

SCLERACTINIA OF TAIWAN

II. Family Fungiidae (Including A New Species)

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Bert W. Hoeksema and Chang-Feng Dai (1991) Scleractinia of Taiwan II. Family Fungiidae (including a new species). *Bull. Inst. Zool., Academia Sinica* 30(3): 201-226. The Fungiidae of Taiwan are treated as a part of a series dealing with the Taiwanese Scleractinia. A total of 27 species, classified with seven subgenera and eight genera, are briefly described. One species, *Fungia (Pleuractis) taiwanensis*, is new to science.

Key words: Scleractinia, Fungiidae, Taiwan, New species.

Recently, a series of reports have started to re-evaluate the present knowledge of the systematics of Taiwanese scleractinian corals, and to supply additional information that was not yet available on this subject (Dai, 1989).

The Fungiidae, is the scleractinian family of 'mushroom corals', which has recently been revised down to a species level (Hoeksema, 1989). Several of the species had no substantiated record (in English) from Taiwan, except in publications in which clear illustrations were given (e.g. Hanzawa, 1931; Yang *et al.* 1980). Therefore, the purpose of the present study is to give an account of the mushroom corals of Taiwan.

MATERIALS AND METHODS

Specimens which were already available are from several sources: the collections made by (1) Jones *et al.* (1972)

and (2) Yang *et al.* (1975-1982), which are deposited at the Institute of Oceanography, National Taiwan University (TUIO-C-) in Taipei; those made by (3) Dr. T. Y. H. Ma and (4) Dr. Y. N. Cheng, which are deposited in the National Museum of Natural Science in Taichung (NMNS); and (5) one at the Institute of Marine Biology of the National Sun Yat-sen University (SYUMB).

In addition, we collected mushroom corals by scuba diving in Yenliao Bay (NE Taiwan), Hsiao-Liuchiu (SE Taiwan Strait), the west coast of Hengchun Peninsula and Nanwan Bay (S Taiwan) (Fig. 1). Collected specimens were deposited in the TUIO and in the National Museum of Natural History (RMNH) at Leiden, the Netherlands. In addition, a paratype has been deposited in the coral collection of the National Museum of Natural History (USNM) in Washington, D. C., U. S. A.

The identifications of the mushroom

corals are according to the taxonomic revision by the first author (Hoeksema, 1989), where also synonymies and their references can be found. To help in the identifications of Taiwanese mushroom corals, short diagnoses are given for species previously described, plus a more extensive description of a new species. A key is given for the recent species only, which is mainly applicable to adult specimens.

KEY TO RECENT FUNGIIDAE OF TAIWAN

1. Corals free-living in adult stage2
Corals remain sedentary.....24
2. Each coral with one, centrally located mouth3
Each coral with several mouths....19
3. Corallum wall solid.....4
Corallum wall perforated.....11
4. Density of septal dentations $\geq 10/cm$; granulations on septal fringe predominantly arranged in rows perpendicular to septal margin.....5
Density of septal dentations usually $< 10/cm$; granulations on septal fringe irregularly arranged or in rows or ridges parallel to septal margin, possibly in zigzag patterns.....10
5. Costae fine; adjacent ones (sub)equal in size.....6
Lower order costae distinctly larger than other ones.....9
6. Septa loosely packed and those of lower orders more exsert than others; corals usually in entirety..7
Septa densely packed and (almost) equal in height; corals only in fragmented (and possibly regenerated) condition.....
.....*Fungia (Cycloseris) sinensis*
7. Corallum outline predominantly round8
Corallum outline predominantly oval*Fungia (Cycloseris) cyclolites*
8. Coralla and septa thin; adjacent costae alternating in height.....
.....*Fungia (Cycloseris) fragilis*
Coralla moderately thick; first order septa thick; costae not (distinctly) alternating in height.....
.....*Fungia (Cycloseris) costulata*
9. Coralla thick and slightly arched; lower order costae thick and irregularly ornamented.....
.....*Fungia (Cycloseris) tenuis*
Coralla flat and thin; lower order costae thin, regularly and finely ornamented; sides of costae covered by rows of granulations, perpendicular to costal margin.....
.....*Fungia (Cycloseris) vaughani*
10. Granulations on septal sides in distinct ridges parallel to septal margin; costal spines club-shaped, short, blunt and densely granulated*Fungia (Verrilofungia) concinna*
Granulations on septal sides irregularly distributed or in indistinct ridges parallel to septal margin; costal spines usually long, sharp and thinly granulated.....
.....*Fungia (Danafungia) horrida*
11. Corallum outline round.....12
Corallum outline oval to elongated..15
12. Density of septal dentations $\leq 25/cm$..
.....13
Density of septal dentations $\geq 30/cm$..
.....*Fungia (Wellsofungia) horrida*
13. Costal spines elongated and sharp; granulations on septal sides irregularly distributed or in rows perpendicular to septal margin.....14
Costal spines blunt and club-shaped; granulations on septal.....
.....*Fungia (Verrilofungia) repanda*
14. Septa relatively densely packed; septal dentations regularly angular; granulations on septal sides in rows perpendicular to septal margin; costae equal to subequal in size and ornamentation; granulations on

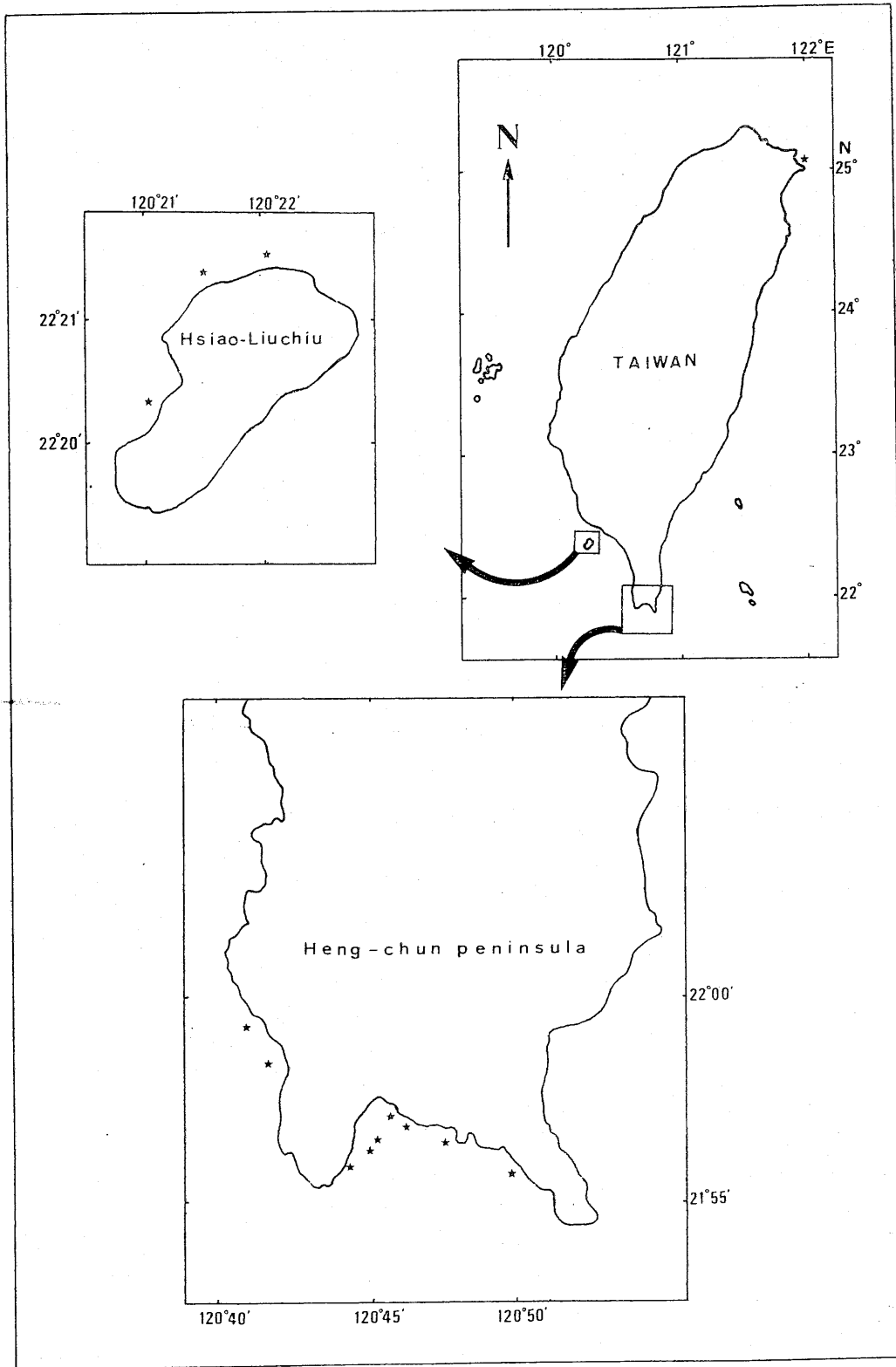


Fig. 1. Map of Taiwan showing the localities where fieldwork was done.

- costal spines concentrated at tip of spines.....*Fungia (Fungia) fungites*
- Septa relatively loosely packed; septal dentations irregularly angular and unequal in size; granulations on septal sides not distinctly patterned; costae of lower orders distinctly larger than others; granulations on costal spines evenly distributed....
.....*Fungia (Danafungia) scruposa*
15. Density of septal dentations $>12/cm$; costal spines granulate or blunt; length of corallum $\leq 25/cm$16
Density of septal dentations $\leq 12/cm$; costal spines echinose; maximum length of corallum $< 25\text{ cm}$
.....*Ctenactis echinata*
16. Upper surface of coral convex around mouth (humped); septal dentations granular; granulations on septal sides irregularly arranged.....17
Upper surface of corallum not convex around mouth; septal dentations angular; granulations on septal sides arranged in rows perpendicular or parallel to septal margin.....18
17. Density of costal spines $>40/cm$; costae unequal in size; septa of lower orders usually perforated near septal margin.....
.....*Fungia (Pleuractis) moluccensis*
Density of costal spines $<40/cm$; costae (nearly) equal in size; lower order septa solid.....
.....*Fungia (Pleuractis) gravis*
18. Tentacular lobes absent; density of septal dentations $<30/cm$; granulations on septal sides arranged in rows parallel to septal margin (zigzagged); costal spines short and granulated.....
.....*Fungia (Pleuractis) paumotensis*
Tentacular lobes present; density of septal dentations $\geq 30/cm$; granulations on septal fringe arranged in rows perpendicular to septal margin; costal spines thin, relatively elongated and acute
.....*Fungia (Lobactis) scutaria*
19. Corals elongated; all mouths or only largest mouths arranged in distinct row along central axis20
Corallum outline oval; mouths not arranged in distinct row, but distributed over whole upper surface..22
20. Mouths arranged in row along and alongside central axis; density of septal dentations $>10/cm$21
Mouths only arranged in row along central axis; density of septal dentations $<10/cm$...*Ctenactis crassa*
21. Mouths alongside central axis unevenly arranged; length of interstomatous septa $>1\text{ cm}$; septa parallel; granulations on septal sides arranged in rows perpendicular to septal margin ...*Herpolitha limax*
Mouths alongside central axis more or less evenly arranged; length of interstomatous septa $<1\text{ cm}$; septa more or less diverging from mouths (radiating); granulations on septal fringe irregularly arranged.....
.....*Polyphyllia talpina*
22. Length of central mouth usually $<1/8$ of coral length; coral not humped around central mouth; secondary mouths either evenly distributed or mainly concentrated at both ends of the central mouth23
Length of central mouth $>1/8$ of coral length; coral usually thick and humped, particularly around central mouth; secondary mouths mainly concentrated alongside central mouth.....
.....*Fungia (Pleuractis) taiwanensis*
23. Secondary mouths mainly concentrated at both ends of the relatively large central mouth, especially in the direction of the central axis; lower order septa distinctly higher than others; septal dentations irregularly shaped, long and sharp
.....*Sandalolitha dentata*

