The BEAGLE

Records of the Northern Territory Museum of Arts and Sciences

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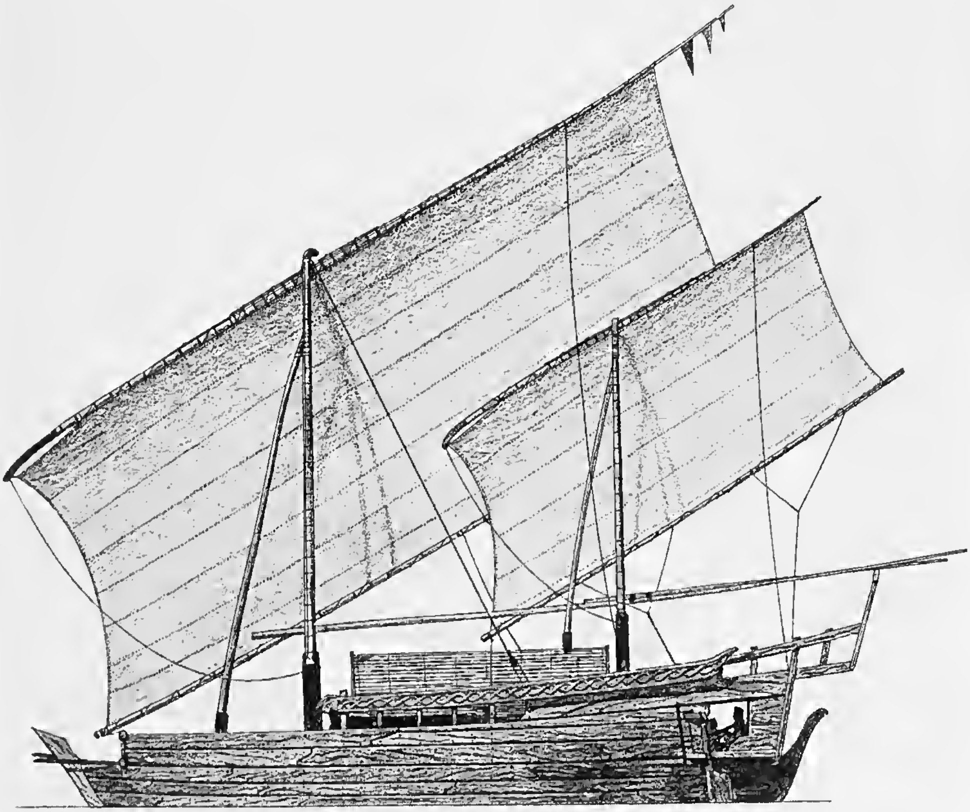

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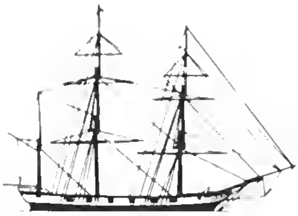
Cover: *Reconstruction of a nineteenth century Makassan perahu padewakang.* Researched and drawn by N. Burningham.



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BOOK REVIEWS

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TWO NEW ACANTHODRILINE EARTHWORMS (OLIGOCHAETA: MEGASCOLECOIDEA) FROM THE NORTHERN TERRITORY, AUSTRALIA

G.R. DYNE
Bureau of Flora and Fauna,
GPO Box 1383, Canberra, ACT 2601, Australia.

ABSTRACT

Two new species of the acanthodriline earthworm genus *Diplotrema* Spencer are described from the Northern Territory and shown to have affinities with the *D. shandi* species-group. The larger of the two species is associated with the production of unusual casts, which are amongst the largest recorded for earthworms. Both species are apparently geophagous, which, together with presumed amphibious propensities, contributes to their ability to survive in the climatic extremes of the wet/dry tropics.

KEYWORDS: Oligochaeta, Megascolecidae, Acanthodrilinae, earthworms, wormcasts, monsoonal adaptations.

