SEVEN NEWLY RECORDED STARFISH FROM TAIWAN (ECHINODERMATA: ASTEROIDEA)

SHYH-MIN CHAO

National Museum of Natural Science, Taichung, Taiwan 404, R. O. C.

ABSTRACT- This paper revises Taiwan's starfish fauna, listing 44 valid species in 13 families. In addition, seven newly recorded asteroids collected by scuba and skin diving in reef areas, and by trawling off the Taiwan coast are described. They include *Euretaster insignis* (Sladen), *Disasterina odontacantha* Liao, *Anthenoides laevigatus* (Liao and Clark), *Astrothauma euphylacteum* Fisher, *Mediaster brachiatus* Goto, *Ophidiaster armatus* Koehler and *Pentaceraster chinensis* (Gray). Species accounts and figures of these 7 species are presented. Besides, a revised table of 44 species of starfish from Taiwan is included.

KEY WORDS: Seastars, Echinoderms, Species account, Taiwan.

INTRODUCTION

Systematic studies on the starfish from the waters of Taiwan (Hayasaka 1949, Applegate 1984, Chao and Chang 1989, Chao et al. 1990, Liao and Clark 1995, Chao 1999a, 1999b) have been limited. Only 37 species in 12 families of starfish have been reported (Table 1). The starfish fauna from Taiwan is poor compared to that of southern China (over 75 species), the Philippines (over 150) and Japan (over 70) (Fisher 1919, Clark and Rowe 1971, Liao and Clark 1995). However, this may be purely a reflection of the limited nature of investigations.

I have collected Taiwanese starfish by both scuba and skin diving off the coast of Taiwan (Fig. 1) since 1989. In addition, trawls were made at irregular intervals on sandy bottoms off western and northeastern Taiwan to a depth of 200 m. Many starfish were collected including 7 species and one family

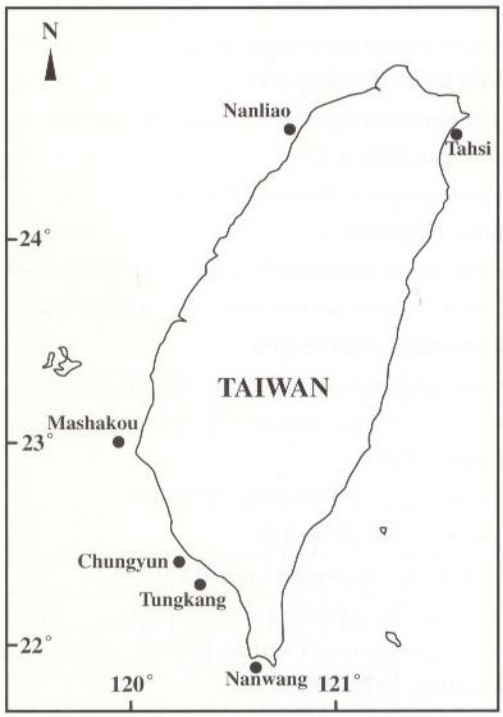

Fig. 1. Map of Taiwan.

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(Pterasteridae) recorded from Taiwan for the first time. They include *Euretaster insignis* (Sladen), *Disasterina odontacantha* Liao, *Anthenoides laevigatus* (Liao and Clark), *Astrothauma euphylacteum* Fisher, *Mediaster brachiatus* Goto, *Ophidiaster armatus* Koehler and *Pentaceraster chinensis* (Gray).

The object of this study was to present species accounts and figures of the 7 newly recorded species. Besides, a revised table of the starfish from Taiwan is included (Table 1). Specimens are deposited in the National Museum of Natural Science (NMNS), Taichung, Taiwan. The following abbreviations are used in the text: R = the length from disc center to ray tip; r = the length from disc center to interradial edge.

