1971: 176 (distribution), Pl. 28, fig. 19.
GUAM: Tumon Bay; Asan Point; Tanguisson; Amantes Point; Pago Bay; Asinite Beach, Ipan; Uruno Point; Sleepy Lagoon; Tarague; Hoover Beach; Agat; Cocos Island.
HABITAT: Either under rocks or, if exposed, then with a covering of "cloak" of pebbles or detritus.
GENERAL DISTRIBUTION: Tropical Indo-Pacific area.

25. ***Holothuria* (*Mertensiothuria*) *pervicax*** Selenka

Fig. 4g, 8c

Holothuria pervicax Selenka, 1867: 327, Pl. 18, fig. 54.
Holothuria (*Holothuria*) *curiosa* var. *pervicax*: Panning, 1935: 6, fig. 109 (synonymy).
Holothuria curiosa var. *pervicax*: Domantay, 1954: 341.
Mertensiothuria pervicax: Deichmann, 1958: 297 (in key).
Holothuria (*Mertensiothuria*) *pervicax*: Rowe, 1969: 149; Clark and Rowe, 1971: 176 (distribution).
GUAM: Uruno Point; Tanguisson; Hoover Beach; Agat; Cocos Island.
HABITAT: Under rocks on reef flat.
GENERAL DISTRIBUTION: Throughout the tropical Indo-Pacific area.

26. ***Chiridota rigida*** Semper

Fig. 4h, 8d

Chiridota rigida Semper, 1868: 18, Pl. 3, fig. 3, Pl. 5, figs. 3 and 13, Pl. 6, fig. 4, Pl. 8, fig. 14; Clark, 1907: 114 (in key); Clark and Rowe, 1971: 188, Pl. 31, fig. 9 (distribution).
GUAM: Bile Bay, Merizo; Pago Bay.
HABITAT: Reef flat, 0.3 m.
GENERAL DISTRIBUTION: Indonesia, North Australia, Philippines, and islands of West Pacific.
REMARKS
Two juvenile specimens (12–30 mm long) were collected by C. Carlson and P. J. Hoff in April, 1976.

27. ***Synapta maculata*** (Chamisso and Eysenhardt)

Fig. 5a, 8e

Holothuria maculata Chamisso and Eysenhardt, 1821: 352, Pl. XXV.
Synapta maculata: Heding, 1928: 113, figs. 2.1–10 (synonymy); Domantay, 1954: 353; Clark and Rowe, 1971: 186 (distribution), Pl. 30, fig. 9.
GUAM: Pago Bay; Asan; Tumon Bay; Tanguisson; Hoover Beach; Agat.
HABITAT: Usually among weed (e.g., *Enhalus acoroides*) or sometimes under

rocks, exposing the anterior end.

GENERAL DISTRIBUTION: Throughout the Indo-West Pacific area but not recorded from Hawaii.

28. ***Polyplectana kefersteini*** (Selenka)

Fig. 5b, 8f

Synapta kefersteinii Selenka, 1867: 360, Pl. 20, fig. 120–121.

Polyplectana kefersteinii: Clark, 1907: 77, Pl. IV, fig. 20–22; 1924: 468, Pl. 1, figs. 8–12; Heding 1928: 143, figs. 11.9–10, 12.3, 13.8–10, 14.7–8; Clark and Rowe, 1971: 186 (distribution), Pl. 31, fig. 1.

GUAM: Pago Bay; Bile Boat Channel, Merizo.

HABITAT: Under rocks.

GENERAL DISTRIBUTION: North Australia (Torres Strait), Indonesia to Hawaii. Records from the Red Sea are doubted (Cherbonnier, 1955b).

29. ***Opheodesoma grisea*** (Semper)

Fig. 5d, 8g

Synapta grisea Semper, 1868: 11, Pl. 4, figs. 6–7.

Opheodesoma grisea Fisher, 1907: 723; Heding, 1928: 129, figs. 4.7, 7.3 and 9 (synonymy). Clark and Rowe, 1971: 186 (distribution), Pl. 30, fig. 11.

? *Opheodesoma spectabilis*: Domantay, 1954: 354 (non *O. spectabilis* Fisher, 1907).

GUAM: Pago Bay; Tumon Bay; Hoover Beach; Agat; Apra Harbor.

HABITAT: Under rocks.

GENERAL DISTRIBUTION: East Africa, Red Sea, Coast of Arabia, Ceylon to the Philippines. The species is not known from the islands of the South and West Pacific, or from Hawaii.

REMARKS

The record of *O. grisea* from Guam considerably extends the known range of this species. The specimens examined have the calcareous ring tinged with green and the rods of the oral disc have expanded ends. Apart from these two features the species runs down to *O. grisea* in Heding's (1928) key. Clark (1924) identified some specimens from Torres Strait, Australia as *O. grisea*, noting that the calcareous ring was green. Heding (1928) thought that Clark's specimens might represent another species, particularly since he maintained that the ring in *O. grisea* was pure white. Synaptid holothurians are rarely collected in any numbers and Heding (1928, 1931) particularly, described many new species on single records. Much more material needs to be collected for comparisons to be made and limits of variations to be assessed.

30. ***Euapta godeffroyi*** (Semper)

Fig. 5c, 8h

Synapta godeffroyi Semper, 1868: 231, Pl. 39, fig. 13.

Euapta godeffroyi: Östergren, 1898: 113; Heding, 1928: 137, figs. 8.3 and 4, 9.2, 10.1 and 2 (synonymy); Domantay 1954: 353; Clark and Rowe, 1971: 185 (distribution), Pl. 30, fig. 8.

GUAM: Tumon Bay; Pago Bay; Agat; Asan; Tanguisson; Hoover Beach.

HABITAT: Usually concealed among weeds or under rocks and stones.

GENERAL DISTRIBUTION: Throughout the Indo-West Pacific area.

Discussion

The 11 localities visited around Guam by F.W.E.R. were: Tarague, Uruno Point, Tanguisson, Tumon Bay (San Vitores or Gogna Beach Section); Sleepy Lagoon (Agana Bay), Asan, Hoover Beach, Piti Channel, Agat, Cocos Island and lagoon, and Pago Bay (Fig. 1). At low tide the depth of water across the reef flats varied between <1–1.5 meters. The reef flats were visited only during daylight hours so that any night-time movement of cryptic holothurians from their observed position was not recorded.

The topography (and degree of exposure) of the local reef flats had marked effect on the distribution of the holothurian species occurring across them. This was particularly obvious on the north and west coasts of the island.

At Tarague (at least within the permitted search or bathing area) the reef flat was covered by a layer of coarse, mostly coral sand in which some seagrass (*Enhalus*) was present in scattered clumps. A few boulders were also present. In this habitat only three species of holothurians were found, *Actinopyga echinites, Holothuria* (*Halodeima*) *atra,* and *H.* (*Mertensiothuria*) *leucospilota* and of these, *A. echinites* was the predominant species, there being at least one per square meter (estimated). *H.* (*H.*) *atra* was uncommon, and *H.* (*M.*) *leucospilota* restricted to the boulder cover.