INTRODUCTION

A previously unknown earthworm fauna was reported from the Northern Territory by Jamieson and Dyne (1976). The predominant taxon, *Microscolex (Diplotrema)* Spencer, was noted in the same work as having an essentially northern distribution in Australia, although the exact extent of the generic domain was not known at that time. More recent studies (Dyne 1978, 1984) have demonstrated a prolific eastern Australian acanthodrile fauna, with a southerly limit near Narrabri (northern NSW). The extent of the generic distribution in the northwest of the continent has yet to be satisfactorily investigated. There is also an apparent distributional hiatus across the Gulf of Carpentaria, such that the eastern Australian and northern Australian components of the fauna have discontinuous ranges. This may, however, prove to be an artefact of low collecting effort in the Gulf region.

Recognized by Jamieson (1974a) as a subgenus of *Microscolex, Diplotrema* Spencer is herein re-elevated to generic rank to signify its geographical and morphological identity, separate from that of the South American and trans-subantarctic *Microscolex*.

ABBREVIATIONS USED IN THE TEXT AND FIGURES

gen.m	genital marking
H	holotype
l	length
NTM	Northern Territory Museum, Darwin
P	paratype
pr.p	prostatic pore
s	number of segments
sp.p	spermathecal pore
U	circumference
w	diameter

The descriptive format largely follows that established by Jamieson (1974b).

SYSTEMATICS

Diplotrema planumfluvialis sp.nov.

(Figs 1,2,4-6)

Type material. HOLOTYPE - NTM Wo1, Upper Adelaide River Experimental Station, Adelaide River Floodplain, 131°14′E, 13°05′S, Northern Territory, solodic (Dy3.63) soil, collector B. Wood, 8 March 1984. PARATYPES - NTM Wo 2-5, 4 clitellate individuals, data as in holotype.

Additional material. Semimature specimens and some fragments, data as in type material (author's collection).