Table 1. Records of Asteroidea from Taiwan

Taxa	Relation to Substratum (depth, m)	Reference
Luidiidae Sladen 砂海星科		
Luidia maculata Müller et Troschel 斑砂海星	S (40-150)	Chao (2000)
Luidia avicularia Fisher 松砂海星	S (150)	Chao (2000)
Luidia quinaria von Martens 砂海星	S (10-150)	Chao (2000)
Acanthasteridae 長棘海星科		
Acanthaster planci (Linnaeus) 棘冠海星	R (3-7)	Hayasaka (1949)
Archasteridae 飛白楓海星科		
Archaster typicus Müller & Troschel 飛白楓海星	S (0-3)	Hayasaka (1949)
Pterasteridae 翅海星科		
**Euretaster insignis* (Sladen) 網海星	S (40)	
Asteriidae 海盤車科		
Coscinasterias acutispina (Stimpson) 尖棘篩海盤車	P (1-5)	Chao and Chang (1989)
Distolasterias nipon (Döderlein) 日本長腕海盤車	S (150-200)	Chao (2000)
Labidiasteridae 叉棘海星科		
Coronaster sakuranus (Döderlein) 櫻花冠海盤車	S (100-150)	Chao (2000)
Coronaster volsellatus (Sladen) 座冠海盤車	S (150-200)	Chao (2000)
Asterinidae 海燕科		
Asterina coronata von Martens 花冠海燕	P (1-3)	Chao and Chang (1989)
A. orthodon Fisher 直齒海燕	R (8)	Chao (1999b)
**Disasterina odontacantha* Liao 齒棘皮海燕	SR (2)	
Nepanthia belcheri (Perrier) 刺腕蠍海燕	R (0-1)	Chao (1999b)
Patiriella pseudoexigua Dartnall 擬淺盤小海燕	R (0)	Chao and Chang (1989)
Asteropseidae 鋸腕海星科		
Asteropsis carinifera (Lamarck) 脊鋸腕海星	R (1-3)	Chao (1999b)
Astropectinidae 槭海星科		
A. polyacanthus Müller and Troschel 多棘槭海星	S (60)	Chao (1999a)
A. vappa Müller and Troschel 華普槭海星	S (30-120)	Chao (1999a)
A. velitaris von Martens 怒棘槭海星	S (30-50)	Chang et al. (1964)

Craspidaster hesperus (Müller & Troschel) 鑲邊海星	S (30-100)	Hayasaka (1949)
Ctenopleura sinica (Döderlein) 中華櫛肋海星	S (60-150)	Chao (1999a)
Dipsacaster pretiosus (Döderlein) 美麗雙沙海星	S (60-100)	Chao (1999a)
Tethyaster aulophorus (Fisher) 海神海星	S (120-150)	Chao (1999a)
Echinasteridae 棘海星科		
Echinaster callosus von Marenzeller 赤麗棘海星	R (6)	Chao (1999b)
Echinaster luzonicus (Gray) 呂宋棘海星	P (1-3)	Lee and Chen (1994)
Goniasteridae 角海星科		
**Anthenoides laevigatus* (Liao and Clark) 光滑花海星	S (110-150)	
**Astrothauma euphylacteum* Fisher 豎棘奇海星	S (200-250)	
Calliaster childreni Gray 玉緣棘角海星	S (100)	Chao (1999b)
**Mediaster brachiatus* Goto 中腕角海星	S (100)	
Stellasteropsis colubrinus Macan 鼠李角海星	R (4)	Chao (1999b)
Ophidiasteridae 蛇星科		
Cistina columbiae Gray 哥倫比亞蛇星	R (3-10)	Chao (1999b)
Fromia monilis Perrier 單鏈蛇星	R (5-15)	Chao and Chang (1989)
Leiaster speciosus von Martens 麗紅蛇星	R (5)	Chao et al. (1990)
Linckia laevigata Linnaeus 藍指海星	R (1-5)	Hayasaka (1949)
L. multifora (Lamarck) 複型指海星	R (4)	Chao (1999b)
Nardoa frianti Koehler 赤瘤蛇星	R (10)	Chao and Chang (1989)
N. tumulosa Fisher 綠瘤蛇星	R (5)	Hayasaka (1949)
Neoferdina insolita Livingstone 棕緣蛇星	R (3-10)	Chao (1999b)
Ophidiaster hemprichi Müller & Troschel 緣斑蛇星	R (8)	Chao and Chang (1989)
**O. armatus* Koehler 飾物蛇星	P (30-40)	
Oreasteridae 瘤海星科		
Anthenea chinensis (Gray) 眞五角海星	S (30-60)	Chao (1999b)
Culcita novaeguineae Müller and Troschel 麵包海星	R (5-10)	Hayasaka (1949)
**Pentaceraster chinensis* (Gray) 中華疣海星	S (40-60)	
Pentaceraster westermanni von Martens 棘瘤海星	S (60)	Chao et al. (1990)

The symbol "*" represent new records in this paper. P = pebble and rock, R = reef, S = sandy bottom, SR = sand bottom at reef area. Number in parenthesis represent water depth.

