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FOREWORD

Since the first major Symposium on Echinoderm Biology was held in London in 1966, sponsored by the Royal Zoological Society, at least six subsequent meetings have been organised by echinodermologists. These have been held in Washington D.C., U.S.A. (2), Rovinj, Yugoslavia (1), Sydney, Australia (1), London (1); the last two meetings (Sydney and London), within the same year (1978), and Brussels, Belgium. Also, at least four meetings are known to have been held in U.S.S.R. Such has been the surge of interest in the study of echinoderms over the past decade, that there is now a demand for the organisation of regular, and more frequent, meetings. The international representation at these meetings indicates the enormous involvement and co-operation which now exists between colleagues working in this exciting field, the world over.

It is more than evident that the satisfaction and pleasure expressed by Professor Norman Millott, in his foreword to the first Symposium volume (1967), at the resurgence of interest in Echinoderm Biology has been clearly justified and can continue so to be.

This volume presents twelve of the forty-one contributions offered at the Echinoderm Conference, Sydney, 1978. The papers are representative of the wide coverage of topics dealt with during the Conference, including echinoderm palaeontology, physiology, reproduction, ecology, behaviour and taxonomy.

To the speakers and chairmen, and to all those who attended the Sydney Conference, I convey my thanks. I must also thank my Technical Officer, Ms Jan Marshall, and Dr Susan Oldfield (Queen's Fellow at The Australian Museum, February, 1977-1979) for their unstinting assistance in the organisation of the Conference. Thanks are also due to the Department of State Fisheries (N.S.W.), Taronga Park Zoo, McWilliams Wines Pty, Leo Buring Wines Pty, Qantas Airways Ltd, and Trans-Australia Airlines (T.A.A.). To The Australian Museum Society (TAMS) I extend a special thanks for assistance.

This Conference could not have been held without the tremendous support and encouragement afforded to the organiser by Dr D. J. G. Griffin, Director, The Australian Museum, and the very generous financial support of the Trustees of the Museum, to both of whom I offer my very sincere thanks.

DECEMBER 1979 FRANCIS W. E. ROWE

CONTENTS

6. A REVISION OF THE ASTERINID GENUS *NEPANTHIA* GRAY, 1840 (ECHINODERMATA: ASTEROIDEA), WITH THE DESCRIPTION OF THREE NEW SPECIES

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SUMMARY

The genus *Nepanthia* Gray, 1840 is revised and eight species recognised, including three new species, one from New South Wales, one from north of Sabah, Borneo and one form the Sulu Sea, Philippines. Fisher's opinion that *Parasterina crassa* should be referred to *Nepanthia* is supported and the species is here included. Variation in the species *N. belcheri* (Perrier) is discussed and the species *N. brevis* (Perrier), *N. suffarcinata* Sladen, *N. joubini* Koehler, *N. variabilis* H. L. Clark and *N. magnispina* H. L. Clark are considered conspecific with it. A key is given for the eight species recognised.

INTRODUCTION

Gray (1840; 1866), described the genus *Nepanthia*, in the family Pentacerotidae, for two species *N. tessellata* (from an unknown locality) and *N.maculata* (From Migupou, Philippine Islands).

Müller and Troschel (1842) referred these species to *Chaetaster* which they described a few months prior to Gray's *Nepanthia* in 1840, considering Gray's species to be congeneric with *C. subulata* (Lamarck) (type-species of *Chaetaster* by monotopy).

Perrier (1875), placed *Chaetaster* in the family Astropectinidae, synonymising *Nepanthia tessellata* with *C. longipes* (Retzius). He considered *Nepanthia* to be a subgenus of *Asterina* (family Asterinidae; in which family it has since remained) recognising the validity of *A. (N.) maculata*, the type-specimen of which he examined. He described two new species *A. (N.) belcheri* and *A. (N.) brevis*. This action leaves *N. maculata* as type species of *Nepanthia*, failing Gray's nomination of a type-species from either of the two he included in his genus.

Viguier (1878), placed *Chaetaster* in the family Linkiadae of his subclass of asteroids (Stellérides) "Astéries adambulacraires" (characterised by the predominence of the adambulacral plates in the mouth ring), listing *Nepanthia* as a synonym of *Chaetaster*. He did not discuss the genus or its species.

Perrier (1884), in his remarkable classification of asteroids, based on the form of the pedicellariae, without comment listed *Nepanthia* in the family Asterinidae, Order "Stelleridae Spinulosae" (p. 164, referred to as Echinulatae in subsequent pages).

Sladen (1889), considered the skeletal features of the species of *Nepanthia* to be sufficiently distinctive to "warrant the retention of *Nepanthia* as an independent genus", in the family Asterinidae (subfamily Asterininae) of the new order Phanerozonia.

Gray, 1847 described *Patiria? crassa* from Western Australia in a third group of species (*P. ocellifera*, *P. obtusa* and *P. ? crassa)* of his genus *Patiria*. These were characterised by having 5

TABLE 1. Status of Species referred to *Nepanthia* Gray

Species/Type Locality	History to Present	Present Status in *Nepanthia*
Nepanthia tessellata Gray, 1840/unknown	Referred to *Chaetaster*, Müller & Troschel, 1842; a synonym of *C. longipes* acc. Perrier 1875	—
Nepanthia maculata Gray, 1840/Migupou, Philippines	Referred to *Chaetaster*, Müller & Troschel, 1842; to *Asterina (Nephanthia)*, Perrier, 1875; to *Nepanthia*, Sladen, 1889	Valid species of *Nepanthia* after Gray, 1840
Patiria ? *crassa* Gray, 1847/Western Australia	Referred to *Asterina (Nepanthia)*, Perrier, 1875; to *Parasterina*, Fisher, 1908; to *Nepanthia*, Fisher, 1941; to *Parasterina*, H. L. Clark, 1946	Referred herein to *Nepanthia*, after Fisher, 1941
Asterina (Nepanthia) belcheri Perrier, 1875/unknown	Referred to *Nepanthia*, Sladen, 1889	Valid species of *Nepanthia*, after Sladen, 1889
Asterina (Nepanthia) brevis Perrier, 1875/Prince of Wales Strait, Torres Strait, N. Queensland, Australia	Referred to *Nepanthia*, Sladen, 1889	A synonym of *N. belcheri*, herein
Nepanthia suffarcinata Sladen, 1889/ Mergui Archipelago, Burma	—	A synonym of *N. belcheri*, herein
Patiria briareus Bell, 1894/ Macclesfield Bank, South China Sea	Referred to *Nepanthia*, A. M. Clark 1956	Valid species of *Nepanthia*, after A. M. Clark, 1956
Nepanthia joubini Koehler, 1908/ Cap St. Jacques, Cochin China (Vietnam)	—	A synonym of *N. belcheri*, herein
Henricia heteractis H. L. Clark, 1909/ Lord Howe Island, Tasman Sea	A synonym of *N. belcheri*, H. L. Clark, 1938	As H. L. Clark, 1938
Nepanthia brachiata Koehler, 1910a/ Andaman Islands, Indian Ocean	Referred to *Paranepanthia*, Fisher, 1919	As Fisher, 1919
Nepanthia polyplax Döderlein, 1926/ Rockhampton, Queensland, Australia	A synonym of *N. belcheri*, H. L. Clark, 1938	As H. L. Clark, 1938

Parasterina troughtoni Livingstone, 1934/Albany, Western Australia	Referred to *Nepanthia*, A. M. Clark, 1966	As A. M. Clark, 1966
Nepanthia magnispina H. L. Clark, 1938/ Augustus (or Champagny) Island, N.W. Australia	—	A synonym of *N. belcheri*, herein
Nepanthia variabilis H. L. Clark, 1938/ Broome, Western Australia	—	A synonym of *N. belcheri*, herein
Nepanthia tenuis H. L. Clark, 1938/ Broome, Western Australia	—	A synonym of *N. maculata*, herein
Parasterina occidentalis H. L. Clark, 1938/S.W. Australia	A synonym of *N. troughtoni*, A. M. Clark, 1966	As A. M. Clark, 1966
Nepanthia hadracantha A. M. Clark, 1966 Port Philip Bay, Victoria Australia	A synonym of *N. troughtoni*, Shepherd, 1968	As Shepherd, 1968
Nepanthia nigrobrunnea Rowe and Marsh/ Solitary Islands, New South Wales, Australia	—	New species herein
Nepanthia fisheri Rowe and Marsh/ Sabah, Indonesia	—	New species herein
Nepanthia gracilis Rowe and Marsh/ Philippines	—	New species herein

arms and "dorsal ossicles, especially those at the ends of the arms, broad rounded, the back covered with 2 or 3-beaked pedicellariae nearly hiding the tubercles". Perrier (1875) restricted the genus *Patiria* to the species *ocellifera* and *crassa*, relegating *coccinea* (the type-species of Gray's *Patiria*), *granifera* and *obtusa* to *Asterina*.

Fisher (1908), noted that Perrier had excluded the type-species, *P. coccinea*, from his genus *Patiria*, which is therefore not the *Patiria* of Gray, and renamed Perrier's genus *Parasterina*, with type-species *Patiria crassa*.

Verrill (1913), revised the subfamily Asterininae of the Asterinidae. He described several new genera and constructed a table (key) of genera and subgenera. He listed *N. maculata* as type-species of *Nepanthia* and included *brevis* in the genus. He included Fisher's *Parasterina* with type-species *crassa* and *P. obesa* H. L. Clark from Peru. The latter species has subsequently (Bernasconi 1973) been referred to *Patiria*. In his key Verrill allied *Parasterina* to his new genus *Allopatiria* with type-species *Patiria ocellifera* Gray, erroneously attributed to Australia by Verrill

Fisher (1940) doubted the validity of *Parasterina* after comparing a specimen of *P. crassa* (the type-species) with *Nepanthia variabilis* and *N. belcheri* and in 1941 used the combination *Nepanthia crassa*. H. L. Clark (1946), however, considered that *crassa*, *troughtoni* and *occidentalis* formed a homogeneous group easily distinguished from *Nepanthia* by having non-crescentic, crowded, often swollen abactinal plates and inconspicuous papulae; he referred the three species back to *Parasterina*.

Spencer and Wright (1966) include *Parasterina* in the synonymy of *Nepanthia*.

A. M. Clark (1971, in Clark & Rowe) indicated that some synonymisation of the tropical species of *Nepanthia* may be necessary when sufficient material has been examined.

After a study of most of the type-specimens of species referred to *Nepanthia* and collections housed in several Australian and international institutions, we have concluded that only 5 of the previously described species of *Nepanthia* warrant recognition, of these four occur around the coasts of Australia. Three new species are described, one each from north of Borneo, the Sulu Sea and New South Wales, Australia. Table 1 summaries the species referred to the genus *Nepanthia*.

ABBREVIATIONS

AM	The Australian Museum, Sydney, N.S.W. Australia.
BM	British Museum (Natural History), London, England.
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA.
NMV	National Museum of Victoria, Melbourne, Victoria Australia.
USNM	United States National Museum (Smithsonian Institution), Washington D.C., USA.
WAM	Western Australian Museum, Perth, Western Australia.

SYSTEMATIC ACCOUNT

Family ASTERINIDAE

Genus **Nepanthia** Gray, 1840: 287

DIAGNOSIS: An asterinid genus with five or more distinct, elongate subcylindrical to tapering arms and a relatively small disc; abactinal surface strongly convex, actinal surface usually flat; adult size between 30 and 80 mm R. The abactinal plates appear crescentic to rhomboidal and are usually in distinct abactinal and lateral 'fields' on the arms; the primary plates imbricate throughout or only in certain areas, small secondary plates are often present. Marginal plates small, not prominent though they may delimit the lateral/actinal line. Actinal plates in 4-9 rows at base of rays, decreasing distally. Adambulacral plates bear a fan or comb of furrow spines backed by a fan or group of variously sized subambulacral spines which are sometimes larger than the furrow spines. All plates evenly covered or bearing tufts of spinelets which vary, between species, from short and thick set with many points to slender and hyaline with 1-3 points. Simple fasciculate pedicellariae are sometimes present. Several species fissiparous. Eight species recognised.

TYPE SPECIES: *N. maculata* Gray, 1840, restricted by Perrier, 1875, designated by Verrill, 1913.

OTHER SPECIES INCLUDED: *N. crassa* (Gray, 1847), *N. belcheri* (Perrier, 1875); *N. briareus* (Bell, 1894), *N. troughtoni* (Livingstone, 1934); *N. nigrobrunnea* n. sp., *N. fisheri* n. sp. and *N. gracilis* n. sp.