- Secondary mouths almost evenly distributed around central mouth, which may only be slightly larger than these; lower order septa slightly higher than others; septal dentations nearly equally blunt and lobate *Sandalolitha robusta*
24. Corallum wall solid.....25
Corallum wall perforated.....
..... *Podabacia crustacea*
25. Coral foliaceous; maximum diameter >10 cm.....*Lithophyllon undulatum*
Coral encrusting; maximum diameter <10 cm.....*Lithophyllon mokai*

SYSTEMATIC ACCOUNTS

Phylum Cnidaria

Class Anthozoa

Subclass Zoantharia De Blainville, 1830

Order Scleractinia Bourne, 1900

Suborder Fungiina Verrill, 1856

Superfamily Fungiidae Dana, 1846

Family Fungiidae Dana, 1846

Diagnosis: The Fungiidae can be distinguished from other scleractinian reef corals by the presence of compound synapticalae between the septo-costal units (Hoeksema, 1989; fig. 39).

Remarks: The family is subdivided into 11 genera: *Fungia*, *Heliofungia*, *Ctenactis*, *Herpolitha*, *Polyphyllia*, *Sandalolitha*, *Zoopilus*, *Halomitra*, *Cantharellus*, *Lithophyllon* and *Podabacia*. All genera except *Zoopilus*, *Halomitra* and *Cantharellus* are represented in Taiwan. *Heliofungia* is recorded only from the Pleistocene fossils.

Genus *Fungia* Lamarck, 1801

Type species: *Fungia agariciformis* Lamarck, 1801 [= *Fungia fungites* (Linnaeus, 1758)].

Diagnosis: Corals usually with a single, centrally located mouth; when supernumerous mouths are present, the

central mouth is distinctly larger than the others. Corals are free-living in adult phase. Their tentacles are short. The maximum diameter of the coralla does not exceed 40 cm.

Remarks: Seven subgenera are recognized. All are represented in the waters around Taiwan: *Cycloseris*, *Verrillofungia*, *Danafungia*, *Fungia*, *Wellsofungia*, *Lobactis* and *Pleuractis*.

Subgenus *Cycloseris* Milne Edwards & Haime, 1849

Type species: *Fungia cyclolites* Lamarck, 1815.

Diagnosis: Animals entire or wedge-shaped, regenerating fragments. Outline of unbroken corals varying from circular to oval. Corallum wall is solid. Septal dentations and costal spines usually fine and sharp. Granulations on septal sides arranged in rows perpendicular to septal edge. Diameter of coralla not exceeding 15 cm.

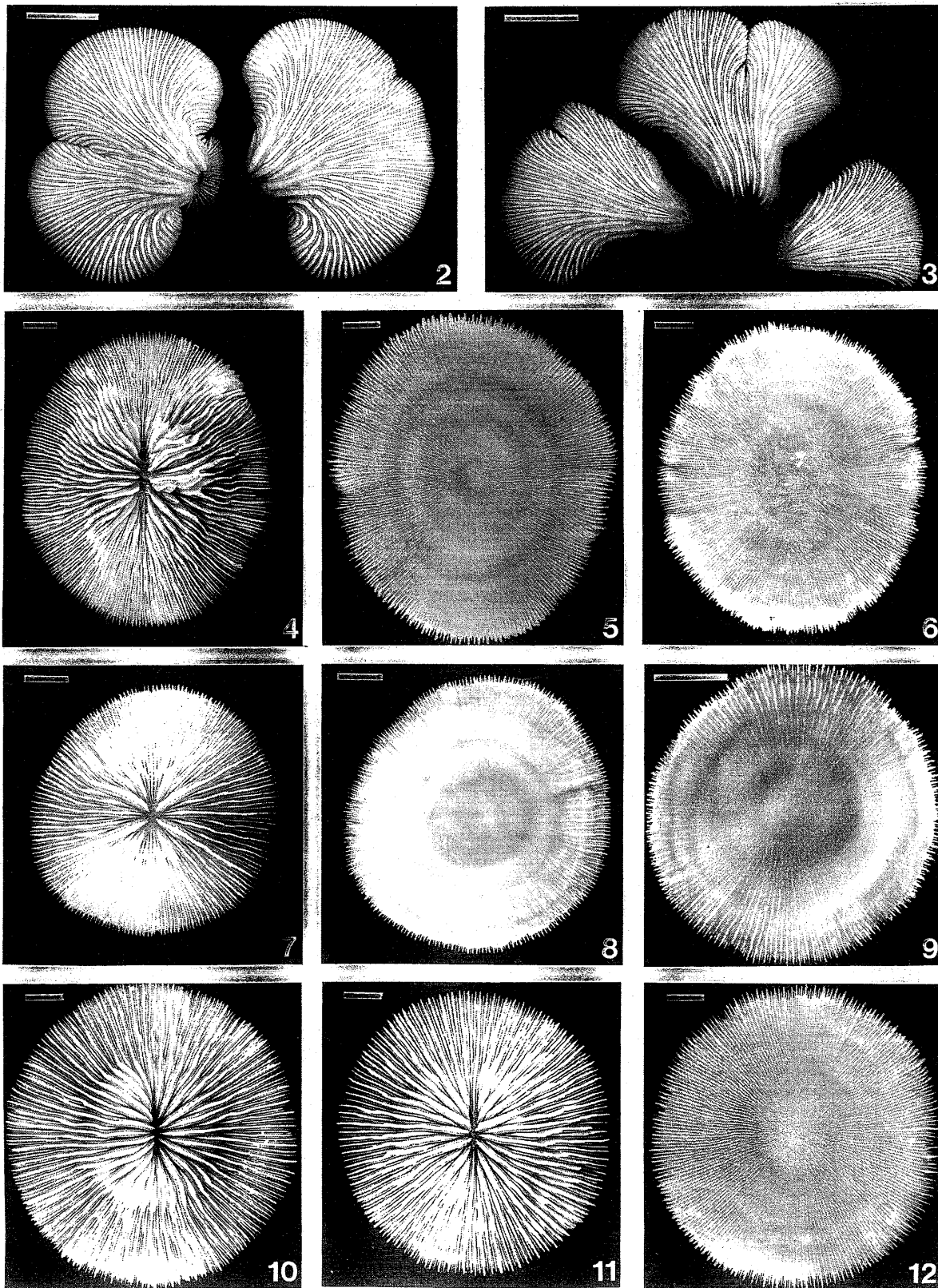
Remarks: Of the ten species, *Fungia* (*Cycloseris*) *sinensis* (Milne Edwards & Haime, 1851), *F. (C.) cyclolites* Lamarck, 1801, *F. (C.) fragilis* (Alcock, 1893), *F. (C.) costulata* Ortmann, 1889, *F. (C.) tenuis* Dana, 1846 and *F. (C.) vaughani* Boschma, 1923 have been recorded from Taiwan. *F. (C.) distorta* Michelin, 1842, *F. (C.) curvata* Hoeksema, 1989, *F. (C.) somervillei* Gardiner, 1909 and *F. (C.) hexagonalis* Milne Edwards & Haime, 1848 were not found during the present study.

Fungia (*Cycloseris*) *sinensis* (Milne Edwards & Haime, 1851)

(Figs. 2-3)

Materials: NMNS 000017-F000481, -F000484, -F0000488 (2), 000196-F001461 (several fragments from Pleistocene at Panpingshan); TUIO-C-600 (2), RMNH 18101 (9 fragments) (Nanwan Bay).

Diagnosis: Coralla usually thin and



varying from flat to arched. Central fossa short. Septa are densely packed. Costae are fine and more or less of equal size. Recent specimens only in fragmented shape.

Remarks: First record for Taiwan, where the species is rare. All living specimens occurred at a single locality and were in fragmented condition. The fragments were found clustered on soft substrata (± 30 m deep) offshore, where strong currents occur. Some of the fossils have the complete shape.

Fungia (Cycloseris) cyclolites

Lamarck, 1815

(Figs. 4-6)

Materials: RMNH 18105 (2) (Yenliao Bay); NMNS 000017-F000494, -F000504, 000196-F001462 (2) (Pleistocene at Panpingshan); RMNH 18106 (30) (Hsiao-Liuchiu); SYUMB-S-0010 (W Hengchun Peninsula); RMNH 18069, 18102 (3), 18103 (3), 18104 (3), TUIO-C-601 (23) (Nanwan Bay).

Diagnosis: Coralla usually thick and varying from flat to arched. Corallum outline of complete individuals slightly oval. Central fossa relatively long. Costae fine and varying from equal to subequal.

Remarks: First substantiated record for Taiwan. The species has been found in several localities. It is common at Hsiao-Liu-Chiu. All specimens were found in unfragmented shape. Most animals were found on slopes with predominantly fine sediment present.

Fungia (Cycloseris) fragilis

(Alcock, 1893)

(Figs. 7-9)

Materials: NMNS 000017-F000503 (Plei-

stocene at Panpingshan); SYUMB-S-0012 (W Hengchun Peninsula); RMNH 18107 (4), 18108 (2), TUIO-C-602 (3) (Nanwan Bay).

Diagnosis: Coralla thin and flat. Outline of unbroken specimens round. Central fossa short. Costae fine and alternating in thickness and height.

Remarks: First record for Taiwan, where the species is rare. Specimens were only found in complete, unfragmented shape; usually at the lower parts of reef slopes and on the soft substrata underneath.

Fungia (Cycloseris) costulata

Ortmann, 1889

(Figs. 10-12)

Materials: NMNS 000017-F000480, -F000482/483, -F000489, -F000498/502, -F000505, 000196-F001461 (12) (Pleistocene at Panpingshan); RMNH 18112 (9) (Hsiao-Liuchiu); RMNH 18111 (2) (W Hengchun Peninsula); RMNH 18109, 18110 (2), TUIO-C-603 (3) (Nanwan Bay).

Diagnosis: Coralla thick and flat. Outline round. Septo-costal ornamentations vary from fine to relatively coarse. Costae more or less equal in size.