TAXONOMIC ACCOUNTS

PTERASTERIDAE

Euretaster insignis (Sladen)
Figs. 3-6

Retaster insignis Sladen 1882: 200 (Type locality: Arafura Sea, Indo-Malay Archipelago).
Euretaster insignis Clark and Rowe 1971: 38 (distribution), 73 (key), pl. 12, figs. 3, 4; Liao and Clark 1995: 138, 139, fig. 57, pl. 11, fig. 4; Rowe and Gates 1995: 110.

Materials: NMNS-2804021, 2534105, 2534104, 7 specimens, Nanliao, sandy bottom, depth range 40-100 m.

Diagnosis: Five rays, rarely 6, curving toward ray tip. Body form stellate, thick and cushion-like. R/r = 8 cm/ 4 cm. Supradorsal membrane

thick and well developed, supported by the tips of the aboral spines. Skeletal plates in meshwork with large papular areas. Abactinal plate with 3-4 spines. Anus at center of disc, surrounded by 20-30 spines. Papular areas large, 60-90 pores in a group. Each adambulacral plate with 5 webbed spines aligned at right angles to the furrow, the innermost shortest, the 5th largest. Color in life completely bright red, dry specimens brownish.

Distribution: East Indies, North Australia, Philippine Is., Macclesfield Bank, Indonesia, Samoa, S. China, S. Japan (Clark and Rowe 1971, Rowe and Gates 1995).

ASTERINIDAE

Disasterina odontacantha Liao
Figs. 2, 7-10

Disasterina odontacantha Liao 1980: 169, figs. 6, 7, pl. 5, figs. 1-4 (type locality: Xisha Is., southern China); Liao and Clark 1995: 132, fig. 55, pl. 16, figs. 9, 10.

Materials: NMNS-3247027, 1 specimen , Nanwang.

Diagnosis: Five rays, R/r = 1.7 cm/0.7 cm. Body flat, surface with thick epidermis. In dry specimen, disc center with 10 elongated skeletal plates in a circle. In each interradial area, this circular plate connects a large interradial plate by two elongated plates (Fig. 9). Anus in disc center, purplish blue color, surrounded by about 10 fine spines. Madreporite single, with radiating striations and fine penetrations. In dry specimen, marginal abactinal plates extend horizontally, each plate with 3-4 fine spines. Each actinal plate with a fine spine. Furrow spines 3 in a set, covered by epidermis (Fig. 2A). Subambulacral spine single and large (Fig. 2B). An incompletely calcified skin area behind each oral plate, and only several small plates under this skin (Fig. 2A). Absence of suboral spines. In life, yellowish on dorsal side, light yellow on ventral side; marginal spines with purplish blue bands. Actinal spines with blue skin, especially those on body margin.

Ecology: One individual was collected from a tide pool at 2 m in depth of reef area. It is a nocturnal animal. Color of abactinal surface is similar to that of the sandy substrate.

Distribution: Xisha Is. (S. China) (Liao and Clark 1995) and S. Taiwan.

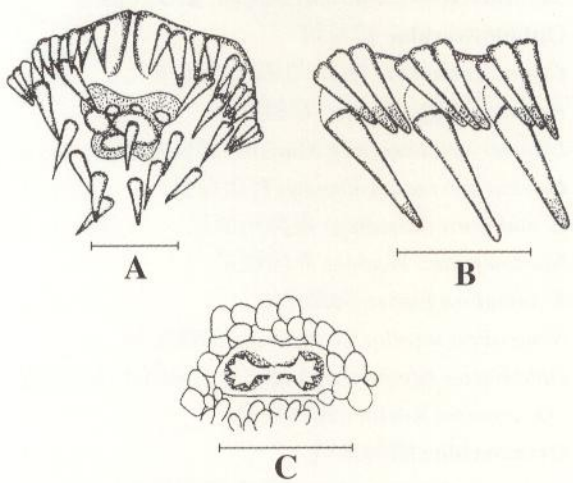

Fig. 2. *Disasterina odontacantha* Liao. A. Oral armature. B. furrow armature. C. *Ophidiaster armatus* Koehler. excavate pedicellaria. Bars = 1 mm.

GONIASTERIDAE

Anthenoides laevigatus (Liao and Clark)
Figs. 11-13

Anthenoides laevigatus Liao and Clark 1989: 37-39 (type locality: off Hainan Island, southern China); Liao and Clark 1995: 90, pl. 7, figs. 1, 2.