KEY TO SPECIES OF *NEPANTHIA*

1. Abactinal spinelets short, thick with many (more than eight) equal points; no prominent convex abactinal plates; distribution — southern Australia; two species 2

— Abactinal spinelets slender with few (not usually more than five) unequal points; one species *(crassa)* with spaced convex abactinal plates; distribution — Australia (except the south coast) and Indo-Malay region; six species 3

2. Exposed portion of plates of dorsal field rhomboidal, scarcely notched for papulae; 4-6 plates across the field at 1/2 R; papulae single; colour whitish-pink to deep rose, papulae red; southern Australia .....*N. troughtoni*

— Plates of dorsal field small, irregulary shaped, 8-10 plates across the field at 1/2 R; usually 2-3 papulae between plates; colour dark brown with black papulae; northern N.S.W. .....*N. nigrobrunnea*

3. Arms arched abactinally, actinal surface flat; marginal plates form a distinct actino-lateral edge 4

— Arms cylindrical or terete, marginal plates not forming a distinct actino-lateral edge . 5

4. Usually prominent convex primary abactinal plates with smaller secondary and granule-like tertiary plates between them; not fissiparous; colour usually mottled red/brown or brown, sometimes (at Abrolhos Is.) bright blue; west coast of Western Australia .....*N. crassa*

— Primary abactinal plates narrow, crescentic with small granule-like secondary plates around papulae; often fissiparous; mottled, variously coloured, often shades of grey or dull green or orange, red or brown; Indo-Malay region to northern Australia .....*N. belcheri*

5. Spinelets with 1-3 points 6

— Spinelets with more than 3 points 7

6. Arms terete, tapering to an acute tip; spinelets in 2-3 small tufts on the primary plates; colour (holotype) grey-blue; Philippines to Timor Sea .....*N. fisheri*

— Arms long, cylindrical or slightly tapering to a blunt tip; spinelets evenly covering primary plates; colour cream to buff, sometimes with dark spots; Philippines to northern Australia .....*N. maculata*

7. Five rays, not known to be fissiparous; cleaned abactinal plates flat; spinelets slender with 7-8 points; Philippine area and N.S.W. .....*N. gracilis*

— Multirayed, fissiparous; cleaned abactinal plates moderately convex; spinelets short with 5 or 6 points; South China sea to Moluccas .....*N. briareus*

Nepanthia troughtoni (Livingstone)
Figs 1; 2d, e; 5k; 6l.

Parasterina troughtoni Livingstone, 1934: 179, pl. 18 figs 1-6 — H. L. Clark, 1938: 180; 1946: 143.—Rowe and Pawson, 1977: 346.

Parasterina occidentalis H. L. Clark, 1938: 180, pl. 21 fig. 5; 1946: 143.—Rowe and Pawson 1977: 346.

Parasterina sp. c.f. *troughtoni*.—A.M. Clark, 1956: 378, text fig. 3, pl. 11.

Nepanthia hadracantha. A. M. Clark, 1966: 320, text fig. 3, pl. 3, figs 4-6.

Nepanthia troughtoni. A. M. Clark, 1966: 322.—Shepherd, 1968: 748.—Rowe and Pawson 1977: 348.

MATERIAL EXAMINED: 1 specimen (R/r = 16/4.5 mm = 3.5), holotype, *N. troughtoni*, AM No. J3978; 1 spec. (R/r = 34/7 mm = 4.8), paratype, *Parasterina occidentalis* AM No. J6178; 1 spec. (R/r = 67/12 mm = 5.6), paratype, *P. occidentalis* WAM 46-32; 1 spec. (R/r = 37/9 mm = 4.1), paratype, *P. occidentalis*, WAM No. 606-31; 1 spec. (R/r = 55/12 = 4.6), holotype, *N. hadracantha*, NMV No. H14.

In addition 77 specimens from the W.A. Museum, 7 specimens from the Australian Museum and 10 specimens from the S.A. Museum were examined. A summary of data for the 99 specimens examined is given in Table 2.

Table 2. Variation in size and R/r ratio of specimens of *N. troughtoni* from five areas of the coast of southern Australia.

Distribution	Number of Specimens	Max. R/r, mm.	Min. R/r, mm.	Range R/r	Mean R, mm.	Mode R, mm.
W.A. 30°05′S to 32°20′S	26	80/17	19/5	3.3-5.8	48.6	41-50
W.A. 33°10′S to 34°0′S	27	64/14	25/6	3.6-5.0	40.7	31-40
South Coast W.A.	28	65/11	16/4.5	3.5-5.9	47.7	41-50
South Australia	16	62/15	38/9	3.7-5.9	46.5	31-40
Victoria	2	57/11	55/12	4.6-5.2	—	—
	99	80/17	16/4.5	3.3-5.9	45.9	41-50

Table 3. Size distribution (R) of the specimens of *N. troughtoni* in 10 mm class intervals.

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90
0	2	8	25	34	22	7	1	0

DIAGNOSIS: A species of *Nepanthia* with 5 cylindrical to slightly tapering blunt ended arms, non fissiparous. Maximum known R/r of 80/17 mm, mean R of 46 mm, range of R:r from 3.3 to 5.9; colour pinkish-white to rose with red papulae; abactinal plates rhomboidal, slightly convex; crystal bodies, secondary plates and pedicellariae absent; abactinal spinelets all over plates, short and stout with ca 10-20 points surrounding a prominent hemispherical to slightly pointed boss; furrow armature in overlapping combs of 4-5 subequal furrow spines with 6-10 subambulacrals in 2-3 rows; intertidal to 73 metres on rock, southern Australia.

COLOUR: *N. troughtoni* varies in colour from pinkish white-through salmon-pink to rose with red papulae and red skin visible between the plates in life.

HABITAT AND DISTRIBUTION: The habitat is on open coasts exposed to considerable wave action where it is found under reef ledges, grazing on encrusting organisms such as compound ascidians, under boulders or on vertical rock faces in the sublittoral. *N. troughtoni* is recorded from Wilsons Promontory, southern Victoria, around southern Australia to Green Head (30° 05' S) on the west coast of Western Australia. The known depth range is from the intertidal to 73 metres.

REMARKS: A. M. Clark (1966) referred *Parasterina troughtoni* to the genus *Nepanthia*, at the same time synonymising *P. occidentalis* with it and describing a new species, *N. hadracantha*. A. M. Clark (1966) also showed that there is quite a significant difference between the form of the spines of the cool temperate species *N. hadracantha* and its tropical congeners.

Shepherd (1968), after examining 47 specimens from Victoria and Western Australia, together with those collected during extensive underwater surveys of the coastal waters of South Australia, discussed the variation in arm taper, size and crowding of the abactinal plates and variation in the spinelets concluding that there was no evidence for maintaining *N. hadracantha* and synonymised it with *N. troughtoni*.

In comparing the holotypes of *N. troughtoni*, *N. occidentalis* and *N. hadracantha* the only detectable difference is in the slightly stouter, squatter shape of the spines of *N. occidentalis*, a difference not considered here of specific importance in view of Shepherd's (1968) observations.

Examination of a large series of specimens (99) shows considerable variation in the size of the abactinal plates and in the regularity of their arrangement. The specimens range in size from R/r = 16/4.5 mm (holotype of *N. troughtoni*) to 80/17 mm, while the R/r ratio varies from 3.3 to 5.9, the mean R measurement is 45.9 mm and the mode lies in the class interval 41-50 mm. The figures (Table 3) show a normal size distribution with a complete lack of very small specimens as with many other asteroids. No geographical differences can be detected in the size of specimens or in R/r ratios. There is considerable variation, however, in the length and breadth of arms within a population.

Nepanthia nigrobrunnea n. sp.
Figs 1; 2a, b, c; 5i; 6j, k.

MATERIAL EXAMINED: 1 specimen (R/r = 65/15 mm = 4.3) holotype, AM No. J10147, Groper I, Coffs Harbour, N.S.W., on reef, 20 m, N. Coleman, September, 1976; 3

specimens (R/r = 69-75/14.5-16 mm = 4.6) paratypes, AM No. J9885, Julian Rocks, Byron Bay, N.S.W., 10-30 m, S. Parish, May, 1976; 3 specimens (R/r = 56-66/13-14 mm = 4.3-4.7) paratypes, AM No. J9135 locality as J9885, on reef, 18 m, N. Coleman, 30.3.75; 2 specimens (R/r = 53-64/14-15 mm = 3.5-4.4) paratypes, AM No. J10920, Groper I, Coffs Harbour, N.S.W., 16 m, J. Ogg and C. Short, 19.8.77.

DIAGNOSIS: A species of *Nepanthia* with 5 subcylindrical to slightly tapering blunt ended arms, non fissiparous. Maximum known R/r of 75/16 mm, mean R of 62 mm, range of R:r from 4.3 to 5; colour dark brown with black papulae; abactinal plates somewhat irregular in shape, often double notched with 2-3 papulae (sometimes 1 or 4) to an area; crystal bodies, secondary plates and pedicellariae absent; abactinal spinelets all over plates, short and stout with 12-16 points, the central one sometimes enlarged; furrow spines in a comb of 3-4 subequal spines with 6-7 subambulacral spines in 2 rows; sublittoral, 10-30 metres, on rock, known only from northern N.S.W., Australia.

DESCRIPTION: The holotype has 5 arms, subcylindrical tapering evenly to a narrow but blunt tip; R/r = 65/15 mm = 4.3; br = 15.5 mm at base and 9 mm at two-thirds R. The madreporite is inconspicuous, lying in one interradius about 4 mm from the centre of the disc. The abactinal plates are all similar in size (about 1.1 mm maximum diameter). There are two 'fields' of plates, the dorsal field, where the order is irregular, and a lateral field each side, with the plates forming 10-11 longitudinal rows (at least proximally). The shape of the plates from the dorsal field is variable, from transversely elongate to triangular or rounded (fig. 5i). The proximal edge of the majority of plates is concave so that the plates can be said to be generally crescentic. Proximally there are about 3 plates between the lateral fields, 8-10 plates at half R and 6-7 plates at the arm tip. The plates of the lateral fields are more regularly triangularly crescentic. The first row extends to the arm tip, the succeeding rows extending to shorter distances so that the 11th row comprises only 3-4 plates at the arm base.

The actino-lateral edge is rounded. The inferomarginal plates form a regular row of longitudinal plates (about 1.7 mm x 0.7 mm proximally) along the arm, becoming shorter, rounded and convex distally. The superomarginals are smaller than the inferomarginals and from the 12th-14th inferomarginal there are 2 small superomarginal plates aligned per inferomarginal. The superomarginals are irregular distally, and difficult to distinguish. The adambulacral plates bear 3-4 subequal, flat-tipped furrow spines backed by six or seven subambulacral spines arranged in 2 rows. The first actino-lateral row of plates extends almost to the arm tip. The second row comprises 7-8 plates, the third row 3-4 plates and 3-4 plates are present in the distal triangle of the actinal surface. The oral plates bear 5 furrow spines and 7-8 suboral spines. The proximalmost suboral spine is largest. The spinelets on the abactinal and actinal plates are spaced and coarse. Abactinally the largest plates bear up to 45 spines, the actinal plates bear about half of this number. The abactinal spinelets are 2.5-3 times as long as their maximum width (base) and some have a median, large, blunt process between the terminal points (fig. 6j, k). The spinelets are remarkably even in size (360-375 μm long x 120-150 μm wide). The actinal spines are larger, 2.7-2.8 times as long as wide (570-600 μm long x 200-240 μm wide) (fig. 2c).

Between the plates of the dorsal field are 1-4, usually 2-3, papular pores but between the plates of the lateral fields only 1 pore per plate occurs. There are no pores between the plates of the 10-11th rows of lateral plates or actinally. There are no fasciculate pedicellariae. Besides the holotype, there are eight paratypes which are similar in all respects to the holotype.

COLOUR: In life the animal is very dark brown, with black papulae.

HABITAT AND DISTRIBUTION: Known from Byron Bay to the Solitary Islands, New South Wales, Australia, in 10-30 m depth.

ETYMOLOGY: *nigrobrunnea* (Lat.) refers to the colour of the animal.

REMARKS: *N. nigrobrunnea* is most closely allied to the Flindersian species *N. troughtoni* from which it is most easily distinguished by the arrangement of marginal plates, the shape of plates in the dorsal field, groups of 2-4 papulae and colour. These features alone would distinguish *nigrobrunnea* from its tropical congeners but additionally the shape of the spines covering the skeletal plates distinguish this species and *troughtoni* from the tropical species.

The closer relationship of *nigrobrunnea* with the Flindersian species would indicate that though this species occurs in the northern parts of New South Wales (where there is a known overlap of tropical and warm temperate species) it can be considered a Peronian species. Its presently known restricted distribution is difficult to assess though a somewhat similar situation occurs on the western coast of Australia where *Nepanthia crassa* occupies the whole west coast. It might be expected that *nigrobrunnea* will be found further south along the New South Wales coast. Whether *nigrobrunnea* is derived from Flindersian stock is difficult to determine. It might be speculated that *troughtoni* and *nigrobrunnea* have developed independently from the progression of a northern species southward along either side of the continent. However, the form of *nigrobrunnea* compares much more closely with that of the Flindersian *troughtoni* than its tropical congeners *belcheri* and *maculata*. That *nigrobrunnea* has developed after a possible isolation from *troughtoni* due to the separation of populations by the Bassian isthmus during the Pleistocene epoch is possibly more likely than a development from the small, highly fissiparous *belcheri* from the north.