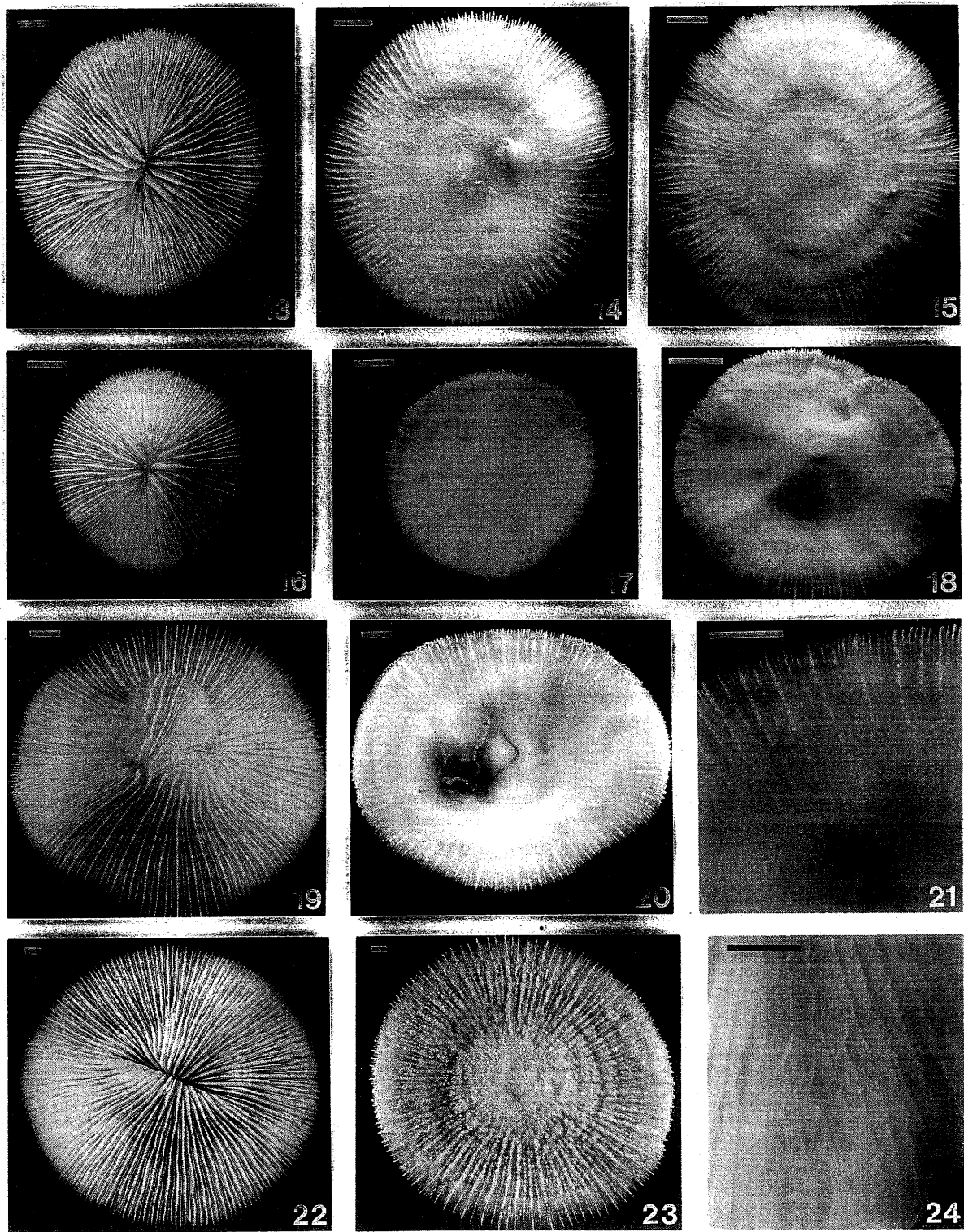
Remarks: First record for Taiwan, where the species is uncommon. The specimens were found on the lower part of reef slopes and on the soft substrata underneath.

***Fungia (Cycloseris) tenuis* Dana, 1846**

(Figs. 13-15)

Materials: RMNH 18113 (2) (Yenliao Bay); RMNH 18114 (15) (Hsiao-Liu-Chiu); RMNH 18115 (7), 18116 (19), TUIO-C-604 (38) (Nanwan Bay).

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- Figs. 2-3. *Fungia (Cycloseris) sinensis* RMNH 18101.
 Figs. 4-6. *Fungia (Cycloseris) cyclolites*, RMNH 18106.
 Figs. 7-9. *Fungia (Cycloseris) fragilis*, RMNH 18107.
 Figs. 10-12. *Fungia (Cycloseris) costulata*, RMNH 18112.
 Scale bars: 1 cm.



Diagnosis: Coralla thick and varying from flat to slightly arched. Outline varying from round to slightly oval. Costae distinctly unequal in size; the largest ones not regularly distributed. Costal spines unequal in size and directing in various direction.

Remarks: First record for Taiwan, where the species is common. Most species were found on reef slopes.

Fungia (Cycloseris) vaughani
Boschma, 1923

(Figs. 16-18)

Materials: RMNH 18117 (W Hengchun Peninsula); RMNH 18960, 18118 (4), TUIO-C-605 (Nanwan Bay).

Diagnosis: Coralla varying from thin to flat. Corallum outline of complete corals usually round. Costae distinctly unequal in size; the largest ones regularly arranged. Costal spines fine and directing downward. Usually distinct rows of granulations on the costal sides, resembling those on the septa.

Remarks: First record for Taiwan, where it is rare. The specimens were found on the lower part of reef slopes and on the soft substrata underneath.

Subgenus *Verrillofungia* Wells, 1966

Type species: *Fungia repanda* Dana, 1846.

Diagnosis: Corallum outline varying from circular to slightly oval. Corallum wall either solid or perforated. Septa and costae either equal or unequal. Septal dentations and costal spines varying from fine to coarse. Granulations on septal sides arranged (or fused) in rows

parallel to septal edge. Costal spines usually short, blunt and club-shaped. They are granulated over their whole surface. Diameter of coralla not exceeding 25 cm.

Remarks: Of the four species, *Fungia (Verrillofungia) concinna* Verrill, 1846 and *F. (V.) repanda* Dana, 1864 were found during the present study. *F. (V.) spinifer* Claereboudt & Hoeksema, 1987 and *F. (V.) scabra* Döderlein, 1901 were not observed around Taiwan.

Fungia (Verrillofungia) concinna
Verrill, 1864

(Figs. 19-21)

Materials: NMNS 000196-F001455, -F001465 (Pleistocene at Panpingshan); RMNH 18119, TUIO-C-606 (3) (Nanwan Bay).

Diagnosis: Coralla usually thick and varying from flat to slightly arched. Corallum outline varying from circular to slightly oval. Corallum wall solid. Septal dentations angular and usually intermediate between fine and coarse. Costae varying in size and bearing short, blunt spines.

Remarks: First substantiated record for Taiwan, where the species is uncommon. Most specimens were found on reef slopes or on patches of coral surrounded by sand.

Fungia (Verrillofungia) repanda
Dana, 1846

(Figs. 22-26)

Materials: RMNH 18120, 18121 (2), SYUMB-S-0005/0009 (W Hengchun Peninsula); TUIO-C-607 (13) (Nanwan Bay).

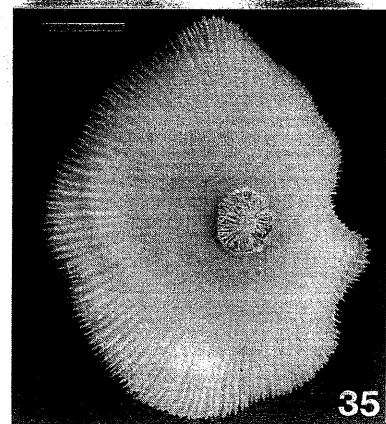
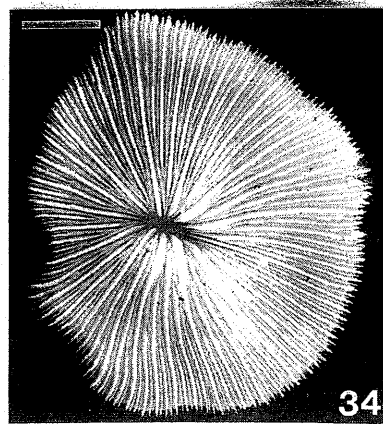
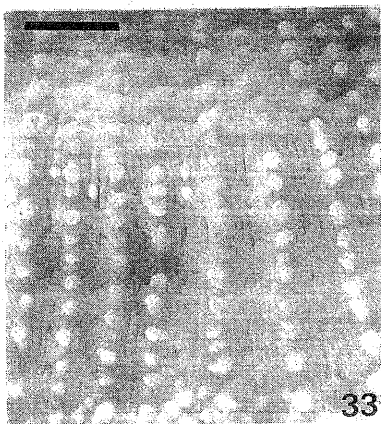
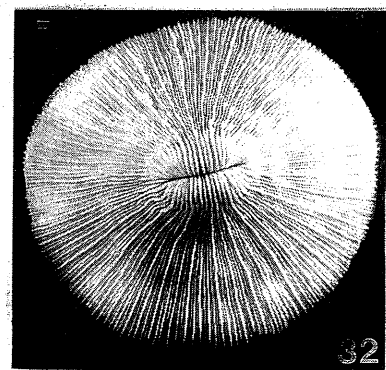
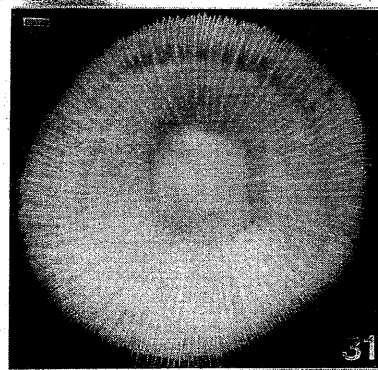
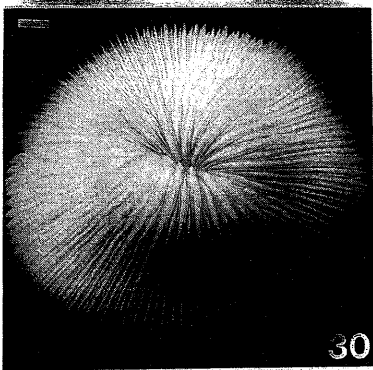
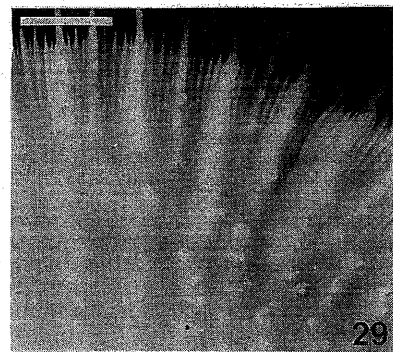
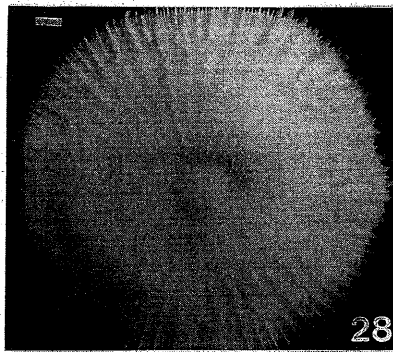
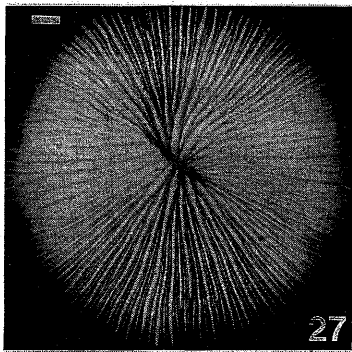
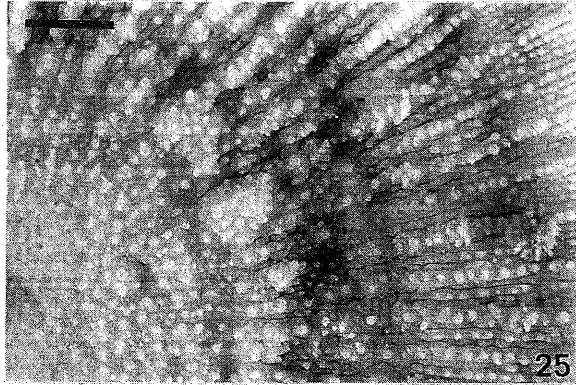
Figs. 13-15. *Fungia (Cycloseris) tenuis*, RMNH 18114.