Materials: NMNS-3047007, 3115009, 160

specimens, Tungkang, sandy bottom, depth range 110-150 m.

Diagnosis: 5 equal rays, R/r = 3.5-5.5 cm/1.5-2.2 cm. Outline flat and depressed. Interradial arcs rounded. In living and alcohol-preserved specimens, outlines of the plates are obscured by skin, but when dried, abactinal plates are easily seen. The exposed surface is naked, with no granules or pedicellariae on abactinal plates. Large specimens with several secondary plates in the center of the disc between the first two or three carinal plates, never forming parallel series on either side of the carinal series. A papula emerges at the corner of each plate, but not in disc center or in the small triangular interradial area. Madreporite large, flat on surface, about 0.5 cm in diameter (at R 6 cm), with numerous fine striations, and slightly raised above the surrounding plates. Anus in disc center, covered by 8-10 elongated granules. Superomarginal plates number 14-17, each with 10-20 deciduous granules; on the distal plates these granules are fewer, often completely lacking. Inferomarginal plates covered with spaced, subequal, deciduous granules. On the distal plates these granules are much fewer. When granulation is lost, the circular scars are still conspicuous. Actinal intermediate areas arranged in 4 or 5 chevrons, decreasing in size toward the margin. Most actinal plates adjacent to the subambulacral plates with one or two granules, others usually naked. Adambulacral plates with a comb of 6 or 7 webbed blunt furrow spines. Subambulacral granules usually 2 or 3. Sometimes, a slender 2-jawed forcipiform pedicellaria set behind the furrow spines. Color in life reddish pink, dry specimens light brown.

Distribution: This species is common in the waters off the southeastern coast of Hainan Island (Liao and Clark 1995) and southern Taiwan.

Astrothauma euphylacteum Fisher
Figs. 14-17

Astrothauma euphylacteum Fisher 1913: 645 (type locality: Albatross, station 5412, between Cebu and Leyte, Philippines); 1919: 320-324, pl. 86, fig. 2, pl. 87, fig. 2, pl.93, figs. 7, 7a-c; Chang et al. 1964: 59; Liao and Clark 1995: 91, pl. 4, fig. 3.

Materials: NMNS-2804011, 3153069, 2597022, 3 specimens, Tungkang, sandy bottom, depth range 200-250 m.

Diagnosis: Animal with 5 flat rays, curving toward ray tip. R/r = 7.5 cm/1.7 cm. Superomarginal plates large, 17 in number, forming a conspicuous side-wall of the body. Each supero-marginal plate with 2-3 erect large spines, and surrounded by a circle of cubic granules. Up to 10 spines on each inferomarginal plate, but these spines dislodge easily. Most abactinal plates naked and surrounded by a circle of 12-25 granules. No granules or spines on abactinal plates except the midradial plates (carinal plates) bearing high conical spines arranged in a longitudinal series. Abactinal plate usually with 1 or 2 straight pedicellaria especially on disc center. Single madreporite 3 mm in diameter, slightly convex with numerous radiating striations. Anus at disc center, concealed by abactinal plates. Adambulacral armature with 14 furrow spines, the first and last spines smaller, the other 12 almost equal in length. Near the mouth, a straight pedicellaria set behind the furrow spines. Oral plates surrounded by a circle of granules with 2-3 spines on top. Tube feet in two rows. Color in life light red.

Distribution: Philippines, off Hainan Island, China, Philippines (Liao and Clark 1995) and southern Taiwan.

Mediaster brachiatus Goto
Figs. 18-20

Mediaster brachiatus Okada and Ugida 1981: 53; Imaoka et al. 1990: 49.

Material: NMNS-2931071, 1 specimen, Tahsi, sandy bottom, 100 m in depth.

Diagnosis: Five rays, R/r = 7 cm/2.4 cm. Abactinal plates covered with larger paxillae in the interbrachial portion and ray base. Large paxillae with 10-15 central and 15-20 peripheral granuliform spinelets. Some abactinal plates bear small bivalvate pedicellariae. Superomarginal plates covered with granules. Inferomarginal plates covered with coarse granules, some bear bivalvate pedicellariae. Adambulacral plates with 2 series of spines, 5-6 clavate furrow spines and a series of 3-4 small spines. Adambulacral plates with short granuliform spinelets. Color in life unknown, formalin or alcohol preserved specimens grayish white.