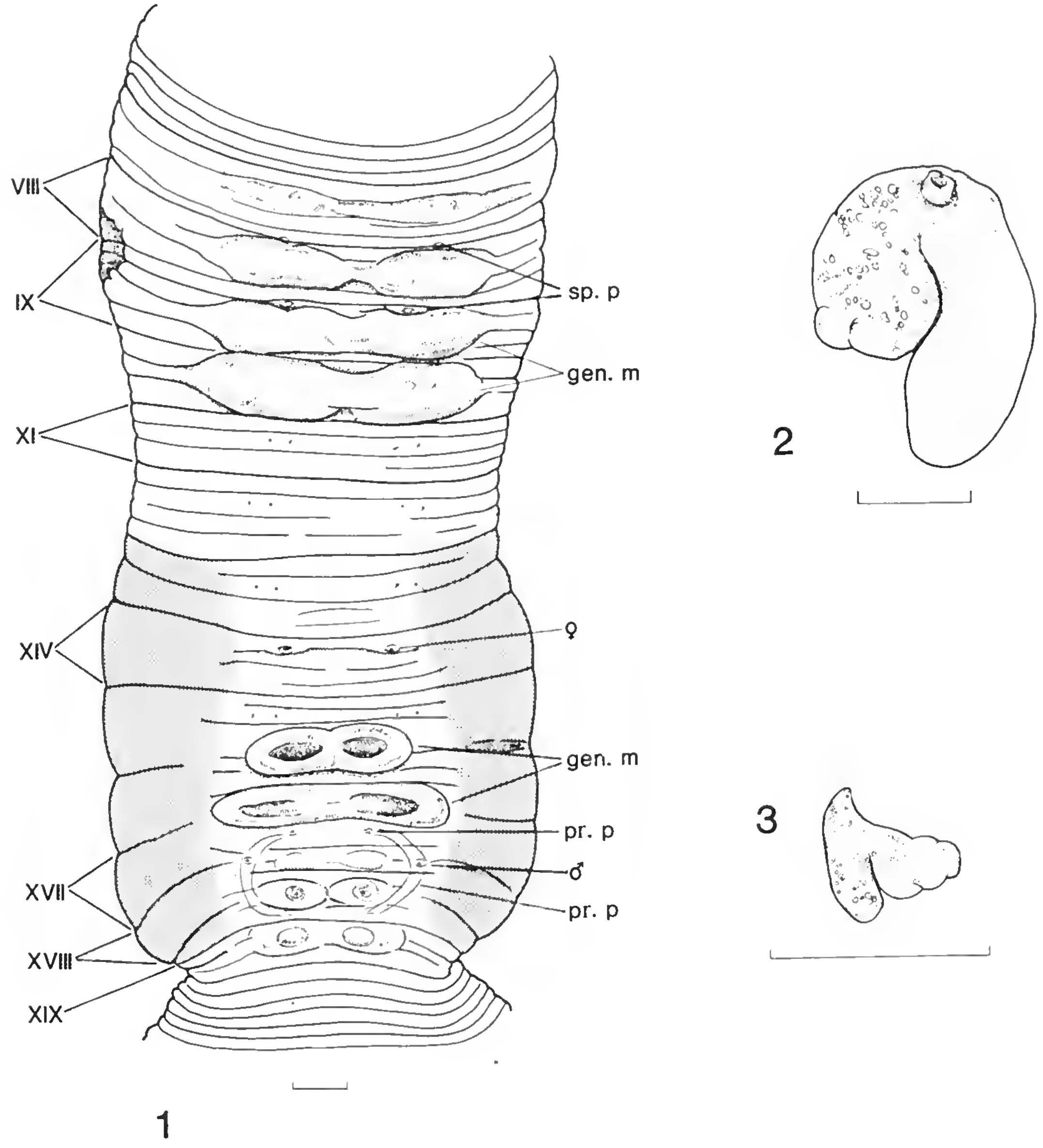
External anatomy. l=192, 145 mm; w=8.6, 6.4 mm; s=255, 266 (H, P2). Whitish-grey in alcohol, clitellum orange-pink. Prostomium proepilobous, peristomium longitudinally creased. First perforate dorsal pore 11/12. Setae in regular rows throughout, ventral setal pairs lacking in XVIII, modified as penial setae in XVII and XIX. Penial setae present, genital setae lacking. Nephropores not externally recognizable.

Clitellum saddle-shaped, skirting the ventrum well lateral of *b*-lines, extending from mid-XII (weak) to mid-XIX; thickly tumid, obscuring all other external features save the intersegmental furrows.

Male pores seen as minute orifices, lateral of *b*-lines, at 17/18, just medially to the edge of a pair of broad, shallow seminal grooves that link the porophores. The latter are poorly defined, ?coincident with *b*-setae, and scarcely elevated, on minute papillae.

Female pores somewhat disguised by the development of glandular tumescence in XIV, located presetally in mid-*ab*. Small spermathecal pores, hidden by tumid pads, present in *a*-lines in 7/8, 8/9.

Accessory markings. Four conspicuous, broad tumid bands almost cover the ventral surface of segments VII-X, the anteriormost marking the least well-developed, those on VIII and IX subequal, that on X the most extensive (all mature specimens). Though



Figs 1-3. *Diplotrema* spp., holotypes: **1**, genital field of *D. planumfluvialis;* **2**, right IX spermatheca of *D. planumfluvialis;* **3**, right IX spermatheca of *D. socialis*. Scale lines 1mm. Abbreviations in text.

these markings resemble the tumescences associated with genital seta follicles in other species, such follicles are lacking. Segment IV has a glandular appearance in H, with a well-developed bipartite marking present in 14/15 in P1. A pair of oculate markings (elevated rims surrounding a circular concave area) present intersegmentally in 15/16 on H, P1, (on P2 present as a single, midventral marking) and in 16/17, where the eyelike markings are most widely separated than in the latter intersegment, on all mature specimens. Ill-defined glandular markings in 17/18 and 19/20 (all specimens, best developed in P3). Small, closely paired oculate markings also present in 19/20 on all mature specimens. Intersegment 20/21 a single, midventral oculate marking on P1, P2.