Figs. 16-18. *Fungia (Cycloseris) vaughani*, RMNH 18118.

Figs. 19-21. *Fungia (Verrillofungia) concinna*, RMNH 18119.

Figs. 22-24. *Fungia (Verrillofungia) repanda*, TUIO-C-607-1.

Scale bars: 1 cm.



Diagnosis: Coralla usually thick and slightly arched. Corallum outline more or less circular. Corallum wall perforated in full-grown specimens. Septal dentations angular and coarse. Costae varying in size and usually bearing short, blunt spines; spines occasionally long and branched, with sharp points.

Remarks: First substantiated record for Taiwan. Specimens of this species were occasionally found on reef slopes.

Subgenus *Danafungia* Wells, 1966

Type species: *Fungia danai* Milne Edwards & Haime, 1851, *sensu* Wells, 1966 [= *Fungia scruposa* Klunzinger, 1879].

Diagnosis: Corallum outline round. Corallum wall either solid or perforated. Higher order costae distinctly less developed than those of lower orders; spines on the former rather rudimentary. Septal dentations varying from fine to coarse. Granulations on septal sides irregularly distributed or arranged (or fused) in rows either perpendicular or parallel to septal edge. Costal spines are granulated over their whole surface. Diameter of coralla not exceeding 40 cm.

Remarks: Of the three species, *Fungia (Danafungia) horrida* Dana, 1846 and *F. (D.) scruposa* Klunzinger, 1879 are reported here. *F. (D.) fralinae* Nemenzo, 1955 has not been found around Taiwan.

Fungia (Danafungia) horrida Dana, 1846 (Figs. 27-29)

Materials: NMNS 000017-F000506, 000196-F001461 (Pleistocene at Panpingshan); RMNH 18122 (W Hengchun Penin-

sula); RMNH 18123 (3), TUIO-C-608 (2) (Nanwan Bay).

Diagnosis: Coralla thick and varying from flat to arched. Corallum wall solid. Septal dentations usually coarse and either angular or irregular in shape. Spines on lower order costae usually long and directing in various directions; those on higher order costae either undeveloped or short and directing downward.

Remarks: First substantiated record for Taiwan, where this species is not common. The specimens were usually found on the deeper parts of reef slopes.

Fungia (Danafungia) scruposa Klunzinger, 1879 (Figs. 30-33)

Materials: NMNS 000017-F000492 (Pleistocene at Panpingshan); RMNH 18128 (2) (Hsiao-Liu-Chiu); RMNH 18071, 18127, TUIO-C-609 (2) (Nanwan Bay).

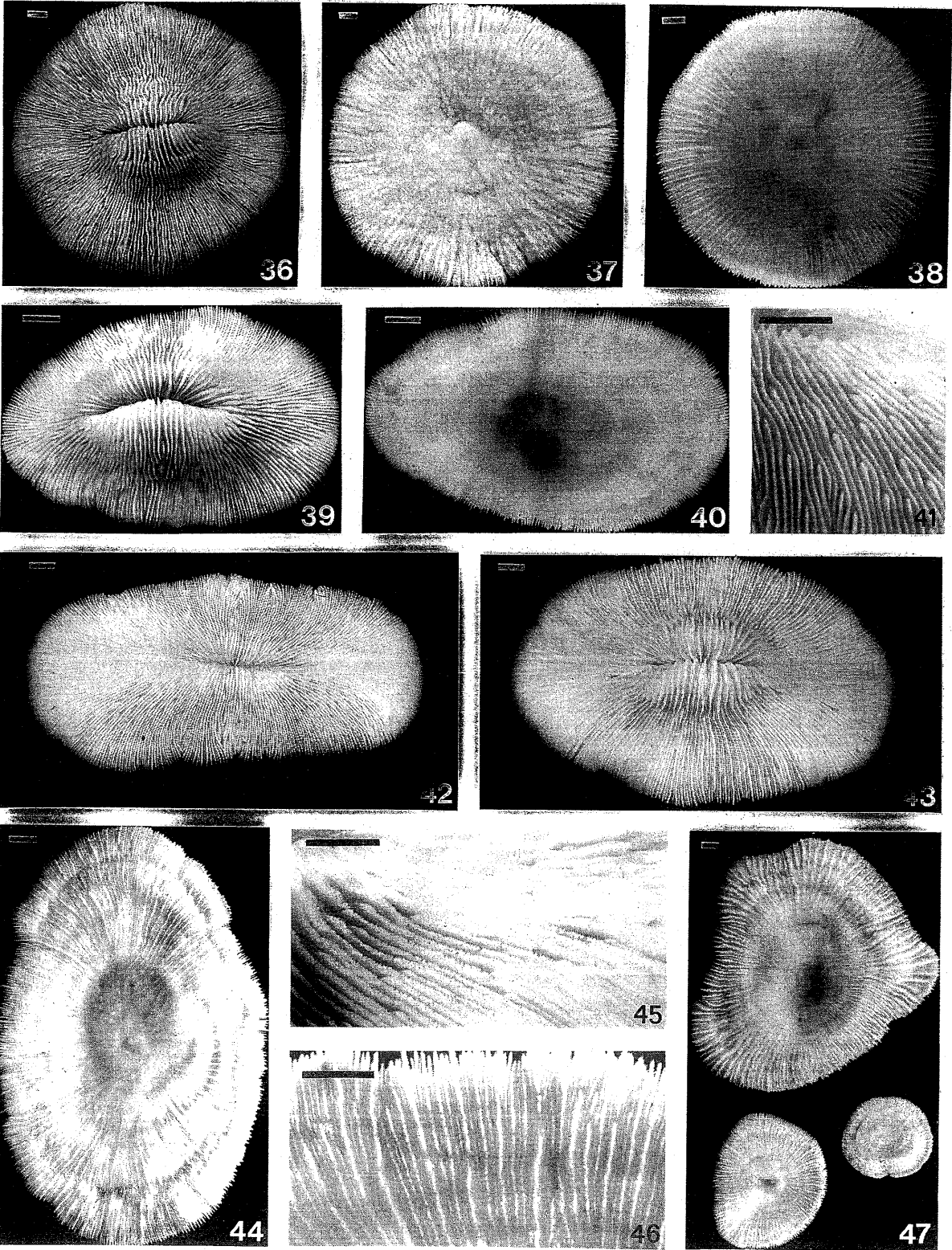
Diagnosis: Coralla varying from thin to thick and from flat to arched. Corallum wall perforated. Septal dentations usually coarse and either angular or irregular in shape. Spines on lower order costae usually long and directing in various directions; those on higher order costae either undeveloped or short and directing downward.

Remarks: First record for Taiwan. Not common in Taiwan. Most specimens were found on relatively shallow parts of reef slopes.

Subgenus *Fungia* Lamarck, 1801

Type species: *Fungia agariciformis*

- Fig. 25. *Fungia (Verrillofungia) repanda*, TUIO-C-607-1, lower surface.
 Fig. 26. *F. (V.) repanda*, RMNH 18121, lower surface.
 Figs. 27-29. *Fungia (Danafungia) horrida*, RMNH 18123.
 Figs. 30-31. *Fungia (Danafungia) scruposa*, RMNH 18127.
 Figs. 32-33. *F. (D.) scruposa*, TUIO-C-609.
 Figs. 34-35. *Fungia (Fungia) fungites*, TUIO-C-601-1.
 Scale bars: 1 cm.



Lamarck, 1801 [= *Fungia fungites* (Linnaeus, 1758)].

Diagnosis: Corallum outline varying from slightly oval to circular. Costae usually unequal in size. Granulations on septal dentations arranged in rows perpendicular to septal margin. Costal spines granulated at their tip. Corallum diameter not over 35 cm.

Remarks: The only species, *Fungia* (*Fungia*) *fungites* (Linnaeus, 1758), has been recorded from Taiwan (Hoeksema, 1989).

***Fungia* (*Fungia*) *fungites* (Linnaeus, 1758)**
(Figs. 34-35)

Material: TUIO-C-610 (Hongchai, W. Hengchun Peninsula).

Diagnosis: Coralla varying from thin to thick and from flat to arched. Corallum wall perforated. Septal dentations usually angular and varying from fine to coarse. Costal spines long and normally directing downward.

Remarks: Earlier record by Hoeksema (1989). Rare in Taiwan. The single specimen found during the present survey occurred on the reef slope of a sea mount.

Subgenus *Wellsofungia* Hoeksema, 1989

Type species: *Fungia granulosa* Klunzinger, 1879.

Diagnosis: Corallum outline varying from slightly oval to circular. Costae either equal or unequal in size. Granulations on septal dentations arranged in rows parallel or perpendicular to septal

margin. Septocostal ornamentations fine and granular. Corallum diameter not more than 20 cm.

Remarks: The only species, *Fungia* (*Wellsofungia*) *granulosa* Klunzinger, 1889, is present in Taiwan.

Fungia* (*Wellsofungia*) *granulosa
Klunzinger, 1879
(Figs. 36-38)

Materials: NMNS 000017-F000496, 000162-F001265, 000196-F001460 (Pleistocene at Panpingshan); RMNH 18074 (3), 18124 (2), 18125, TUIO-C-611 (23) (Nanwan Bay).

Diagnosis: Coralla varying from thin to thick and from flat to arched. Corallum wall perforated. Septa and costae densely packed. Tentacular lobes may be present.

Remarks: Earlier record by Hanzawa (1931: pl. 2, fig. 2) not clear. The species is relatively common in Taiwan, where it is most abundant on the lower parts of reef slopes.

Subgenus *Lobactis* Verrill, 1864

Type species: *Fungia dentigera* Leuckart, 1841 [= *Fungia scutaria* Lamarck, 1801].

Diagnosis: Corallum outline varying from oval to elongated. Costae equal to subequal in size. Granulations on septal dentations arranged in rows perpendicular to septal margin. Costal spines blunt or long and granulated at their tip. Corallum diameter not over 20 cm.

Remarks: The single species, *Fungia* (*Lobactis*) *scutaria* Lamarck, 1801, is present in Taiwan.

Figs. 36-37. *Fungia* (*Wellsofungia*) *granulosa*, TUIO-C-611-1.

Fig. 38. *F.* (*W.*) *granulosa*, RMNH 18124.