Nepanthia crassa (Gray)
Figs 1; 3a, b, c; 5g, j; 6d, e.

Patiria? crassa Gray, 1847: 83; 1866: 17.

Patiria crassa. — Perrier, 1875: 326-327.

Parasterina crassa. — Fisher, 1908: 90; 1940: 270-271. — H. L. Clark, 1923: 243; 1938: 179-180; 1946: 143.

Nepanthia crassa. — Fisher, 1941: 451-455, figs 20, 21, pl. 70, fig. 2.

non Patiria crassa. — Bell, 1884: 131. — Whitelegge, 1889: 201.

MATERIAL EXAMINED: See Table 4 for a summary of data for the 127 specimens examined from the Australian and Western Australian Museums.

DIAGNOSIS: A species of *Nepanthia* with 5 subcylindrical to slightly tapering, stout, blunt ended arms. Maximum known R of 72/17 mm, mean R of 40 mm, range of R:r from 2.8 to 5.1; colour variable, unicolorous blue, blue-green or orange, more often mottled browns or pink to red and brown; papulae single; primary abactinal plates subcrescentic, imbricating when young, tumid to hemispherical, surrounded by numerous secondary plates when large; few crystal bodies on plate margins; fasciculate pedicellariae usually on plates of the lateral field; thorny abactinal spinelets with 5-8 points cover primary plates and occur in tufts on secondary plates; furrow spines in a graduated fan of 7-10 (usually 9) spines with a fan of 7-10 subambulacral spines and 5-7 spinelets; intertidal to 38 metres, on rock, sand and muddy sand, on the west coast of Western Australia, from Point Cloates to Cape Naturaliste.

COLOUR: In colour *N. crassa* is variable, usually brownish, sometimes mottled with darker shades; a specimen from Shark Bay was pinkish-buff, mottled with red-brown and dark brown while at the Abrolhos Islands most specimens are blue or blue-green.

Table 4. Variation in size and R/r ratio of specimens of *N. crassa* from four areas in Western Australia.

Distribution (Western Australia)	Number of specimens	Max. R/r, mm.	Min. R/r, mm.	Range, R/r	Mean, R, mm.	Mode, R, mm.
22°40′S to 29°55′S	23	60/14	23/7	3.1-4.6	38.0	31-40
Abrolhos, 28-29°S	45	72/17	18/6	2.8-4.4	38.1	31-40
Fremantle area, 32°S	52	65/15	15/5	3.0-5.1	42.2	41-50
Geographe Bay, 33°35′S	7	56/14	34/9	3.7-4.7	43.6	41-50
	127	72/17	15/5	2.8-5.1	40.5	31-40

Table 5. Size distribution (R) of the specimens of *N. crassa* in 10 mm class intervals.

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90
0	4	24	44	38	16	3	1	0

HABITAT AND DISTRIBUTION: *N. crassa* is found in sheltered bays, commonly under jetties and on piles but is also found on sand amongst seagrass, mud or amongst algal covered rocks. In the Abrolhos *N. crassa* occurs near islands on the western platforms e.g. around Gun Island (Pelsaert group), Rat I. (Easter Group) and Pigeon I. (Wallabi group) in areas protected by seaward reefs from much wave action. The substrate is rock with a thin covering of algae and silty sand. During the day the animals are concealed in crevices or under dead coral slabs and are active at night on the reef platform. They are rarely found elsewhere in the Abrolhos. *N. crassa* is confined to the west coast of Western Australia between Cape Naturaliste (33°35′S) and the Point Cloates area (22°40′S) where it is separated by North West Cape from populations of *N. belcheri* and *N. maculata* in Exmouth Gulf. The recorded depth range is from the intertidal to 38 metres.

REMARKS: The history of generic changes undergone by this endemic Western Australian species are given in Table 1.

Fisher (1940, 1941) re-described *N. crassa,* showing (1941, figs 20, 21) the imbrication of the abactinal plates, thus removing the main character by which his genus *Parasterina* was distinguished from *Nepanthia*. H. L. Clark (1946) stressed the shape of the abactinal plates as characterising *Parasterina crassa, troughtoni* and *occidentalis*. Since the latter two species have already been included in *Nepanthia* (A. M. Clark, 1966) and the shape of the plates does not differ significantly in small specimens of *crassa,* H. L. Clark's view cannot be upheld.

In small specimens of *N. crassa,* e.g. WAM 54-79, which has R/r of 30/9 mm, (fig. 5j), the abactinal plates imbricate regularly and are notched for papulae; they are slightly tumid with secondary plates only around the papular pores and few tertiary plates in the dorsal field. The plates of the lateral field also imbricate regularly but most lack secondary plates. A large specimen, WAM. 625-75 with R/r of 57/15 mm, (fig. 5g), has the primary abactinal plates

widely separated, linked by secondary plates with numerous small tertiary plates in the dorsal field and 2-5 small plates around the papulae of the lateral field. In this specimen the primary plates are not greatly enlarged nor very tumid but a few examples e.g. WAM. 756-75, (fig. 3a), the primary plates are almost hemispherical, on short stout arms. The abactinal and actinal plates are covered in a dense coat of thorny spinelets which radiate from the small secondary and tertiary plates but give an even coating to the primary plates. Detail of the abactinal spinelets is shown in figure 6d, e; they most closely resemble those of *N. belcheri*. The furrow armature, actinal surface and pedicellariae all closely resemble *N. belcheri*, pointing to a close relationship of the two species. The fact that both Bell (1884) and Whitelegge (1889) identified specimens of *N. belcheri*, from the east coast of Australia, as *N. crassa*, highlights the resemblance of the two species. The principal difference is in the shape of the abactinal plates, crescentic in *N. belcheri*, very convex and rounded or irregular in shape in adult *N. crassa*, and in the presence of tertiary as well as secondary plates in *N. crassa*.

Among the specimens examined the arms vary in shape from slightly tapering to quite cylindrical, apart from a slight ventro-lateral angle, but are always blunt ended. The majority of specimens have moderately convex primary plates and slightly tapering arms.

The variation in size of specimens from four areas on the Western Australian coast (Table 4) shows a geographical trend with higher mean and modal sizes (R) in specimens from the southern part of the range (Fremantle to Cape Naturaliste). Measurements of the 127 specimens as a whole, however, show a similar trend to that shown in *N. troughtoni*, but with a slightly lower mean R measurement, 40.5 mm, the mode falling in the class interval 31-40 mm (Table 5), there being a similar lack of very small specimens.

Nepanthia belcheri (Perrier)
Figs. 1; 3d, e; 5a, b; 6a, b.

Asterina (Nepanthia) belcheri Perrier, 1875: 320.

Asterina belcheri. — Bell, 1884: 131.

Asterina (Nepanthia) brevis Perrier, 1875: 321. — Bell, 1884: 131, pl. 8, figs A, a. — Studer, 1884: 41.

Nepanthia suffarcinata Sladen, 1888: 328, pl. 28, figs. 9-12. — Koehler, 1910a: 133; 1910b: 288. — Clark and Rowe, 1971: 38 (distribution), 66 (key).

Nepanthia belcheri. — Sladen, 1889: 387. — H. L. Clark, 1938: 169; 1946: 141. — Kenny, 1969: 51, figs. 1-4. — Endean, 1953: 54; 1956: 125; 1957: 240; 1961: 291. — Clark and Rowe, 1971: 38 (distribution), 66 (key). — Otteson, 1976.

Nephanthia brevis. — Sladen, 1889: 387, pl. 63, figs 3-5 — Döderlein 1896: 40. — H. L. Clark, 1921: 95, pl. 6, figs 3-4 (col.); 1938: 172; 1946: 141. — Endean, 1953: 54; 1956: 125; 1957: 240; 1965: 230. — Clark and Rowe, 1971: 38 (distribution), 66 (key).

Patiria crassa. — Bell, 1884: 131. — Whitelegge, 1889: 201 (*non P. crassa* Gray).

Nepanthia joubini Koehler, 1908: 232, figs 1-4. — Fisher, 1919: 423, pl. 113, figs 1-2. — H. L. Clark, 1938: 172 (footnote). — Clark and Rowe, 1971: 38 (distribution), 66 (key). — Domantay, 1972: 55.

Henricia heteractis H. L. Clark, 1909: 530, pl. 49, figs 1-2; 1926:2.

Nepanthia polyplax Döderlein, 1926: 20, pl. 4 figs 2-2a.

Nepanthia ? brevis. — Livingstone, 1932: 262, pl. 5, figs 8-9.

Nepanthia magnispina H. L. Clark, 1938: 174, pl. 20, figs 1-2; 1946: 142.

Nepanthia variabilis H. L. Clark, 1938: 176, pl. 10, figs 4-5 (col.), pl. 20, figs 4-5; 1946: 141. — Fisher, 1941: 454, fig. 22. — Clark and Rowe, 1971: 38 (distribution), 66 (key).

MATERIAL EXAMINED: 1 specimen (R/r = 15/3.8 mm = 3.9) holotype of *N. belcheri*, BM No. 1847.3.10.4; 1 specimen (R/r = 24/5.7 mm = 4.2) holotype of *N. brevis*, BM 1854.11.15.290; 1 specimen (R/r = 25/8 mm = 3.1) holotype of *Henricia heteractis*, AM No. G11430; 1 specimen (R/r = 31.9/8.5 mm = 3.8) holotype of *N. magnispina*, MCZ No. 3230; 2 specimens (R/r = 30-50/6.7-10 mm = 4.5-5.0) paratypes of *N. variabilis*, MCZ No. 3225; 2 specimens (R/r = 40-47/10-11 mm = 3.6-4.7) paratypes of *N. variabilis*, WAM No. 119-39, 120-39; 4 specimens (R/r = 32-62.5/7.5-12.5 mm = 4.3-5.3) paratypes of *N. variabilis*, AM No. J6187.

In addition 138 specimens from the Western Australian and Australan Museums were examined. A summary of data for the 150 specimens is given in Table 6.

DIAGNOSIS: A fissiparous species of *Nepanthia* with 4-7 (usually 5-6) subcylindrical to slightly tapering, moderately stout arms. Maximum known R/r of 65/14 mm, mean R of 31 mm, range of R:r from 2.0 to 5.3; colour highly variable, often grey-green or fawn ground colour mottled with red, green, brown or black; papulae single, lying in notch of abactinal plates which have a raised crescentic ridge carrying spinelets, with crystal bodies on the lower parts of the plates; fasciculate pedicellariae usually present on plates of the lateral field; abactinal spinelets, with 3-5 acute points, on ridges of primary plates and on 2-4 secondary plates, adjacent to the papulae; furrow spines in a graduated fan, usually 8-9, with a subambulacral fan of 7-12 spines and 3-7 additional spinelets; intertidal to 46 metres on a muddy sand and rock substrate, Burma to northern Australia.

COLOUR: Highly variable, often grey-green or fawn ground colour mottled with red, green, brown or black.

HABITAT AND DISTRIBUTION: *N. belcheri* is found from the intertidal to a known depth of 46 metres. Near low tide mark it may be found clinging to the underside of boulders on a muddy sand or rock substrate. The species appears to be always associated with somewhat muddy conditions. Geographically *N. belcheri* ranges from the tropical coast of Australia, northwards to the Philippines, Cochin China (Vietnam) and west to Burma.

REMARKS: Although he was convinced that his species *Henricia heteractis* from Lord Howe Island and Döderlein's *Nepanthia polyplax* from Rockhampton, Queensland, were conspecific with *Nepanthia belcheri*, H. L. Clark (1938) described two new species *N. magnispina* and *N. variabilis* from north-western Australia.

The similarity of specimens of *N. variabilis* and *N. brevis* led the present authors separately to question the basis for separating them and a comparison with specimens of *N. belcheri* indicated that this species could not be distinguished morphologically from the other two species. The results of an examination of 150 specimens of the three nominal species, ranging from Lord Howe Island and Port Jackson, N.S.W. through Queensland and Torres Strait to Exmouth Gulf, Western Australia, including the holotypes of *N. belcheri*, *N. brevis*, *H. heteractis* and *N. magnispina* and eight paratypes of *N. variabilis*, are presented in Table 6. It is evident that two of the key characters used by Clark (1938) to separate *N. belcheri*, *N. brevis* and *N. variabilis* i.e. the number of arms and number of furrow spines, do not provide a basis for distinguishing them. Samples from the three areas, east coast of Australia, Torres Strait to Darwin and north western Australia (Table 6), corresponding to the distribution of the three nominal species

Table 6. Variation in *Nepanthia belcheri*.