Distribution: Japan Sea, Sagami Bay (Imaoka et al. 1990), southern Taiwan.

OPHIDIASTERIDAE

Ophidiaster armatus Koehler
Figs. 2C, 21-24

Ophidiaster armatus Koehler 1910: 277 (type locality: Aru Is., Indonesia); Clark and Rowe 1971: 36 (distribution), 60 (key); Liao and Clark 1995: 120, pl. 17, fig. 7; Rowe and Gates 1995: 90.

Materials: NMNS-3046001, 3047001, 2 specimens, Chungyun.

Diagnosis: Five rays, long, slender, cylindrical, tapering to a point and curved at tip, R/r = 11 cm/1.2 cm Abactinal plates regularly arranged in seven longitudinal series. Entire surface covered by granules. Papular areas regularly distributed in eight longitudinal series. At the base of ray, each papular area bears 20-30 papulae, with only 3-5 papulae near the end. Each papula surrounded by 3-5 granules. Madreporite single, in oval to triangular shape, 4 mm in transverse diameter, with numerous radiating striations. There is an excavate pedicellaria on the edge of papular area (Fig. 2C). Superomarginal plates distinct, arranged in regular series, 42 on each side of ray. A regular row of abactinolateral plates above the superomarginals. Inferomarginals correspond in number and position to superomarginals. From half of the ray to tip, there is a conical tubercle on the center of each inferomarginal. The last several superomarginals sometimes bear a conical tubercle. Intermarginal papular areas well developed, arrenged in longitudinal series, extending nearly to the tip of ray. Actinal plates in two series, and covered with granules. Each adambulacral plate bearing two short and blunt furrow spines, alternatively a larger and a smaller one. A flat and short subambulacral spine behind the furrow spines. Subambulacral spines arranged in a longitudinal series. The subambulacral spines and furrow spines separated by 12-18 flattened granules. In life, grayish brown on abactinal surface. Dark brown on disc center. Several dark brown spots on the abactinal surface of rays. Color in formalin or alcohol not degraded.

Ecology: Two specimens were dredged from 30-40 m in depth. The habitat is not a reef area, but a sandy bottom with sparse rocks and pebbles.

Distribution: East Indies, Andaman Is., Hong Kong, Aru Is. (Indonesia), Queensland (Clark and Rowe 1971, Liao and Clark 1995, Rowe and Gates 1995) and southern Taiwan.

OREASTERIDAE

Pentaceraster chinensis (Gray)
Figs. 25, 26

Pentaceros chinensis Gray 1840: 276 (type locality: China).

Pentaceraster orientalis Döderlein 1936: 356, pl. 31, figs. 4-4b.
Pentaceraster chinensis Clark and Rowe 1971: 34 (key), 56 (distribution); Liao and Clark 1995: 108, pl. 14, fig. 4.

Materials: NMNS-2328105, 1 specimen, Nanliao, sandy bottom, 40 m in depth.; NMNS-2328104, 2 specimens, Mashakou, sandy bottom, depth range 60 m in depth.

Diagnosis: Five rays. Massive stellate form. Ray slightly curved at tip. R/r = 12.7 cm/4.1cm, 6.7 cm/2.4 cm. At the base of ray, abactinal and superomarginal plates are in 7 longitudinal series. On disc, abactinal plates in reticulate, with wide papular areas. Surface of all skeletal plates and tubercles covered by granules; actinal plates with larger and coarser granules. Primary radial plates prominent, convex and capped with a conical tubercle. Superomarginal spines only present in the interradial arcs, but the inferomarginal spines continue throughout the ray. Adambulacral plate with 8-9 furrow spines, 4-6 subambulacral spines and 3-4 large granules. Color in life purplish brown, formalin or alcohol preserved specimens light brown.

Distribution: Southern China (Liao and Clark 1995) and western Taiwan.