Figs. 39-41. *Fungia* (*Lobactis*) *scutaria*, TUIO-C-612-1.

Fig. 42. *F.* (*L.*) *scutaria*, RMNH 18130.

Figs. 43-46. *Fungia* (*Pleuractis*) *moluccensis*, RMNH 18133.

Fig. 47. *F.* (*P.*) *moluccensis*, SYUMB-S-0001/0003.

Scale bars: 1 cm.

***Fungia (Lobactis) scutaria* Lamarck, 1801**
(Figs. 39-42)

Materials: NMNS 000196-F001454, F-001457 (Pleistocene at Panpingshan); RMNH 18131, SYUMB-S-0018/0019 (W Hengchun Peninsula); RMNH 18073, 18129 (2), 18130 (4), TUIO-C-612 (77) (Nanwan Bay).

Diagnosis: Coralla varying from thin to thick and from flat to arched. Corallum wall perforated. Septa densely packed and wavy, costae interrupted. Tentacular lobes usually present.

Remarks: Earlier record by Yang *et al.* (1980; pl. 1, fig. b, pl. 5). The species is relatively common in Taiwan, where it is most abundant on the deeper parts of reef slopes.

Subgenus *Pleuractis* Verrill, 1864

Type species: *Fungia scutaria* Lamarck, 1801, *sensu* Verrill, 1864 [= *Fungia paumotensis* Stutchbury, 1833].

Diagnosis: Corals of three species usually with a single, centrally located mouth and possibly with supernumerous mouths; in one species smaller mouths are obligatory present around the central mouth of adult specimens. Corallum outline varying from oval to elongated. Costae either equal or unequal in size. Granulations on septal dentations irregularly arranged or in rows parallel to septal margin. Costal spines blunt, simple and granulate or laterally compressed. Maximum corallum diameter 28 cm.

Remarks: All four species occur in Taiwan: *Fungia (Pleuractis) moluccensis* Van der Horst, 1919, *F. (P.) gravis* Nemenzo, 1955, *F. (P.) paumotensis* Stutchbury, 1833 and *F. (P.) taiwanensis* sp. nov.

***Fungia (Pleuractis) moluccensis* Van der Horst, 1919**
(Figs. 43-47)

Materials: NMNS 000058-001010, 001011 (Pleistocene near Kaohsiung); RMNH 18132, SYUMB-S-0001/0004 (W Hengchun Peninsula); RMNH 18133, TUIO-C-613 (6) (Nanwan Bay).

Diagnosis: Corallum outline irregularly oval. Corallum usually strongly humped around the fossa. Lower side flat or concave. Detachment scar distinct or at least discernible. Corallum wall perforated. Costae unequal and irregularly shaped. Costal spines blunt and granular. Septa densely packed. Tentacular lobes may be present. Septal dentations fine, blunt and irregularly granular or slightly angular and sharp. Septal sides densely granulated in an almost even pattern.

Remarks: First substantiated record for Taiwan. The species is not common in Taiwan. Most animals were found on the lower parts of reef slopes and on the soft bottom underneath.

***Fungia (Pleuractis) taiwanensis* sp. nov.**
(Figs. 48-62)

Type materials: RMNH 18152 (holotype) and RMNH 18153 (3), 18154 (5), TUIO-C-614-1 (6), USNM 87618 (paratypes) (type locality Hsiao-Liu-Chiu, ca. 10 km off SW Taiwan).

Additional materials: RMNH 18155 (4) (W Hengchun Peninsula); RMNH 18156, 18157 (4), 18158 (17), TUIO-C-614-7 (10) (Nanwan Bay).

Description: Adults (anthocyathi) are free-living, whereas juveniles (anthocauli) live attached by means of a stalk. The length of the specimens (measured along the aboral side) varies from 3.5 to 28.0 cm. The corals have an irregularly oval-elongated corallum outline with rounded or tapering ends. In addition to a large centrally located mouth, many smaller ones are formed in an irregular pattern, by circumoral (circumstomadaeal) budding. The length of the central fossa,



Fig. 48a. A specimen of *Fungia (Pleuractis) taiwanensis* (right, with brown upper surface and white tentacles, RMNH 18158) and a coral of the resembling species *Sandalolitha dentata* (left, with green-grey coloration, RMNH 18143). Locality: sea mount in Nanwan Bay, ca. 20 m deep.

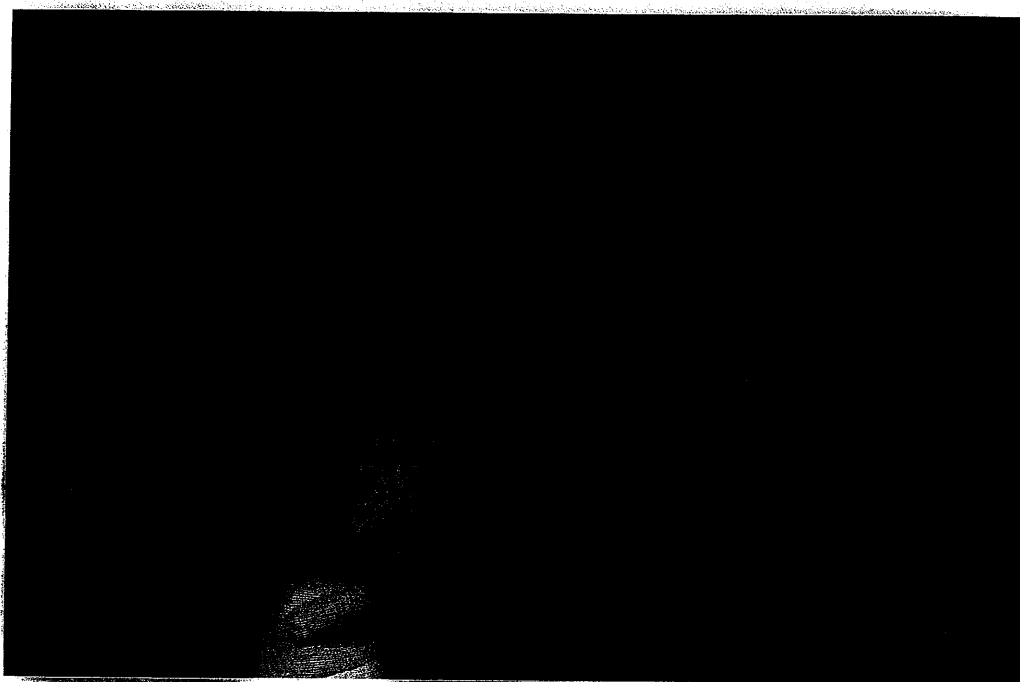
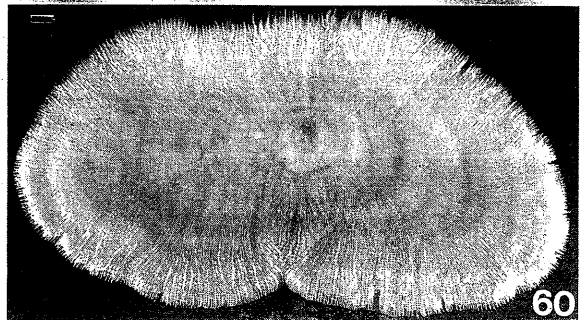
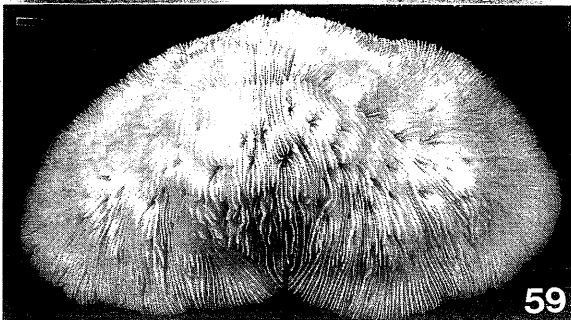
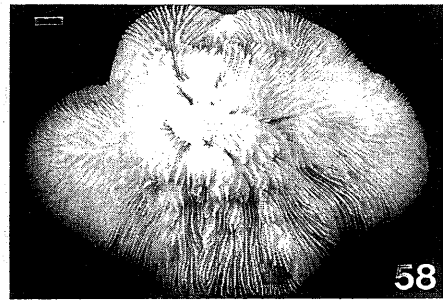
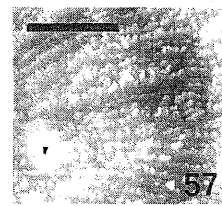
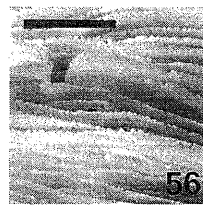
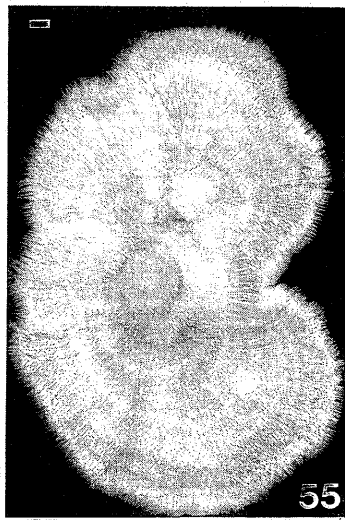
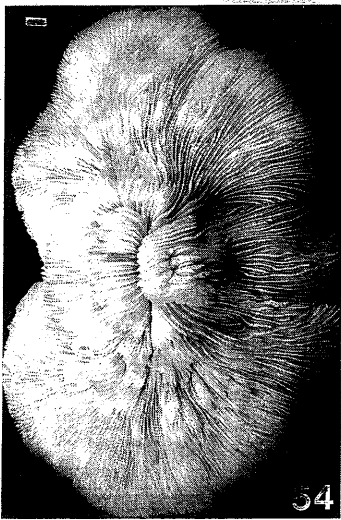
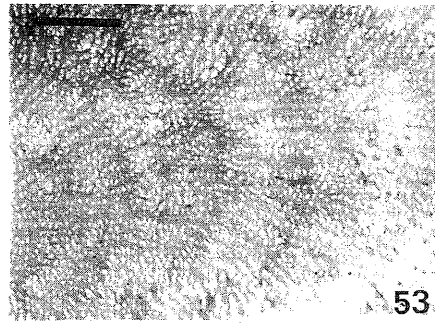
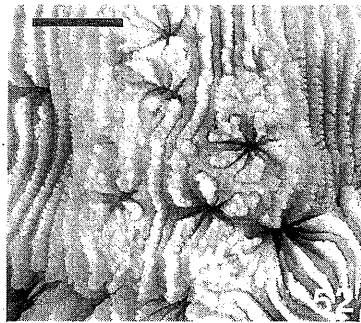
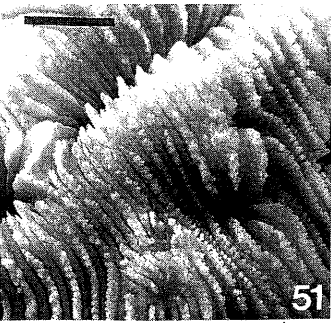
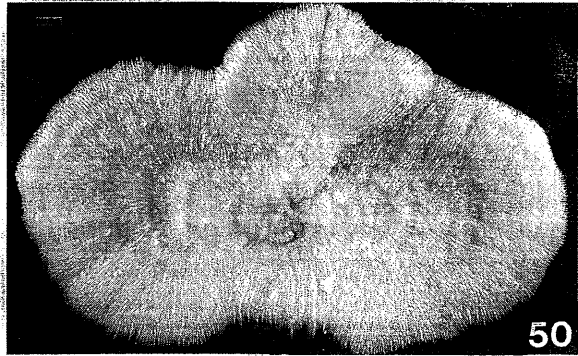
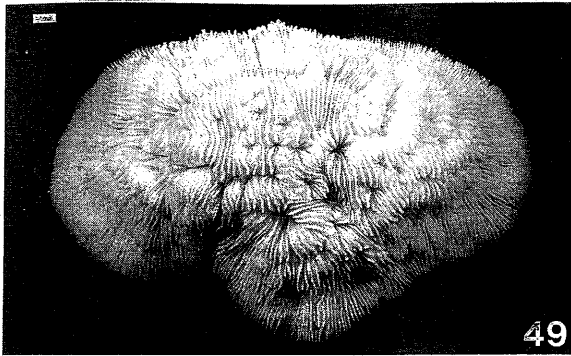


Fig. 48b. A broken and regenerated coral of *Sandalolitha dentata*, TUIO-C-620. Locality: Nanwan Bay.



measured at its bottom, is 1/8 to 1/3 of the corallum length. The septal edges around it stand upright, whereas those at both ends diverge away from it. Its columella is formed by a mingled mass of tightly packed, sometimes fused paliform lobes and trabeculae with their tips pointing upward or in various directions.