Internal anatomy. Septa 5/6-6/7 moderately thickened, 7/8-9/10 fairly strongly muscularized, 8/9 perhaps the thickest, 10/11-11/12 moderately thickened, remainder thin. Dorsal blood vessel single, traceable anteriad to the pharynx; last hearts in XIII. A supra-oesophageal vessel is present in VIII-XIV. In X-XIII, the commissurals appear to communicate only with the supra-oesophageal vessel, but with the anteriad diminution of the latter, the connectives (from IX anteriorly) become associated with the dorsal vessel. Gizzard moderately developed, globose and readily compressed, in V. Oesophagus broad and vascular, particularly in posteriormost section, but narrowing immediately before commencement of intestine, in XVIII. No distinct calciferous glands present. Typhlosole absent. Ingesta: soil particles only (no recognizable organic remains).

Small-medium sized iridescent spermatic funnels present in X and XI, and large acinous seminal vesicles present in XI and XII. Prostate glands consist of a tubular, compactly coiled glandular portion, restricted to segment of origin, or, in the case of the anterior organs only, rarely extending partially into the succeeding segment; anterior prostatic pairs are more than twice the size of the posterior organs. Prostatic ducts short and non-muscular. Penial seta follicles contain several setae, some reddish in appearance, associated with the prostatic ducts. Setae gently curving, ornamented over the distal half with regularly arranged depressions which appear as jagged excavations, and approximately 2 mm in length when mature.

Ovaries consist of delicate, flattened webs of connective tissue with embedded oocytes; these and medium-sized iridescent oviducal funnels present in XIII, ovisacs absent. Spermathecae 2 pairs, each composed of a short duct, tubulo-digitiform ampulla, and sessile, sacciform diverticulum, the latter filled with numerous iridescent sperm locules. Length right IX spermatheca = 3.1 mm. Genital setae or associated glands absent.

Remarks. The new species has affinities with the widespread *D. shandi* Jamieson and Dyne, agreeing in the overall construction of the spermathecae, ornamentation of the penial setae, position of the seminal vesicles, and arrangement of the blood vascular system. *D. planumfluvialis* is distinctive, however, in having the prostatic glands almost always restricted to their segments or origin, an abbreviated condition, which elsewhere in the Northern Territory is only seen in two very small species. The appearance of the genital field is also diagnostic.

