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THE SHALLOW-WATER HOLOTHURIANS (ECHINODERMATA: HOLOTHURIOIDEA) OF SOUTHERN TAIWAN[1]

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Shyh-Min Chao and Kun-Hsiung Chang (1989) The shallow-water Holothurians (Echinodermata: Holothurioidea) of southern Taiwan. *Bull. Inst. Zool., Academia Sinica* **28**(2): 107-137. This paper deals with the taxonomy and distribution of the holothurians live in the littoral areas up to a depth of 30 meters at the southern tip of Taiwan, Pescadores Is., Liu-chiu-yu and Lan-yu. Twenty three species of 11 genera belonging to the Families Holothuriidae, Stichopodidae, Phyllophoridae, Synaptidae and Chiridotidae were collected. The majority of the species are widely distributed throughout the Indo-West Pacific region. The family Holothuriidae is the most aboundant one (13 species) among the five families. Of the 23 species, 17 are reported from Taiwan for the first time. A key to species is given along with color illustrations and line-drawings on spicules; scanning electronic micrographs of major spicules in 20 species are also included.

Key words: Distribution, Echinoderms, Holothurians, Southern Taiwan, Systematic account.

Echinoderms are common macrobenthos of the Taiwan and the surrounding islands. However, only a few papers deal with these animals. Echinoderm fauna of Taiwan has been studied by Hayasaka (1948, 1949), Chen and Chang (1981), Wu (1982), Applegate (1984), Chao (1986), Chen (1986) and Chen *et al.* (1988). Only two of them (Applegate 1984, Chao 1986) deal with the holothurians of Taiwan. The earliest published record of a holothurian collected from Taiwan is that of *Holothuria vagabunda* (=*H.* (*Mertensiothuria*) *leucospilota*) by Sohima in 1957. Applegate (1984) investigated the echinoderms from southern Taiwan and described *Holothuria* (*Cystipus*) *rigida*, *H.* (*Halodeima*) *atra*, *H.* (*Semperothuria*) *cinerascens* and *Synapta maculata*. Apart from these records, little attention has been given to these group of common costal animals in Taiwan.

This report describes the holothurian specimens collected from intertidal area up to a depth of 30 meters at the Kenting National Park, Pescadores Is., Lan-yu and Liu-chiu-yu (Fig. 1). It presents the first attempt to make a survey of the holothurians inhabiting the shallow water of these areas. The objectives of this study are: 1. Collect and identify the holothurians in southern Taiwan and preserve the specimens obtained. 2. Establish a

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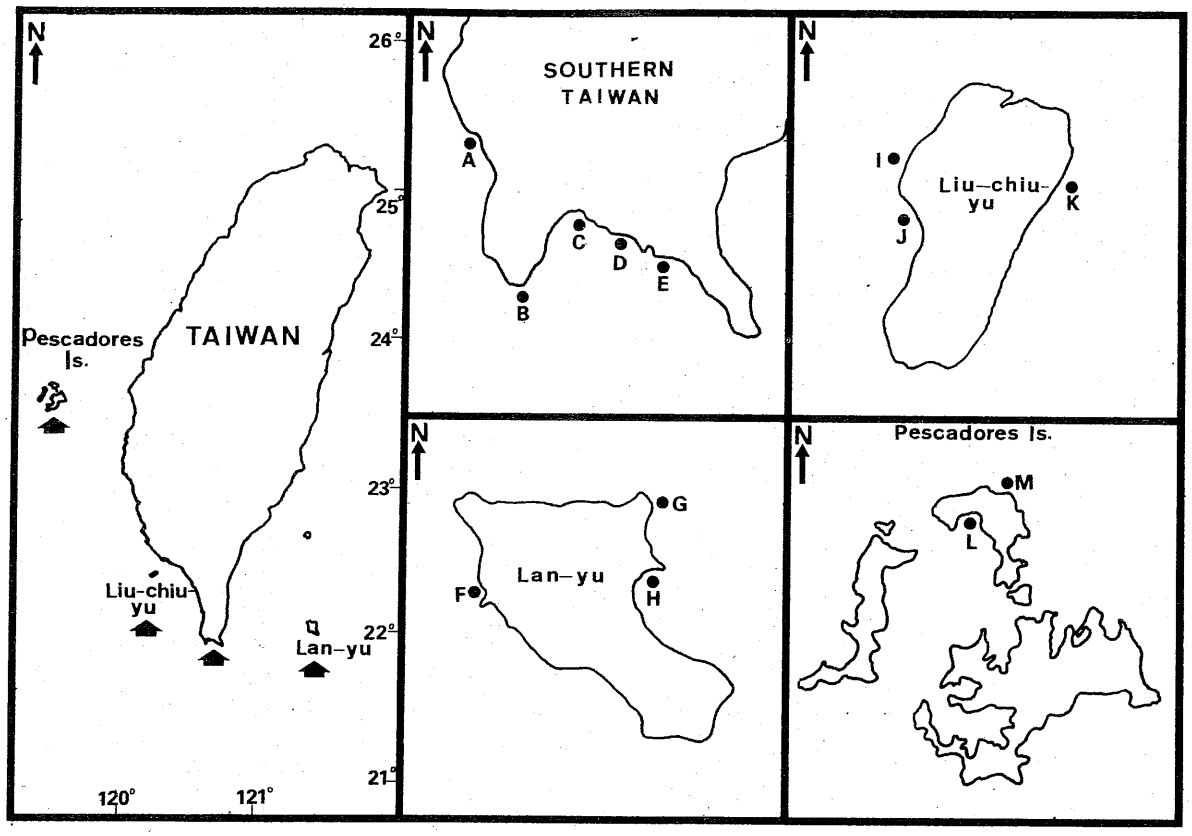

Fig. 1. Map of southern tip of Taiwan, Pescadores Is., Liu-chiu-yu and Lan-yu showing the study areas. A, Wan-li-tung (萬里桐); B, Mao-bi-tou (貓鼻頭); C, Tiao-shih (跳石); D, Shiao-wan (小灣); E, Shan-geo-wang (香蕉灣); F, Yeh-yu (椰油); G, Shuang-shih-yen (雙獅岩); H, Tung-chin-wang (東清灣); I, Du-tsai-ping (肚仔坪); J, San-pan-lu (杉板路); K, Lung-hsia-tung (龍蝦桐); L, Hao-liao (後寮); M, Tsyh-kaan (赤崁).

key to species identification and describe taxonomic characteristics of these animals. 3. Compare and describe the minor structure of spicules by Scanning Electronic Micrographs. The holothurian fauna of Indo-West Pacific still lacks the data from Taiwan, and the results of the present study can provide more information.

MATERIALS AND METHODS

Collections were made by hand during skin and with SCUBA diving. Most holothurians are nocturnal; it is more effective to capture these animals at night.

Holothurians were relaxed before preservation so that tentacles, papillae and tube-feet remained extend. This was achieved by narcotisation for about 12 hours using a 10% of magnesium sulphate ($MgSO_4$) in tap water (Lincoln and Sheals, 1979; Applegate, 1984). After narcotisation, the animals were preserved by injecting 95% methyl or ethyl alcohol into the body cavity and then submerging the whole animal into 85% alcohol for permanent storage. Also, the live animals were narcotized and killed with relaxed tentacles and tube-feet by freezing gradually. Holothurians with sea water in a small container were put into a refrigerator and frozen gradually for about half an hour. Needle was used to check for complete narcotisation and killing.

Identification of the specimens was made by the examination of the following features: externally the form and number of tentacles, the distribution of tube-feet and papillae, and internally the shape of the calcareous ring around the mouth part, the presence or absence of respiratory trees and Cuvierian organs in the posterior part of the body. Most important, species were identified by careful examination the calcareous spicules embedded in the dorsal region, tentacles, tube-feet and papillae.

Examination of spicules involved the preparation of a permanent microslide. A very small piece of skin was cut and placed in the center of a glass slide. One or two drops of domestic bleaching agent (active ingredient, sodium hypochloride 3.5%) flooded the skin, dride, rinsed in tap water, and then dried again. The procedure was continued until no further crystals was formed when the area containing the spicules is dried. Then a cover slip was mounted on the slide with Canadian balsam to make a permanent microslide.

Although 23 species are included in this paper, all the specimens were obtained from intertidal and subtidal area less than 30 meters depth. No collection was made from more than 30 meters depth. The coral reef of Kenting National Park area was visited more frequently than the other places. Pascadores Is., Liu-cuiu-yu and Lan-yu were visited only four times during the study period while the Kenting National Park coral reef area was visited once a month. All the specimens are preserved in the Laboratory of Marine Invertebrates, Institute of Zoology, Academia Sinica (ASIZ), Taipei, Taiwan, R.O.C.

TERMINOLOGY

The following terms are modified from Clark and Rowe (1971) and Rowe and Doty (1977).

Anal "teeth" or papillae: usually five radially placed calcareous papillae (some are not calcareous) which encircle the anus, well developed in *Actinopyga*.

Ambulacra and interambulacra: the ambulacra run in 5 radial bands longitudinally between the anterior mouth and posterior anus. The ambulacra run in such a way that two can be described as dorsal and three as ventral. The tube-feet may be restricted to these areas or may be distributed also between these area in the interambulacra.

Calcareous ring (Figs. 2, 4): an internal ring usually of 10 plates surround the

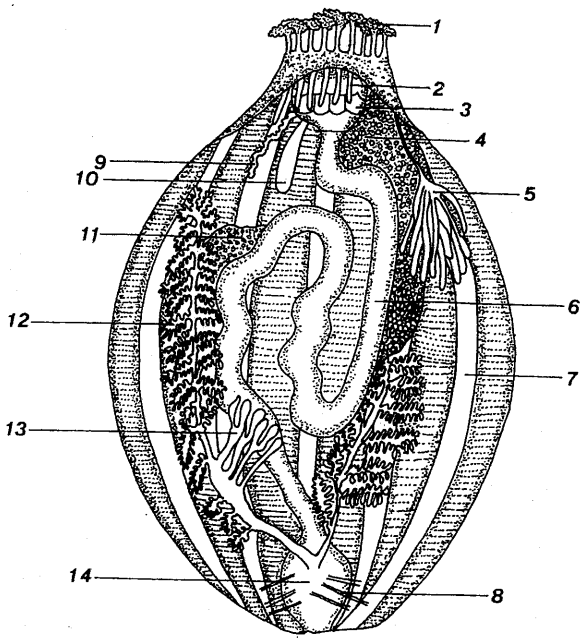

Fig. 2. Schematic representation of a typical holothurian. 1, tentacle; 2, tentacle ampulla; 3, calcareous ring; 4, dorsal mesentery; 5, gonad; 6, intestine; 7, radial longitudinal muscle; 8, cloacal suspensor; 9, madreporite; 10, Polian vesicle (posterior parts is stone cannel); 11, ventral mesentery; 12, respiratory tree; 13, Cuvierian organ; 14, cloaca.

anterior part of the gut (pharynx). The plate 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 relatively short, simple and ring-like or long, compound and tubular.

Dorsal mesentery (Fig. 2): an internal mesentery from the middorsal interambulacral area which is attached to the gut.

Spicules: two to three dimensional calcareous skeletal elements mainly in the body wall.

Anchors (Fig. 5A′): anchor-shaped spicules attached at posterior end, the stock, by tissue to the posterior "bridge" of the anchor plates.

Anchor plates (Fig. 5A): more or less rectangular or circular, 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.

Buttons (Fig. 5E): two dimensional oval ossicle perforated with four, six, or more holes in two rows. The surface of the button may be smooth or knobbed. In some specimens, the button may with incomplete holes to form incomplete button (Fig. 5K) or twisted to form pseudobutton (Fig. 5I′).

Fenestrated ellipsoids (Fig. 5I): modified and three-dimensional button forming elongate hollow fenestrated structures.

Lenticulate plate (Fig. 5N): very thick, lens-shaped, perforated, large plate.

Miliary granules (Fig. 10B): small solid, rounded or elongated bodies.

Pseudobuttons (Fig. 5I′): imperfect buttons, often twisted to three dimension or reduced to a simple row of holes.

Rods (Figs. 5B, F, G, P): bar-like spicules, variously developed and branched.

Rosettes and dichotomous rosettes (Figs. 5M, O): two-dimensional, perforated spicule formed from branched rods and often button-like.

Tables (Fig. 5D): three-dimensional spicules with a more or less circular, perforated disc from which arise 2-4 vertical pillars which are linked by transverse bars (beam) to form a spire. Tables occur above the two-dimensional buttons in the body wall.

Wheel (Fig. 5C): circular, wheel-like spicules with six, or more spokes.

Tentacles (Fig. 3): modified tube-feet forming a single or double circle around the mouth. There are five types of tentacles: dendritic, digitate, peltate, pelto-digitate and pinnate.

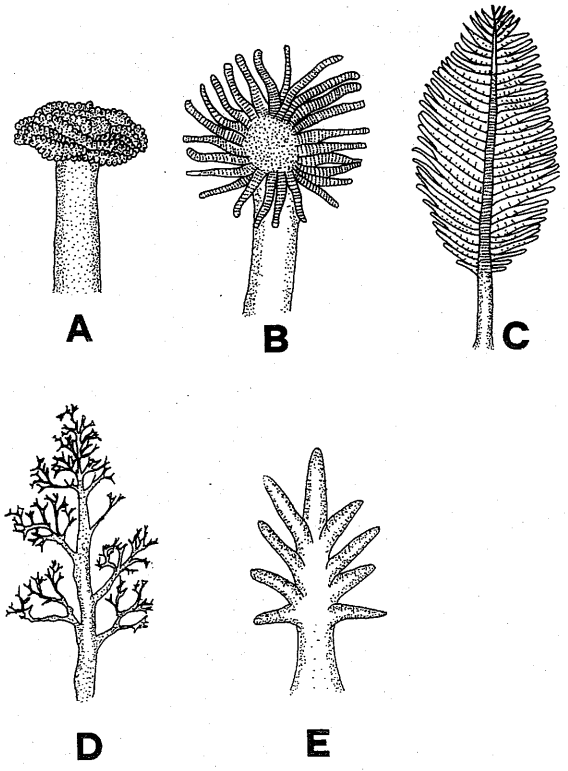

Fig. 3. Introductory figure for tentacles. A, peltate; B, pelto-digitate; C, pinnate; D, dendritic; E. digitate.