The corals vary in thickness and they are either slightly to strongly curved. The oral surface is convex; the area around the fossa is usually slightly humped. The septa are densely packed. They are usually straight at the corallum periphery; they may be slightly curved in between or near the stomata. The septa of lower orders are thick and either perforated or solid, while those of higher orders are thin and always perforated. The former ones are more exsert than the latter ones. Tentacular lobes may be present, but are not common. The septal margins are finely ornamented with septal dentations which are either fine and sharp or slightly elongated and lobated, or shaped like ravels. Their number varies from 12 to 25 per cm. The septal sides are densely granulated. The granulations are almost evenly distributed. The compound synapticulae in between the septa cannot easily be detected, because of the tight septal arrangement.

The corallum wall is perforated in adults. A clear detachment scar (usually >1 cm in diameter) is visible at the aboral side of small anthocyathi. It is less distinct and eventually almost not discernible in adults. The wall is not granulated. The costae are unequal in size. They are usually distinct and high

in adults; those of lower orders may be thickened. In smaller specimens they are less distinct, but still clear. They are finely to coarsely ornamented with spines which are either blunt and granular, or laterally compressed and lobated, or slightly echinose (particularly in small corals). The number of costal spines varies from 10 to 45 per cm costa. The animals do not form fragmentation clefts in the periphery of the corallum wall.

The living animals are brown. Their small tentacles are usually distinctly white (Fig. 48a), occasionally transparent.

Remarks: The species is relatively common in Taiwan. In the field, it can easily be distinguished from co-occurring specimens of *F. (P.) moluccensis* by the large number of mouths and the usually white tentacles. Related to other *Fungia* (*Pleuractis*) species, *F. (P.) taiwanensis* appears to have the largest maximum size. Due to the large number of mouths, the animals resemble corals belonging to *Sandalolitha* (Figs. 80-87). Nevertheless, adults in the latter genus do not show such a long central fossa. In contrast to that genus, the corallum wall of the new species is not distinctly covered by granulations, although it may sometimes seem so where costal spines are not completely developed. Furthermore, the area around the central fossa is more humped compared to that genus, which is an apomorphic character state shared with *F. (P.) moluccensis* and with *F. (P.) gravis* (Hoeksema, 1989).

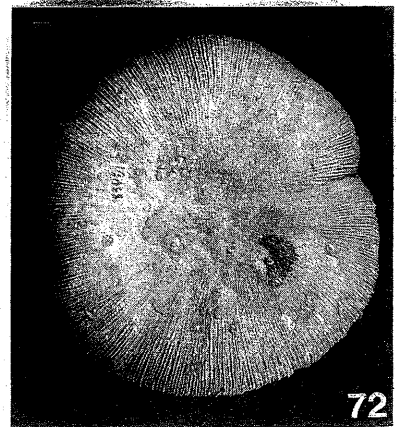
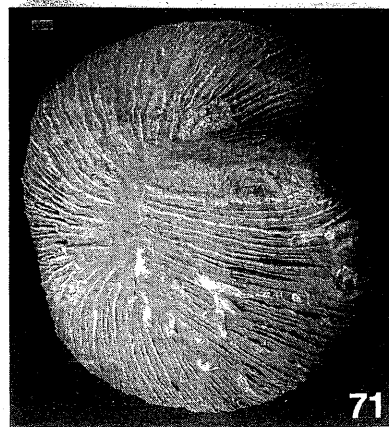
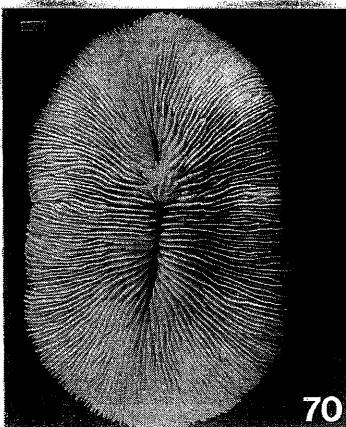
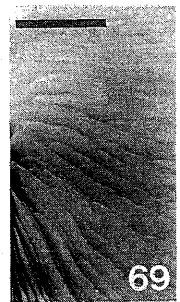
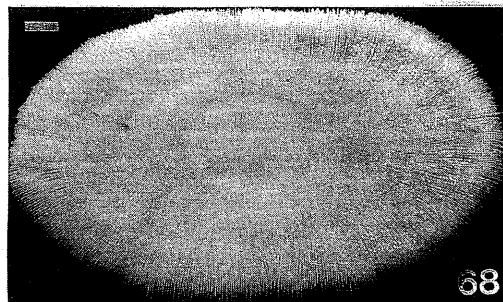
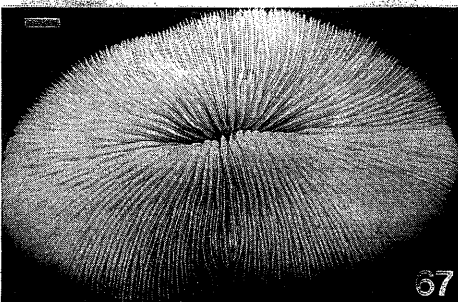
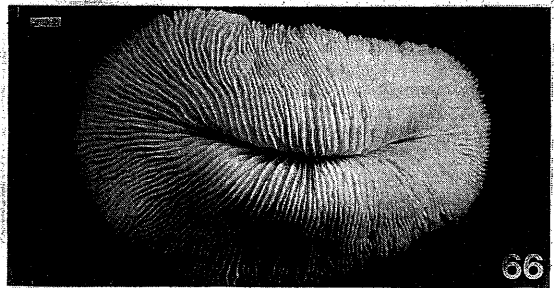
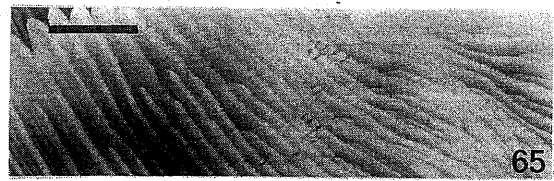
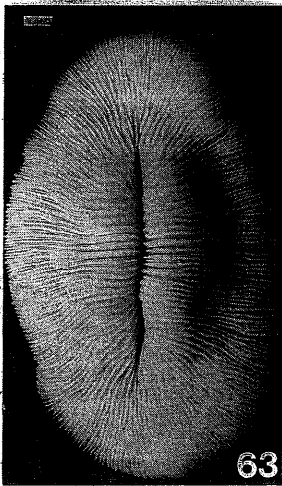
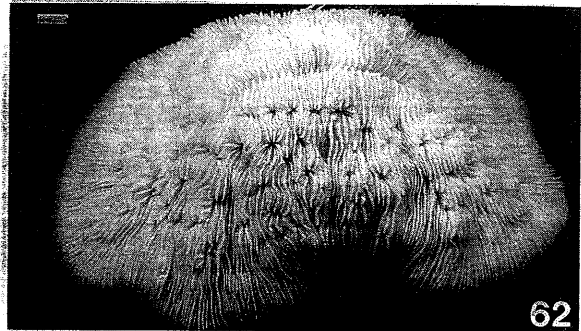
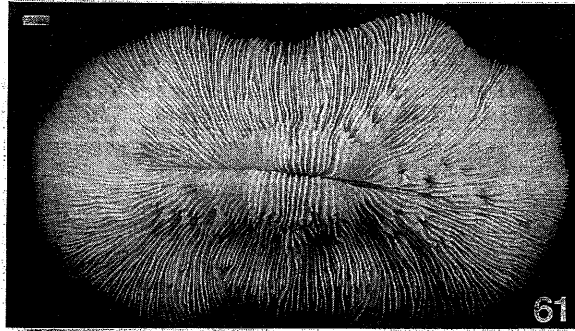
Most specimens occurred on the lowest parts of reef slopes and on the soft substrata of reef bases, where it can be found even deeper than 30 m.

Figs. 49-53. Holotype of *Fungia (Pleuractis) taiwanensis*, RMNH 18152, upper and lower surface, and close-ups of septa, mouths and costae.

Figs. 54-58. A paratype of *F. (P.) taiwanensis*, RMNH 18154.

Figs. 59-60. A paratype of *F. (P.) taiwanensis*, RMNH 18153.

Scale bars: 1 cm.



***Fungia (Pleuractis) gravis* Nemenzo, 1955**
(Figs. 63-66)

Materials: NMNS 000017-F000485, 000162-F001267, 000196-F001454/F001455, -F001457 (Pleistocene at Panpingshan); RMNH 18134 (2), TUIO-C-615 (5) (Hsiao-Liuchiu); SYUMB-S-0011 (W Hengchun Peninsula).

Diagnosis: Corallum outline varying from oval to slightly elongated. Corallum thick and usually with a slightly humped oral surface. Lower side varying from flat to slightly concaved. Detachment scar usually not visible. Corallum wall perforated. Costae equal and regularly shaped. Costal spines blunt and laterally compressed. Septa densely packed. Tentacular lobes occasionally present. Septal dentations fine, blunt and irregularly granular or slightly angular and sharp. Septal sides densely granulated at the septal edge in an almost even pattern.

Remarks: First record for Taiwan. The species is common in Taiwan. Most specimens were found on reef slopes.

Fungia (Pleuractis) paumotensis
Stutchbury, 1833
(Figs. 67-70)

Materials: NMNS 000017-F000487, -F000490, 000196-F001461 (Pleistocene at Panpingshan); RMNH 18135, TUIO-C-616 (9) (Hsiao-Liu-Chiu); SYUMB-S-0013 (W Hengchun Peninsula).