At Uruno Point the topography of the reef flat was varied. At the inner margin there was a sand covered moat. Boulders were strewn across the flat. Patches of dead coral (*Acropora* sp.) were common. Towards the outer reef margin the sand cover was replaced by *Sargassum* and *Turbinaria.* This habitat provided conditions to support at least 12 species of holothurians. Near the inner margin *H.* (*H.*) *atra* was very common (16–22/10 m^2) and *Stichopus chloronotus* was also relatively abundant here and towards the outer margin. *Actinopyga echinites* occurred in a band across the mid reef area, parallel with the shore, in sandy areas, but was not as common as it was at Tarague. *Bohadschia argus* and *H.* (*Microthele*) *nobilis* were found at the same level as *A. echinites.* A single specimen of *B. marmorata* was also found in sand at the mid-reef-flat level. Towards the outer reef margin where *Turbinaria* sp. and *Sargassum* sp. were common, the predominant species of holothurian was *Actinopyga mauritiana. H.* (*Platyperona*) *difficilis* was abundant among dead coral heads but was not found elsewhere. *H.* (*Mertensiothuria*) *leucospilota* was common under stones across the major part of the reef flat. The least common species *H.* (*Thymiosycia*) *hilla, H.* (*Semperothuria*) *cinerascens* and *H.* (*Mertensiothuria*) *pervicax* were found in the mid-reef-flat area under stones and boulders.

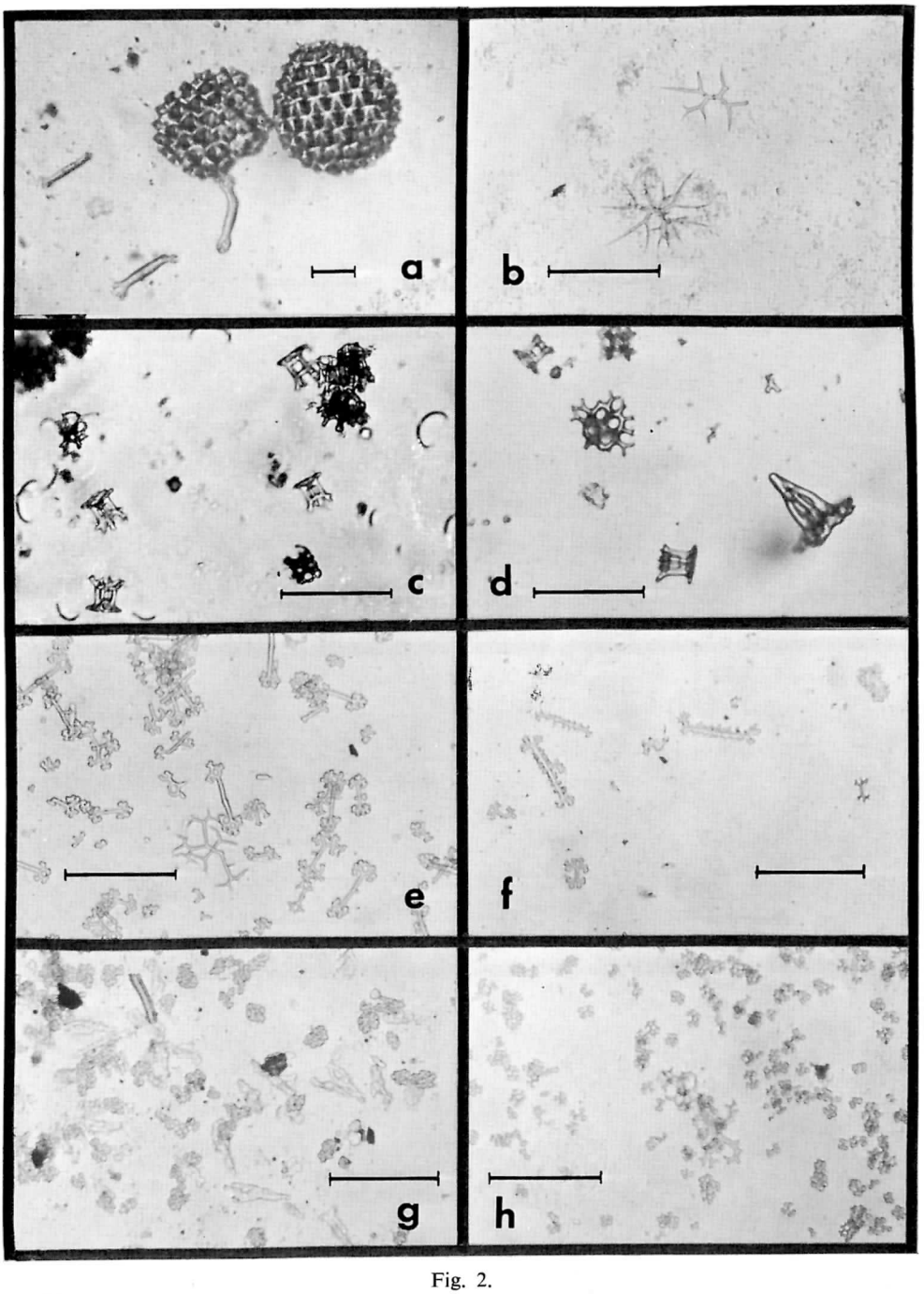


Fig. 2.