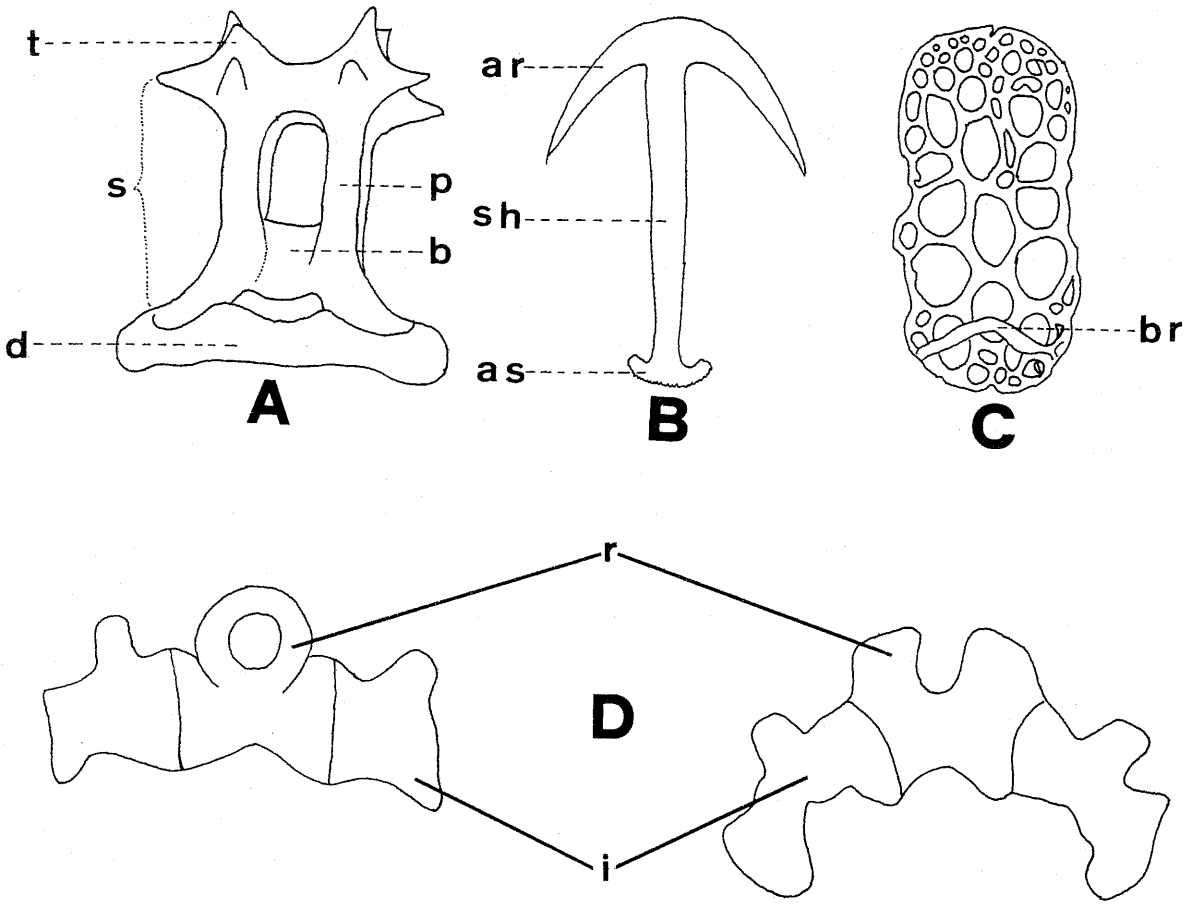

Fig. 4. Introductory figure of spicules and calcareous ring. A, table; B, anchor; C, anchor plate; D, calcareous ring. ar=arm, as=anchor stock, b=beam, br=bridge, d=disc, i=interradial, p=pillar, r=radial plate, s=spire, t=teeth.

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 scatter 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.

RESULTS

Key to the species of holothurians found in southern Taiwan.

1. Tube-feet present (usually as ventral pedicels); body rather stout, sausage-shaped; body wall not sticky to touch; tentacles peltate or dendritic; spicules include tables, various buttons, rods or plates; no wheels, anchors or anchor plates... ..... Dendrochirotida and Aspidochirotida 2

   Tube-feet absent; body worm-like; body wall thin and sticky to touch; tentacles pelto-digitate, pinnate or digitate; spicules include wheels, anchors and anchor plates..... ..... Apodida 19

2. Tentacles dendritic (richly branched and bushy); body U-shaped..... .....Dendrochirotida 3

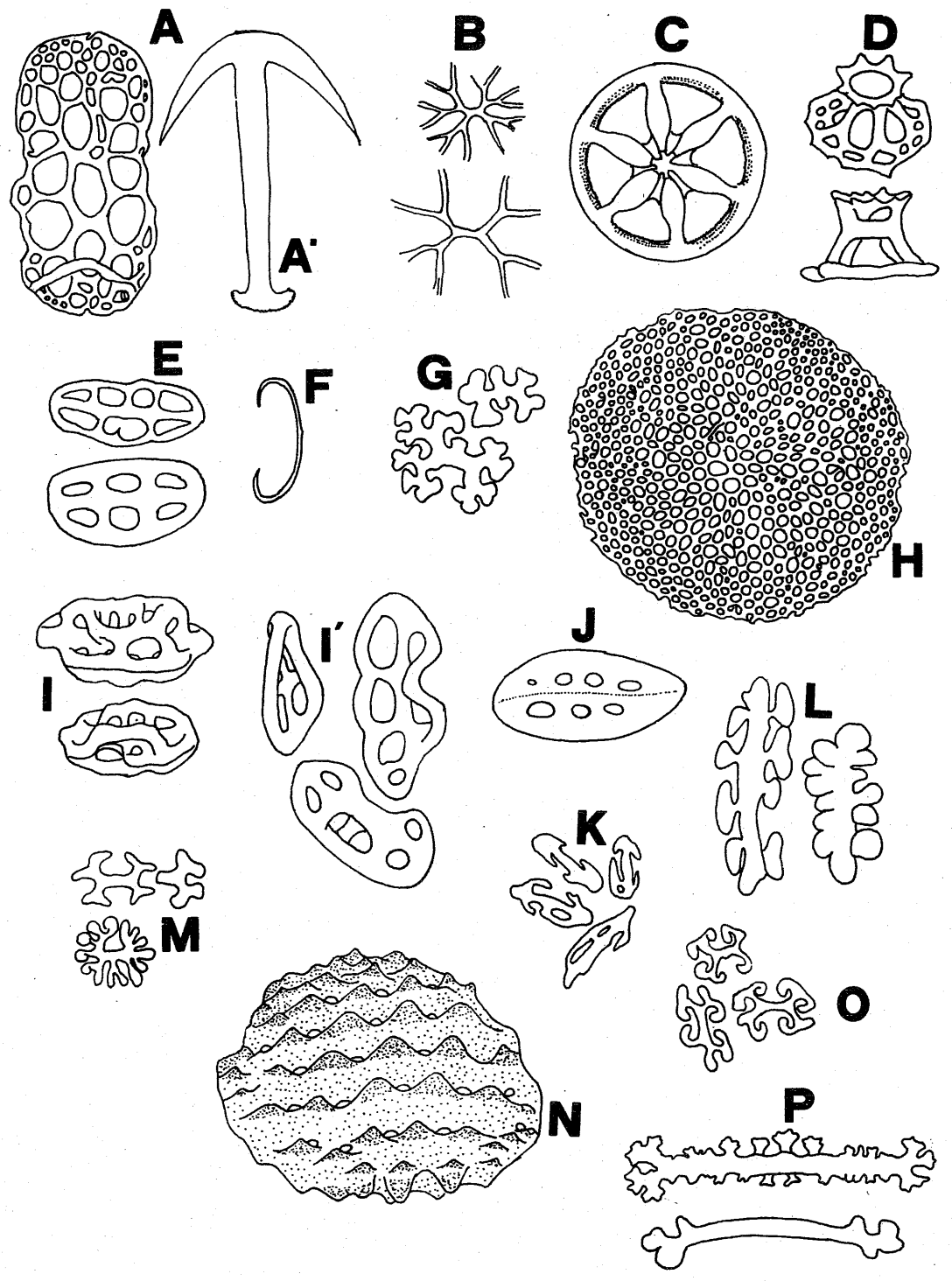

Fig. 5. Introductory figure of spicules. A, anchor plate; A', anchor; B, X-shaped dichotomous branched rod; C, wheel; D, tables; E, buttons; F, C-shaped rod; G, branched rods; H, terminal disc; I, fenestrated ellipsoids; I′, pseudobuttons; J, flattened oval button with medial optical discontinuity; K, incomplete buttons; L, knobbed bars; M, rosettes; N, lenticulate plate; O, dichotomous rosettes; P, rods.

Tentacles peltate (leaf-shaped), rarely bushy [*H.* (*Semperothuria*) *cinerascens*]; body not U-shaped..... ..... Aspidochirotida 4

3. Spicules in body wall mainly circular, lenticulate, perforated plates; tube-feet in two rows along each ambulacrum; color purplish black, black or dark gray..... ..*Afrocucumis africana* (figs. 6, 29A)
   Spicules mainly tables with low spires; tube-feet covered all body; color light yellow..... .....*Phyrella fragilis* (figs. 7, 29B)
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 rods, dichotomous rosettes, tables or dichotomous branched rod ..... Stichopodidae 5
   Gonads in a single tuft to the left of the dorsal mesentery; body ellipse in cross section; dorsal papillae smaller and numerous; spicules include buttons, tables, rods but never C-shaped rods ....Holothuriidae 7
5. Spicules are slender dichotomously branched rods and small grains; dorsal papillae large, trilobed, leafy; color brick-red..... ..... *Thelenota ananas* (figs. 10, 29E)
   Spicules are tables, C-shaped rods and dichotomous rosettes ....*Stichopus* 6
6. Two types of tables, one with large disc (with more than 25 penetrations) and reduced pointed spire, the other with smaller disc and not reduced in spire; color mottled green-black-cream..... ..... *Stichopus horrens* (figs. 8, 29C)
   Tables only one type, disc with less than 15 penetrations and spire develop very well; color mottled black-gray-orange..... ....*Stichopus variegatus* (figs. 9, 29D)
7. Spicules are branched rods, no table or button; five calcareous anal teeth around anus.....*Actinopyga* 8
   Spicules are variously developed tables, buttons and rosettes..... ..... *Holothuria* 9
8. Spicules are complex branched rods, including larger spiny branched rods (Fig. 12C); color mottled brown and black ....*Actinopyga echinites* (figs. 12, 29G)
   Spicules are elongate rods with lateral projections, and branched rods; no larger spiny branched rods; color brown and usually with white spots around anus..... ..*Actinopyga mauritiana* (figs. 11, 29F)
9. Spicules are tables and accompanied by curved rods or rosettes.....10
   Spicules are tables and accompanied by buttons, pseudobuttons (fig. 5I′), fenestrated ellipsoids (fig. 5I), incomplete buttons (fig. 5K), flattened oval button with medial optical discontinuity (fig. 5J) or knobbed bars (fig. 5L).....11
10. Spicules are tables with reduced disc and thorny curved rods; color mottled black and orange .... *Holothuria* (*Semperothuria*) *cinerascens* (figs. 14, 30A)
    Spicules are tables and rosettes; color black ....*H.* (*Halodeima*) *atra* (figs. 13, 29H)
11. Spicules are tables and accompanied by fenestrated ellipsoids; body wall thick and muscular ..... *H.* (*Microthele*) *nobilis* (figs. 15, 30B)
    Spicules are tables and accompanied by buttons, pseudobuttons, incomplete buttons, flattened oval button with medial optical discontinuity or knobbed bars.....12
12. Spicules are tables and accompanied by flattened oval button with medial optical discontinuity..... *H.* (*Platyperona*) *difficilis* (figs. 16, 30C)

Spicules are tables and accompanied by buttons, pseudobuttons, incomplete buttons or knobbed bars....13

13. Spicules are tables and accompanied by knobbed bars..... .....*H.* (*Mertensiothuria*) *pervicax* (figs. 22, 31A)

Spicules are tables and accompanied by buttons, pseudobuttons or incomplete buttons.....14

14. Spicules are tables and accompanied by pseudobuttons ....*H.* (*Lessonothuria*) *pardalis* (figs. 20, 30G)

Spicules are tables and accompanied by buttons or incomplete buttons.. 15

15. Spicules are tables and accompanied incomplete buttons..... ....*H.* (*Mertensiothuria*) *fuscocinerea* (figs. 23, 31B)

Spicules are tables and accompanied by buttons 16

16. Table's disc with spinous rim..... .....*H.* (*Mertensiothuria*) *leucospilota* (figs. 21, 30H)

Table's disc with smooth rim.....17

17. Tables and buttons are small, table disc diameter rarely up to 65 μm, buttons rarely up to 70 μm long and usually with 6 small perforations; color uniformly cream with about 6 pairs of dorsal purplish brown spots; found buried in sands and rubble .. ..*H.* (*Thymiosycia*) *arenicola* (figs. 19, 30F)

Spicules are larger tables and buttons, perforations of buttons relatively large; color not as above.....18

18. Spicules are moderate size tables with disc diameter 65-80 μm and buttons up to 80 μm long with 3-5 pairs of holes; color, dorsally light to rich brown with bright yellowish papillae .....*H.* (*Thymiosycia*) *hilla* (figs. 17, 30D)

Tables with squarish disc up to 90 μm diameter and buttons up to 60-90 μm long; color dark brown with transverse black bands along dorsal side.....*H.* (*Thymiosycia*) *impatiens* (figs. 18, 30E)

19. Spicules are anchors and anchor plates, no wheel.....20

Spicules are wheels and curved rods, no anchor and anchor plate.....22

20. Anchor stock with symmetrical branches (fig. 24F)..... ...*Opheodesoma grisea* (figs. 24, 31C)

Anchor stock with spinous rim, no branch 21

21. Spicules are massive anchors (up to 1200 μm long) and plates (up to 850 μm long); plates more or less oblong with more than 20 fenestrations ... . *Synapta maculata* (figs. 26, 31D)

Anchors up to 280 μm and anchor plates 250 μm long; anchor plates with 7-9 larger spiny fenestrations ..... *Polyplectana kefersteini* (figs. 25, 31E)

22. Tentacles usually 12; curved rods with branch or projections at both ends; color light pink..... .....*Chiridota ridiga* (fig. 28)

Tentacles 16-18; curved rods smooth; color black, purplish black or dark gray.....*Palycheira rufescens* (figs. 27, 31F)

SYSTEMATIC ACCOUNTS

Order: Dendrochirotida

Family: Phyllophoridae

非洲異瓜參 *Afrocucumis africana* (Semper, 1868)

(Figs. 6, 29A)

Afrocucumis africana, Clark and Rowe, 1971: 182 (distribution), pl. 30, fig. 3; Liao, 1975: 202, fig. 3.

Materials: Wan-li-tung, 4 specimens, ASIZ-50017.