Diagnosis: Corallum outline varying from oval to slightly elongated. Corallum thick and varying from flat to slightly arched; no humped oral surface. Detachment scar usually not visible. Corallum wall perforated. Costae equal

and regularly shaped. Costal spines blunt and laterally compressed. Septa relatively loosely arranged. Tentacular lobes absent. Septal dentations varying from fine to moderately coarse; they are angular and blunt. Granulations on septal sides arranged in ridges parallel to septal edge.

Remarks: First substantiated record for Taiwan. The species is rare in Taiwan. The specimens were found on reef slopes.

Genus *Heliofungia* Wells, 1966

Type species: *Fungia actiniformis* Quoy & Gaimard, 1833.

Diagnosis: Corals usually with a single mouth. Corals free-living in adult phase. Tentacles long. The maximum corallum diameter does not exceed 25 cm.

Remarks: The single species, *Heliofungia actiniformis* (Quoy & Gaimard, 1833), has been found in the Pleistocene of Taiwan only.

***Heliofungia actiniformis* (Quoy & Gaimard, 1833)**
(Figs. 71-72)

Materials: NMNS 000017-F000491, -F000493, -F000497, -F000516, -F000520 (several casts), 000162-F001267, 000196-F001450/1452 (4), -F001455, -F001459, -F001463/1464 (3) (Pleistocene at Panpingshan, SW Taiwan).

Diagnosis: Coralla thick. Corallum wall solid and with distinct detachment scar. Corallum outline varying from slightly oval to circular. Septal dentations lobated and coarse. Granulations

Figs. 61-62. Paratypes of *Fungia (Pleuractis) taiwanensis*, RMNH 18153.

Figs. 63-65. *Fungia (Pleuractis) gravis*, RMNH 18134.

Fig. 66. *F. (P.) gravis*, SYUMB-S-0011.

Figs. 67-69. *Fungia (Pleuractis) paumotensis*, RMNH 18145.

Fig. 70. *F. (P.) paumotensis*, SYUMB-S-0013.

Figs. 71-72. *Heliofungia actiniformis*, NMNS 000017-F000516.

Scale bars: 1 cm.

on their sides in radiating rows. Costal spines laterally compressed and with rows of granulations on their sides.

Remarks: First record for Taiwan. No records of living specimens. The species occurred abundantly in the Pleistocene. Several specimens were collected when clustered together. Most specimens were embedded in clay, which suggests that the animals occurred in a sheltered environment where fine sediment had been able to accumulate.

Genus *Ctenactis* Verrill, 1864

Type species: *Madrepora echinata* Pallas, 1766.

Diagnosis: Corals free-living in adult phase. Corallum outline varying from oval to elongated. Animals either have one mouth or more than one. Septal dentations coarse and either angular or rounded lobate. Granulations on septal dentations either arranged in indistinct rows perpendicular or parallel to septal margin, or evenly distributed. Costae unequal in size. Costal spines varying from blunt and granular to large and echinose. Tentacles short. Maximum corallum diameter over 50 cm.

Remarks: At least two species occur around Taiwan: *Ctenactis echinata* (Pallas, 1766) and *C. crassa* (Dana, 1846). *C. albitentaculata* Hoeksema, 1989 have not been found.

Ctenactis echinata (Pallas, 1766)

(Figs. 73-74)

Material: NMNS 000048-3357 (S Taiwan).

Diagnosis: Corallum outline elongated. Adults usually with single mouth, occasionally with several mouths along central axis. Coralla thick and varying from flat to arched. Corallum wall perforated. Septa loosely to densely arranged. Septal dentations coarse and lobated.

Granulations on septal sides evenly distributed.

Remarks: First record for Taiwan, where it is rare. Exact habitat unknown; the single specimen may have lived on the upper part of a reef slope.

Ctenactis crassa (Dana, 1846)

(Figs. 75-77)

Materials: RMNH 18136 (Hsiao-Liu-chiu); TUIO-C-617 (2) (Nanwan Bay).

Diagnosis: Corallum outline elongated. Adults with several mouths along central axis. Coralla thick and varying from flat to arched. Corallum wall perforated. Septa densely arranged. Septal dentations coarse and angular. Granulations on septal sides evenly distributed.

Remarks: First record for Taiwan. Specimens were occasionally found on the deepest part of reef slopes, or just on the sandy bottom below.

Genus *Herpolitha* Eschscholtz, 1825

Type species: *Herpolitha limacina* (Lamarck, 1801) [= *Herpolitha limax* (Esper, 1797)].

Diagnosis: Corals free-living in adult phase. Corallum outline elongated. Fused individuals may form coralla in V-, Y- or X-shape. Animals with rows of mouths along and alongside central axis. Tentacles short. Corallum length may exceed 60 cm.

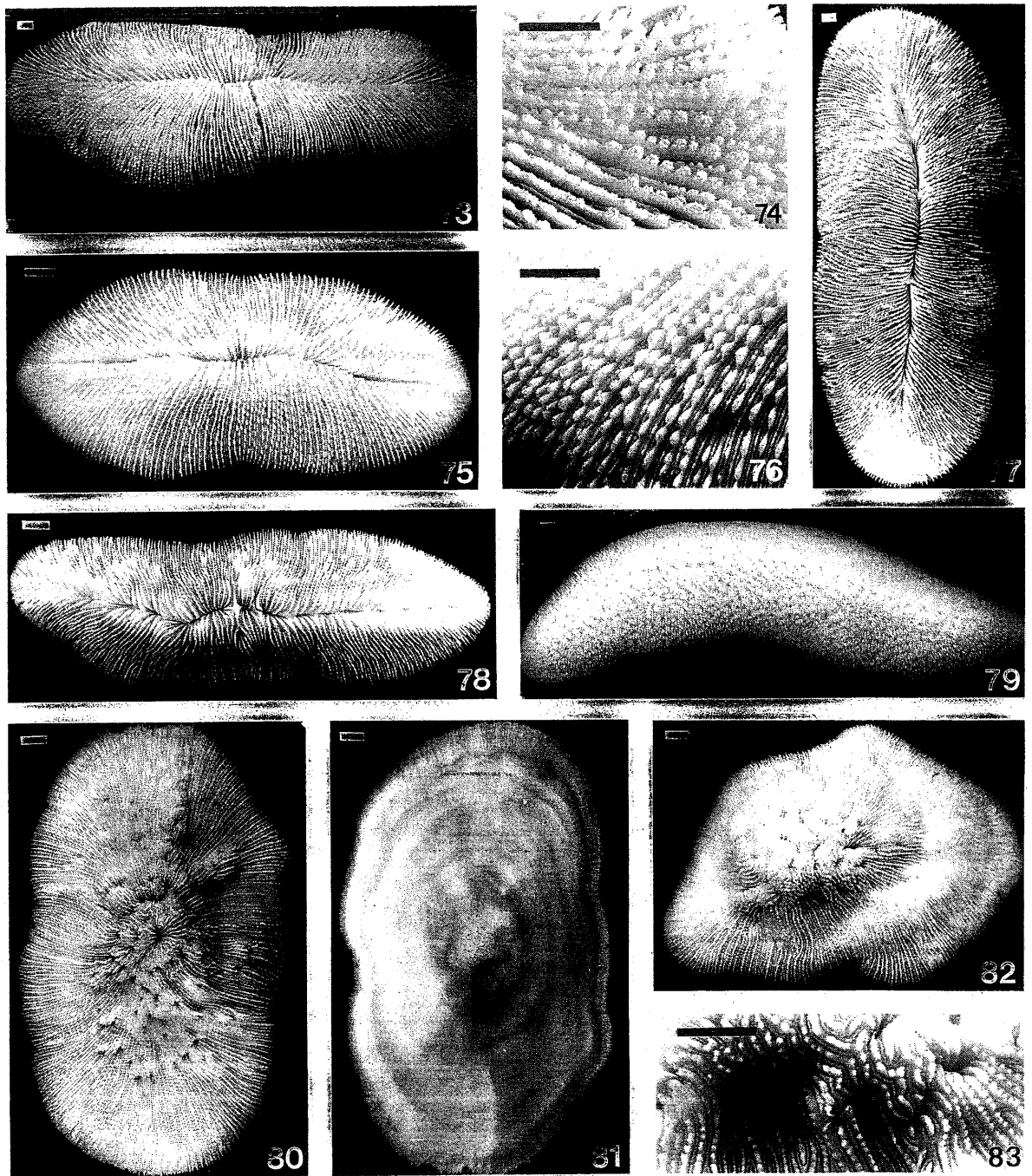
Remarks: The single species, *Herpolitha limax* (Esper, 1797), occurs in Taiwan.

Herpolitha limax (Esper, 1797)

(Fig. 78)

Materials: NMNS 000162-F001265, 000196-F001458, -F001468, -F001457 (Pleistocene at Panpingshan); RMNH 18137, SYUMB-S-0014/0017 (W Hengchun Peninsula); RMNH 18138 (2), TUIO-C-618 (7) (Nanwan Bay).

Diagnosis: Corallum wall perforated.



Figs. 73-74. *Ctenactis echinata*, NMNS 000048-3357.

Figs. 75-76. *Ctenactis crassa*, RMNH 18136.

Fig. 77. *C. crassa*, TUIO-C-617-1.

Fig. 78. *Herpolitha limax*, RMNH 18138.

Fig. 79. *Polyphyllia talpina*, TUIO-C-619-1.

Figs. 80-81. *Sandalolitha dentata*, RMNH 18143.

Figs. 82-83. *S. dentata*, TUIO-C-620.

Scale bars: 1 cm.

Coralla varying from thin to thick and from flat to arched. Fossae along central axis larger than those alongside. Septa densely packed and more or less parallel arranged. Septal dentations fine and angular with granulations in rows perpendicular to septal margin. Costal spines varying from blunt and granular to long and sharp.

Remarks: Earlier record by Hanzawa (1931: pl. 4, as *H. stricta*). The species is quite common in Taiwan, where it has been found on reef slopes and on the upper part of reef bases.

Genus *Polyphyllia* De Blainville, 1830

Type species: *Fungia talpa* Lamarck, 1815 [= *Polyphyllia talpina* (Lamarck, 1801)].

Diagnosis: Corals free-living in adult phase. Corallum outline elongated. Distinct row of fossae along central axis; smaller ones distributed alongside. Upper surface densely covered with short tentacles. The corallum length may exceed 50 cm.

Remarks: Of the two species, *Polyphyllia talpina* (Lamarck, 1801) and *P. novaehiberniae* (Lesson, 1831), only the former occurs in Taiwan.

Polyphyllia talpina (Lamarck, 1801)

(Fig. 79)

Materials: NMNS 000196-F001456 (Pleistocene at Panpingshan); RMNH 18139 (2), TUIO-C-619 (2) (Hsiao-Liu-Chiu).

Diagnosis: Corallum wall perforated. Coralla usually thick and varying from flat to arched. Septa densely packed and more or less radiating from the fossae (near the margin more parallel). Septal dentations fine and angular with granulations irregularly distributed over their sides. Costal spines varying from blunt and spinose to long with granulations.

Remarks: First substantiated record for Taiwan. Specimens were occasionally found on reef slopes.

Genus *Sandalolitha* Quelch, 1884

Type species: *Sandalolitha dentata* Quelch, 1884.