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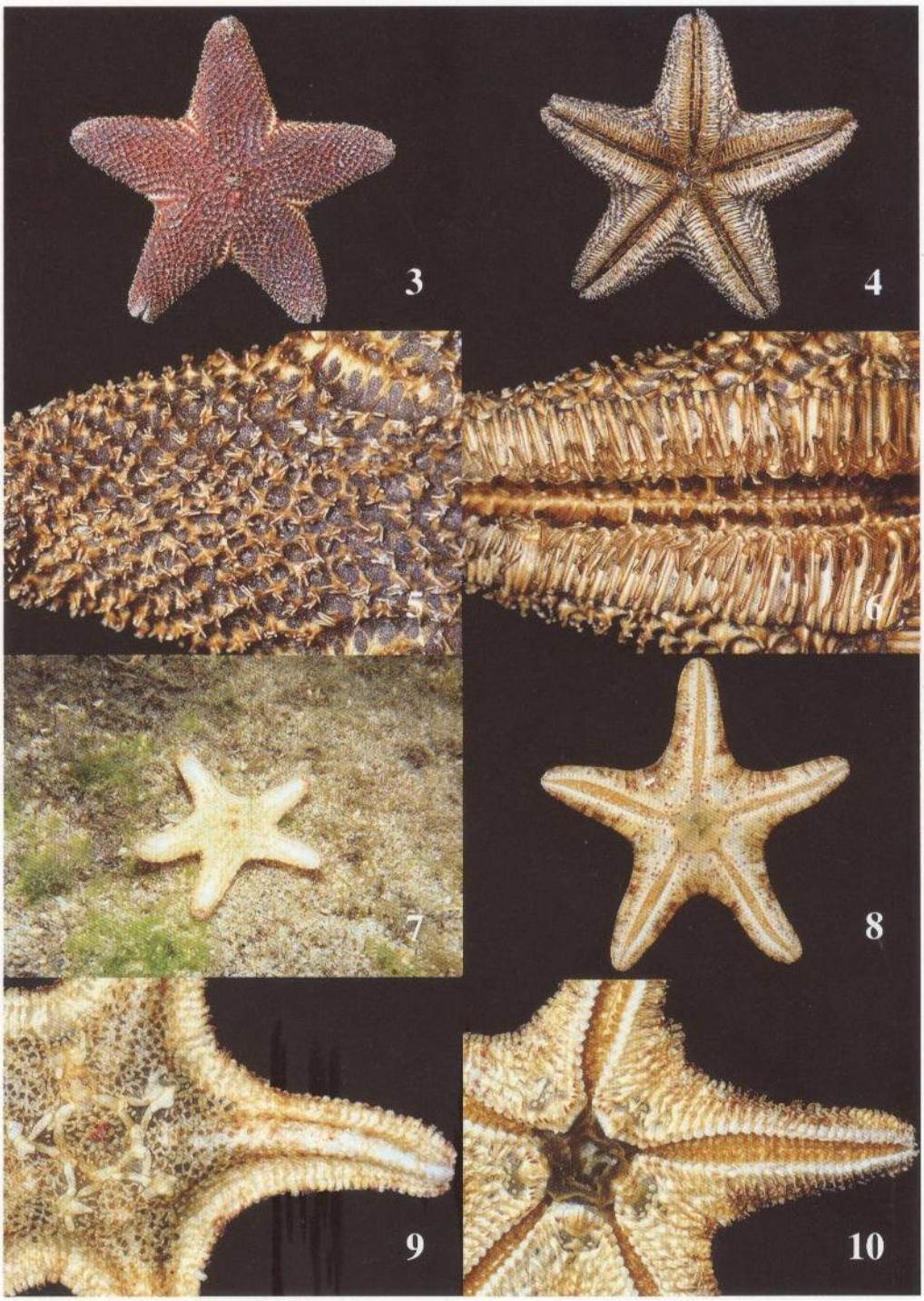
七種臺灣新記錄海星 (棘皮動物門：海星綱)