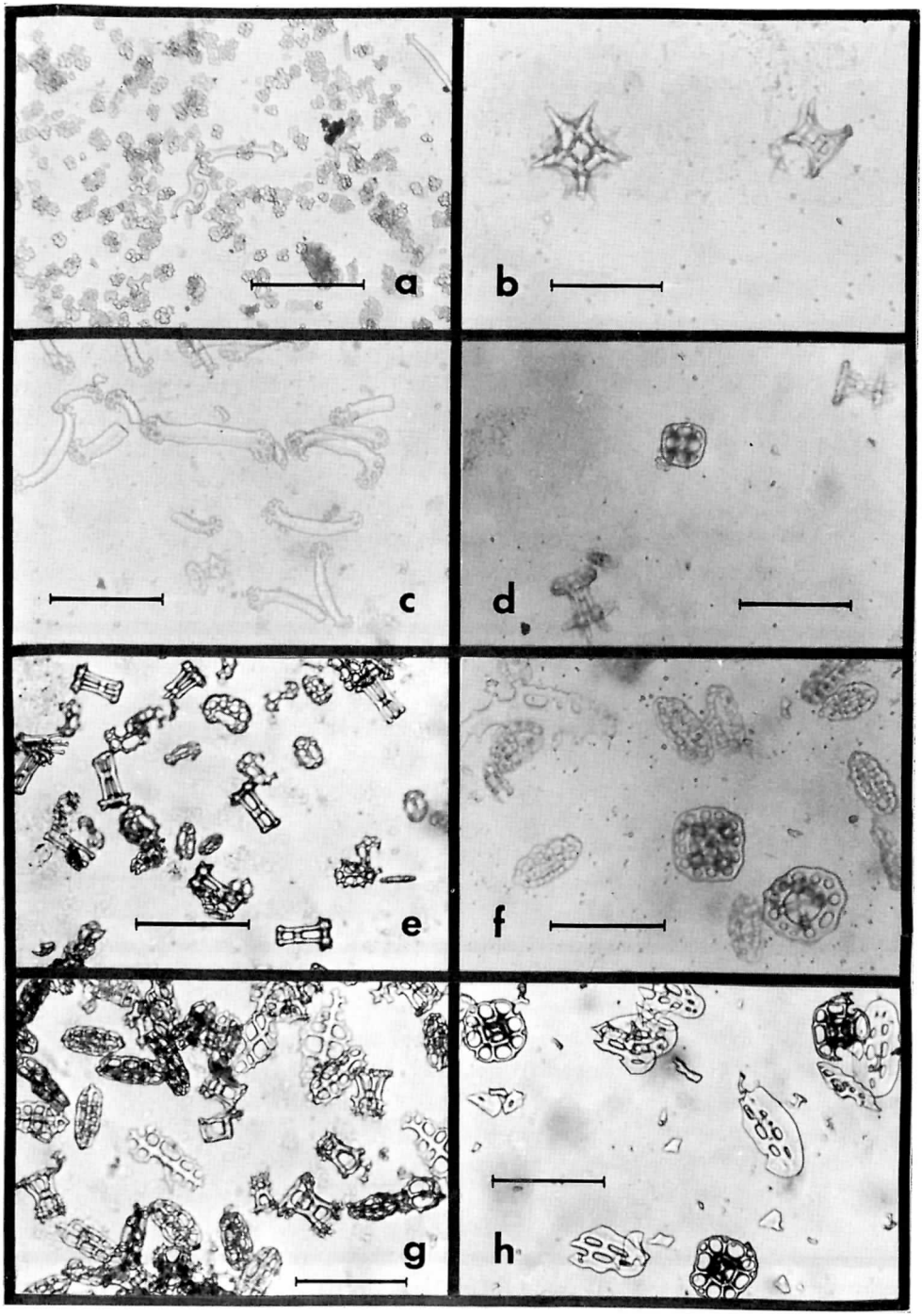
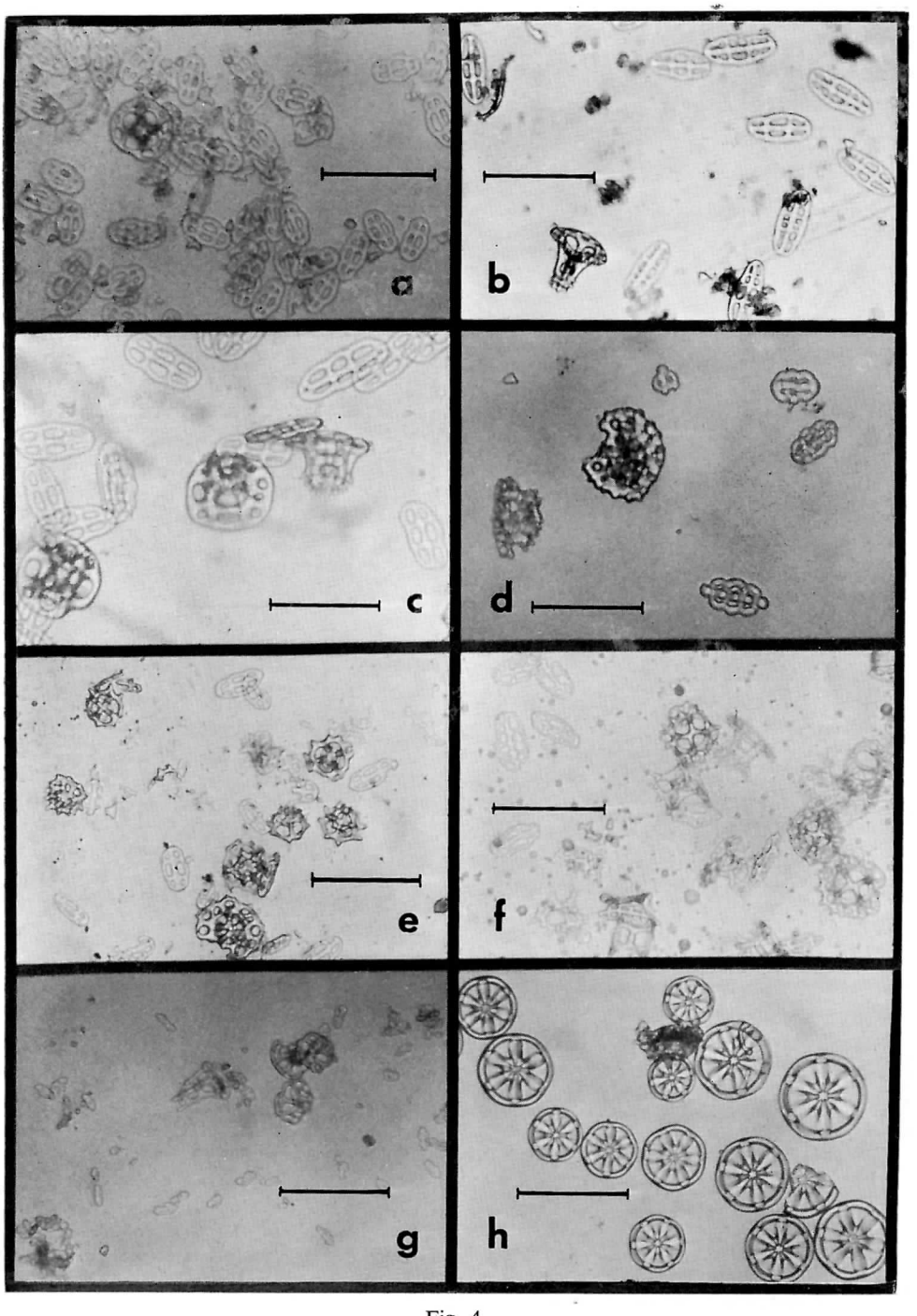


Fig. 3.