Diagnosis: Podia present in two rows along each ambulacrum; 20 dendritic (richly branched and bushy) tentacles; body U-shaped; calcareous ring with rather short posterior bifurcate prolongations on the radial plates which formed of several small pieces (fig. 6D); spicules in body wall mainly circular, lenticulate and perforated plates; color purplish black, or dark gray; body length usually less than 5 cm.

Distribution: Throughout the Indian Ocean, Indonesia, and western Pacific Islands but not yet recorded from Hawaiian Islands (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remark: Animals usually live in the crevices of rock, dead coral of intertidal or subtidal areas up to the depth of 5 meters.

脆沙雞子參 ***Phyrella fragilis*** **(Ohshima, 1912)**

(Figs. 7, 29B)

Phyrella fragilis, Clark and Rowe, 1971: 184 (distribution), pl. 30, fig. 1; Liao, 1975: 203, fig. 4.

Materials: Wan-li-tung, 3 specimens, ASIZ-50018.

Diagnosis: Numerous podia present both dorsal and ventral surface; 20 dendritic tentacles; body U-shaped; radial and interradial plates often composed of many small pieces giving the appearance of a mosaic pattern (fig. 7D); spicules mainly tables with low spires; color light yellow.

Distribution: East Indies, southern Japan and southern China (Clark & Rowe, 1971).

Remarks: Animals were found under rocks, dead coral fragments or coral sands at intertidal platforms of coral reef area. They are very easy to give up intestine when disturbed.

Order: Aspidochirotida
Family: Stichopodidae

糙刺參 ***Sticopus horrens*** **Selenka, 1867**

(Figs. 8, 29C)

Stichopus horrens, Domantay, 1960: 101, fig. 21; Clark and Rowe, 1971: 178 (distribution), pl. 27, fig. 19; Liao, 1975: 204, fig. 5; Rowe and Doty, 1977: 222, figs. 2d, 6b.

Materials: Wan-li-tung, 1 specimen, ASIZ-50026.

Diagnosis: Pedicels present ventrally, 20 peltate (leaf-shaped) tentacles; body squarish in cross section with large dorsal papillae; gonads in two tufts, on either side of dorsal mesentery; spicules of two types of tables, C-shaped rods and dichotomous rosettes, one type tables with large disc (with more than 25 penetrations) and reduced pointed spire (fig. 8B), other with smaller disc and well develop in spire (fig. 8C); color mottled green-black-cream.

Distribution: From the Maldive Islands in the Indian Ocean, through Indonesia to the Hawaiian Islands (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remark: Animals are nocturnal. They were found under rock at daytime and crawling on platform at night within the depth of 3 meters.

花刺參 ***Stichopus variegatus*** **Semper, 1868**

(Figs. 9, 29D)

Stichopus variegatus,. Domantay, 1960: 99, fig. 19; Clark and Rowe, 1971: 180 (distribution), pl. 27, fig. 20; Liao, 1975: 204.

Materials: Wan-li-tung, 1 specimen, ASIZ-50027.

Diagnosis: Pedicels present ventrally; 20 peltate tentacles; body squarish in cross section with large dorsal papillae; gonads in two tufts, on either side of

dorsal mesentery; spicules being tables, C-shaped rods and dichotomous rosettes; table disc with less than 15 penetrations, spire well developed; color mottled black-gray-orange.

Distribution: Throughout the tropical Indo-West Pacific area except W. India, Pakistan and Hawaiian Is. (Clark & Rowe, 1971).

Remarks: Animals are nocturnal. They were found under rock at daytime in the depth of 5 meters of reef area.

梅花參 ***Thelenot ananas***
(Jaeger, 1833)

(Figs. 10, 29E)

Thelenota ananas, Clark and Rowe, 1971: 178 (distribution), pl. 27, fig. 17; Liao, 1975: 204; Tan Tiu, 1981: 64, pl. 6, figs. 1, 2.

Materials: Shiao-wan, 1 specimen, ASIZ-50016.

Diagnosis: Pedicels present ventrally; 20 peltate tentacles; body squarish in cross section with large, trilobed, leafy dorsal papillae; gonads in two tufts on either side of dorsal mesentery; spicules being slender dichotomously branched rods and small grains; color brick-red.

Distribution: Mascarene Is., Maldive area, East Indies, North Australia, China and S. Japan, Philippine Is. and South Pacific Is. (Clark & Rowe, 1971).

Remarks: Animals were found on rock or dead coral fragments at the depth of 3-10 meters of reef area.

Family: Holothuriidae

棘輻肛參 ***Actinopyga echinites***
(Jaeger, 1833)

(Figs. 12, 29G)

Actinopyga echinites, Domantay, 1960: 93, fig. 14; Rowe, 1969: 130, fig. 3; Clark and Rowe, 1971: 176 (distribution), pl. 27, fig. 1; Liao, 1975: 208, fig. 16; Rowe and Doty, 1977: 223, figs. 2e, 6c; Rowe, 1983: 154.

Materials: Wan-li-tung, 10 specimens, ASIZ-50002.

Diagnosis: Pedicels present ventrally; 20 peltate tentacles; body stout, body wall thick and muscular; gonads in a single tuft to the left of dorsal mesentery; five calcareous anal teeth encircle the anus; dorsal papillae small and numerous; spicules being complex branched rods, including larger spine branched rods (fig. 12C); color mottled brown and black.

Distribution: Throughout the tropical Indo-West Pacific area but not recorded from Hawaii, Red Sea, Persian Gulf, W. India, Pakistan and Maldive area (Clark & Rowe, 1971).

Remarks: Animals were found on intertidal reef flats and pools, usually with covering layer of sand dorsally. These animals are edible.

白底輻肛參 ***Actinopyga mauritiana***
(Quoy & Gaimard, 1833)

(Figs. 11, 29F)

Actinopyga mauritiana, Domantay, 1960: 94, fig. 15; Clark and Rowe, 1971: 176 (distribution), pl. 27, fig. 3; Liao, 1975: 208; Rowe and Doty, 1977: 228, figs. 2f, 6d; Rowe, 1983: 155.

Materials: Wan-li-tung, 4 specimens, ASIZ-50003; Liu-chiu-yu, 2 specimens, ASIZ-50027.

Diagnosis: Pedicels present ventrally; 23-27 peltate tentacles; body stout, body wall thick and muscular; gonads in a single tuft to left of dorsal mesentery; five calcareous anal teeth encircled anus; spicules being elongated rods with lateral projections, and branched rods; color rich brown-chestnut with or without white motting.

Distribution: Throughout the tropical Indo-West Pacific area (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: Animals were found in the outer area of intertidal platforms and subtidal zone at depth down to 5 meters.

They suck tightly on rocks with their numerous tube-feet. These animals are edible.

黑海參 ***Holothuria* (*Halodeima*) *atra* Jaeger, 1833**

(Figs. 13, 29H)

Holothuria (*Halodeima*) *atra*, Rowe, 1969: 137, fig. 7; Clark and Rowe, 1971: 177 (distribution), pl. 27, fig. 11; Liao, 1975: 210, fig. 10; Rowe and Doty, 1977: 224, figs. 3d, 7a; Tan Tiu, 1981: 73, pl. 15, figs. 2, 3; Rowe, 1983: 155.
Holothuria atra, Domantay, 1960: 160, fig. 1.

Materials: Wan-li-tung, 6 specimens, ASIZ-50004.

Diagnosis: Pedicels present ventrally: 20 peltate tentacles; body sausage-shaped; gonads in a single tuft to the left of dorsal mesentery; spicules being tables and rosettes, tabe with squarish disc, spire exhibit a maltese cross design when viewed from top; color uniformly black; body usually covered with a layer of sand but with 3-6 pairs of bare patches dorsally.

Distribution: Throughout the tropical Indo-Pacific Oceans (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: This species is quite common in intertidal platforms and sandy tide pools. They eat coral sand and digest the organic matter. They are edible.

黑赤星海參 ***Holothuria* (*Semperothuria*) *cinerascens* (Brandt, 1835)**

(Figs. 14, 30A)

Holothuria (*Semperothuria*) *cinerascens*, Rowe, 1969: 135; Clark and Rowe, 1971: 178 (distribution), pl. 27, fig. 12; Rowe and Doty, 1977: 230, figs. 3c, 7h.

Materials: Wan-li-tung, 6 specimens, ASIZ-50010.

Diagnosis: Pedicels present ventrally; 20 peltate tentacles, but more or less dendritic when extended; gonads in a single tuft to left of dorsal mesentery; spicules being tables and thorny curved rods, table with reduced disc, spire exhibited a maltese cross design when viewed from top; color mottled black and orange.

Distribution: Throughout the tropical Indo-West Pacific area (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: *H.* (*Semperothuria*) *cinerascens* is found in crevices of rock or under pebble or rock at outer area of intertidal platforms. They are edible.

黑乳參 ***Holothuria* (*Microthele*) *nobilis* (Selenka, 1867)**

(Figs. 15, 30B)

Holothuria (*Microthele*) *nobilis*, Rowe, 1969: 162, fig. 21; Clark and Rowe, 1971: 178 (distribution), pl. 27, fig. 10, pl. 28, fig. 20; Tan Tiu, 1981: 84, pl. 27, figs. 1-4; Rowe, 1983: 157.

Materials: Wan-li-tung, 1 specimen, ASIZ-50001.

Diagnosis: Pedicels present ventrally; 20 peltate tentacles; body stout, body wall thick and muscular; 3-4 prominent lobes along ventral-lateral edge; gonads in a single tuft to left of dorsal mesentery; spicules being tables and fenestrated ellipsoids, table with smooth rim to disc and top of spire crowded with small spines; color black and mottled with white.

Distribution: Throughout the tropical Indo-West Pacific area (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: Only one specimen was found at the outer area of intertidal platforms. *H. nobilis* is edible.

棘手乳參 ***Holothuria* (*Platyperona*) *difficilis* Semper, 1868**

(Figs. 16, 30C)

Holothuria (*Platyperona*) *difficilis*, Rowe, 1969: 143, fig. 12; Clark and Rowe, 1971: 178 (distribution), pl. 27, fig. 9; Rowe and Doty, 1977: 232, fig. 3h; Rowe, 1983: 157.

Materials: Tsyh-kaan, 1 specimen, ASIZ-50009.

Diagnosis: Pedicels present ventrally; 20 peltate tentacles; body sausage-shaped; gonads in a single tuft to left of dorsal mesentery; spicules being tables and flat, thin, oval button which with a distinct median optical discontinuity present; color uniformly brown.

Distribution: Throughout the tropical Indo-Pacific area (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: Only one specimen had been collected under pebbles at the outer intertidal platforms.

黃疣海參 ***Holothuria* (*Thymiosycia*) *hilla* Lesson, 1830**

(Figs. 17, 30D)

Holothuria (*Thymiosycia*) *hilla*, Rowe, 1969: 147; Clark and Rowe, 1971: 178 (distribution), pl. 28, fig. 9; Rowe and Doty, 1977: 225, figs. 4b, 8b; Tan Tiu, 1981: 75, pl. 17, figs. 1-2, pl. 29, figs. 1, 2g; Rowe, 1983: 158.

Materials: Wan-li-tung, 2 specimens, ASIZ-50012; Hao-liao, 7 specimens, ASIZ-50028.

Diagnosis: Pedicels present ventrally; 18-20 peltate tentacles; body sausage-shaped; dorsal papillae dispersed and light yellow in color; gonads in a single tuft to left of dorsal mesentery; spicules being tables with disc diameter 50-75 μm and buttons up to 90 μm long with 3-5 pairs of holes; color, dorsally light to rich brown, ventrally bright yellowish.

Distribution: Throughout the tropical Indo-Pacific area (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: *H.* (*Thymiosycia*) *hilla* is found under rock of intertidal area. This species is very common at Pescadores Is. but rare at southern Taiwan.

醜海參 ***Holothuria* (*Thymiosycia*) *impatiens* (Forskal, 1775)**

(Figs. 18, 30E)

Holothuria (*Thymiosycia*) *impatiens*, Rowe, 1969: 145, fig. 13; Clark and Rowe, 1971: 178 (distribution), pl. 28, fig. 8; Rowe and Doty, 1977: 225, figs. 4c, 7e; Rowe, 1983: 159.

Materials: Wan-li-tung, 14 species, ASIZ-50013.

Diagnosis: Pedicels present ventrally; 20 peltate tentacles; body sausage-shaped; coarse dorsal papillae dispersed dorsally; gonads in a single tuft to left of dorsal mesentery; spicules being tables with disc diameter up to 90 μm and buttons up to 95 μm long with three to five pairs of holes; color mottled brown and black, usually with some transverse black bands along the dorsal side.

Distribution: Throughout the tropical Indo-Pacific and Atlantic oceans, and Mediterranean (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: *H.* (*Thymiosycia*) *impatiens* is found under pebbles or in the crevices of rocks of intertidal area at reef platforms.

沙海參 ***Holothuria* (*Thymiosycia*) *arenicola* Semper, 1868**

(Figs. 19, 30F)

Holothuria (*Thymiosycia*) *arenicola*, Rowe, 1969: 147; Clark and Rowe, 1971: 178 (distribution), pl. 28, fig. 3; Rowe and Doty, 1977: 225, fig. 4a.

Materials: Wan-li-tung, 1 specimen, ASIZ-50011.

Diagnosis: Dispersed pedicels present ventrally and coarse papillae dorsally; 20 peltate tentacles; body sausage-shaped; gonads in a single tuft to the left of dorsal mesentery; spicules being tables and buttons, tables with smooth rims and 8-12 fenestrations, disc diameter 50-60 μm, button up to 70 μm long and usually with three pairs holes.

Distribution: Throughout the tropical Indo-Pacific area (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: *H.* (*Thymiosycia*) *arenicola*

is found under rocks of intertidal area at reef platform.

豹斑海參 ***Holothuria (Lessonothuria) pardalis*** **Selenka, 1868**

(Figs. 20, 30G)

Holothuria (Lessonothuria) pardalis, Rowe, 1969: 149, fig. 15; Clark and Rowe, 1971: 176 (distribution), pl. 28, fig. 11; Rowe and Doty, 1977: 225, fig. 4e.

Materials: Wan-li-tung, 3 specimens, ASIZ-50005.

Diagnosis: Pedicels dispersed ventrally; 20 small peltate tentacles; body sausage-shaped; coarse papillae dispersed dorsally; gonads in a single tuft to the left of dorsal mesentery; spicules being spinose tables, rarely smooth rimmed tables present, disc diameter 30-90 μm, buttons mainly twisted pseudobuttons and up to 70 μm long; color mottled light fellow, brown and gray.

Distribution: Throughout the tropical Indo-Pacific area (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: H. (Lessonothuria) pardalis is found under rocks of intertidal area at reef platform.