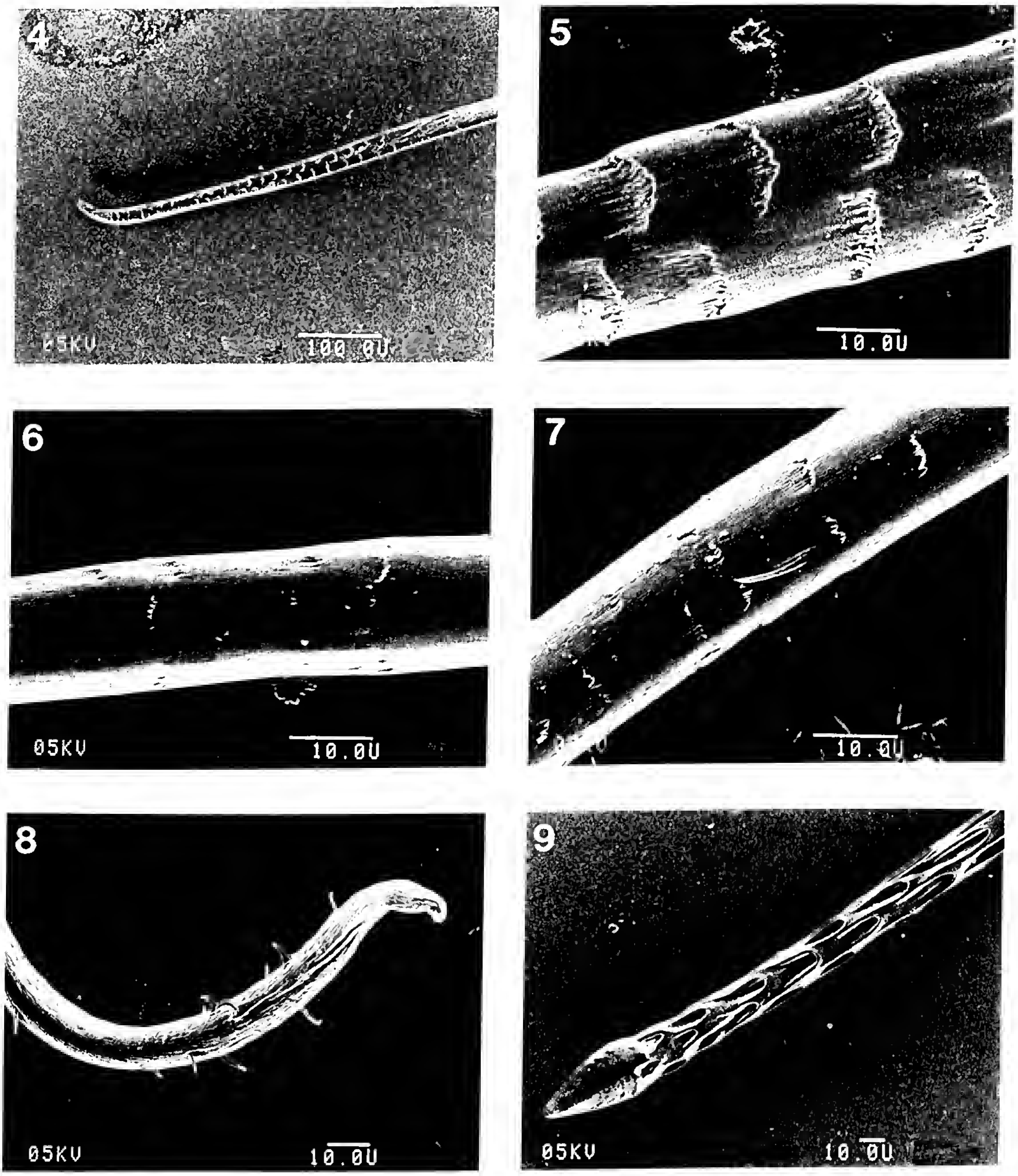
The worms produce large columnar cast accumulations up to 25 cm in height and 12 cm in diameter (B. Wood, pers. comm.), rivalling the largest recorded in the Oligochaeta. Extensive surface casting is also known for *D. heteropora* Dyne in the Townsville region (A.V. Spain, pers. comm.) Dyne (1979) noted that the latter species was also geophagous and apparently adapted to a wet/dry climatic regime. Lee (1967) reported on the adaptive exploitation of soil microrelief for wet season survival by the large surface casting earthworm, *Pheretima tumulifaciens* Lee, in New Guinea, but this phenomenon has not been investigated in the Acanthodrilinae. The prolific casting activity of *D. planumfluvialis*, its seasonality, and its pedological and adaptive significance are aspects currently under investigation (B. Wood, pers. comm.). The ability of *D. planumfluvialis* to survive a floodplain habitat with a monsoonal climatic regime may be at least partially due to its geophagous, rather than phytophagous, dietary mode and an amphibious propensity, a feature shared by a number of its eastern Australian congeners (Dyne 1984).

Diplotrema socialis sp.nov.
(Figs 3, 7-9)

Type material. HOLOTYPE - NTM Wo6, Upper Adelaide River Experimental Station, Adelaide River Floodplain, 131°14′E, 13°05′S, Northern Territory, solodic (Dy3.63) soil, collector B. Wood, 8 March 1984. PARATYPE - NTM Wo7, 1 semimature specimen, data as in holotype.