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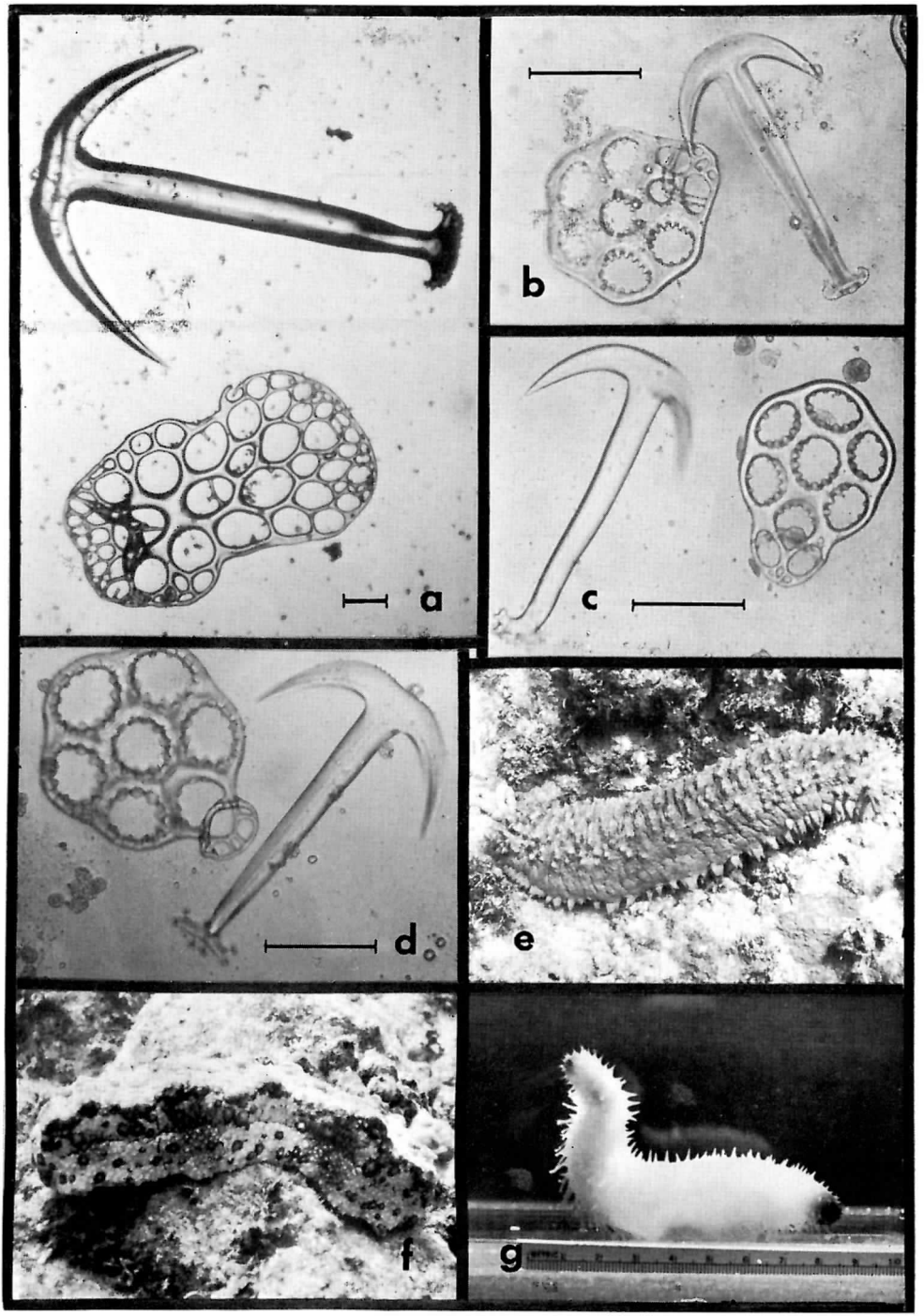

Fig. 5.

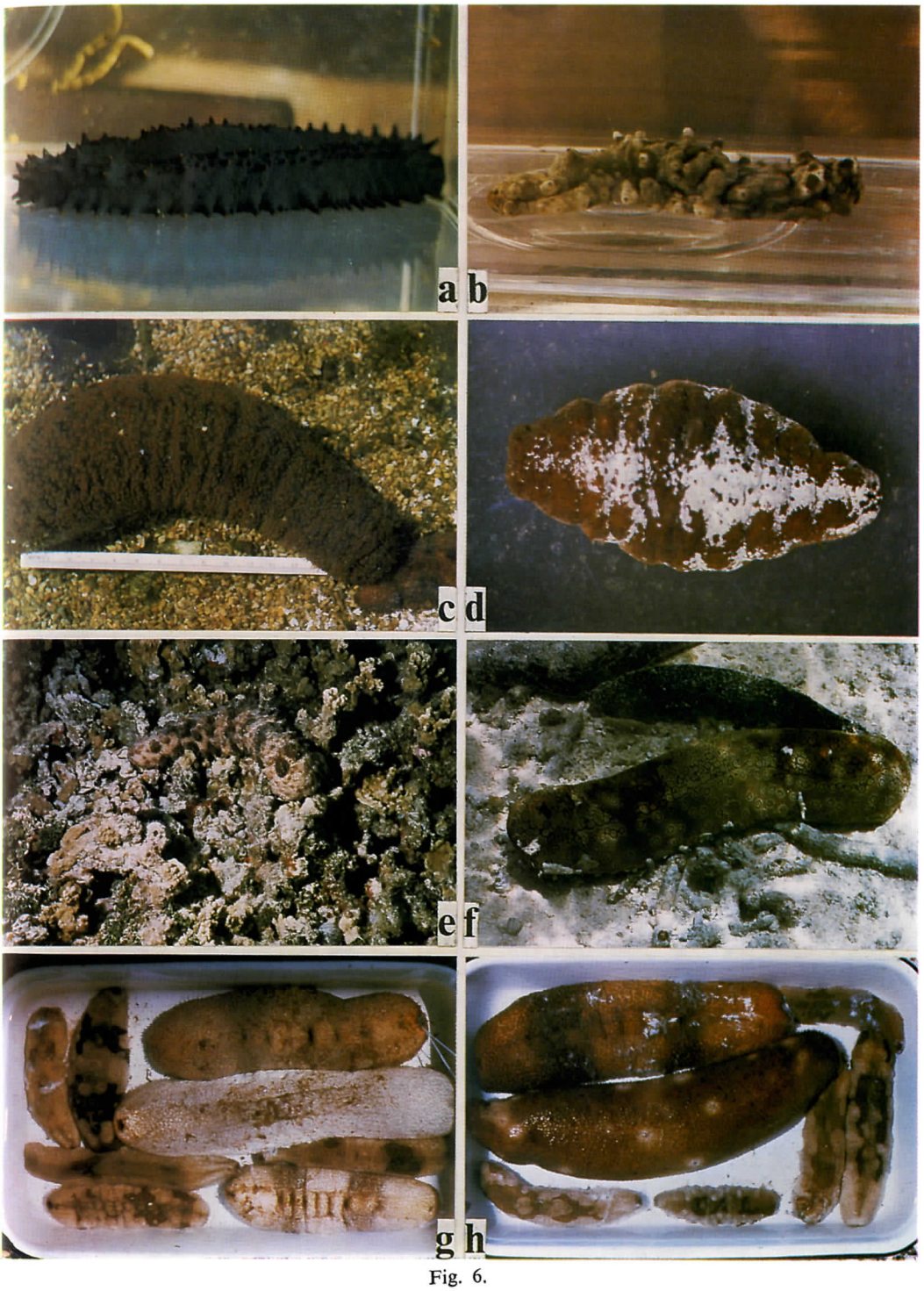

Fig. 6.