蕩皮參 ***Holothuria (Mertensiothuria) leucospilota*** **(Brandt, 1835)**

(Figs. 21, 30H)

Holothuria (Mertensiothuria) leucospilota, Rowe, 1969: 148, fig. 14; Clark and Rowe, 1971: 176 (distribution), pl. 28, fig. 19; Rowe and Doty, 1977: 225, figs. 4f, 7g; Tan Tiu, 1981: 78, pl. 20, figs. 1, 2; Rowe, 1983: 156; Cherbonnier, 1984: 682, fig. 11.

Holothuria vagabunda, Heding, 1934: 24.

Materials: Wan-li-tung, 8 specimens, ASIZ-50007.

Diagnosis: Pedicels present ventrally and small papillae dispersed dorsally; gonads in a single tuft to left of dorsal mesentery; body sausage-shaped and body wall soft; 20 peltate tentacles; spicules being tables, buttons and rosettes, tables mostly with spinose rim, disc with one big fenestration and 6-13 small fenestrations, spire with four pillow and 8-12 spines at top; button smooth and irregular in shape, usually with 3 pairs of holes, 40-60 μm long; color uniformly purplish black or black.

Distribution: Throughout the tropical Indo-Pacific area (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: H. (Mertensiothuria) leucospilota is the most common holothurians of Taiwan. Animals live in tide pool or under rocks of various substrata at intertidal area.

虎紋參 ***Holothuria (Mertensiothuria) pervicax*** **Selenka, 1867**

(Figs. 22, 31A)

Holothuria (Mertensiothuria) pervicax, Rowe, 1969: 149; Clark & Rowe, 1971: 176 (distribution); Tan Tiu, 1981: 79, pl. 21, figs. 1-2; Cherbonnier, 1984: 685, fig. 12.

Holothuria fuscocinerea var. *pervicax*, Domantay, 1960: 91, fig. 10.

Materials: Tsyh-kaan, 6 specimens, ASIZ-50008.

Diagnosis: White pedicels present ventrally and brownish papillae dispersed dorsally; gonads in a single tuft to left of dorsal mesentery; body sausage-shaped and body wall soft; 20 peltate tentacles; spicules being tables with reduced spires and knobbed bars, disc diameter up to 40 μm, knobbed bars 15-25 μm long.

Distribution: Throughout the tropical Indo-Pacific area (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: H. (Mertensiothuria) pervicax is nocturnal and always live within the depth of 3 meters to intertidal area. They are very common at Pescadores Is. reef area.

棕環參 ***Holothuria* (*Mertensiothuria*) *fuscocinerea* Jaeger, 1833**

(Figs. 23, 31B)

Halodeima fusco-cinerea, Heding, 1934: 24.
Holothuria fuscocinerea, Domantay, 1960: 90, fig. 9.
Holothuria (*Mertensiothuria*) *fuscocinerea*, Rowe, 1969: 149; Clark and Rowe, 1971: 176; Liao, 1975: 215; Cherbonnier and Feral, 1984: 680, fig. 10.

Materials: Wan-li-tung, 3 specimens, Tsyh-kaan, 5 specimens, ASIZ-50006.

Diagnosis: Pedicels present ventrally; papillae dispersed dorsally, a black ring surrounding base of both pedicels and dorsal papillaes; body sausage-shaped and body wall soft; gonads in a single tuft to left of dorsal mesentery; 20 peltate tentacles; five sets of small papillaes surrounding anus; spicules being tables and incomplete buttons; table incomplete, with a big and 0-6 small fenestrations, disc diameter up to 40 μm, spire greatly reduced, incomplete buttons 25-50 μm long; color brownish with several dark brown spots.

Distribution: Mascarene Is., E. Africa & Madagascar, Red Sea, Ceylon area, Bay of Bengal, East Indies, North Australia, Philippine Is., China & S. Japan and South Pacific Is. (Clark & Rowe, 1971).

Remarks: This animal is nocturnal and lives within the depth of 3 meters to intertidal area of reef platform. They are quite common at Pescadores Is.

Order: Apodida

Family: Synaptidae

灰蛇錨參 ***Opheodesoma grisea* (Semper, 1868)**

(Figs. 24, 31C)

Opheodesoma grisea, Domantay, 1960: 105, fig. 24; Clark and Rowe, 1971: 186 (distribution), pl. 30, fig. 11; Rowe and Doty, 1977: 226, figs. 5d, 8g; Tan Tiu, 1981: 62, pl. 4, fig. 1-3.

Materials: Nan-wan, 8 specimens, ASIZ-50019.

Diagnosis: No tube-feet; body worm-like, usually more than one meter in length, body wall thin and sticky to touch; 15 pinnate tentacles; spicules being anchors, plates and rosettes, anchors with stock branched, 300-350 μm long, 3-5 projections at the top of the arm, anchor plate with 7 big holes, hole's rim appear warty, plate up to 250 μm long and 200 μm width; bridge develop well; rosettes diameter up to 20 μm; radial plate with a fenestration; Polian vesicles and stone cannel numerous; no respiratory tree; color in small specimen with green strap or bands, while in large specimen mottled orange, yellow with 5 transverse green bands.

Distribution: East Africa, Red Sea, Coast of Arabia, Ceylon to the Philippines and Guam (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: *Opheodesoma grisea* is found in tide pool of reef platforms.

斑錨參 ***Synapta maculata* (Chammisso & Eysenhardt, 1821)**

(Figs. 26, 31D)

Synapta maculata, Domantay, 1960: 104, fig. 23; Clark and Rowe, 1971: 186 (distribution), pl. 26, fig. 12, pl. 30, fig. 9; Liao, 1975: 220, fig. 22; Rowe and Doty, 1977: 225, figs. 5a, 8e; Rowe, 1983: 161.

Materials: Wan-li-tung and Liu-chiu-yu, 4 specimens, ASIZ-50022.

Diagnosis: No podia present; body worm-like, usually more than 1 meter, body wall thin and sticky to touch; 15 pinnate tentacles; spicules being anchor, anchor plates and rosettes, anchor stock with spinous rim, 900-1200 μm long, several projections at top of arm (fluke), anchor plate 800-850 μm long, 450-550 μm width, 8-14 large fenestrations at center and numerous small fenestrations on both ends; bridge well developed; radial plate with a circular projection; color mottled

brownish with five transverse darker bands or blotches.

Distribution: Throughout the Indo-West Pacific area but not recorded from Hawaii (Clark & &owe, 1971; Rowe & Doty, 1977).

Remarks; *Synapta maculata* is found in tide pool or small gulf and bay to the depth of 5 meters at reef area.

褶錨參 ***Polyplectana kefersteini*** **(Selenka, 1867)**

(Figs. 25, 31E)

Polyplectana kefersteini, Clark and Rowe, 1971: 186 (distribution), pl. 31, fig. 1; Liao, 1975: 222, fig. 25; Rowe and Doty, 1977: 226, figs. 5b, 8f.

Materials: Shan-geo-wang, 2 specimens, ASIZ-50021.

Diagnosis: No tube-feet; body worm-like, usually less than 40 cm, body wall thin and sticky to touch; 24 pinnate tentacles, tentacles stock with black spots; calcareous ring more or less oblong, radial plate with a hole; no respiratory tree; several Polian vesicles and one stone cannel; spicules being anchors, plates and rosettes, anchor 200-220 μm long, 2-6 small projections at top of arm, stock without branched but with spinous rim, plate 170-200 μm long, with 7 big holes, hole's rim with numerous small teeth; bridge well developed; rosettes diameter 8-15 μm; color red-brownish.

Distribution: North Australia, Indonesia and Hawaii (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: *P. kefersteini* is found under rocks or pebbles at gulf or bay within the depth of 5 meters of reef areas.

Family: Chiridotidae

硬指參 ***Chiridota rigida*** **(Semper, 1868)**

Figs. 28

Chiridota rigida, Clark and Rowe, 1971: 188 (distribution), pl. 31, fig. 9; Liao, 1975: 223, fig. 26; Rowe and Doty, 1977: 225, figs. 4h, 8d.

Materials: Tiao-shih, 1 specimen, ASIZ-50023.

Diagnosis: No tube-feet; body worm-like, body wall thin; white wheel papillaes present; 12 digitate tentacles; spicules being wheel and curved rods, wheel diameter 50-100 μm, rod 25-60 μm, more or less "C" shape and with projections or short branches at both ends.

Distribution: Indonesia, North Australia, Philippines and islands of West Pacific (Clark & Rowe, 1971; Rowe & Doty, 1977).

Remarks: Only one specimen was found under coral sands at intertidal area of reef platform. This small specimen is only 8 cm in length and pink in color.

紫輪參 ***Polycheira rufescens*** **(Brandt, 1835)**

(Figs. 27, 31F)

Polycheira rufescens, Clark and Rowe, 1971: 188 (distribution), pl. 31, fig. 11; Liao, 1975: 223; Rowe, 1983: 161.

Materials: Mao-bi-tou, 20 specimens, ASIZ-50024.

Diagnosis: No tube-feet; body worm-like, usually less than 25 cm, body wall thin, white wheel papillaes present; 16-18 pelto-digitate tentacles; spicules being wheels and curved rods (Figs. 27A, B), wheel diameter 60-120 μm, curved rod 25-70 μm long.

Distribution: Islands of W. Indian Ocean, E. Africa & Madagascar, Ceylon area, Bay of Bengal, East Indies, North Australia, Philippine Is., China, S. Japan and S. Pacific Is.

Remark: *P. rufescens* is found under rocks, pebbles or coral sand at upper intertidal area of reef platform. When low tide, they retain a lot of water in their bodies and bury the posterior part in coral sands.

DISCUSSION

During this two years of study, 23 species of holothurians in 11 genera, 5 families were recorded. Seventeen of them are new records from Taiwan. In 1984, Dr. A. L. Applegate investigated the echinoderms of southern Taiwan describing a new record *H. (Cystipus) rigida*. Therefore, 24 species of shallow-water holothurian are now recorded from Taiwan (Table 1).

Distribution of the holothurians in southern Taiwan mainly concentrates at intertidal areas. There are only a few specimens collected from subtidal areas within the depth of 30 meters. During two years of SCUBA diving collections, only one *T. ananas*, two *P. kefersteini*, two *S. variegatus*, several larger *H. leucospilota* and *S. maculata* were found; and they mainly live in bays, harbors and gulfs.

The common holothurians at the tip of southern Taiwan, Kenting National Park waters are: *H. atra, H. leucospilota, A. echinites, A. mauritiana, O. grisea, S. maculata, P. rufescens, A. africana, P. fragilis, H. cinerascens* and *H. impatiens*.

Table 1. Distribution Table for Holothurioidea of Southern Taiwan

	Philippines Is.	South China	South Japan	South Pacific Is.	Hawaiian Is.
HOLOTHURIIDAE					
Actinopyga echinites	+	+	+	+	−
Actinopyga mauritiana	+	+	+	+	+
Holothuria (Cystipus) rigida	+	+	−	+	−
H. (Halodeima) atra	+	+	+	+	+
**H. (Lessonothuria) pardalis*	+	+	+	+	+
**H. (Mertensiothuria) fuscocinerea*	+	+	+	+	−
H. (Mertensiothuria) leucospilota	+	+	+	+	−
**H. (Mertensiothuria) pervicax*	+	+	−	+	+
**H. (Microthele) nobilis*	+	+	+	+	+
**H. (Platyperona) difficilis*	+	+	+	+	+
H. (Semperothuria) cinerascens	+	+	+	+	+
**H. (Thymiosycia) arenicola*	+	+	+	+	+
**H. (Thymiosycia) hilla*	+	+	+	+	+
**H. (Thymiosycia) impatiens*	+	+	+	+	+
STICHOPODIDAE					
**Stichopus horrens*	+	+	+	+	+
**Stichopus variegatus*	+	+	−	+	−
**Thelenota ananas*	+	+	−	+	−
PHYLLOPHORIDAE					
**Afrocucumis africana*	−	+	+	+	−
**Phyrella fragilis*	−	+	+	−	−
SYNAPTIDAE					
**Opheodesoma grisea*	+	+	+	−	+
**Polyplectana kefersteini*	+	+	−	+	+
Synapta maculata	+	+	+	+	−
CHIRIDOTIDAE					
**Chiridota rigida*	+	+	−	+	−
**Polycheira rufescens*	+	+	+	+	−

A plus sign (+) indicates a confirmed report of the species, whereas, a minus (−) indicates absence. The asterisk (*) indicates new record in this paper.

Although 11 species, *C. rigida, H. nobilis, S. horrens, T. ananas, H. arenicola, H. hilla, H. fuscocinerea, H. pervicax, H. pardalis, S. variegatus* and *P. kefersteini* are recorded in this paper, the former 6 species were found with only one specimens for each species and the latter 5 species 2 specimens each. Therefore, it is likely that these rare species maybe come from South China or Philippine islands by their planktonic larvae.

The holothurians of Pescadores islands are quite different from those in southern Taiwan. The most common holothurians at Pescadores are *H. hilla, H. pervicax, H. fuscocinerea, H. leucospilota* and *S. horrens.* Except *H. leucospilota,* the other common holothurians of Pescadores are just the rares in southern Taiwan.

The holothurian fauna of Liu-chiu-yu is similar to southern Taiwan. *H. arta, H. leucospilota, A. echinites, A. mauritiana, H. cinerascens, T. ananas, S. maculata* and *O. grisea* are common at this place. It is worth to mention that *T. ananas* is very common at this place between the depth of 5-15 meters.

The holothurian fauna of Lan-yu is incomplete, only two field trips were done by the authors. Three species are recorded; they are: *T. ananas, H. leucospilota* and *H. mauritiana.*

An analysis on the holothurians fauna composition of Taiwan indicates that most of the species are typical Indo-West Pacific coral reef species. *H. impatiens, H. arenicola* and *H. leucospilota* are distributed both in Pacific and Atlantic waters, while *A. mauritiana, H. atra, H. pardalis, H. pervicax, H. nobilis, H. difficilis, H. cinerascens, H. hilla, S. horrens, O. grisea* and *P. kefersteini* are throughout the Indo-West Pacific region. The other species, *A. echinites, H. rigida, H. fuscocinerea, S. variegatus, T. ananas, A. africana, P. fragilis, S. maculata, C. rigida* and *P. rufescens,* are throughout the Indo-West Pacific area, but not yet recorded from Hawaii.