趙 世 民

摘要

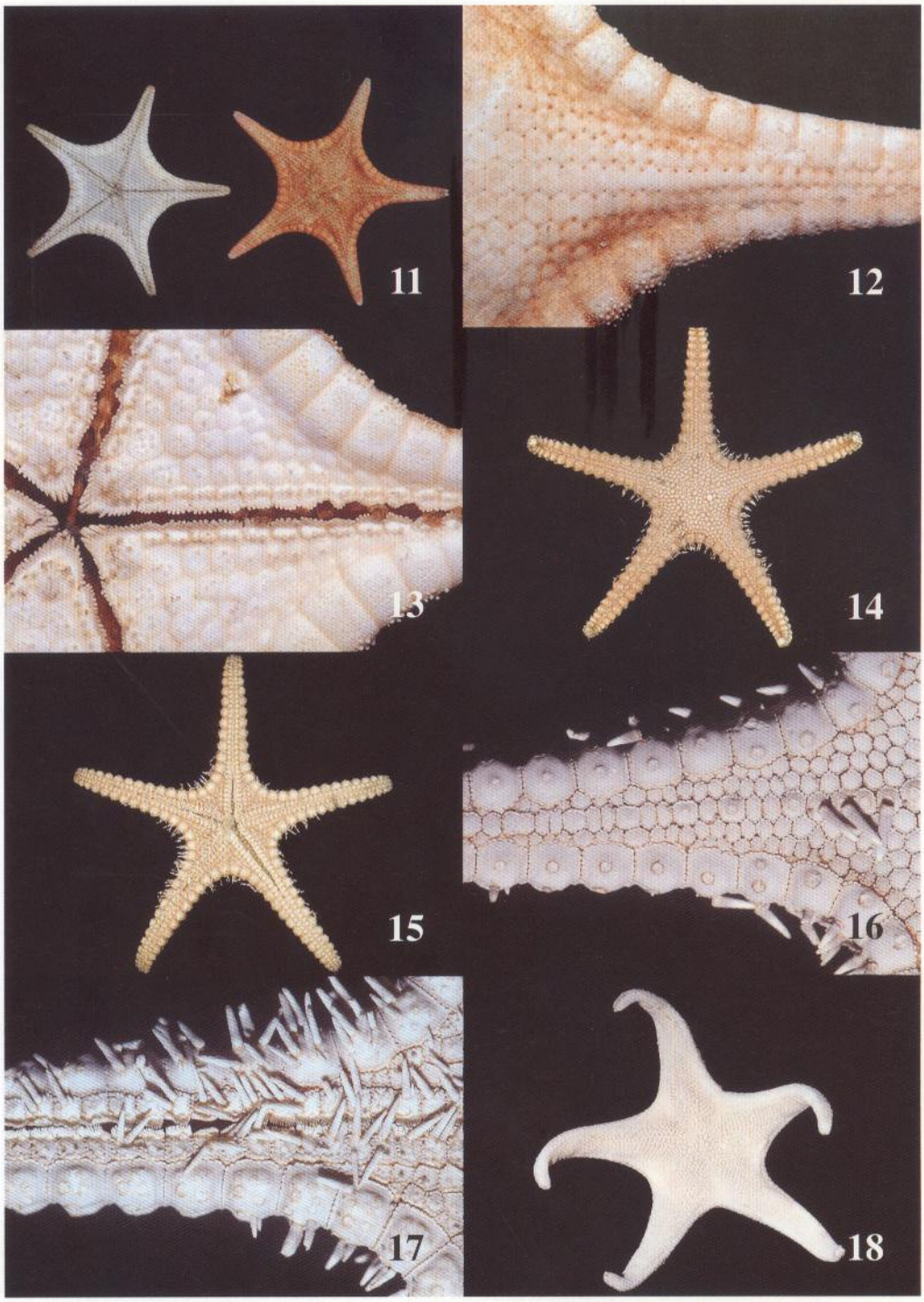
本文回顧臺灣產海星，並增列7種新記錄種海星，共列出13科44種。這7種新記錄種爲：*Euretaster insignis* (Sladen)網海星、*Disasterina odontacantha* Liao齒棘皮海燕、*Anthenoides laevigatus* (Liao and Clark)光滑花海星、*Astrothauma euphylacteum* Fisher豎棘奇海星、*Mediaster brachiatus* Goto中腕角海星、*Ophidiaster armatus* Koehler飾物蛇星、*Pentaceraster chinensis* (Gray)中華疣海星。這7種的描述及標本照均在文中。此外，本文亦表列臺灣產44種海星。