	Number of specimens		
	East coast and Lord Howe I,	Torres Strait to Darwin	Kimberley to Exmouth Gulf
Size R in mm			
1-10	8	1	0
11-20	22	3	3
21-30	17	11	12
31-40	11	25	10
41-50	2	4	15
51-60	0	0	3
61-70	0	1	2
	N = 60	45	45
	Mean 22.2	33.4	38.1
	Mode 11-20	31-40	41-50
Number of Furrow spines			
5-6	6	0	0
6-7	16	0	2
7-8	13	12	11
8-9	19	22	17
9-10	5	6	5
10-11	0	6	6
	N = 59	45	41
	Mean 7.5	8.8	8.5
	Mode 8-9	8-9	8-9
Number per plate, Abactinal spines			
<30	8	1	0
31-40	35	5	5
41-50	13	17	3
51-60	1	12	13
61-70	1	5	7
71-80	0	4	8
>81	1	0	7
	N = 59	44	43
	Mean 38.15	51.25	61.56
	Mode 31-40	41-50	51-60
Number of arms			
4	0	1	2
5	21	38	39
6	28	3	4
7	11	3	0

	N = 60 Mean 5.8 Mode 6	45 5.2 5	45 5.0 5
R/r ratio			
Max. R/r	46.5/15.0	63.0/13.5	65.0/14.0
Min. R/r	8.0/3.0	10.0/3.0	12.0/4.0
Range R/r	2.0-5.0	2.8-4.4	3.0-5.3

Table 7. Percentage of specimens of *N. belcheri* with various arm numbers.

	N	< 5	5	6	7	> 7
Moreton Bay (Kenny, 1969)	837	10	8	55	25	1
Townsville (Otteson, pers. comm.)	613	22	<2	25	44	<6
East Coast Queensland	60	0	35	47	18	0
Torres Strait to Darwin	45	2	84	7	7	0
Kimberley to Exmouth Gulf	45	4	87	9	0	0

respectively, show close similarity in the number of furrow spines, all having a modal number of 8-9. The slightly lower mean number in the east coast population is related to the smaller mean and modal R measurements of these specimens.

The mean and modal size of specimens increases progressively northwards and westwards, with a corresponding decrease in fissiparity. The sample of the east coast population is 65% multibrachiate and 35% five rayed, the north coast sample is 13% multibrachiate and 84% five rayed and the northwest sample is 9% multibrachiate and 87% five rayed. A few specimens from northern Australia and the northwest are four rayed.

A comparison of the arm numbers of specimens from Moreton Bay, Townsville and the present, smaller, sample from the whole east coast of Queensland (Table 7) shows a preponderance of 6 rayed specimens in Moreton Bay and on the east coast overall while 7 rayed specimens predominate at Townsville. A much higher proportion of 5 rayed specimens occur in the present sample from the Queensland coast than in the other two studies. The reason for the preponderance of small fissiparous specimens in the east coast population is unknown. Kenny (1969) showed that members of the Moreton Bay population of *N. belcheri* reproduce asexually by fission in their second or third year. Otteson (1976), studying the reproductive pattern of *N. belcheri*, found the Townsville population to be serially protandric hermaphrodites in which sexual reproduction appeared to be modified by fissiparity.

A parallel to the east coast population of small sized fissiparous *N. belcheri* is found in *Coscinasterias acutispina* Stimpson, where a dwarf race, reproducing fissiparously was reported from the island of Maui, Hawaii while normal specimens were found in Kaneohe Bay, Oahu, Hawaii (Edmondson, 1935). Edmondson also referred to a small fissiparous *Nepanthia?* sp. However, one of us (F.W.E.R.) has re-examined this specimen and found it to represent *Asterina burtoni* Gray.

Clark's third distinguishing character, the shape of the abactinal plates, varies within each population and is not a reliable distinguishing character. The number of spinelets per abactinal

plate also varies within each population, but since it is related to the size of the specimen, the number is higher in the populations of larger individuals from north and northwestern Australia (Table 6). The shape of the abactinal spinelets is identical in the three populations (Figs 6a, b).

The type locality of *N. belcheri* is uncertain though Bell (1884) recorded specimens from Port Jackson, N.S.W. and there are three specimens in The Australian Museum and one in the Stockholm Museum from Lane Cove River, Port Jackson, N.S.W. These were reported by Whitelegge (1889) as *Patiria crassa*, redetermined by H. L. Clark as *Henricia heteractis* (1926) and later as *Nepanthia belcheri* (1938). No other records of this species exist from New South Wales. A. M. Clark (pers. comm.) has thoroughly researched the literature and found that the type locality for the species could not be New South Wales since Belcher did not visit Australia on his voyages. His specimens were more likely to be from Indonesia. Its occurrence in the Moluccas is confirmed by Koehler (1910a), as *N. suffarcinata* (2 five rayed specimens taken from 15 m in Aru) and by specimens recorded here from 25-45 m in the Aru Islands.

Nepanthia joubini was described from Cap St. Jacques, Cochin China (Vung Tau, Vietnam). Both Fisher (1919) and Clark (1938) doubted the validity of *N. joubini*, Fisher considering it to be probably conspecific with *N. brevis* and Clark with *N. belcheri*. A. M. Clark (in Clark and Rowe, 1971) also noted that *N. joubini* would probably prove to be conspecific with *N. belcheri*. Livingstone (1932) identified a specimen of *N. belcheri*, with 6 rays and 5 madreporites, from the vicinity of Low Islands, North Queensland as *N. brevis*, remarking on the resemblance to Fisher's example of *N. joubini*.

A. M. Clark (1971) also indicated that *N. suffarcinata* might be conspecific with *brevis* or *variabilis*. In comparing Sladen's (1888) description of *N. suffarcinata*, collected from Burma, with our data, we consider the species to be conspecific with *N. variabilis* or *N. brevis*, and therefore falling within the range of *N. belcheri*. Examination of the holotype of *N. magnispina* by one of us (F.W.E.R.) shows it to be virtually identical with specimens of *N. belcheri* from Queensland and New South Wales. There is evidence of a third regenerating arm (H. L. Clark notes only 2), a small madreporite is present (H. L. Clark missed it) and the number of spines on the abactinal plates and adambulacral plates is similar to the specimens of *N. belcheri* collected from Lane Cove River, N.S.W. The "enlarged oral spine" recorded by H. L. Clark, is not particularly prominent and falls certainly within the range of variation of sizes of spines seen within the 150 specimens examined.

This study has led to the conclusion that *N. brevis*, *N. suffarcinata*, *N. joubini*, *N. magnispina* and *N. variabilis* should be regarded as junior synonyms of *N. belcheri*, a somewhat variable species occurring on the east, north and northwest coasts of Australia from Lord Howe Island and southern Queensland to Exmouth Gulf and in Indonesia, the Philippines, Vietnam and Burma.

Nepanthia fisheri n. sp.
Figs 1; 4a, b, c; 5d, h; 6g.

Nepanthia maculata. — Fisher, 1919: 423 (part) (non *N. maculata* Gray).

MATERIAL EXAMINED: 2 specimens, the holotype, WAM 102-78, and paratype WAM 101-78, from west Banguey channel, northeast of Sabah, dredged on mud, 25 fms (46 m), B. R. Wilson on 'Pele', 11.III.1964; 1 specimen WAM 42-69 from 8 km west of Agal Bay, N.W. Sabah, dredged on mud, 16 fms (29 m), B. R. Wilson on 'Pele', 12.III.1964; 1 specimen WAM 100-78, from 14 km west of Cape Melville, Balabac I., Philippines, dredged on sand, 27 fms (49 m), B. R. Wilson on 'Pele', 9.III. 1964; 2 specimens, USNM40290 & 40371, from Linapacan Strait, N. of Palawan I., Philippines, 11° 37' 15" N: 119° 48' 45" E, Albatross st. 5335, 46 fms (84 m) sand, mud, 18.XII.1908 (included in *N. maculata* by Fisher, 1919); 1 specimen AM

J12649, from st. 1154, 11° 48' S: 129° 19' E, 68 m (Timor Sea), R. Martin (CSIRO).

DIAGNOSIS: A species of *Nepanthia* with 5 regular, strongly tapering arms, not known to be fissiparous. Maximum known R/r of 40/9.5 mm, mean R of 19 mm, range of R:r from 3.4 to 4.1; colour of holotype blue-grey; abactinal plates broadly crescentic slightly notched for single papulae with 2-3 raised areas bearing spinelets separated by lower areas with crystal bodies; 1-2 secondary plates usually occur in the papulae areas; abactinal spinelets in radiating groups of short sharp single pointed spinelets on the raised areas of each plate and on the secondary plates; furrow spines in a graduated fan of 8 with a fan of 8 subambulacral spines and 10-15 additional spinelets; sublittoral on mud or sand, 29-84 metres, Philippines to the Timor Sea.

DESCRIPTION: The holotype has 5 subequal tapering arms, R/r = 38-40/9.5 mm = 4.1, br = 9-10 mm at base of ray decreasing to 5 mm at half R and 2.5 mm just proximal to the terminal plate; R/br at base = 4.1. Rays elongate, broad at the base, tapering to a narrow tip. Abactinal surface of the disc and rays convex, depressed interradially, interbrachial arcs acute; actinal surface plane but margin of disc and rays not distinct. There are two madreporites both situated nearer the centre of the disc then the margin, one is radial in position, 2 mm in diameter, the other interradial and 1.5 mm in diameter. The anus is central, surrounded by about 8 small granules.

The abactinal spinelets are in radiating groups arising from 2 or 3 raised areas on each plate, giving the impression of a large number of small convex plates. The imbricating abactinal plates are arranged in dorsal and lateral fields; when denuded the exposed part of the plates of the dorsal field are seen to be broadly crescentic, 1 to 1.2 mm in diameter on the proximal part of the arm, and slightly notched for single papulae, beside which are two small rounded supplementary plates. Secondary plates are absent distally. Plates of the dorsal field are fairly regularly arranged with alternating transverse rows of plates across the ray. There are 6 plates in a diagonal series across the dorsal field at half R. Plates of the dorsal field have 2-3 raised areas separated by lower areas with embedded crystal bodies. Each raised area bears a radiating group of 20-25 short, sharp spinelets, tapering to a single point while each secondary plate has a group of 5-10 similar spinelets, fig. 6g.

The lateral field of plates is in six longitudinal rows at the base of the ray decreasing to three at half R. Two rows extend to the arm end. The terminal plate is rounded, 1 mm in diameter.

The spinelets of the lateral arm plates are arranged in a horseshoe shape proximally giving the impression that they surround a pedicellaria pit but no modified or enlarged spinelets are present, nor are pits present on the denuded plates.

Superomarginal plates, small and rounded, alternate with elongate, angled inferomarginals; occasionally small supplementary plates lie between the superomarginals. The proximal end of each inferomarginal slightly overlaps the distal end of the preceding one; they project very slightly, scarcely forming an angled margin to the rays. Interradially they are less conspicuous and tend to lie on the actinal surface. Spinelets on the marginals are similar to those of the abactinal plates, about 20 on each superomarginal and 40 to each inferomarginal, proximally.

Actinal plates in 4 series at base of rays with an extra plate or two interradially in some arm angles. The innermost row of squarish plates, each opposite a similar adambulacral plate extends nearly to the arm end; distally they become compressed and similar in shape to the inferomarginals; the second row extends to about half R, with odd plates extending further; the third row extends to between one third and half R or to about the 15th inferomarginal; the fourth row extends to the 5th inferomarginal and three interradial plates represent a fifth series of actinal plates. The convex actinal plates are closely covered by about 50 radiating, short,

pointed, glassy spinelets.

Adambulacral plates bear a webbed fan of 8 graduated furrow spines, of which the central one is up to 1 mm in length, followed by a webbed fan of 8 slightly smaller, blunt subambulacral spines while 10-15 tapering, pointed spinelets cover the remainder of the plate; these spinelets are considerably thicker than those of the adjacent actinal plates (fig. 4c).

Oral plates have a similar armature to the adambulacrals each with a marginal series of 8 spines, of which the innermost pair are longer and stouter than the remainder; there are 6-7 suboral spines, of which the last two are very small and 10-14 smaller thorny spinelets on the actinal surface of the plates.

The paratype (WAM 101-78) has five equal rays and one madreporite, R/r = 20/5.5 mm = 3.6, br = 5.5 mm at base of ray, 4 mm at half R (Fig. 4b).

The specimen is similar to the holotype although little more than half the size. The arms are less attenuated, there are 4 instead of 6 series of plates in the lateral field at the base of the rays and fewer papulae; secondary abactinal plates are few and scattered. The innermost row of actinal plates extends nearly to the arm end, the second row varies between the 7th to 12th inferomarginal, the third row extends to the 2nd or 3rd inferomarginal and the fourth is represented by 1-3 plates in the arm angle. The furrow and oral spines are as described for the holotype.