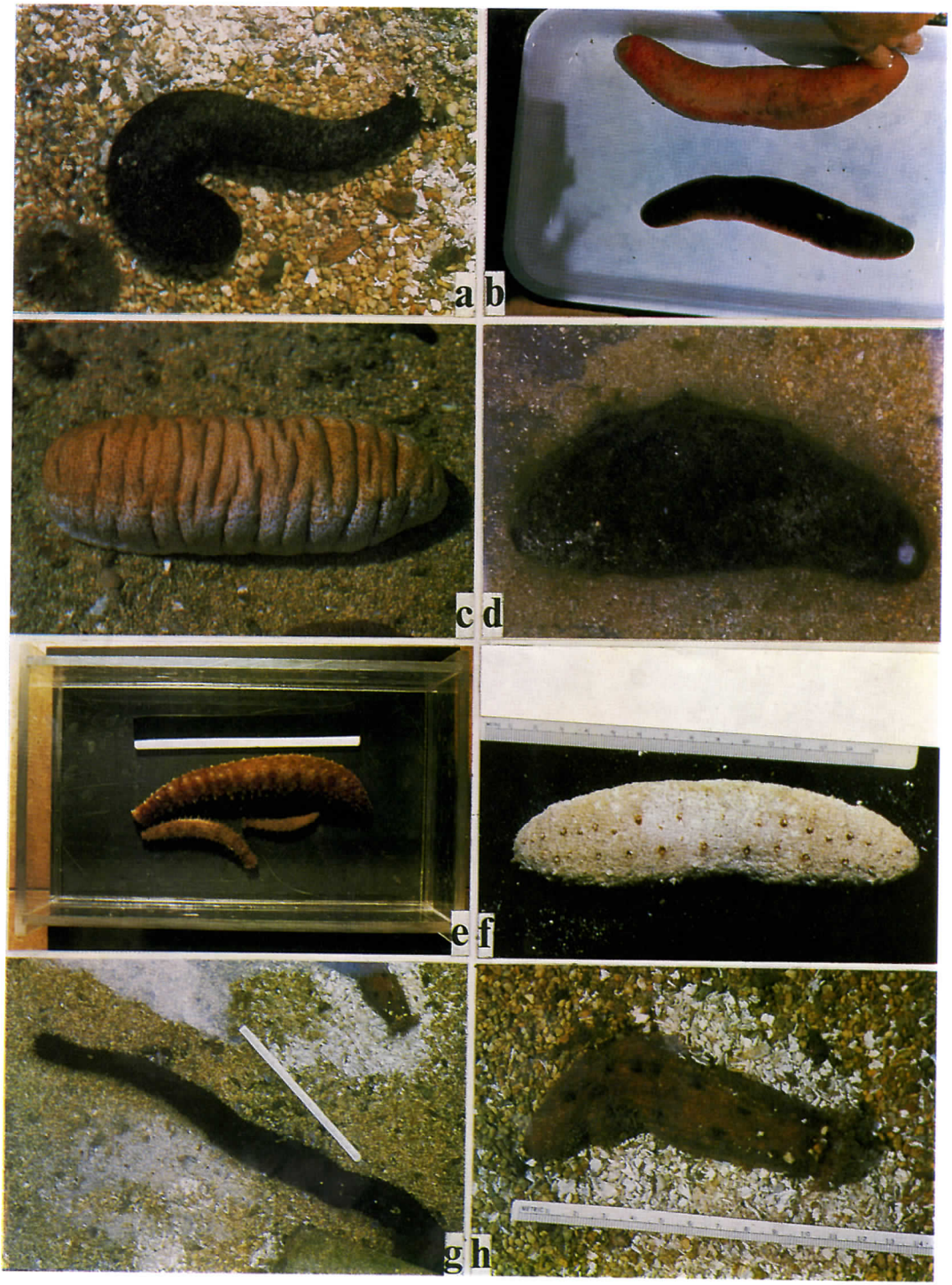

Fig. 7.

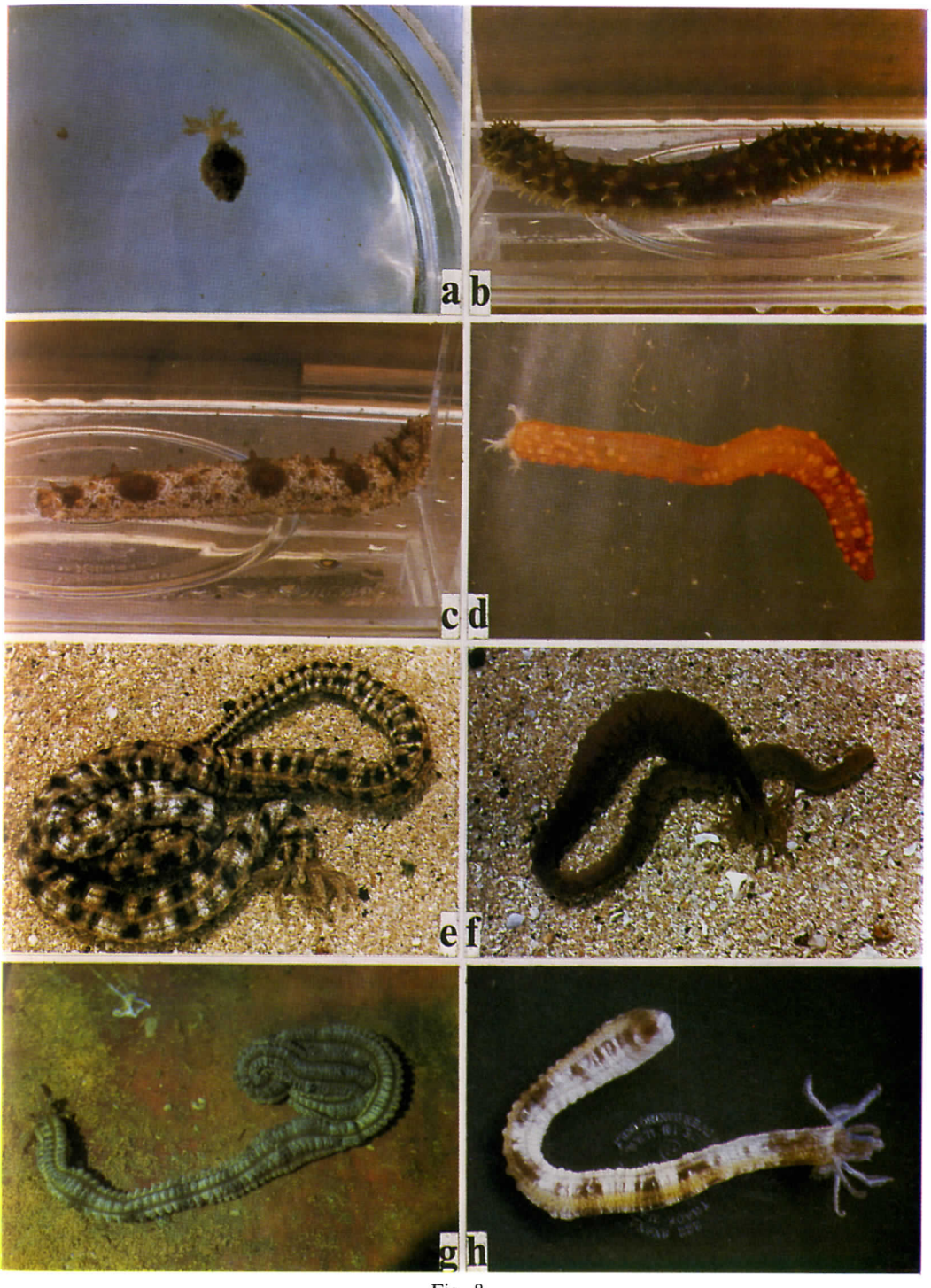

Fig. 8.