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臺灣南部沿岸海參之研究

趙 世 民　張 崑 雄

本文報導墾丁海域、澎湖、琉球嶼及蘭嶼潮間帶及水深 30 公尺以內亞潮帶產海參之分佈及分類。共記述 5 科 11 屬 23 種，17種爲臺灣首次記錄。其中以海參科 (Holothuriidae) 種類最多，共佔 13 種。本文包括種的描述、檢索表、生態及標本照片、20 種海參主要骨針電子顯微圖片及 23 種之體壁各部骨針圖。

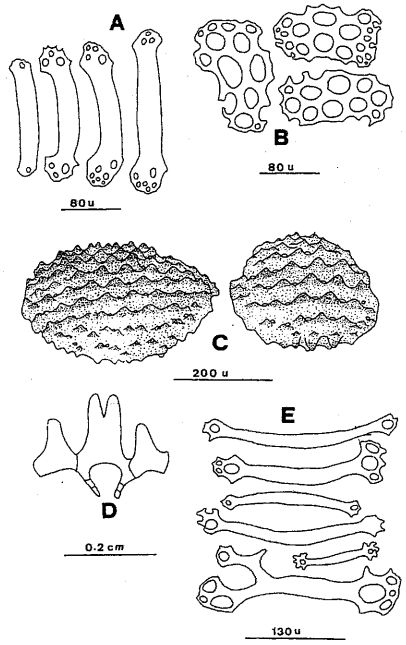

Fig. 6. *Afrocucumis africana.* A, rods from tube-feet; B, fenestrated plate around the terminal disc from tube-feet; C, lenticulate plate; D, calcareous ring; E, rods from tentacle.

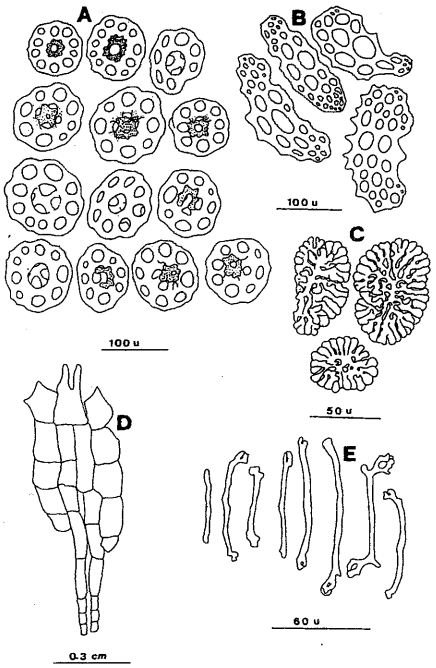

Fig. 7. *Phyrella fragilis.* A, tables; B, fenestrated plate around the terminal disc from tube-feet; C, rosettes from tentacle; D, calcareous ring; E, rods in tentacle.

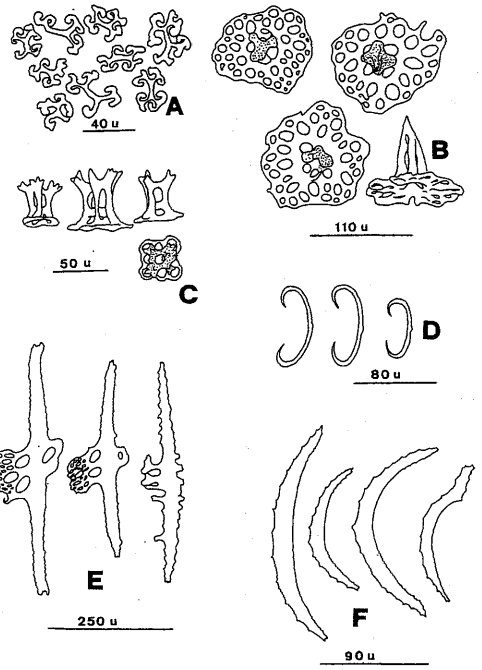

Fig. 8. *Stichopus horrens.* A, dichotomous rosettes; B, tables; C, tables; D, C-shaped rods; E, rods from tube-feet and papillae; F, rods from tentacle.

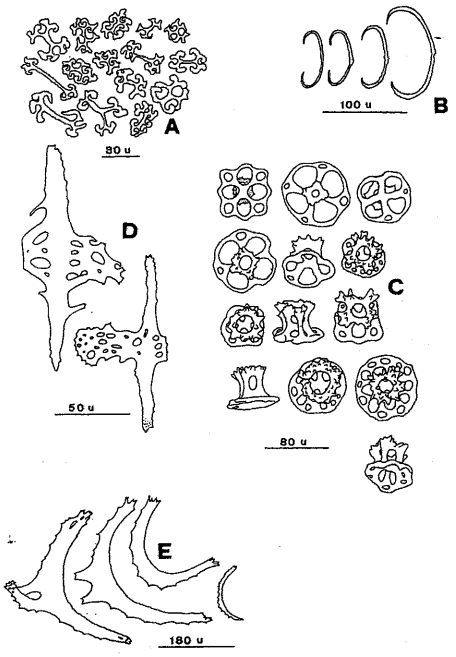

Fig. 9. *Stichopus variegatus.* A, dichotomous rosettes; B, C-shaped rods; C, tables; D, rods from tube-feet and papillae; E, rods from tentacle.

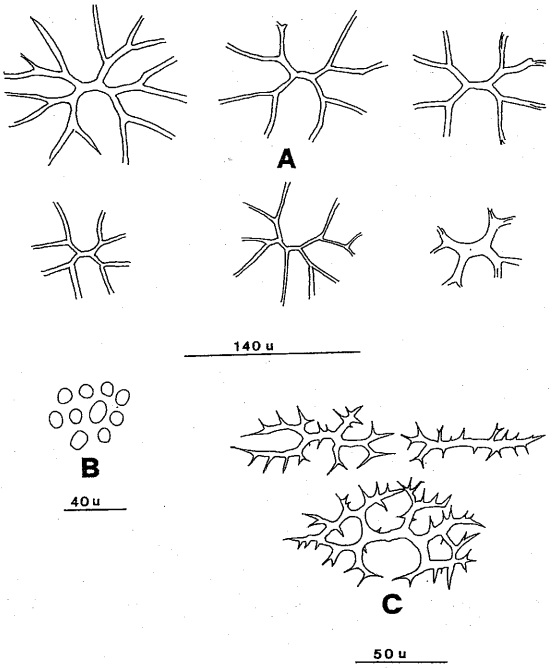

Fig. 10. *Thelenota ananas.* A, X-shaped dichotomous branched rods; B, granules; C, spiny rods from tentacles.

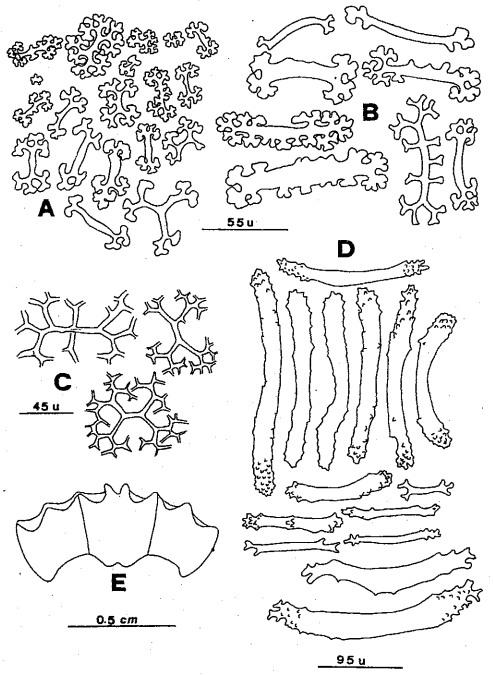

Fig. 12. *Actinopyga echinites.* A, B, various branched rods from body-wall; C, spiny rods from body-wall; D, rods from tentacles; E, calcareous ring.

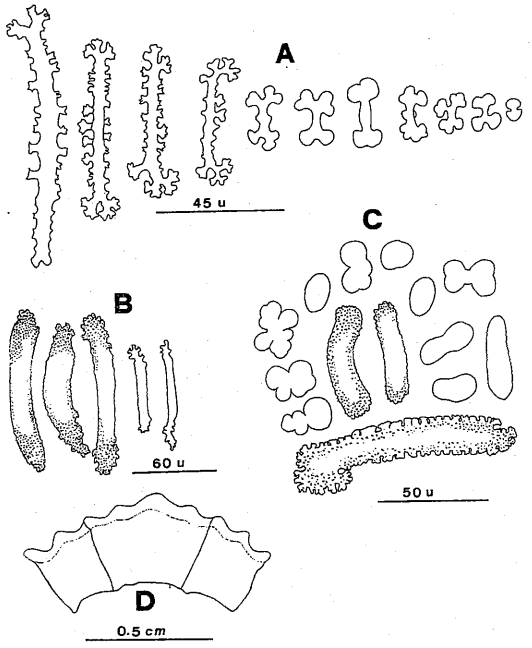

Fig. 11. *Actinopyga mauritiana.* A, rods B, rods from tentacle; C, granules and rods from tube-feet; D, calcareous ring.

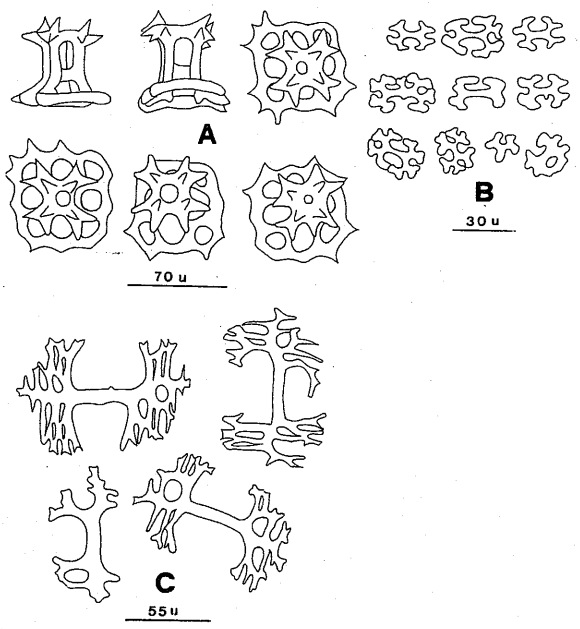

Fig. 13. *H. (Halodeima) atra.* A, tables; B, rosettes; C, spicules around the terminal disc in tube-feet.

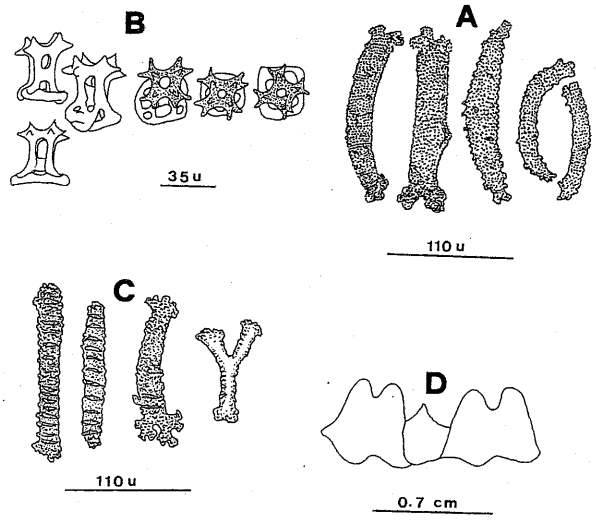

Fig. 14. *H.* (*Semperothuria*) *cinerascens.* A, rods; B, tables; C, rods in tentacle; D, calcareous ring.

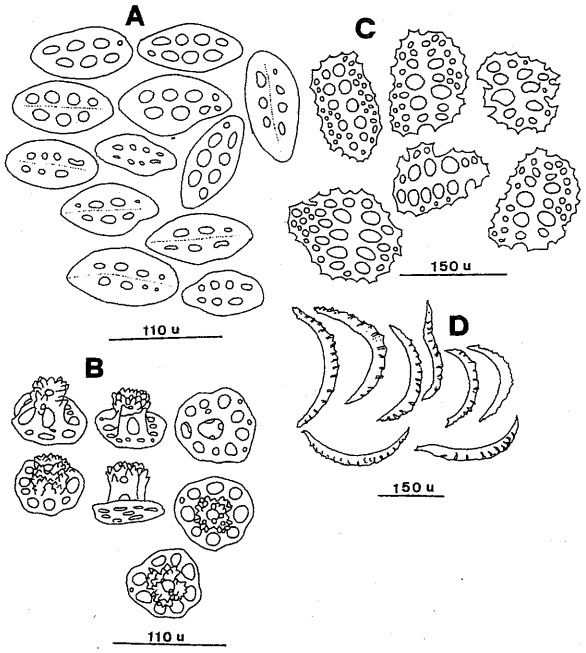

Fig. 16. *H.* (*Platyperona*) *difficilis.* A, flattened oval button with medial optical discontinuity; B, tables; C, fenestrated plate from tube-feet and papillae; D, rods in tentacle.

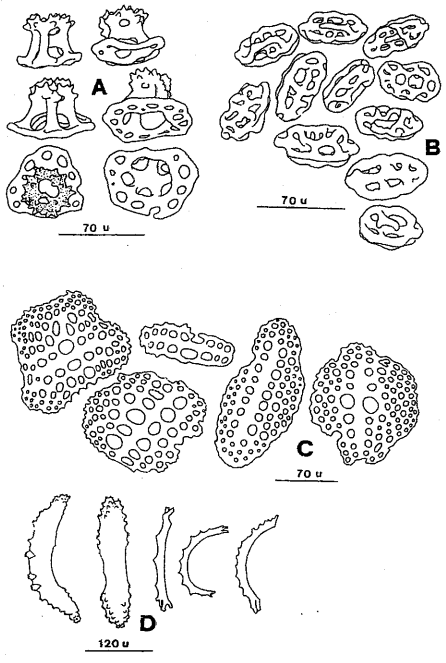

Fig. 15. *H.* (*Hicrothele*) *nobilis.* A, tables; B, fenestrated ellipsoids; C, fenestrated plates from tube-feet and papillae; D, rods from tentacle.

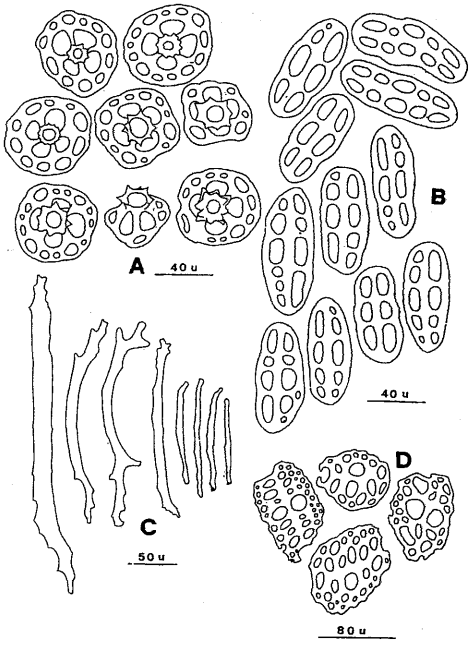

Fig. 17. *H.* (*Thymiosycia*) *hilla.* A, tables; B, buttons; C, rods from tentacle; D, fenestrated plates from pedicels and papillae.