OTHER SPECIMENS: Among the other specimens, WAM 42-69 has five equal rays and a single madreporite, R/r = 18/5 mm = 3.6, br = 5.5 mm at base of ray, 4 mm at half R. This specimen differs from WAM 101-78 only in having the plates of the dorsal field on the rays less distinctly subdivided. WAM 100-78 has six rays, two of 11 mm R and four of 8 mm, r = 3 mm, R/r = 3.7, br at base = 3 mm, 2.5 mm at half R. There are two madreporites. The characteristic features of the species are less developed in this small specimen but it resembles the larger specimens more closely than it does *N. belcheri*.

The characteristic appearance of the abactinal plates, their surface subdivided and bearing tufts of spinelets is progressively less clearly seen in the smaller specimens and is scarcely distinguishable in the smallest.

One specimen (AM J12649), from the Timor Sea, has five unequal rays, two of 27.5 mm, two of 26.5 mm and one of 12 mm, r = 5-7 mm, R/r = 2-3.5, br at base = 7 mm, 4 mm at half R. There are 2 madreporites. The appearance of the abactinal plates is characteristic. However, there are often 3 secondary plates proximal to the crescentic abactinal plates.

Two small specimens (USNM 40290 and 40371) from the Philippines were doubtfully referred by Fisher (1919, p. 423) to *N. maculata*. These are both five rayed with a single madreporite and anus and have R/r of 12/3.5 mm and 15/4 mm. Fisher noted that "A peculiarity of these two specimens is the grouping of spinelets of the abactinal crescentic plates in 3 or sometimes 2 distinct tufts to each plate. This gives the appearance of numerous small plates. These small specimens are distinct from *N. brevis* and *N. suffarcinata*, and of course may represent a third species. Their affinities are close to *N. maculata*".

These two specimens have been examined and are here referred to *N. fisheri*. Had Fisher seen a larger specimen he would have been in no doubt that they represented an undescribed species. Fisher's specimens agree closely with the holotype and other specimens examined.

COLOUR: Uniform blue-grey with madreporites cream in life.

HABITAT AND DISTRIBUTION: The holotype and paratypes were all taken in the area north of Sabah, Borneo, dredged on mud or sand at 29-49 metres. Fisher's specimens were taken

north of Palawan Island, Philippines, on sand and mud at 84 metres.

ETYMOLOGY: The species is named in honour of W. K. Fisher.

REMARKS: *Nepanthia fisheri* has affinities with both *N. belcheri* and *N. maculata* but has a very distinct facies of its own. It differs from *N. maculata* in having tapered arms and in the character of the abactinal plates which bear tufts of spinelets on two or three raised areas on each plate in contrast to the uniform covering of spinelets on each plate in *N. maculata*. Like *N. maculata* the pointed spinelets are in radiating groups but are shorter and less numerous in *N. fisheri*.

The similarity in general form of the small specimens to those of *N. belcheri* points to the close relationship between the two species. *N. fisheri* has crystal bodies embedded in the skeletal plates, as in *N. belcheri*. The adambulacral armature of *N. fisheri* differs little from either species. The fact that one specimen is six rayed and that the holotype has two madreporites indicates that the species is potentially fissiparous although the other specimens are five rayed with a single madreporite.

The most distinctive feature of *N. fisheri*, apart from the shape, is the grouping of the short, sharp glassy spinelets on several raised areas on each abactinal plate. A comparison with *N. gracilis* n. sp. is made under the latter species.

Nepanthia maculata Gray
Figs 1; 2f; 5e; 6h,i.

Nepanthia maculata Gray, 1840: 287; 1866: 15. — Studer, 1884: 42. — Sladen, 1889: 388, pl. 64, figs 1-4. — Fisher, 1919: 422, pl. 113, figs 3, 4. — A. M. Clark, 1956: 377, text fig. 2. — Clark and Rowe, 1971: 38 (distribution), 66 (key). — Domantay, 1972:55.

Chaetaster cylindratus Mobius, 1859: 3, pl. I, figs 3, 4.

Asterina (Nepanthia) maculata.— Perrier, 1875: 322.

Nepanthia tenuis H. L. Clark, 1938: 175, pl. 20, fig. 3; 1946: 142.— Clark and Rowe, 1971: 38 (distribution), 66 (key).— Rowe and Pawson, 1977: 347.

MATERIAL EXAMINED: 1 specimen (R/r = 38.6/6.8 mm = 5.7) holotype of *N. maculata*, BM No. 1953. 4.27.40, Migupou, Philippines 7-12 fms (2-5.5 m), fine sand, coral; 1 specimen (R/r = 38.5/5.5 mm = 7) paratype of *N. tenuis*, AM No. J6176, Broome, Western Australia; 2 specimens (R/r = 94/15 and 83/10 mm), Darwin Museum, off Weipa, Gulf of Carpentaria; 1 specimen (R/r = 75/11 mm) Darwin Museum, off Christmas Creek, Gulf of Carpentaria, 14°30′S: 141°30′E; 1 specimen (R/r = 72/13 mm), Darwin Museum off Tasman Pt., Gulf of Carpentaria; 1 specimen (R/r = 47/8 mm), Exmouth Gulf, W.A., WAM 1825-75, coll. J. Penn on 'Flinders' 1.VIII.1975, trawled 9-20 m; 1 specimen (R/r = 50-70/13 mm), 6 km west of Dampier, W.A., WAM 587-75 coll. L. Marsh, 28.X.1972, on muddy sand flat, exposed at low spring tide; 2 specimens (R/r = 50/7 mm and 35/6.5 mm), N.E. of Malus I., Dampier Archipelago, W.A., Mariel King Exped., 31.V.1960, WAM 586-75, dredged on sandy rubble, 18 m; 2 specimens (R/r = 38/6 mm and 23/4 mm) 11-16 km W.N.W. of Cape Melville light, Balabec I., Philippines, WAM 585-75, coll. B. R. Wilson on 'Pele', 9.III.1964, dredged on coarse sand, 37-49 m; 1 specimen (R/r = 44/6 mm) off Elat Bay, west coast of Nuhu Tjut, Kai Is., Indonesia, st. KN II, 5°40′S: 132°59′E, WAM 57-79, M. King Mem. Exped., 13 VI.1970, dredged on sand and rubble, 49-84 m; 1 specimen (R/r = 31/4 mm) north of Du Rowa I., Kai Is., Indonesia, st. KR VI/1, 5°32′S: 132°41′E, M. King Mem. Exped., 10.VI.1970, dredged on sand, 33-37 m; 1 specimen (7 rays, R/r = 18-28/r mm) off Tg Tutuhuhur, Piru Bay, Ceram, st. CPI/1-6, 3°15′S: 128°8′E, M. King Mem. Exped., 1.VI.1970, dredged on coarse sand, 42-64 m.

DIAGNOSIS: A species of *Nepanthia* usually with 5 regular, subcylindrical arms, non fissiparous. Maximum known R/r of 94/15 mm, mean R of 51 mm, range of R:r from 5.4 to 8.3; colour cream to buff unicolorous or with the central disc area dark blue, brown or green with a few flecks of the same colour on the arms; abactinal plates broadly crescentic to rhomboidal, notched for single papulae and often pitted for pedicellariae, a few crystal bodies on plate margins, often absent; fasciculate pedicellariae, when present, in the dorsal field; secondary plates few, usually absent; abactinal spinelets slender, tapering with 1-3 (rarely 4) acute points, all over plates; furrow spines in a graduated fan of 7-8 with a fan of 9-12 subambulacrals and 9-12 additional spinelets; intertidal to 84 metres, on muddy to coarse sand with rubble or coral, Philippines to northern Australia.

COLOUR: Specimens from the Philippines and Indonesia vary in colour from cream with a large dark blue to violet spot on the disc centre and small spots on the arms to mottled light orange and cream with a few dark brown spots on the arms or light brown with a dark brown spot in the centre of the disc and small brown spots on the arms. Northern Australian specimens are either uniformly cream or buff with or without dark brown spots. The holotype of *N. tenuis* was light grey with scattered flecks of deep green.

HABITAT AND DISTRIBUTION: *N. maculata* is a rather uncommon species found on mud, sand or sand and rubble bottoms from the intertidal to at least 84 metres. Studer's record of a specimen of R = 10 mm from 400 fms (731 m), McCluer Gulf, New Guinea is questionable since the maximum chart depth in the Gulf is 56 fms (102 m) although deep water (to 1000 fms) is found between the Gulf and Ceram. *N. maculata* is known from the Philippines, Moluccas and northern Australia, from the Gulf of Carpentaria to Exmouth Gulf, Western Australia.

REMARKS: A. M. Clark (in Clark & Rowe, 1971) commented that *N. tenuis* might prove to be a synonym of *N. maculata*. Direct comparison of the holotype of *N. maculata* and a paratype of *N. tenuis* shows them to be conspecific, neither possessing secondary abactinal plates, and both being similar in size. The presence of secondary plates may well be related to size of the animal since large specimens from northern Australia (Gulf of Carpentaria and northwestern Australia) possess scattered secondary plates. The other characters (R/r ratio and number of furrow spines) used in H. L. Clark's 1938 key do not provide distinguishing features, since the R/r ratio of one of the paratypes of *N. tenuis* is identical to that of the holotype of *N. maculata*. Likewise, although the holotype of *N. tenuis* has 5-6 furrow spines, a paratype has 7-8.

The R/r ratio of specimens of *N. maculata* examined varies from 5.8 to 7.8 in those from the Philippines and Indonesia and from 5.5 to 8.3 in those from northern Australia. There are 8 furrow spines in the specimens from the Philippines and Indonesia, 7 to 8 in those from northern Australia. We can see no valid reason, therefore, for not considering *N. tenuis* and *N. maculata* to be conspecific. Pedicellariae, not previously described in *N. maculata*, occur on some of the northern Australian specimens, usually on the dorsal field of arm plates with a few on the disc and lateral field of arm plates. The fasciculate pedicellariae consist of 4-7 stout, thorny, tapering spinelets surrounding a furrow on the plate just distal to the papular pore.

Nepanthia gracilis n. sp.
Figs 1; 4d, e, f; 5f; 6f.

MATERIAL EXAMINED: Two specimens, the holotype, WAM 103-78 from 14 km and 242° from Zal I., S.W. of Pearl Bank, Sulu Sea, Philippines, dredged from 122-124 m, heavy sponge, B. R. Wilson on 'Pele', 22.XI.1964 and the paratype WAM 104-78, from 15 km and 242° from Zal I., S.W. of Pearl Bank, Sulu Sea, dredged from 100 to 110 m, heavy sponge, B. R. Wilson on 'Pele', 22.XI.1964; two specimens (R/r of 65/14 and 57/12 mm) trawled off Crowdy Head, N.S.W., 31°59′S: 152°57′E to 31°56′S: 152°58′E, 'Kapala' st. 78.05.08, 110 m, AM No.

J11880.

DIAGNOSIS: A species of *Nepanthia* with 5 regular strongly tapering arms, non fissiparous. Maximum known R/r of 65/14 mm, mean R of 49 mm, range of R:r from 4.6 to 5.3; colour unknown, cream when dry; abactinal plates triangular to rhomboidal, flat except for bosses for spinelets, sometimes a few crystal bodies on plate margins; single papulae; no secondary plates; abactinal spinelets subcylindrical, with thorny tips (7-8 acute points), all over plate; furrow spines in a comb of 4-5 subequal spines and 6-7 shorter subambulacral spines sometimes arranged in two rows; sublittoral, 100-124 metres, with sponges; Philippines and eastern Australia.

DESCRIPTION: The holotype has 5 equal tapering arms, R/r = 37/7 mm = 5.3, br = 7 mm at base of ray decreasing to 4 mm at half R and 1.5 mm just proximal to the terminal plate (Fig. 4d, e, f).

Rays elongate, pointed, tapering from the base to a very narrow tip. Abactinal surface of the disc and rays convex, depressed interradially; interbrachial arcs acute; actinal surface plane but margin of disc and rays not distinctly angled. The single madereporite is interradial in position, nearer the margin than the centre of the disc. The anus is central, concealed amongst the disc spinelets.

The skeletal plates are covered in slender spinelets standing vertically, not radiating. Arm skeleton composed of dorsal and lateral fields of imbricating plates; the exposed portion of those of the dorsal field varies in shape from broadly crescentic to rounded or squarish, often irregular in outline; surface of plates flat except for minute bosses for spinelet attachment; few crystal bodies. The plates are scarcely notched for single papulae; secondary plates absent (fig. 5f). There are 3 plates across the dorsal field at base of ray, 6 in a diagonal series at about half R; near the arm end dorsal and lateral fields not clearly distinguished. At the base of the ray there are 10 rows of triagnular to squarish plates in the lateral field, decreasing to 6 at half R; distally the series are no longer differentiated from the dorsal field but on some rays one row extends to the arm end.

Papulae occur singly between all plates of the dorsal and lateral fields except near the arm tip and in the arm angle.