Fig. 2. Photomicrographs of spicules. The scales indicate lengths of 100 μm.
a. *Afrocucumis africana* (Semper)
b. *Thelenota ananas* (Jaeger)
c. *Stichopus chloronotus* Brandt
d. *Stichopus horrens* Selenka
e. *Actinopyga echinites* (Jaeger)
f. *Actinopyga mauritiana* (Quoy and Gaimard)
g. *Bohadschia graeffei* (Semper)
h. *Bohadschia argus* Jaeger

Fig. 3. Photomicrographs of spicules. The scales indicate lengths of 100 μm.
a. *Bohadschia marmorata* Jaeger
b. *Labidodemas pertinax* (Ludwig)
c. *Holothuria* (*Semperothuria*) *cinerascens* (Brandt)
d. *Holothuria* (*Halodeima*) *atra* Jaeger
e. *Holothuria* (*Halodeima*) *edulis* Lesson
f. *Holothuria* (*Microthele*) *nobilis* Selenka
g. *Holothuria* (*Microthele*) *axiologa* H. L. Clark
h. *Holothuria* (*Platyperona*) *difficilis* Semper

Fig. 4. Photomicrographs of spicules. The scales indicate lengths of 100 μm.
a. *Holothuria* (*Thymiosycia*) *arenicola* Semper
b. *Holothuria* (*Thymiosycia*) *hilla* Lesson
c. *Holothuria* (*Thymiosycia*) *impatiens* (Forskal)
d. *Holothuria* (*Cystipus*) *rigida* (Selenka)
e. *Holothuria* (*Lessonothuria*) *pardalis* Selenka
f. *Holothuria* (*Mertensiothuria*) *leucospilota* (Brandt)
g. *Holothuria* (*Mertensiothuria*) *pervicax* Selenka
h. *Chiridota rigida* Semper

Fig. 5. Holothurians and spicules. The scales in figures a–d indicate lengths of 100 μm. The lengths of the living animals shown are indicated below.
a. *Synapta maculata* (Chamisso and Eysenhardt) spicules
b. *Polyplectana kefersteini* (Selenka) spicules
c. *Euapta godeffroyi* (Semper) spicules
d. *Opheodesoma grisea* (Semper) spicules
e. *Thelenota ananas* (Jaeger), 40 cm
f. *Thelenota anax* H. L. Clark, 30 cm
g. *Labidodemas pertinax* (Ludwig), 10 cm

Fig. 6.

a. *Stichopus chloronotus* Brandt, 15 cm
b. *Stichopus horrens* Selenka, 10 cm
c. *Actinopyga echinites* (Jaeger), 20 cm
d. *Actinopyga mauritiana* (Quoy and Gaimard), 15 cm
e. *Bohadschia graeffei* (Semper), 40 cm
f. *Bohadschia argus* Jaeger, 30 cm
g–h. *Bohadschia marmorata* Jaeger, 15–30 cm

Fig. 7.

a. *Holothuria* (*Halodeima*) *atra* Jaeger, 20 cm
b. *Holothuria* (*Halodeima*) *edulis* Lesson, 20 cm
c. *Holothuria* (*Microthele*) *axiologa* H. L. Clark, 30 cm
d. *Holothuria* (*Microthele*) *nobilis* (Selenka), 20 cm
e. *Holothuria* (*Thymiosycia*) *impatiens* (Forskal), 8–22 cm
f. *Holothuria* (*Cystipus*) *rigida* (Selenka), 15 cm
g. *Holothuria* (*Mertensiothuria*) *leucospilota* (Brandt), 45 cm
h. *Holothuria* (*Semperothuria*) *cinerascens* (Brandt), 11 cm

Fig. 8.

a. *Thyone okeni* Bell, 2 cm
b. *Holothuria* (*Thymiosycia*) *hilla* Lesson, 15 cm
c. *Holothuria* (*Mertensiothuria*) *pervicax* Selenka, 15 cm
d. *Chiridota rigida* Semper, 1.2 cm
e. *Synapta maculata* (Chamisso and Eysenhardt), 40 cm
f. *Polyplectana kefersteini* (Selenka), 20 cm
g. *Opheodesoma grisea* (Semper), 60 cm
h. *Euapta godeffroyi* (Semper), 15 cm (small specimen)

At Tanguisson Pt., to the north side of a power station, the reef flat was constantly scoured by wave action at low tide. There was little debris settlement or loose rocks, except at the very inner margin of the flat. The common species found across the majority of the flat was *A. mauritiana*, in numbers similar to *A. echinites* at Tarague. In the "moat" area, *H. (H.) atra, H. (M.) leucospilota, Synapta maculata, H. (M.) pervicax*, and *Afrocucumis africana* were collected. All but *H. atra* were under rocks. None of these species was common.

Similar conditions occurred at the northern end of Tumon Bay (San Vitores or Gogna Beach) as occur at Uruno Point. The area was more sheltered and clumps of *Sargassum* were common across the inner reef flat. Eleven species were collected, including two species of synaptid (*Synapta maculata* and *Opheodesoma grisea*) from among the *Sargassum*. *Afrocucumis africana* was found under stones near to the outer reef margin. The distribution of the remaining species was similar to their distribution at Uruno Point.

At Sleepy Lagoon (in East Agana Bay) the substrate between the shore of the main island and Alupat Island is entirely deep sand. This comprised no more than about 5 cm of clean coral sand below which is an anaerobic zone. This condition was probably caused by the effects of local freshwater seepage from the main island. There were a few clumps of sea grass (*Enhalus acoroides*) between the islands and a few small rocks and stones near the shore lines. The conditions were very sheltered. Only three species of holothurians were collected. *H. (M.) leucospilota* was found amongst the sea grass, a few *H. (M.) atra* were seen exposed, but the predominant species was the burrowing *B. marmorata*, which occurred in greatest number about half way between the islands. This species was either exposed with a thin layer or "cloak" of sand covering it or was buried in a mound of sand.