Additional material. Immature specimens, data as in type material (author's collection).

External anatomy. l=52, 47 mm; w=1.5, 1.1 mm; s=103, 105 (H, P1). Prostomium epilobous ½, closed. Body uniform in diameter throughout, but segments of the caudal extremity much reduced in size and compressed longitudinally. First dorsal pore not demonstrable with certainty (?absent). Setae



Figs 4-9. *Diplotrema* spp., mature setae: **4**, penial seta of *D. planumfluvialis*, holotype; **5**, detail of shaft; **6**, penial seta of *D. planumfluvialis*, paratype 1; **7**, penial seta of *D. socialis*, holotype, right XVII follicle; **8**, penial seta of *D. socialis*, holotype, right XIX follicle; **9**, genital seta of *D. socialis*.

closely paired throughout, ventral setal couples present in XVIII, modified as penial setae in XVII and XIX, and as genital setae in VIII. Clitellum not developed in the specimens examined.

Male field a simple, rectangular depression extending from mid XVII to 19/20; the porophores situated at the edges of this concavity, atop small, but definite papillae. The porophores of a side joined by ill-defined seminal grooves that traverse the raised lateral rims of the male field. Male pores not demonstrable.

Female pores a minute pair of presetal slits in XIV; spermathecal pores indistinct, in 7/8 and 8/9, aligned with the ventral setal pairs. No accessory markings present.

Internal anatomy. Only septal partitions 8/9-10/11 show any degree of muscularization; 6/7 and 7/8 somewhat thickened, as is 11/12, the remainder thin. Dorsal blood vessel single throughout. Last hearts in XIII. A supra-oesophageal vessel present from mid-VIII to XIII; the major commissurals (i.e. those in X-XIII) appear to be exclusively connected to the supra-oesophageal vessel, having no communion with the dorsal vessel. Anteriad commissurals certainly dorso-ventral, but their continued association with the supra-oesophageal not certain. Gizzard, in V, moderately large and shiny, with obvious proventriculus; oesophagus moniliform, vascular, in VI-XV. Intestine commences abruptly in XVI, broadening to maximal width by the succeeding segment; typhlosole lacking.

Ingesta: fine soil particles, silica grains and some blackened organic remains.

Holonephric; anterior tufted nephridia absent. In the intestinal segments, the coils of each nephridial body enveloped in ?connective tissue, giving the units a wafer-like appearance. Nephridial ducts uniformly enter the parietes in *d*-lines.

Holandric; 2 pairs of small, weakly iridescent spermatic funnels present in X and XI, with finely loculate seminal vesicles seen in IX and XII. Vasa deferentia not traceable. Prostatic glands tubular: long, sinuous and delicate, anterior pairs extending posteriad through septal walls into segments XXI or XXII; posterior pairs somewhat shorter, extending to XXII. Prostatic ducts narrow, hardly muscular. Both pairs of organs associated with penial seta follicles that penetrate into succeeding segments. The latter are joined to the prostates by diaphanous connective tissue, and to the body wall by limited copulatory musculature. The reddish setae ornamented over distal half with a variable number of fairly long, acuminate spines projecting at an acute angle to the setal shaft; these are interspersed with short circumfe-

Table 1. Intersetal ratios in segment XII for *Diplotrema planumfluvialis* and *D. socialis*, expressed as percentages of the total circumference (U).