Plates of the dorsal field bear 25-35 slender, more or less cylindrical spinelets with thorny tips (fig. 6f) while those of the lateral field have 15-20 similar spinelets, near the base of the ray, decreasing in number distally. No pedicellariae.

Superomarginal plates large and rounded, more prominent than inferomarginals, usually lying opposite them, occasionally alternating; inferomarginals elongate, angled, proximal end of one overlapping the distal end of the preceding one; inferomarginals lie entirely on the actinal surface of the rays so that the superomarginals form the ventrolateral margin of the arms and disc although not forming a conspicuous angle; spinelets on marginals similar to those on abactinals, about 20 per superomarginal and 16 per inferomarginal.

Actinal plates in 5 rows, with 1 or 2 plates of a 6th row, at base of ray; innermost row extends to 0.8 R (5 mm from arm tip), second row to nearly half R or the 18th inferomarginal, third row to 9th or 10th inferomarginal, fourth row to 4th inferomarginal, with 1 or 2 plates in the arm angle representing a 6th row. The actinal plates are moderately convex and carry 5-10 slender thorny tipped spinelets standing vertically.

Adambulacrals usually bear 4 (3-5) elongate cylindrical furrow spines, up to 1 mm in length, the middle two slightly longer than the others; 6-7 similar but shorter subambulacral spines, sometimes arranged in two rows. Oral plates each have a marginal series of 6 spines decreasing in size from the innermost towards the furrow and 7 elongate suboral spinelets.

The paratype (WAM 104-78) has R/r of 37/7 mm = 5.3, br = 7 mm. It is identical to the holotype except for the presence of 2 small secondary plates in the dorsal field on one ray and the furrow spines are more frequently in combs of 5 rather than 4.

OTHER SPECIMENS: Two specimens from N.S.W. are provisionally referred to this species. They are badly distorted and not well preserved but agree in most respects with the description of *N. gracilis*. The abactinal plates of the dorsal field are less regular in shape and arrangement, and are more numerous than in the holotype or paratype but near the ends of the arms the cleaned plates match those of the holotype very closely. At the base of the ray there are 8 rows of actinal plates in the N.S.W. specimens compared with 5-6 in the holotype of *N. gracilis*. These differences could well be attributable to the larger size of the N.S.W. specimens. The abactinal and actinal spinelets and the furrow spines agree closely with *N. gracilis*. The specimens are referred to *N. gracilis* with some hesitation but they are not sufficiently distinctive to describe as new; further specimens should clarify the position. They were taken at the same depth as the Philippines specimens and the occurrence of *N. gracilis* at 31°S is not impossible.

COLOUR: Not recorded in life, but dry it is cream.

HABITAT AND DISTRIBUTION: This species is known only from the two specimens described above, both taken with sponges from 100 to 124 m near Pearl bank in the Sulu Sea and two specimens provisionally referred to this species, from 110 m, off N.S.W., Australia.

ETYMOLOGY: The species is named from the Latin *gracilis* in reference to the slender, tapering arms.

REMARKS: *N. gracilis* resembles *N. fisheri* in size and form but closer examination shows them to be very different. The disc of *N. gracilis* is smaller and the rays more slender than those of *N. fisheri* but the most distinctive difference is in the nature of the spinelets which are cylindrical and slender, standing more or less vertically in *N. gracilis* in contrast to the short, tapering acutely pointed spinelets radiating from 2-3 elevations on each abactinal plate in *N. fisheri*. Crystal bodies are present in *N. fisheri*, absent in *N. gracilis*. Papulae extend further into the lateral field in *N. gracilis* than in *N. fisheri* and there are more rows of lateral plates in *N. gracilis*. The superomarginals are more prominent than the inferomarginals in *N. gracilis* while the reverse is true of *N. fisheri*. The furrow spines are in combs of 4-5 spines of nearly equal length in *N. gracilis* in contrast to the fans of 8 graduated spines in *N. fisheri*.

N. gracilis is most nearly related to *N. briareus* from which it differs in being non fissiparous and in the form and covering of the abactinal plates.

In *N. briareus* the plates tend to be crescentic particularly on the proximal part of the arms and spinelets are borne on the convex ridge of each plate. The proximal plates of *N. gracilis* are not convex or crescentic and tend to be rhomboidal or irregular in shape. The disc plates of *N. briareus* are smaller than the dorsal arm plates and irregular in shape, in *N. gracilis* they tend to be larger than the dorsal arm plates. The dorsal field of plates is more distinctly set off from the lateral field in *N. gracilis* than in *N. briareus*. The arrangement of marginal and actinal plates is similar in both species.

The abactinal spinelets of both species are shown in figs 6f and 6c. The sponelets of *N. gracilis* are longer than those of *N. briareus*, with up to eight acute points in contrast to up to six rather blunt points in *N. briareus*.

Nepanthia briareus (Bell)
Figs 1; 4g; 5c; 6c.

Patiria briareus Bell, 1894: 404, pl. 25, figs 1-3.

Nepanthia briareus.— A. M. Clark, 1956: 374-377, text fig. 1, pl. 10.— Jangoux, 1978: 297-298.

MATERIAL EXAMINED: 1 specimen, lectotype, Macclesfield Bank, South China Sea, 55 to 83 m. BM No. 1892. 8.22.267, 7 rays, (3 long, R = c. 35 mm, 4 short, R = 17-20 mm, r = 6.5 mm, R/r = 5.4); 1 specimen from Taluk Dodinga, Halmahera, Indonesia, st. Hd 1/4-5, 0°49′N: 127°31′E, M. King Mem. Exped., 20.V.1970, dredged with sponge and alcyonarians, 82 m, 7 rays, (3 long, R = 29 mm, 4 small, R = 17-20 mm, r = 6 mm, R/r = 5.0), 3 madreporites; 2 specimens, off Elat Bay, West coast Nuhu Tjut, Kai Is, Indonesia, st. KN II, 5°40′S: 132°59′E, M. King Mem. Exped., 13.VI.1970, dredged on sand and rubble, 27-46 m, 7 rays, (4 long , R = 36-44 mm, 3 small, R = 25-26 mm, r = 9 mm, R/r = 5.0), 2 madreporites; and 7 rays, (3 long, R = 30 mm and 4 smaller, R = 25-26 mm, r = 7 mm, R/r = 4.3), 2 madreporites, WAM 56-79.

DIAGNOSIS: A fissiparous species of *Nepanthia* with 7-10 (usually 7) slender, terete arms. Maximum known R/r of 44/9 mm, mean R of 34.4 mm, range of R:r from 4.3 to 5.4; colour uncertain, one specimen faded orange after drying from formalin; papulae single; abactinal plates oval, diamond shaped or irregular tending to have an oval or crescentic ridge bearing short thorny spinelets with 5-6 blunt points; no secondary plates, no crystal bodies; furrow spines in a comb of 4-5 with an oblique comb of 5 subambulacral spines followed by 1-4 spinelets. Found on sand and rubble sometimes with sponges and Alcyonaria; sublittoral, known depth range 27-83 m, South China Sea and Indonesia.

COLOUR: The colour of the three Indonesian specimens (after drying from formalin) is pale orange.

HABITAT AND DISTRIBUTION: This apparently uncommon species is known only from the South China Sea, Philippines (Jangoux, 1978) and the Moluccas, at a depth of 27 to 83 metres.

REMARKS: A. M. Clark (1956) redescribed the eight specimens collected from Macclesfield Bank (South China Sea) and selected a lectotype. Re-examination of the lectotype by one of us (F.W.E.R.) has revealed it to possess three small madreporites and two anal openings, indicating fissiparity, as suggested by A. M. Clark from observation of regenerating multibrachiate specimens in the British Museum (Natural History).

The specimens examined here (figs 4g, 5c) agree closely with the lectotype. Detail of the spinelets is shown in figure 6c.

N. briareus appears to be more closely related to *N. gracilis* n. sp. than to *N. maculata*, the differences are shown in the key.

DISCUSSION

The genus *Nepanthia* traverses the Indo-Malay Australian region extending from Mergui Archipelago (Burma) eastwards to the Philippine Islands and southwards through Indonesia to circumscribe Australia (fig. 1). Altogether 17 species have been described and referred at one time or another to the genus *Nepanthia*, either as valid species or as synonyms of those species (Table 1). In this study the number of previously described species has been further reduced, by synonymy, to five and three new species are described. *Nepanthia tenuis* is considered conspecific with *maculata* while *suffarcinata, brevis, joubini, variabilis* and *magnispina* are considered to be conspecific with *belcheri*. The synonymy of *belcheri* was realised after a study of 150 specimens ranging from New South Wales northward through Queensland and Torres Strait to Exmouth Gulf in Western Australia. Specimens vary in size from R of 8 mm to 65 mm and show a geographical cline from southern Queensland (?N.S.W.) to Exmouth Gulf (W.A.) with size and, concomitantly, spinulation increasing and fissiparity decreasing in that direction.

Both fissiparous and five rayed specimens have been recorded from Aru Is in the Moluccas (Koehler, 1910a and present study), fissiparous specimens from Vietnam (Koehler, 1908) and the Philippines (Fisher, 1919) and five rayed specimens from Burma (Sladen, 1888). Fissiparity appears to become predominant as a method of reproduction in response to certain ecological conditions, as yet undetermined.

The origin of the genus may well have been in the Indo-Malay region from where it extended to the southern coast of Australia. Ekman (1953) has pointed out that a high proportion of species and genera of the southern Australian fauna is of tropical origin. He also concluded that Australia had a basically northern (tropical/subtropical) fauna and southern (warm-temperate/temperate) fauna. H. L. Clark (1946) found that the distribution of echinoderm species corresponded fairly well with Hedley's (1904, 1926) four zoogeographical provinces, the Dampierian (Torres Strait to Geraldton on the west coast), Solanderian (Torres Strait to 26°S, on the Queensland coast), Peronian (south east coast) and Flindersian (southern and south western coasts). Clark ignored the Banksian province proposed by Whitley (1932) for the Queensland coastal fauna as distinct from the 'Solanderian' reef fauna. Wilson and Gillett (1971) prefer to divide the Australian molluscan fauna simply into northern and southern regions with a long overlap zone on the east and west coasts. The distribution of species of *Nepanthia* around Australia is therefore most interesting as it appears to support both of these views. That there is a northern and southern fauna is demonstrated by the *belcheri/maculata* versus *troughtoni/nigrobrunnea* distribution, with a distinctive difference in the more hyaline spinulation of the northern species compared with the coarse spinulation of the southern species. These species, on present known distribution, can be further assigned to zoogeographical provinces with *belcheri* extending across the Dampierian/Banksian regions, *maculata* being Dampierian in Australian distribution, *troughtoni* Flindersian and *nigrobrunnea* Peronian. *N. crassa* occupies the western overlap zone. Wilsons Promontory, Cape York and North West Cape all provide sharp dividing lines (?barriers) between the distribution of *Nepanthia* species. North West Cape separates populations of *N. maculata* and *N. belcheri* from *N. crassa*, Cape York is the other end of the Australian range of *N. maculata* and Wilsons Promontory marks the eastern limit of *N. troughtoni*. It is curious that, if both *N. maculata* and *N. belcheri* originated in the Indo-Malay region, *N. belcheri* has spread through Torres Strait and far down the east coast of Australia, while *N. maculata* is only found west of Cape York despite the fact that their habitat requirements appear to be identical and they occur together in north Western Australia.

Neither species extends beyond Exmouth Gulf, which is the last suitable embayment until Shark Bay 500 km south of North West Cape is reached. However, *Nepanthia crassa*, which appears to be closely related to *N. belcheri*, replaces the latter on the western side of North West Cape extending from Point Cloates southwards to Cape Naturaliste, wherever suitable habitats occur.

Most of the *Nepanthia* species are found in sheltered, sometimes muddy, situations from shore to the inner continental shelf perhaps explaining why they have not spread far into the Indian and Pacific Oceans. They are what Endean (1957) has termed "mainland" rather than "reef" species.

N. troughtoni and *N. nigrobrunnea* differ from the other species in habitat requirements since they are both open coast species favouring rocky substrates exposed to considerable wave action.

N. belcheri has a floating yolky egg suggesting pelagic lecithotrophic development but the larval life span is unknown (Otteson, 1976). Nothing is know of the reproduction of the other species.

Further study of the ecological/physiological factors responsible for the predominance of

fissiparity over sexual reproduction in some populations of *N. belcheri* should be rewarding.