關鍵詞: 海星，棘皮動物，種的說明，臺灣。



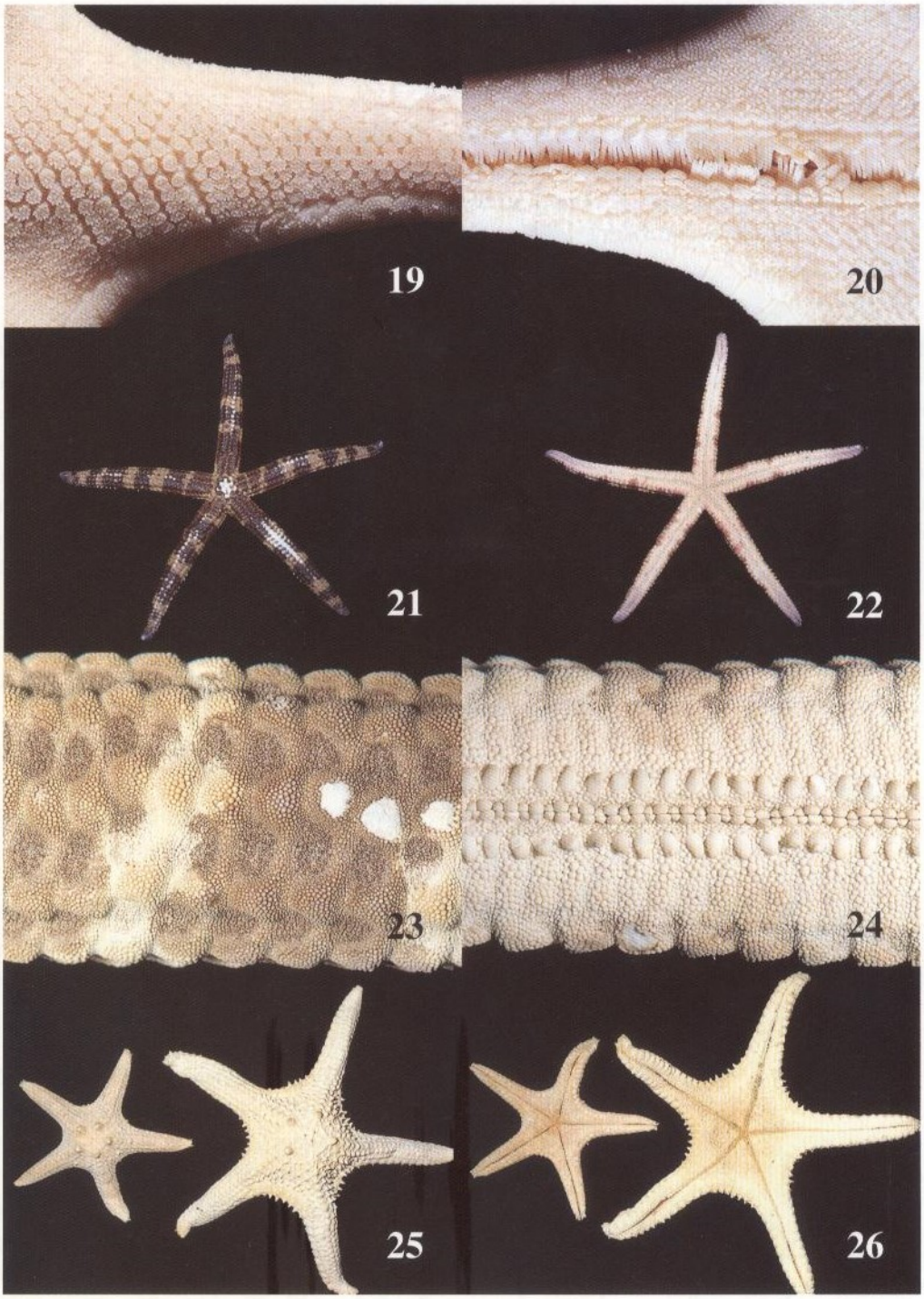
Figs. 3-6 *Euretaster insignis* (Sladen), 3. dorsal view, 4. ventral view, 5. dorsal armature, 6. ambulacral armature , R = 8 cm.

Figs. 7-10 *Disasterina odontacantha* Liao, 7. in living, 8. ventral view, 9. dorsal armature, 10. ambulacral armature, R = 1.7 cm.



Figs. 11-13 *Anthenoides laevigatus* (Liao and Clark), 11. dorsal and ventral view, 12. dorsal armature, 13. ambulacral armature, R = 5.3 cm and 4.9 cm.

Figs. 14-17 *Astrothauma euphylacteum* Fisher, 14. dorsal view, 15. ventral view, 16. dorsal armature, 17. ambulacral armature, R = 7.5 cm.



Figs. 18-20 *Mediaster brachiatus* Goto, 18. dorsal view, 19. dorsal armature, 20. ambulacral armature, R = 7 cm.
Figs. 21-24 *Ophidiaster armatus* Koehler, 21. dorsal view, 22. ventral view, 23. dorsal armature, 24. ambulacral armature, R = 11 cm.
Figs. 25, 26 *Pentaceraster chinensis* (Gray), 25. dorsal view, 26. ventral view, R = 12.7 cm and 6.7 cm.