D. planumfluvialis

	aa	ab	bc	cd	dd	dc	cb	ba	U(mm)
H(NTM Wo1)	10.1	1.7	16.9	1.4	49.7	1.5	16.9	1.8	27.4
P(NTM Wo2)	10.3	1.9	19.3	1.3	46.9	1.3	17.1	1.8	21.1
P(NTM Wo4)	10.0	2.0	18.1	1.2	49.4	1.3	16.2	1.9	25.8
mean	10.1	1.9	18.1	1.3	48.6	1.4	16.7	1.8	24.8

D. socialis

	aa	ab	bc	cd	dd	dc	cb	ba	U(mm)
H(NTM Wo6)	10.9	3.8	13.1	4.4	45.7	3.5	15.2	3.5	4.5
P(NTM Wo7)	9.6	3.1	12.9	3.1	52.5	2.8	13.1	2.8	5.3
Immature	9.8	3.1	14.4	3.8	47.1	3.9	14.3	3.6	4.6
mean	10.1	3.3	13.5	3.8	48.6	3.4	14.2	3.3	4.8

rential bracts of irregularly jagged teeth. Latter ornamentation may predominate in some setae (Fig. 7), but some spines always present.

Ovaries not seen, but small, plicate oviducal funnels present in XIII. Spermathecae 2 pairs in VIII and IX, subequal, consisting of a lobulated, sacciform ampulla joining diverticulum/duct axis at 45°, and a short, blunt diverticulum iridescent with inseminate leading directly to a short duct. Length right spermatheca of VIII=0.9 mm. Genital seta follicles present in VIII only. Setae (Fig. 9) sculptured by regularly and closely disposed deep, axially directed excavations. Apical portion of seta swollen, terminating in a rounded point.

Remarks. The spinose penial setae of *D. socialis* are reminiscent of those seen in *D. mantoni* Jamieson and Dyne, as is the construction of the spermathecae. In other respects (genital markings, typhlosole, position of seminal vesicles, length of prostates, position of nephropores) the two species exhibit little affinity. It is noteworthy, however, that the Manton River (from which the latter species was collected) joins the Adelaide River only some 40 km northwards (downstream) from the type-locality of the two new species. *D. socialis* is also placeable in the *D. shandi* species-group.

ACKNOWLEDGEMENTS

I am grateful to Mr Blair Wood, of the Conservation Commission of the Northern Territory, for providing the material that formed the basis of this study, as well as information on the casting phenomenon. Production of the micrographs would not have been possible without the kind co-operation of Mr Wally Goydych and the facilities of the Electron Microscope Unit, Bruce College of Technical and Further Education.

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FREE-LIVING NEMATODES FROM DARWIN MANGROVES

M. HODDA[1] AND W.L. NICHOLAS
Department of Zoology, Australian National University,
GPO Box 4, Canberra, ACT 2601, Australia.
[1]Present address: Research School of Biological Sciences,
Australian National University,
GPO Box 475, Canberra, ACT 2601, Australia.

ABSTRACT

Species from 22 genera of nematodes are recorded from the sediments supporting *Rhizophora stylosa* Griff. mangroves in Darwin harbour. Most, perhaps all, belong to different species from those found in *Avicennia marina* (Forsk.) Vierh. mangroves in south-east Australia. Six genera have not been previously recorded from Australian mangroves, but are closely related to taxa which do occur in Australia. The taxonomic differences between the Darwin fauna and that of mangroves elsewhere in Australia are discussed.

KEYWORDS: Free-living nematodes, mangroves, Northern Territory, Australia, biogeography.

INTRODUCTION

Although nematodes are very small relatively simple animals, they are probably the most numerous multicellular organisms on earth. They occur almost everywhere that life can be supported from the poles to the tropics and from the driest desert to beneath fresh or salt waters. However, records of nematode occurrences are very patchy, especially so for the marine nematodes, and the nematodes of tropical mangroves have been virtually ignored. This is no doubt largely due to their small size, but also due in part to the difficulties of sampling and extracting animals from the sediment as well as taxonomic problems. Despite these difficulties, marine nematodes are now thought important as nutrient recyclers (Platt and Warwick 1980; Heip, Vincx and Vranken 1985) and as sensitive indicator organisms for detecting pollution (Platt, Shaw and Lambshead 1984). Consequently, there has been increasing interest in marine nematodes.