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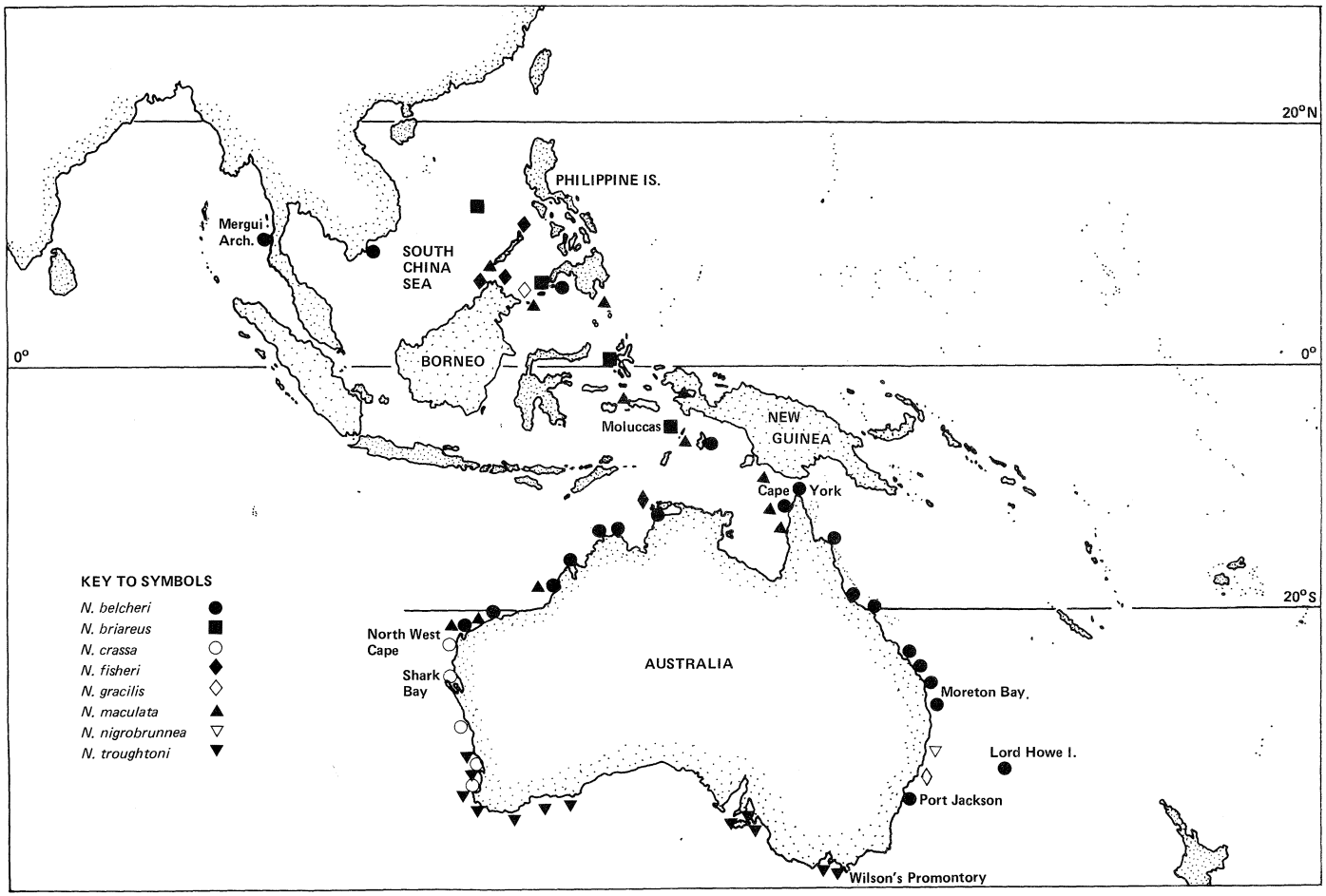

Fig. 1. Distribution of species of *Nepanthia*.

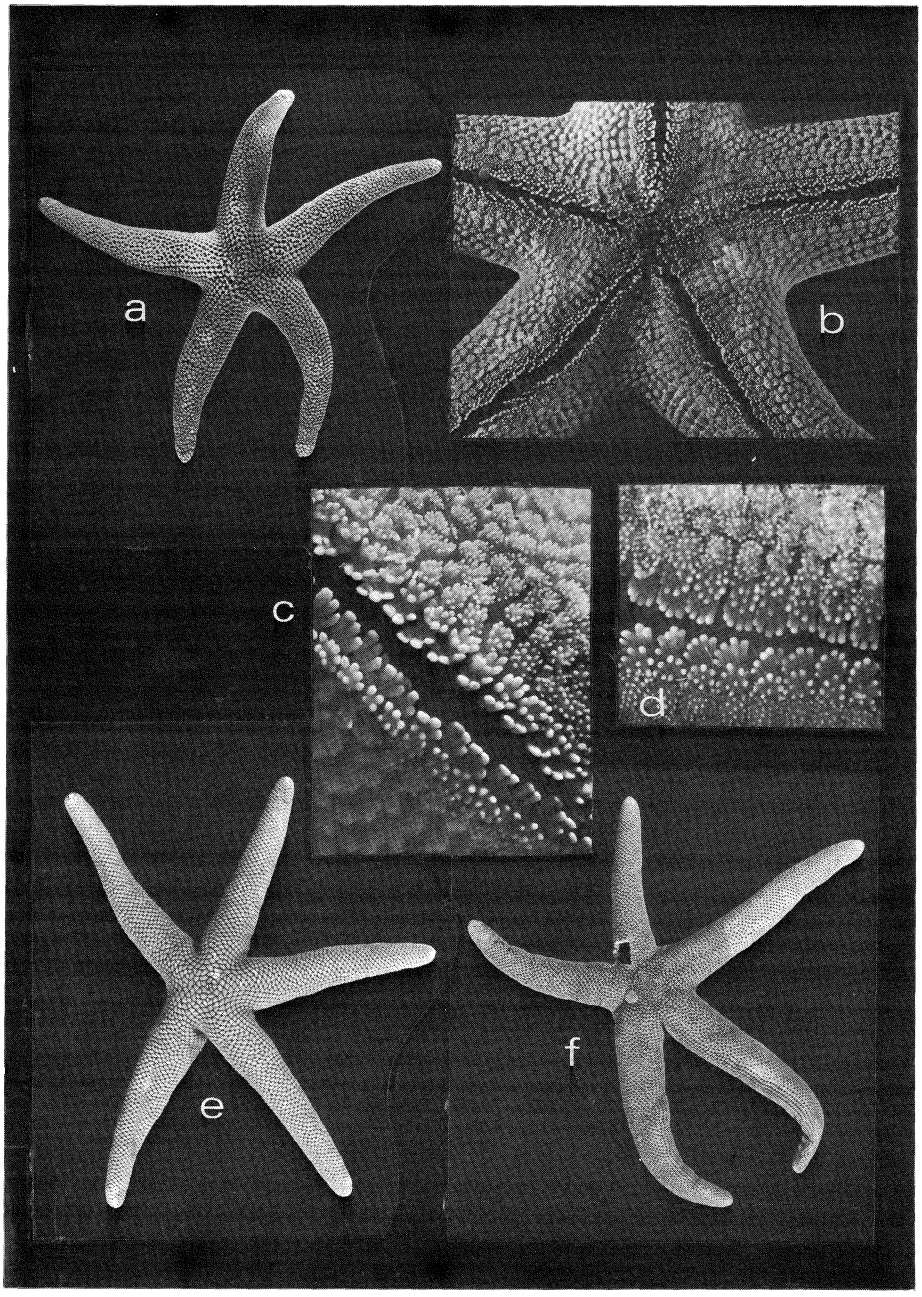

Fig. 2. a-c, *Nepanthia nigrobrunnea* sp. nov., holotype, **a.** abactinal, **b.** actinal, **c.** adambulacral armature, R/r = 65/15 mm; d-e, *N. troughtoni*, WAM 55-79 **d.** adambulacral armature, **e.** abactinal, R/r = 70/14 mm; **f.** *N. maculata*, WAM 587-75, abactinal, R/r = 70/13 mm.

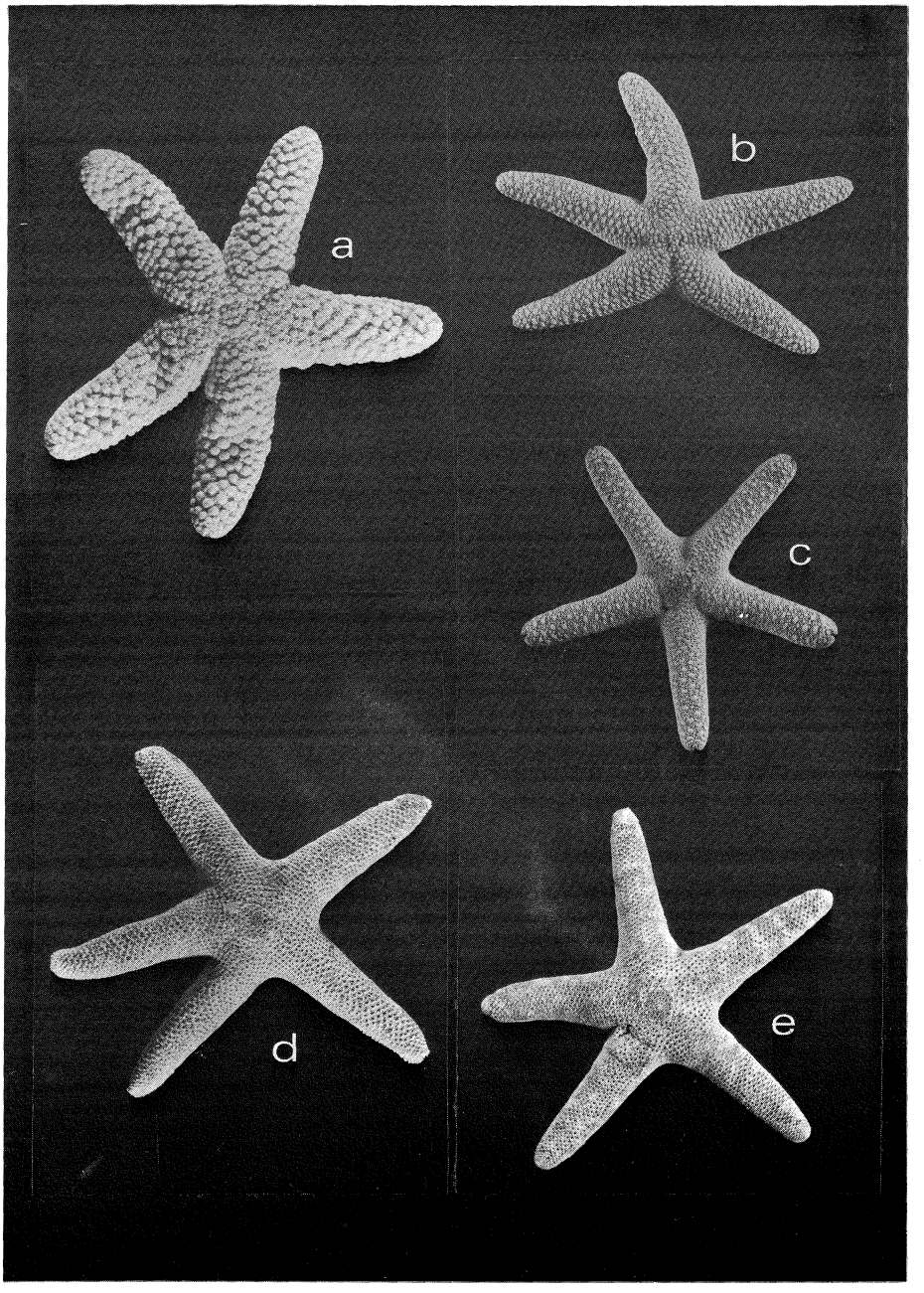

Fig. 3. a-c, *Nepanthia crassa*, **a.** WAM 756-75, abactinal, R/r = 43/13 mm; **b.** WAM 12-77, abactinal, R/r = 42/10 mm; **c.** WAM 607-75, abactinal, R/r = 37/10 mm; d-e, *N. belcheri*, **d.** WAM 590-75; Dampier, W.A., abactinal, R/r = 43/12 mm; **e.** WAM 615-77, Thursday Island, Qld., abactinal, R/r = 40/11 mm.