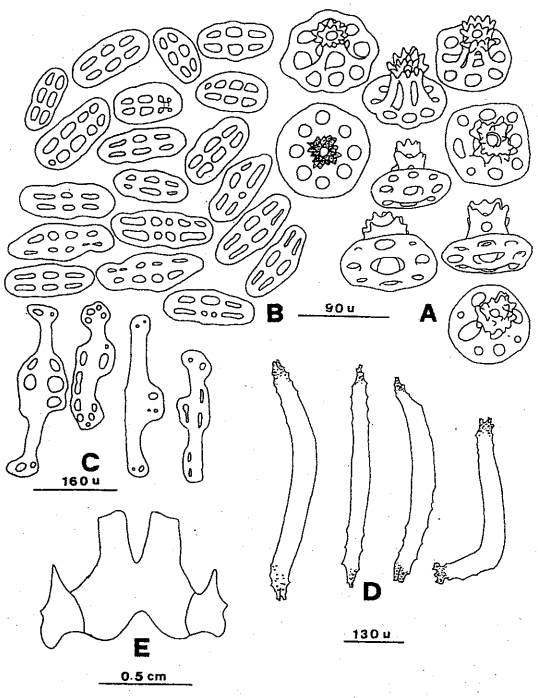

Fig. 18. *H.* (*Thymiosycia*) *impatiens.* A, tables; B, buttons; C, rods from pedicels and papillae; D, rods from tentacle; E, calcareous ring.

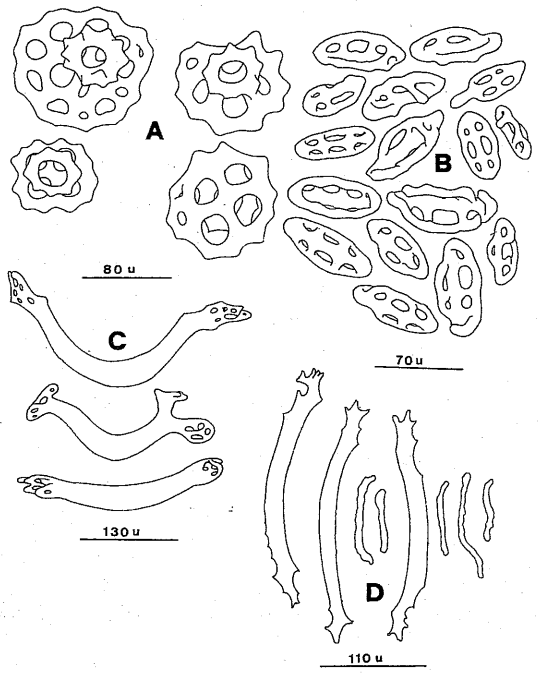

Fig. 20. *H.* (*Lessonothuria*) *padalis.* A, tables; B, pseudobuttons; C, rods from papillae; D, rods from tentacle.

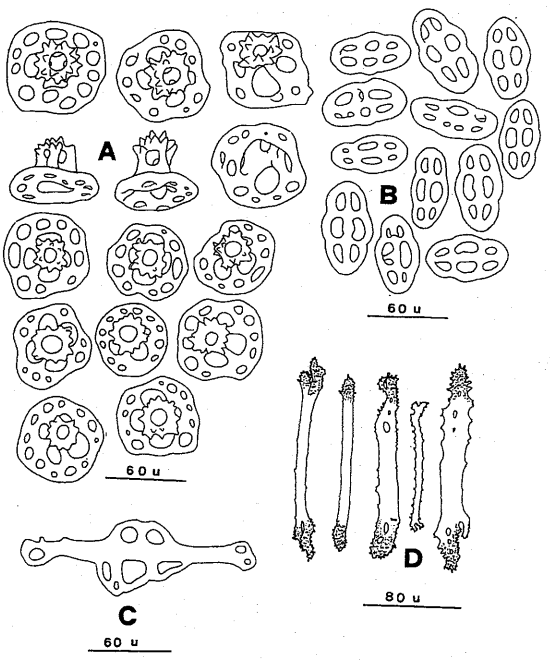

Fig. 19. *H.* (*Thymiosycia*) *arenicola.* A, tables; B, buttons; C, rod from papillae; D, rods from tentacle.

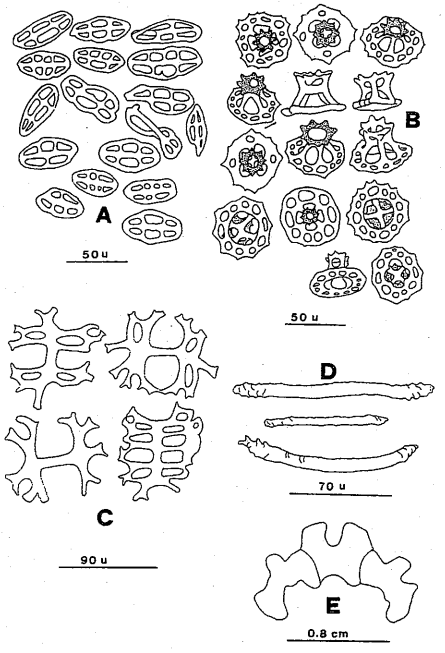

Fig. 21. *H.* (*Mertensiothuria*) *leucospilota.* A, buttons; B, tables; C, fenestrated plate around pedicel; D, rods from tentacle; E, calcareous ring.

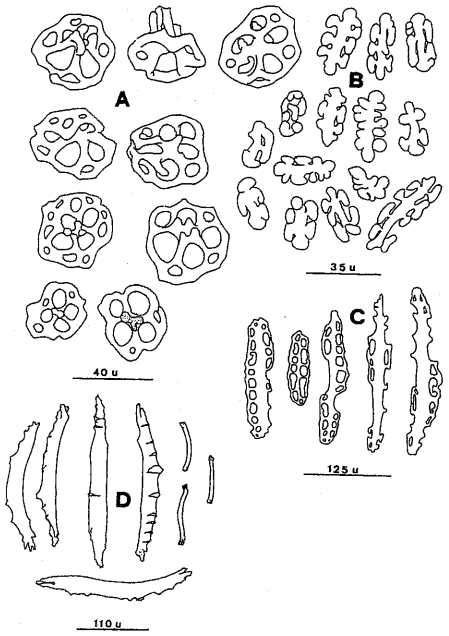

Fig. 22. *H.* (*Mertensiothuria*) *pervicax.* A, tables; B, knobbed bars; C, fenestrated plates from pedicel and papillae; D, rods from tentacle.

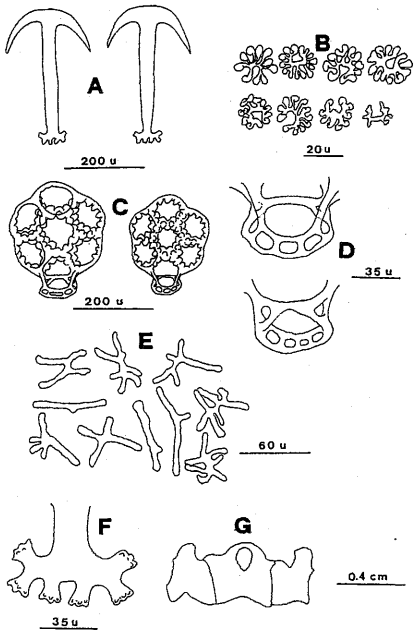

Fig. 24. *Opheodesoma grisea.* A, anchors; B, rosettes; C, anchor plates; D, anchor bridges; E, various rods from tentacle; F, anchor stock; G, calcareous ring.

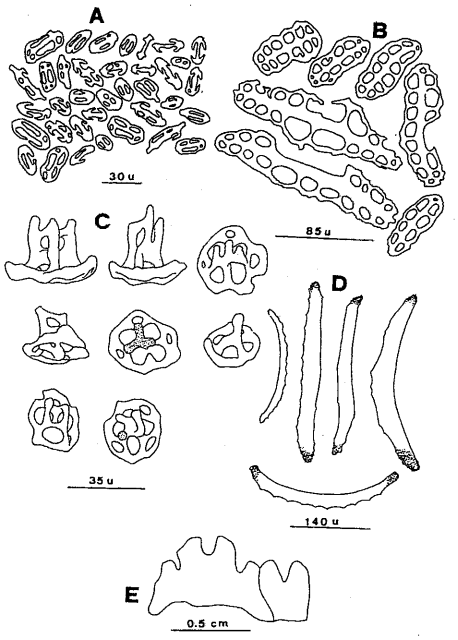

Fig. 23. *H.* (*Mertensiothuria*) *fuscocinerea.* A, incomplete buttons; B, fenestrated plates from pedical and papillae; C, tables; D, rods in tentacle; E, calcareous ring.

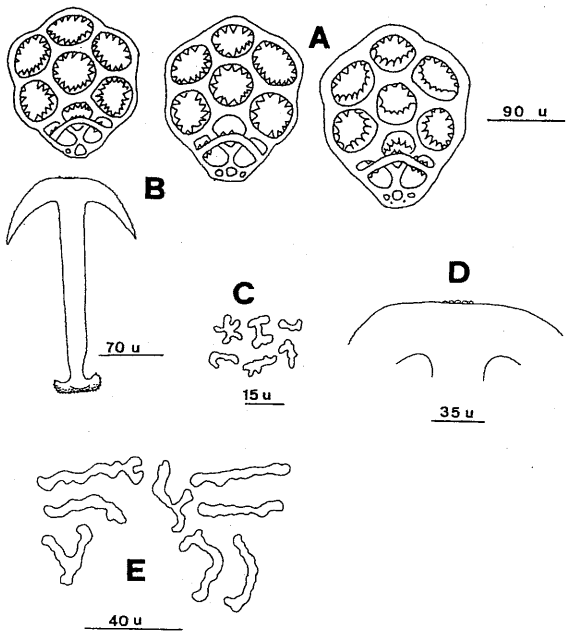

Fig. 25. *Polyplectana kefersteini.* A, anchor plates; B, anchor; C, irregular rosettes; D, several projections at the top of arm (fluke); E, various rods from tentacle.

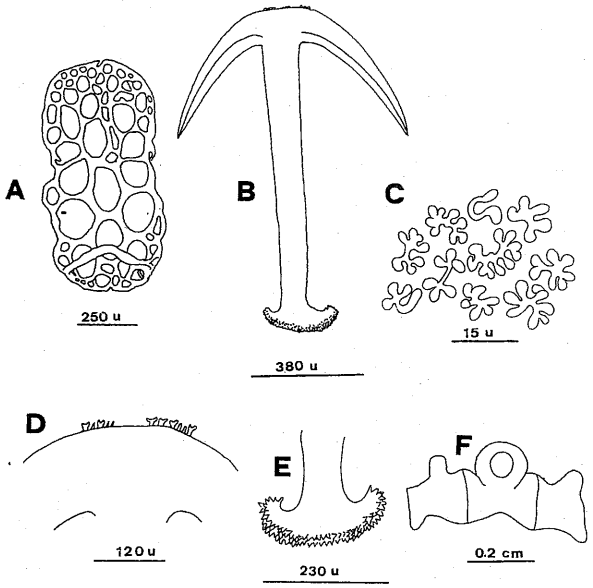

Fig. 26. *Synapta maculata.* A, anchor plate; B, anchor; C, rosettes; D, several projections at the top of arm (fluke); E, anchor stock; F, calcareous ring.

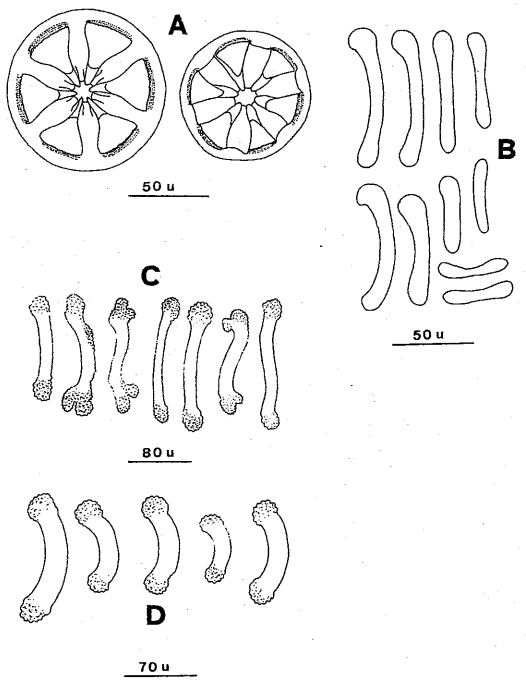

Fig. 27. *Polycheira rufescens.* A, wheels; B, rods; C, D, rods from tentacle.

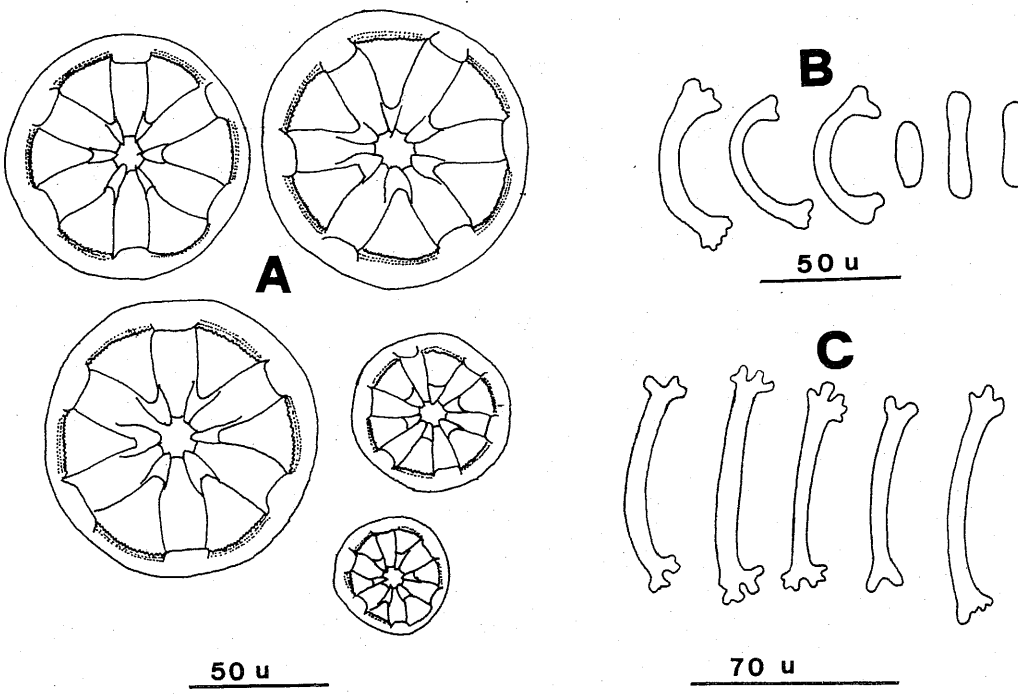

Fig. 28. *Chiridota rigida.* A, wheel; B, rods; C, rods from tentacle.