With the exception of a single *Synapta maculata*, the only holothurian species found in the silty-sand in Piti channel (which forms part of the run-out from a power station) was *B. marmorata*. This formed a community of variously sized and colored individuals (see Fig. 6g–h).

On Hoover Beach, almost adjacent to Piti Channel, the reef flat provided a greatly varied topography and this was reflected in the large number of species (17) of holothurians found there. The reef flat comprised an inner zone of coral rubble; a zone of large, loose *Porites* heads; a zone of closely placed, large immovable *Porites* heads; a zone of smaller, spaced *Porites* heads with fire coral (*Millepora* sp.) and the loose rubble towards the rocky outer reef margin which was densely covered with *Turbinaria* and *Sargassum*. The distribution of eight of the species along a 300 m transect perpendicular to the shore and reaching the outer reef margin and carried out by the authors in April, 1975, is illustrated in Figure 9 (also from Marsh and Doty, 1975, fig. 22). Of those species illustrated, the distribution of *A. echinites, A. mauritiana,* and *H. (S.) cinerascens* is particularly striking. Other species collected were *H. (Lessonothuria) pardalis, H. (Cystipus) rigida, H. (Thymiosycia) impatiens, B. argus, B. marmorata, H. (Mertensiothuria) pervicax, Synapta*

maculata, Opheodesoma grisea, and *Euapta godeffroyi.*

Beche-de-Mer Species

Of the species of holothurians occurring on the reef flats and reef slope of Guam those which are most utilisable as trepang or beche-de-mer are: *Thelenota ananas, Bohadschia marmorata*; *Actinopyga mauritiana, A. echinites, H.* (*Microthele*) *nobilis, H.* (*H.*) *edulis, H.* (*H.*) *atra,* and *Stichopus chloronotus.* The distribution of these species around the island is patchy. The most numerous in any

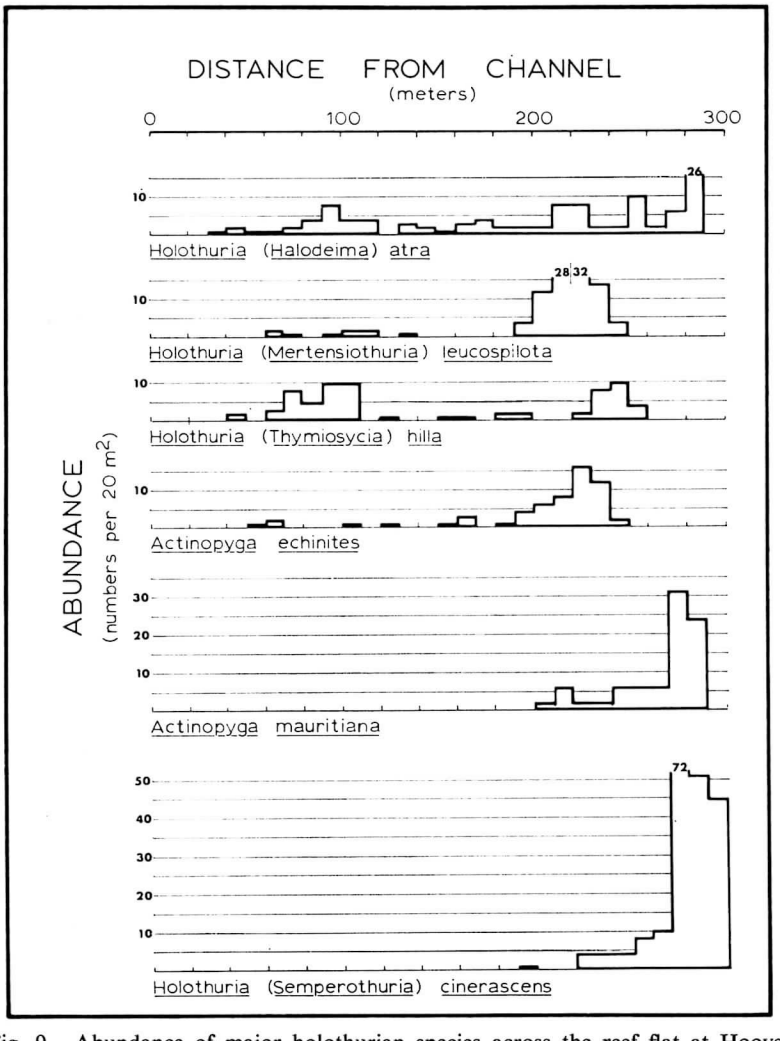

Fig. 9. Abundance of major holothurian species across the reef flat at Hoover Beach (from Marsh and Doty, 1975). The horizontal scale shows distance from a channel dredged 100 meters from shore. The reef margin is at the 300-meter mark on this scale.

place was *H. atra* (the least attractive from the market point of view) at Uruno (22/10 m²). Further research would be necessary to properly assess possibilities for restoring an industry for the island.

Zoogeographic Relationships

The species found around the reef flats of Guam are for the most part common shallow-water western Pacific or Indo-West Pacific species, as could be predicted from the position of the island. The probable source of the species is the central western Pacific and eastern Indonesian areas. Six species show extensions of range: *Thyone okeni, Labidodemas pertinax, Holothuria (Microthele) axiologa, Thelenota anax, Bohadschia graeffei,* and *Opheodesoma grisea.* The discovery of *T. okeni* on Guam must indicate a wide distribution in at least the west Pacific area, from Australia northwards. *L. pertinax* seems to be a widespread Indo-Pacific species from the few records now available. *O. grisea* has been recorded from the Philippines but not from the islands of the western Pacific region. The close resemblance of *H. (M.) axiologa* to *B. marmorata* may have resulted in *H. (M.) axiologa* being overlooked. This species (*H. (M.) axiologa*), together with *Thelonota anax* and *Bohadschia graeffei*, probably extends throughout the western Pacific.

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References Cited

Beaty, J. J. 1964. A herd of cucumbers. Guam Times Weekly, Aug. 1, p. 18–21, 6 figs.

————. 1966. Guam's curious critters. The Sea Cucumber. The Pacific Journal, Oct. 30, p. 4, 3 figs.

Bell, F. J. 1884. Echinodermata. *In* R. W. Coppinger. Report on the zoological collections made in the Indo-Pacific Ocean during the voyage of H.M.S. Alert 1881–2. London: 117–177, and 509–512, pls. 8–17 and 45.

Brandt, J. F. 1835. Prodromus descriptionis animalium ab H. Mertensio in orbis terrarum circumnavigatione observatorum. Petropoli 1: 1–75, 1 pl.

Bronn, H. G. 1860. Die Klassen und Ordnungen der Strahlenthiere (Actinozoa). Klassen und Ordnungen des Thier-reiches. Leipzig I (2): 1–434, 48 pls.

Chamisso, A. de, and C. G. Eysenhardt. 1821. De animalibus quibusdam e classe vermium linneana in circumnavigatione terrae, auspicante Comite N. Romanzoff, Duce Ottore de Kotzbue, 1815–18 peracta observatis. II Nova Acta Acad. Caesar. Leop. Carol. 10: 345–374, pls. 24–33.