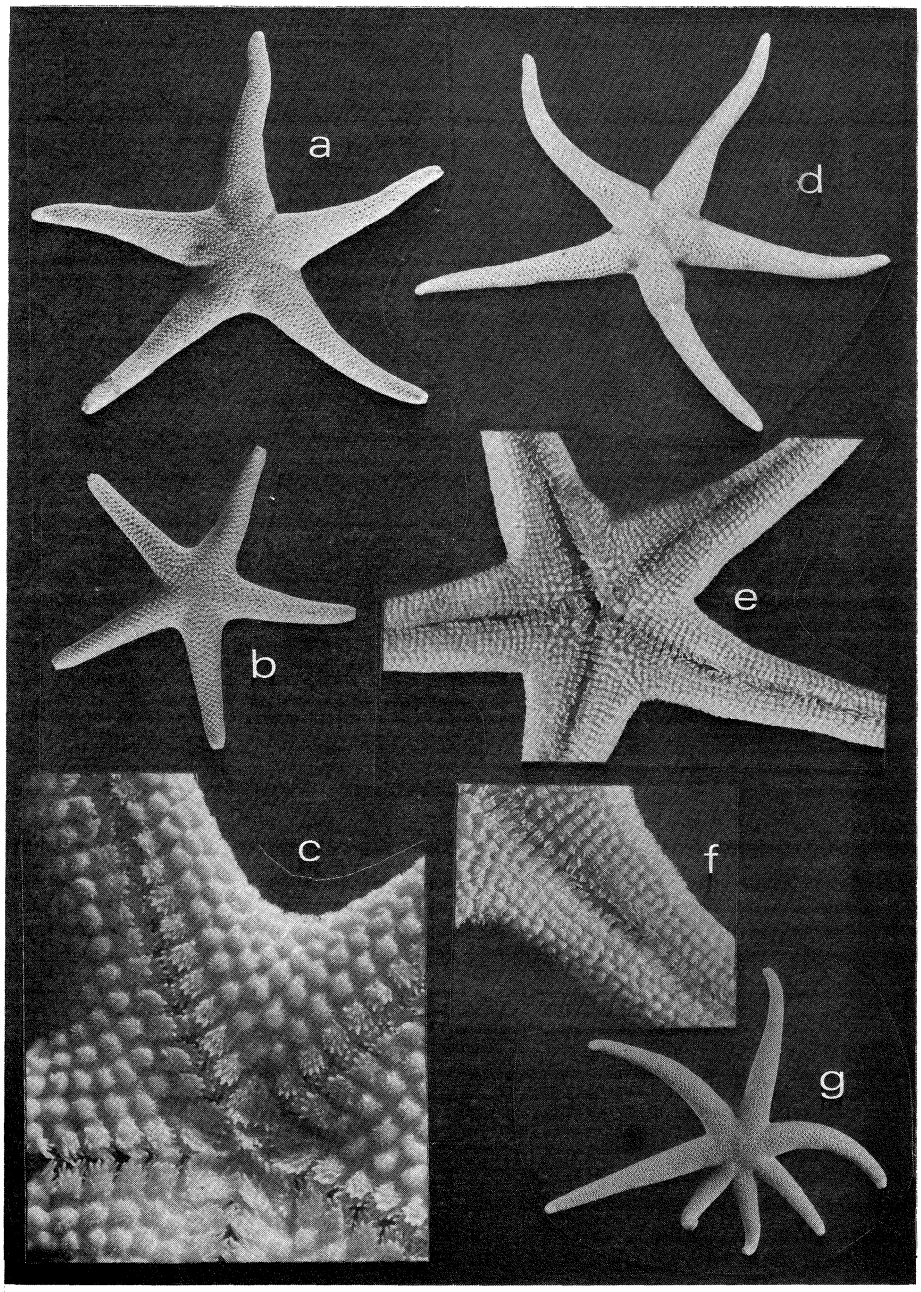

Fig. 4. a-c, *Nepanthia fisheri* sp. nov., holotype, **a.** abactinal, **c.** actinal, R/r = 40/9.5 mm; **b.** paratype, abactinal, R/r = 20/5.5 mm, d-f, *N. gracilis* sp. nov., holotype, **d.** abactinal, **e.** actinal, **f.** adambulacral armature, R/r = 37/7 mm; **g.** *N. briareus*, WAM 56-79, abactinal, R/r = 44/9 mm.

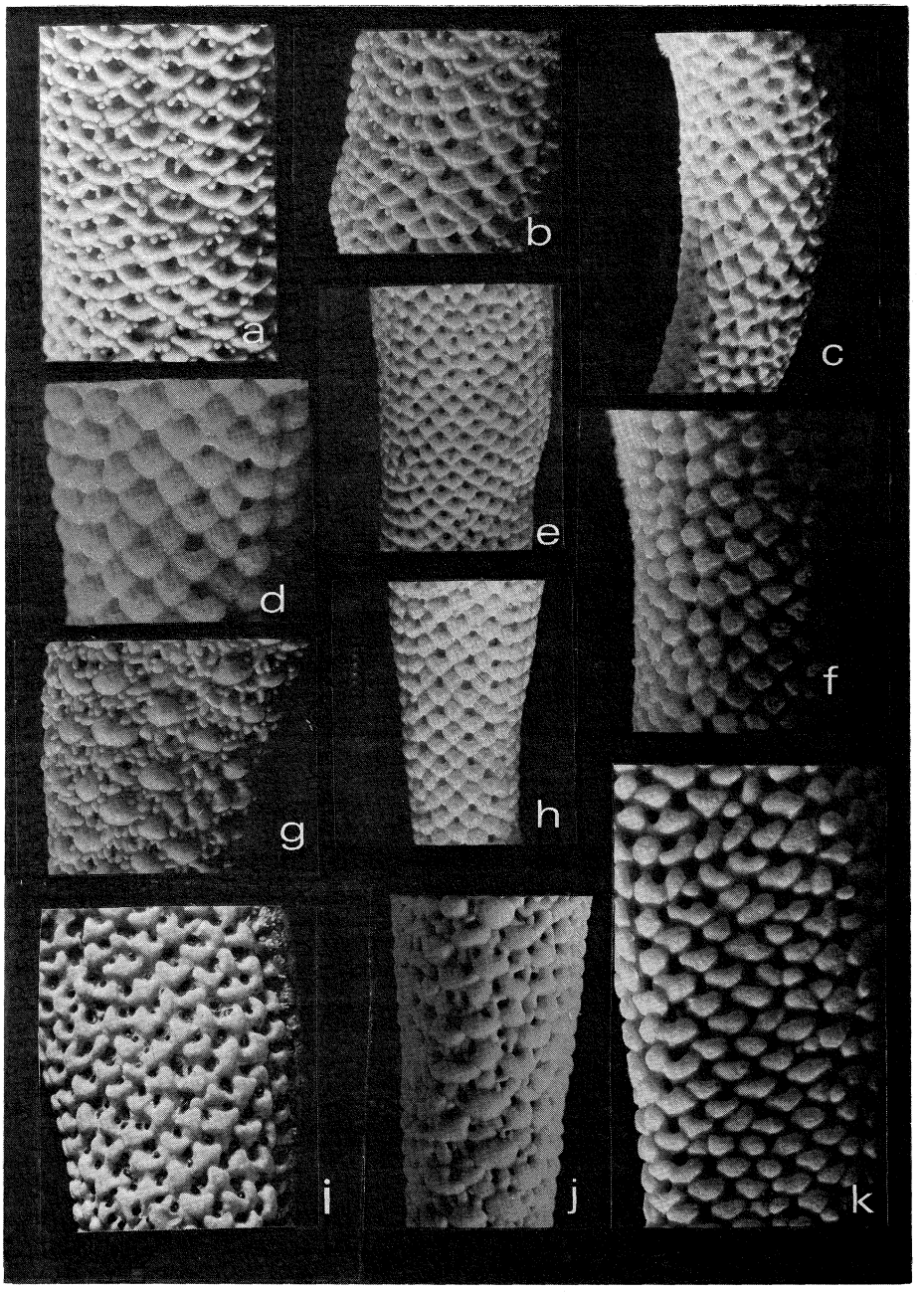

Fig. 5. Denuded arms of *Nepanthia* species. a-b, *N. belcheri*, **a.** WAM 615-77, Thursday I., Qld., R/r = 40/11 mm, **b.** WAM 296-75, Dampier, W.A., R/r = 41/12 mm; **c.** *N. briareus*, WAM 56-79, Moluccas, R/r = 44/9 mm; **d,h.** *N. fisheri* sp. nov., holotype, Sabah, R/r = 40/9.5 mm; **e.** *N. maculata*, WAM 1825-75, Dampier, W.A. R/r = 70/13 mm; **f.** *N. gracilis* sp. nov., holotype, Philippines, R/r = 37/7 mm; **g,j.** *N. crassa*, **g.** WAM 625-75 Cockburn Sound, W.A., R/r = 57/15 mm; **j.** WAM 54-79 Houtman Abrolhos, W.A. R/r = 30/9 mm; **i.** *N. nigrobrunnea* sp. nov., holotype, N.S.W., R/r = 65/15 mm; **k.** *N. troughtoni*, WAM 1486-74, Sorretono, W.A., R/r = 52/13 mm.

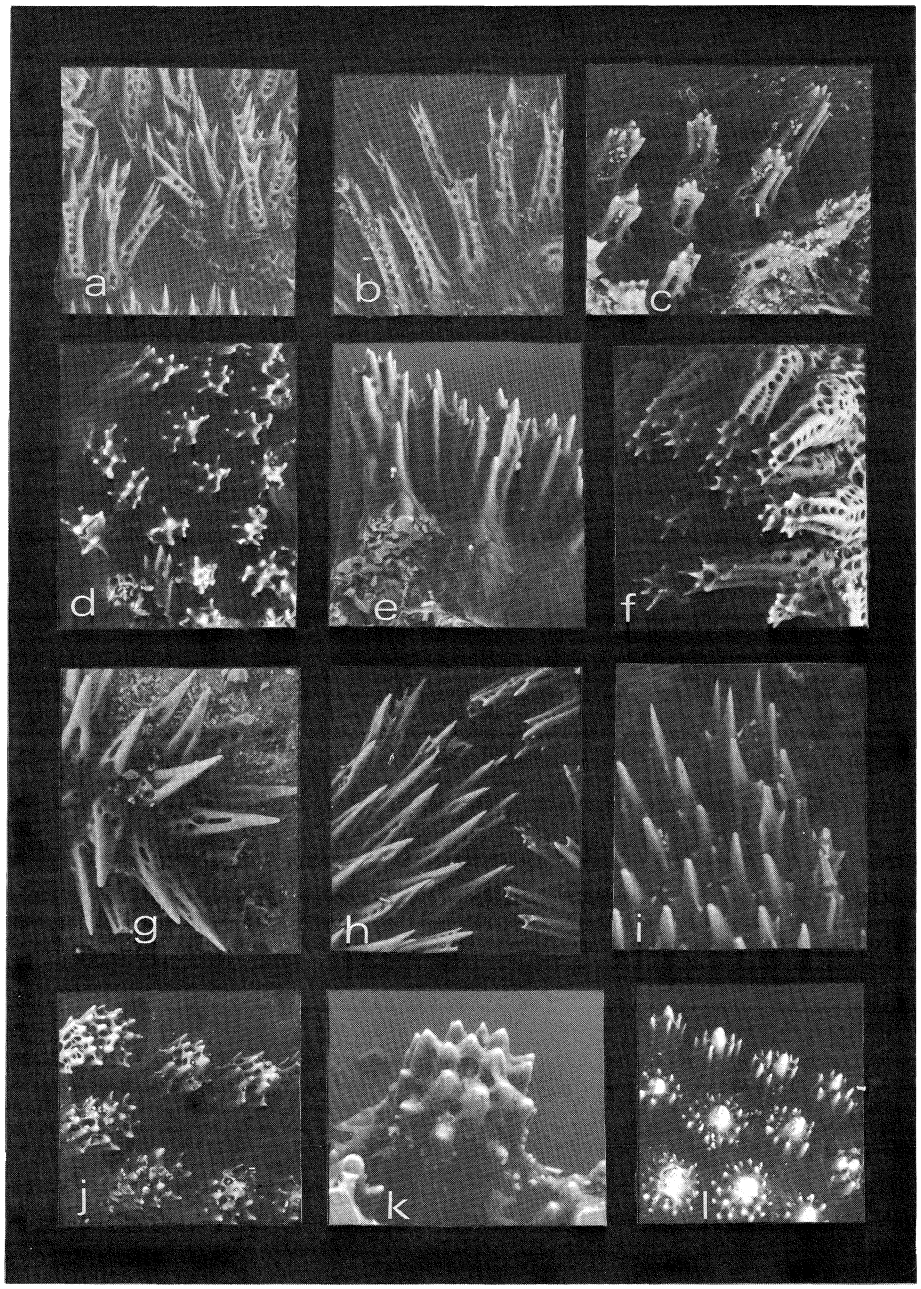

Fig. 6. Scanning electron photomicrographs of abactinal spinelets from plates of dorso-lateral area at base of ray of *Nepanthia* species. **a.** *Nepanthia belcheri*, WAM 613-77, Townsville, Qld.; **b.** *N. belcheri*, WAM 935-76, Dampier, W.A.; **c.** *N. briareus*, WAM 56-79, Moluccas, Indonesia; **d, e.** *N. crassa*, WAM; **f.** *N. gracilis* sp. nov., holotype, WAM 103-78, Philippines; **g.** *N. fisheri* sp. nov. holotype, WAM 102-78, Sabah; **h.** *N. maculata*, WAM 587-75, Dampier, W.A.; **i.** *N. maculata*, WAM 57-79, Moluccas, Indonesia; **j, k,** *N. nigrobrunnea* sp. nov., holotype, AM-J 10147 N.S.W.; **l.** *N. troughtoni*, WAM 570-75, Esperance, W.A.

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