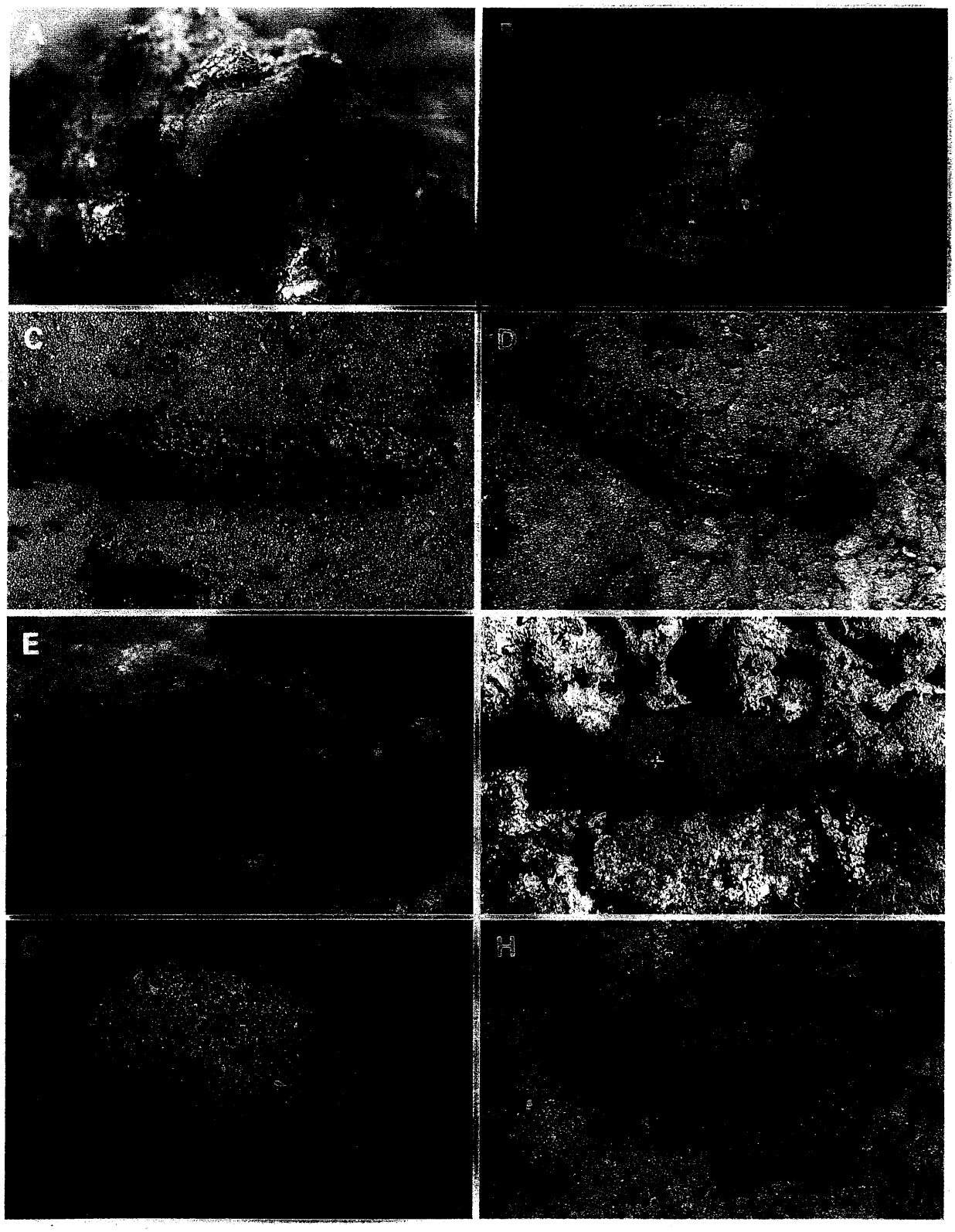

Fig. 29

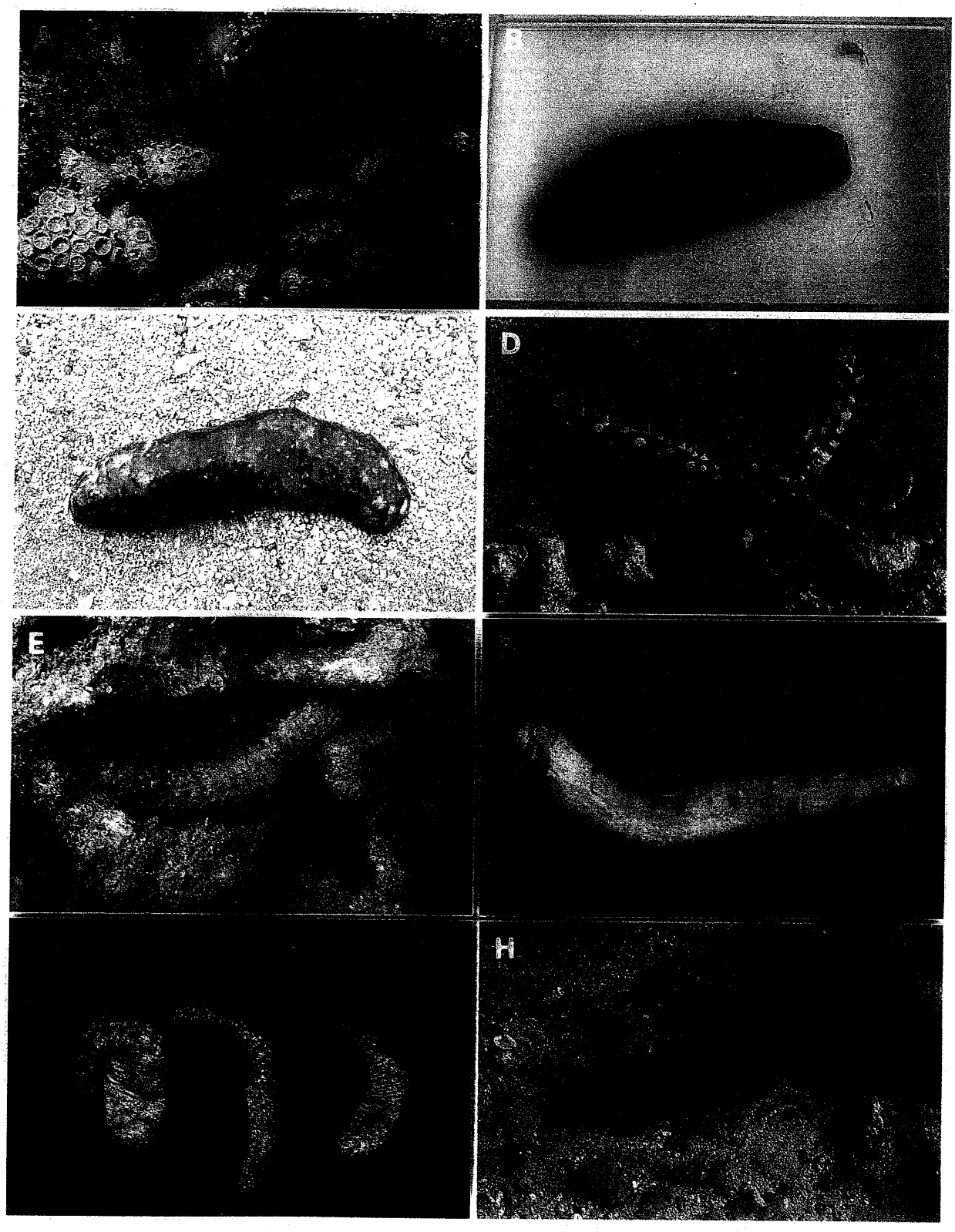

Fig. 30

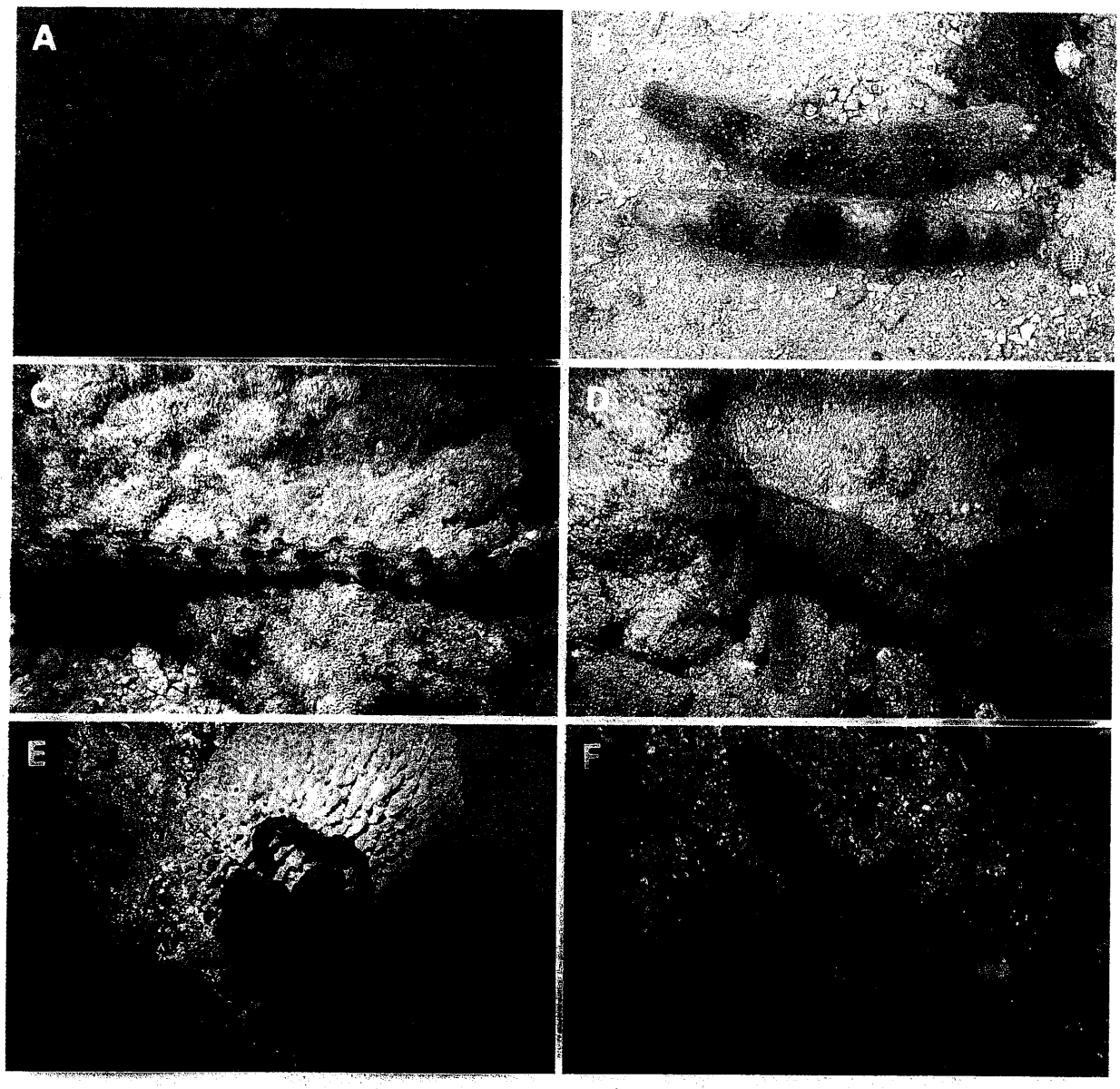

Fig. 31

Fig. 29A. *Afrocucumis africana* (Semper)
29B. *Phyrella fragilis* (Ohshima)
29C. *Stichopus horrens* Selenka
29D. *Stichopus variegatus* Semper
29E. *Thelenota ananas* (Jaeger)
29F. *Actinopyga mauritiana* (Quoy & Gaimard)
29G. *Actinopyga echinites* (Jaeger)
29H. *Holothuria* (*Halodeima*) *atra* Jaeger

Fig. 30A. *H.* (*Semperothuria*) *cinerascens* (Brandt)
30B. *H.* (*Microthele*) *nobilis* (Selenka)
30C. *H.* (*Platyperona*) *difficilis* Semper
30D. *H.* (*Thymiosycia*) *hilla* Lesson
30E. *H.* (*Thymiosycia*) *impatiens* (Forskal)
30F. *H.* (*Thymiosycia*) *arenicola* Semper
30G. *H.* (*Lessonothuria*) *pardalis* Selenka
30H. (*Mertensiothuria*) *leucospilota* Brandt

Fig. 31A. *H.* (*Mertensiothuria*) *pervicax* Selenka
31B. *H.* (*Mertensiothuria*) *fuscocinerea* Jaeger
31C. *Opheodesoma grisea* (Semper)
31D. *Synapta maculata* (Chamisso & Eysenhardt)
31E. *Polyplectana kefersteini* (Selenka)
31F. *Polycheira rufescens* (Brandt)

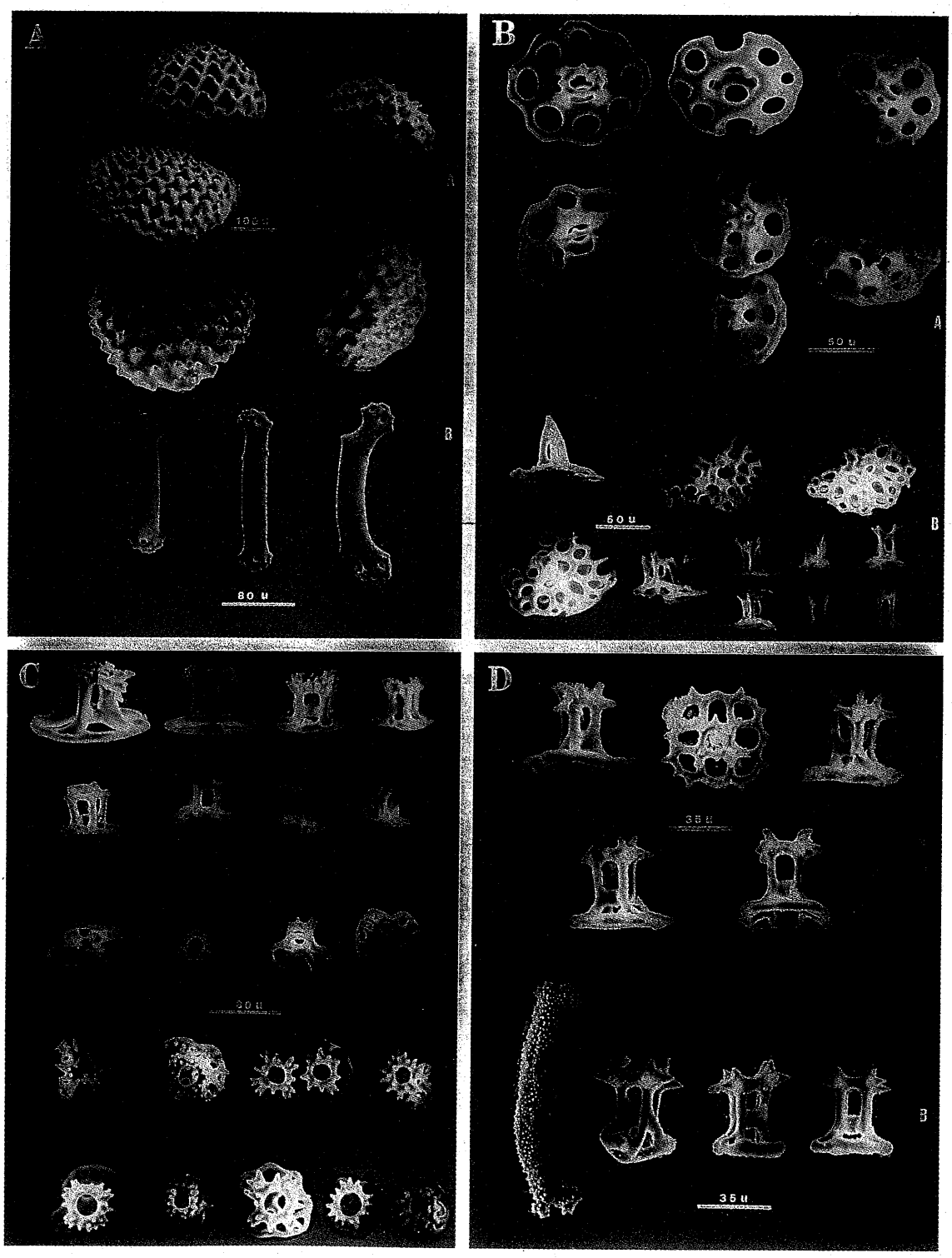

Fig. 32.