Diagnosis: Adult animals free-living and polystomatous. Tentacles short. Corallum outline oval. Septal dentations lobated or elongated, with granulations irregularly distributed on their sides. Costal spines varying from fine and granulated to coarse and echinose. The length of the coralla does not exceed 50 cm.

Remarks: Both species, *Sandalolitha dentata* Quelch, 1884 and *S. robusta* (Quelch, 1886), occur in Taiwan.

Sandalolitha dentata Quelch, 1884

(Figs. 48b, 80-83)

Materials: RMNH 18145 (3) (Hsiao-Liu-Chiu); RMNH 18141 (W Hengchun Peninsula); RMNH 18072, 18142 (2), 18143, 18144 (5), TUIO-C-620 (6) (Nanwan Bay).

Diagnosis: Secondary mouths primarily clustered around distinctly larger principal one and mainly concentrated along central axis. Septa of low orders distinctly higher than neighboring septa of higher orders. Septal dentations elongated.

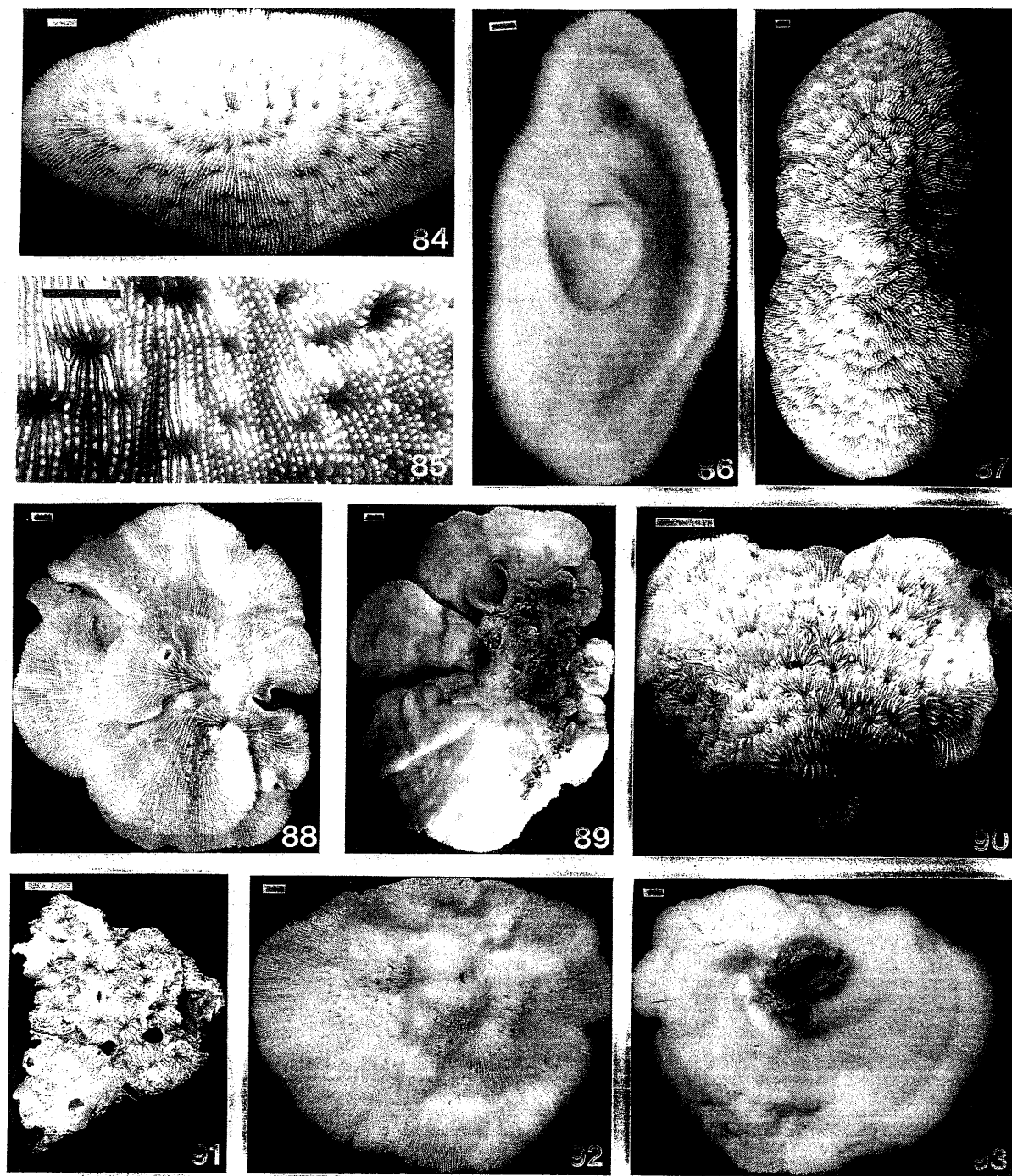
Remarks: First substantiated record for Taiwan. The species is relatively common in Taiwan. Specimens were found on reef slopes and on upper parts of reef bases. They were frequently encountered in broken and regenerated shape (Fig. 48b).

Sandalolitha robusta (Quelch, 1886)

(Figs. 84-87)

Materials: NMNS 000196-F001453 (Pleistocene at Panpingshan), RMNH 18140, TUIO-C-621 (2) (W Hengchun Peninsula).

Diagnosis: Secondary mouths evenly distributed around slightly larger principal one. Septa more or less alternating in height. Septal dentations usually lobated.



Figs. 84-86. *Sandalolitha robusta*, RMNH 18140.
 Fig. 87. *S. robusta*, TUIO-C-621.
 Figs. 88-89. *Lithophyllum undulatum*, RMNH 18146.
 Fig. 90. *Lithophyllum mokai*, RMNH 18149.
 Fig. 91. *Lithophyllum mokai*, TUIO-C-623.
 Figs. 92-93. *Podabacia crustacea*, RMNH 18151.
 Scale bars: 1 cm.

Remarks: First substantiated record for Taiwan. The species has occasionally been found on reef slopes.

Genus *Lithophyllon* Rehberg, 1892

Type species: *Lithophyllon undulatum* Rehberg, 1892.

Diagnosis: Adult animals attached to substratum. Coralla encrusting, cup-shaped or foliaceous. Tentacles short. Corallum on their sides. Costal spines small and granular, cylindrical-conical or arborescent. The diameter of the animals may exceed 80 cm.

Remarks: Both species, *Lithophyllon undulatum* Rehberg, 1892, and *L. mokai* Hoeksema, 1989, occur in Taiwan.

***Lithophyllon undulatum* (Rehberg, 1892)**

(Figs. 88-89)

Materials: RMNH 18146 (5) (Yenliao Bay); RMNH 18147 (W Hengchun Peninsula); RMNH 18148, TUIO-C-622 (21), NMNS 000048-3295 through 3336 (Nanwan Bay).

Diagnosis: Corallum cup-shaped or foliaceous. Mouths relatively widely spaced; their color usually bluish-grey. Diameter of adults more than 15 cm.

Remarks: First substantiated record for Taiwan. The species is one of the most common fungiids of Taiwan, where it has been found on relatively shallow hard substrata.

***Lithophyllon mokai* (Hoeksema, 1989)**

(Figs. 90-91)

Materials: RMNH 18149, TUIO-C-623 (W Hengchun Peninsula).

Diagnosis: Corallum encrusting. Mouths relatively densely distributed; their color usually brown. Diameter of adults less than 15 cm.

Remarks: First record for Taiwan. It has only been found on the rocky substratum of a sea mount, just above the sandy bottom.

Genus *Podabacia* Milne Edwards & Haime, 1849

Type species: *Agaricia cyathoides* Valenciennes, ms., Milne Edwards & Haime, 1849. [= *Podabacia crustacea* (Pallas, 1766)].

Diagnosis: Adult animals attached to substratum. Coralla cup-shaped or foliaceous. Tentacles short. Fragments that break off may survive as free-living animals. Corallum wall perforated. Corallum diameter may exceed 1 m.

Remarks: The single species, *Podabacia crustacea* (Pallas, 1766), occurs in Taiwan.

***Podabacia crustacea* (Pallas, 1766)**

(Figs. 92-93)

Materials: RMNH 18150, 18151, TUIO-C-624 (4) (Nanwan Bay).

Diagnosis: Septal dentations fine and lobated, with granulations scattered over the sides. Costal spines small and slightly echinose.

Remarks: First substantiated record for Taiwan, where it was occasionally found on hard substrata.

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臺灣的石珊瑚

II. 蕈珊瑚科 (含一新種)

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本報告為臺灣產石珊瑚系統分類研究的第二部份。筆者等根據珊瑚標本收藏和野外調查結果，共鑑定了27種蕈珊瑚科的石珊瑚，分屬於8屬7亞屬，分別是：中國蕈珊瑚 *Fungia (Cycloseris) sinensis* (Milne Edwards & Haime, 1851)，環形蕈珊瑚 *F. (C.) cyclolites* Lamarck, 1815，脆弱蕈珊瑚 *F. (C.) fragilis* (Alcock, 1893)，直肋蕈珊瑚 *F. (C.) costulata* Ortmann, 1889，細緻蕈珊瑚 *F. (C.) tenuis* Dana, 1846，佛氏蕈珊瑚 *F. (C.) vaughani* Boschma, 1923，和諧蕈珊瑚 *F. (Verrillfungia) concinna* Verrill, 1864，盤形蕈珊瑚 *F. (V.) repanda* Dana, 1846，多刺蕈珊瑚 *F. (Danafungia) horrida* Dana, 1846，礁形蕈珊瑚 *F. (D.) scruposa* Klunzinger, 1879，真蕈珊瑚 *F. (Fungia) fungites* (Linnaeus, 1758)，顆粒蕈珊瑚 *F. (Wellsofungia) granulosa* Klunzinger, 1879，元寶蕈珊瑚 *F. (Lobactis) scutaria* Lamarck, 1801，摩鹿加蕈珊瑚 *F. (Pleuractis) moluccensis* Van der Horst, 1919，臺灣蕈珊瑚 *F. (P.) taiwanensis* sp. nov.，沉重蕈珊瑚 *F. (P.) gravis* Nemenzo, 1955，笏形蕈珊瑚 *F. (P.) paumotensis* Stutchbury, 1833，輻形太陽蕈珊瑚 *Heliofungia actiniformis* (Quoy & Gaimard, 1833)，棘狀梳蕈珊瑚 *Ctenactis echinata* (Pallas, 1766)，厚實梳蕈珊瑚 *C. crassa* (Dana, 1846)，蛞蝓匍石珊瑚，*Herpolitha limax* (Esper, 1797)，多葉珊瑚 *Polyphyllia talpina* (Lamarck, 1801)，鋸齒展珊瑚 *Sandalolitha dentata* Quelch, 1884，強壯展珊瑚 *S. robusta* Quelch, 1886，波形靈芝珊瑚 *Lithophyllon undulatum* Rehberg, 1892，摩卡氏靈芝珊瑚 *L. mokai* Hoeksema, 1989，殼形足柄珊瑚 *Podabacia crustacea* (Pallas, 1766)，其中臺灣蕈珊瑚 *Fungia (Pleuractis) taiwanensis* 為新種。本文簡要描述了各屬、亞屬及種的分類特徵。