Cherbonnier, G. 1951. Les Holothuries de Lesson. Bull. Mus. Hist. Nat., Paris 23 (2): 532–536, fig. 1–3.

————. 1952. Les Holothuries de Quoy et Gaimard. Mem. Inst. r. Sci. Nat. Belg 44 (2):

1–50, 16 figs, 3 pls.

———. 1954–1955a. Holothuries récoltées en Océanic Francaise par G. Ranson, en 1952. Bull. Mus. Hist. Nat., Paris (1954) 26 (2): 685–690, 2 figs; (1955) 27 (2): 77–82, 2 figs; 135–141, 3 figs.

———. 1955b. Résultats scientifiques des compagnes de la "Calypso." Les Holothuries de la Mer Rouge. Annls. Inst. Oceanogr., Monaco 30: 129–183, pls. 22–49.

———. 1970. Note sur l'holothurie aspidochirote *Labidodemas semperianum* Selenka. Bull. Mus. Hist. Nat., Paris 42 (2): 566–569, fig. A–P.

Clark, A. M., and F. W. E. Rowe. 1971. Monograph of the shallow-water Indo-west Pacific echinoderms. London. 238 pp., 100 figs, 31 pls.

Clark, H. L. 1907. The apodous holothurians. Smithson. Contr. Knowl. 35: 1–206, 13 pls.

———. 1921. The echinoderm fauna of Torres Strait. Pap. Dep. Mar. Biol. Carnegie Inst. Wash. 10: VI+223, 38 pls.

———. 1922. Holothurians of the genus *Stichopus*. Bull. Mus. Comp. Zool. Harv. 65: 39–74, 2 pls.

———. 1924. Holothurians of the Museum of Comparative Zoology. The Synaptinae. Bull. Mus. Comp. Zool. Harv. 65: 459–501, 12 pls.

———. 1946. The echinoderm fauna of Australia. Publs. Carnegie Inst. No. 566: 1–567.

Deichmann, E. 1958. The Holothurioidea collected by the Velero III and IV during the years 1932–1954. Part 2. Aspidochirota. Allan Hancock Pacif. Exped. 11: 249–349, pls. 1–9.

Dickinson, R. E., and R. T. Tsuda. 1975. A candidate marine environmental impact survey for the potential development of the Uruno Point reef area on Guam, Mariana Islands. Univ. Guam Mar. Lab. Tech. Rept. No. 19. 57 pp.

Domantay, J. S. 1954. Some holothurians from Guam and vicinity. Nat. Appl. Sci. Bull. Univ. Philipp. 12: 336–357.

Fisher, W. K. 1907. The Holothurians of the Hawaiian Islands. Proc. U.S. Nat. Mus. 32: 637–744, pls. 66–82.

Forskål, P. 1775. Descriptiones animalium quae in itinere orientali observavit P. Forskål. Hauniae 1–164, 1 map.

Frey, D. G. 1951. The use of sea cucumbers in poisoning fishes. Ichthyological Notes 1951, No. 2: 175–176.

Heding, S. G. 1928. Synaptidae. Vidensk. Meddr dansk naturh. Foren. 85: 105–323, 69 figs, pls. 2, 3.

———. 1931. Über die Synaptiden des Zoologischen Museums zu Hamburg. zool. Jb. (Syst.) 61: 637–696, 17 figs., 2 pls.

Heding, S. G., and A. Panning. 1954. Phyllophoridae. Eine Bear beitung der polytentaculaten dendrochiroten Holothurien des zoologischen Museums in Kopenhagen. Spolia Zool. Mus. Haun. 13: 7–209, 102 figs.

Jaeger, G. F. 1833. De Holothuriis. Turici 1–40, 3 pls.

Lesson, R. P. 1830. Centurie zoologique ou choix d'animaux rares, nouveaux on imparfaitement connues. Paris 1–244, 80 pls.

Lindsey, L. N. 1935. Curious things about Guam. The Guam Recorder (February): 300–301.

Ludwig, H. 1875. Beiträge Zur Kenntniss der Holothurien. Arb. Zool.-Zoot. Inst. Wurzburg. 2 (2): 77–120, pls. 6, 7.

Marsh, J. A., Jr., and J. E. Doty. 1975. Power plants and the marine environment: additional observations in Piti Bay and Piti Channel, Guam. Univ. Guam Mar. Lab. Tech. Rept. No. 21. 44 pp.

Östergren, H. von. 1898. Das System der Synaptiden. Ofr. Kongl. Vetens Akad. Forhandl. Stockholm. No. 2: 111–120, 9 figs.

Panning, A. 1929–1935. Die Gattung Holothuria. Mitt. zool. St.Inst. Hamb. 44 (1929): 91–138, figs. 1–21; 45 (1934): 24–50, figs. 22–44; (1934): 65–84, figs. 45–71; (1935): 85–107,

figs. 72–102; 46 (1935): 1–18, figs. 103–121.

————. 1944. Die Trepangfischerei. Mit. zool. St.Inst. Hamb. 49: 1–76, 40 figs.

Pearson, J. 1914. Proposed reclassification of the genera *Müllеria* and *Holothuria*. Spolia zeylan. 9 (35): 163–172, pl. 26.

Quoy, J. R. C., and J. P. Gaimard. 1833. Voyages de découvertes de l' "Astrolabe." Zoologie: Zoophytes. Paris 1–390, 26 pls.

Randall, R. H., and L. G. Eldredge. 1974. A marine survey for the Sleepy Lagoon Marina. Univ. Guam. Mar. Lab. Environ. Surv. Rept. No. 14. 42 pp.

Rowe, F. W. E. 1969. A review of the family Holothuriidae (Holothurioidea: Aspidochirotida). Bull. Br. Mus. nat. Hist. (Zool.) 18 (4): 119–170, 21 figs.

Selenka, E. 1867. Beiträge zur Anatomie und Systematik der Holothurien. Z. wiss. Zool. 17: 291–374, pls. 17–20.

Semper, C. 1868. Holothurien. Reisen im Archipel der Philippinen. 2. Wissenschaftliche Resultate. Weisbaden X+288, 40 pls.

Théel, H. 1886. Holothurioidea. Part 2. Rep. scient. Results Voy. "Challenger" (Zool.) 39: 1–290, 16 pls.

Yamaguchi, M. 1975. Sea level fluctuations and mass mortalities of reef animals in Guam, Mariana Islands. Micronesica 11 (2): 227–243. 10 figs., 4 tables.

Yamanouti, T. 1939. Ecological and physiological studies of holothurians on coral reefs of Palao Is. Palao trop. biol. Stn. Stud. 4: 603–635, I pl.

Yulin, L. 1975. The Echinoderms of Xisha Islands. I. Holothurioidea, Guangdong Province, China. Studia Marina Sinica No. 10: 199–228, 27 figs. (in Chinese); 229–230 (description of new species in English).