32A. *Afrocucumis africana* (Semper). A, lenticulate plates; B, rods from tube-feet.

32B. A, *Phyrella fragilis* (Ohshima); B, *Stichopus horrens* Selenka.

32C. *Stichopus variegatus* Semper.

32D. A, *Holothuria* (*Halodeima*) *atra*; B, *H.* (*Semperothuria*) *cinerascens* (Brandt).

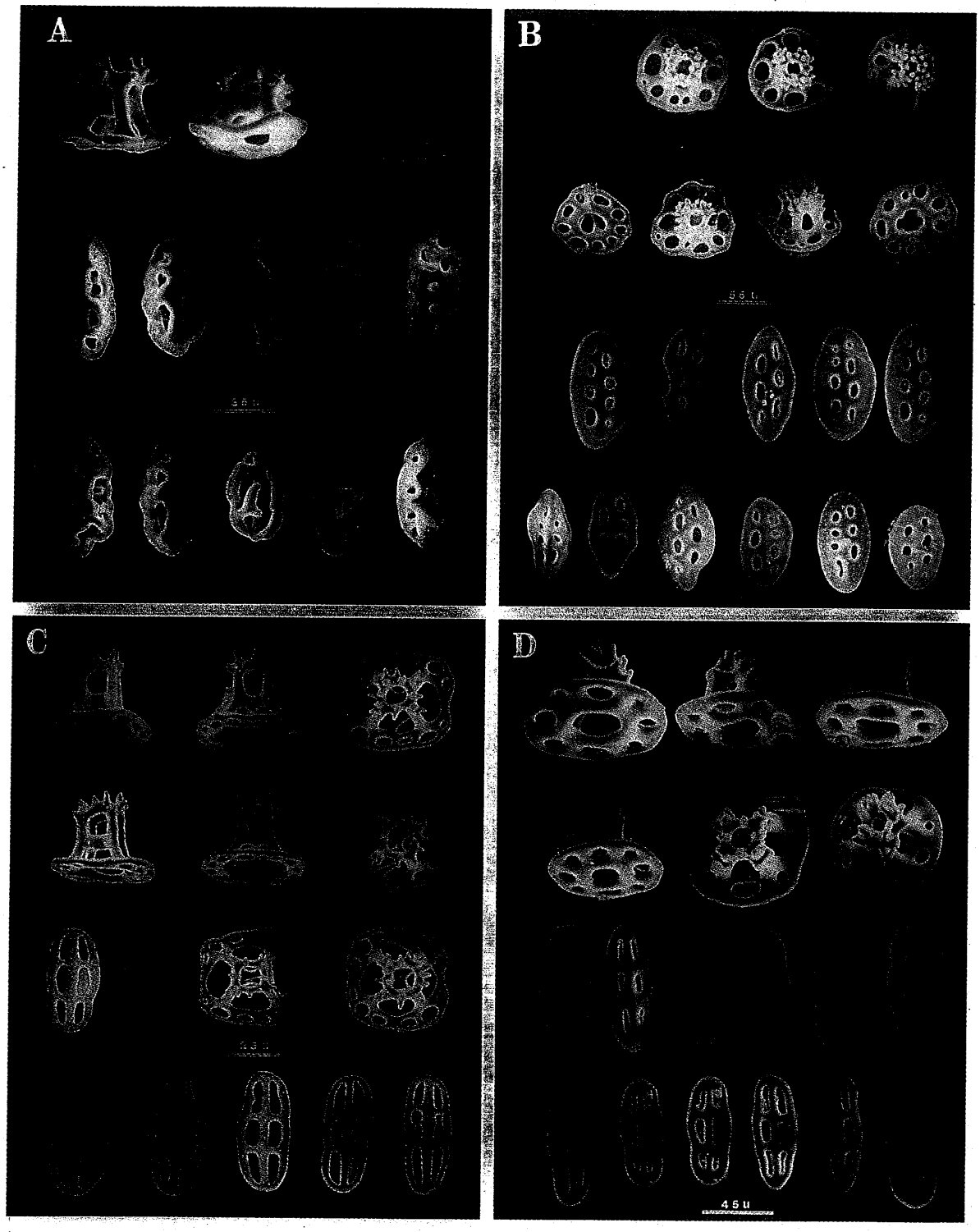

Fig. 33

33A. *H.* (*Microthele*) *nobilis* (Selenka).
33B. *H.* (*Platyperona*) *difficilis* Semper.
33C. *H.* (*Thymiosycia*) *hilla* Lesson.
33D. *H.* (*Thymiosycia*) *impatiens* (Forskal).

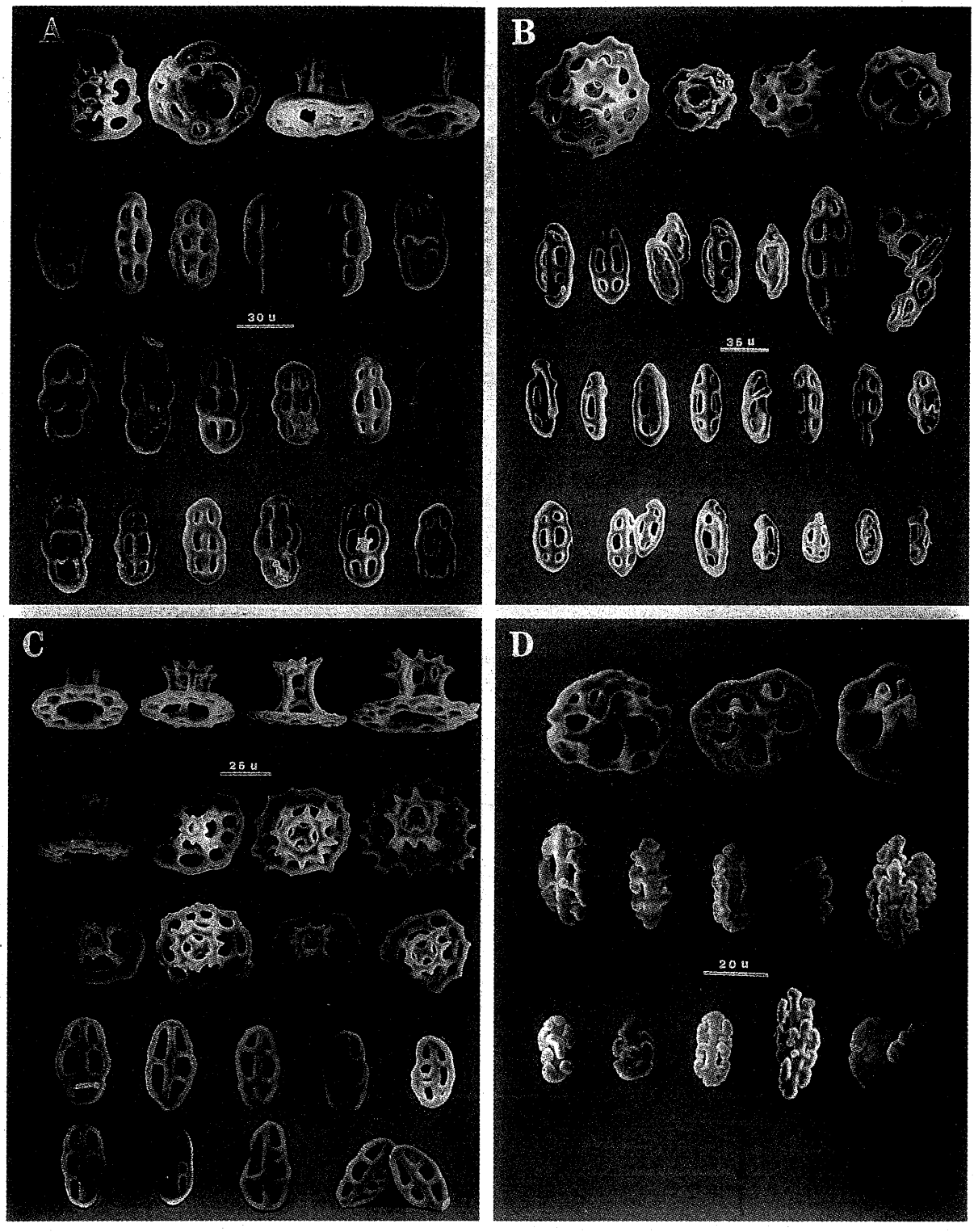

Fig. 34

34A. *H.* (*Thymiosycia*) *arenicola* Semper.
34B. *H.* (*Lessonothuria*) *pardalis* Selenka.
34C. *H.* (*Mertensiothuria*) *leucospilota* Brandt.
34D. *H.* (*Mertensiothuria*) *pervicax* Selenka.

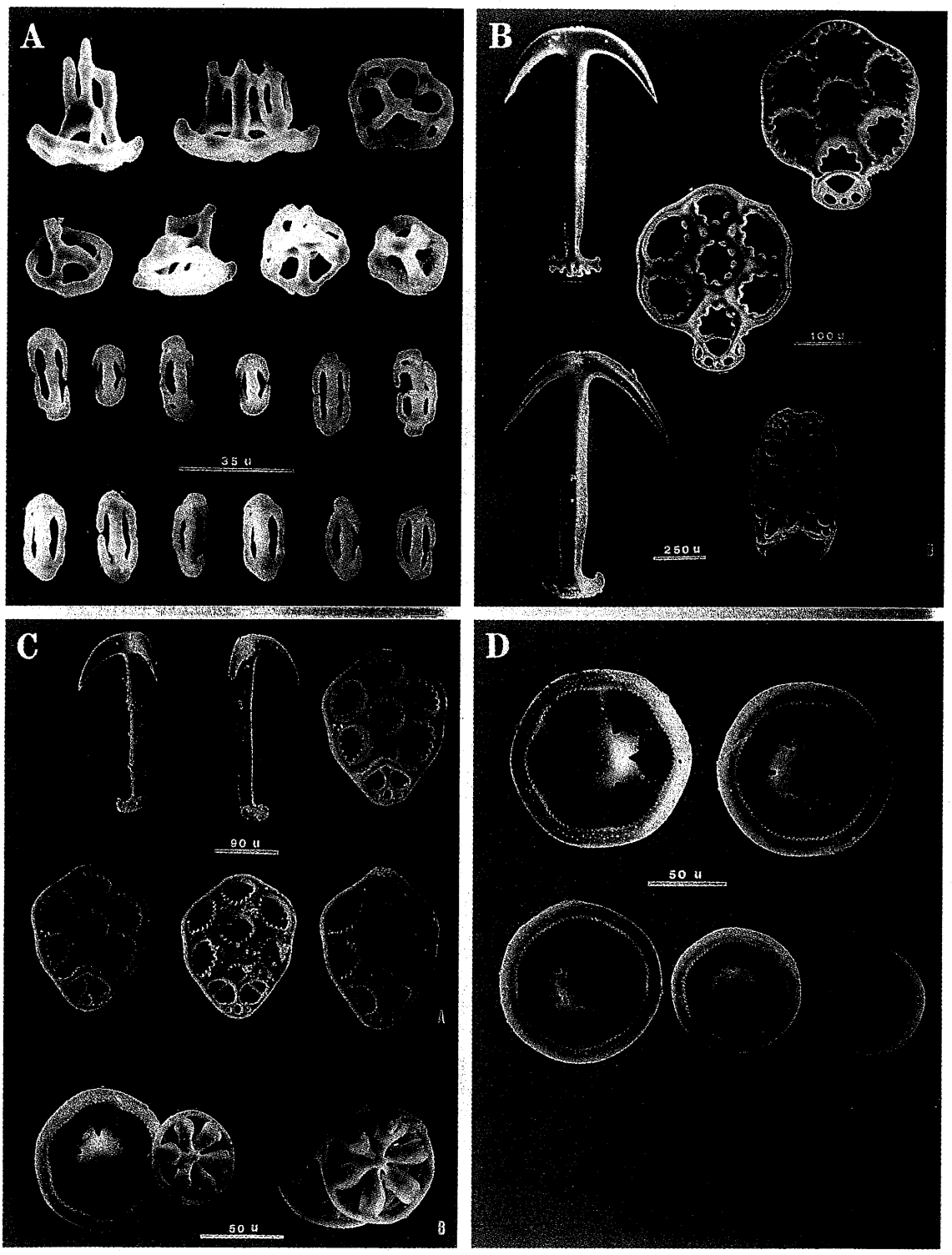

Fig. 35

35A. *H.* (*Mertensiothuria*) *fuscocinerea* Jaeger.
35B. A, *Opheodesoma grisea* (Semper); B, *Synapta maculata* (Chamisso & Eysenhardt).
35C. A, *Polyplectana kefersteini* (Selenka); B, *Chiridota rigida* Semper.
35D. *Polycheira rufescens* (Brandt).