In Australia, Decraemer and Coomans (1978) made a very limited taxonomic study of the nematode fauna from mangroves on Lizard Island, Great Barrier Reef. More recently, we began an extensive study on the meiofauna from mangroves in southern Australia (Hodda and Nicholas 1985, 1986a,b; Nicholas and Stewart 1985). The nematodes from northern and western Australia remain unknown. This paper presents the results of a preliminary survey from Darwin harbour. The genera present are recorded and compared with the fauna from elsewhere in Australia.

MATERIALS AND METHODS

A small sample of mud (about 30 cm^2 surface area and 150 ml volume) was taken amongst *Rhizophora stylosa* Griff. mangroves at the Northern Territory Museum of Arts and Sciences collecting site on Creek "H" in Darwin harbour. Sampling date was 5 May 1986. The sample was taken by pushing a small inverted cup into the mud. The sample was immediately fixed with 5% formalin. The nematodes were extracted from the sediment by a combination of sedimentation, sieving and centrifugation described elsewhere (Hodda and Nicholas 1985).

Genera were assigned to feeding categories using the widely accepted scheme and lists of genera produced by Wieser (1953, 1959) and modified by Boucher (1973). Genera not included in these lists were allocated to the same feeding category as the listed genus with the most similar buccal morphology.

RESULTS

Twenty-four species of nematodes were found (Table 1). The nematodes were sorted to specific level, but lack of previous taxonomic work makes it difficult to give species names. However, we could assign most specimens to well-described genera. A comprehensive voucher collection and key to the genera of marine nematodes in Australia is currently being prepared by W.L. Nicholas with the support of the Australian Biological Resources Advisory Committee but this will take several years to complete. When the species are eventually described, type specimens will be deposited in the Northern Territory Museum of Arts and Sciences.

DISCUSSION

That the species involved here are undescribed is not unusual. Almost 60% of the species found at Lizard Island were undescribed (Decraemer and Coomans 1978) and over 90% of the species from the Hunter estuary could not be reconciled with currently described species (Hodda and Nicholas 1985, 1986b). Given that most taxonomic descriptions are of species found

Table 1. Genera of nematodes collected from Darwin Harbour and their recorded occurrence elsewhere in Australia.

Family Genus from Darwin	Feeding† Category	Also Recorded* at Lizard Is.	Also Recorded** in Hunter Estuary, NSW
Desmoscolecidae			
Quadricoma	1A	-	-
Chromadoridae			
Actinonema	2A	Yes	-
Spilophorella	2A	Yes	-
Dichromadora	2A	Yes	Yes
Cyatholaimidae			
Pomponema	2A	-	-
Selachinematidae			
Halichoanolaimus	2BS	Yes	Yes
Desmodoridae			
Desmodora 2 spp.	2A	Yes	Yes
Desmodorella	2A	-	-
Onyx	2B	Yes	Yes
Metachromadoroides	2B	Yes	-
Monoposthiidae			
Nudora	2A	Yes	-
Leptolaimidae			
Camacolaimus	2A	Yes	Yes
Xyalidae			
Filipjeva	1B	-	Yes
Daptonema	1B	-	Yes
Theristus	1B	Yes	Yes
Sphaerolaimidae			
Sphaerolaimus	*2BS*	-	*Yes*
Comesomatidae			
Hooperia	1B	-	-
Sabatieria	1B	-	Yes
Anoplostomatidae			
Anoplostoma	1B	-	Yes
Oxystominidae			
Halalaimus	1A	-	Yes
Thallassolaimus	1A	-	-
Oncholaimidae			
Viscosia	2B	Yes	Yes
Ironidae			
Trissonchulus	2A	Yes	-
Dorylaimidae			
Unidentified genus	-	-	-

† Feeding categories. 1A, selective deposit feeders; 1B, non-selective deposit feeders; 2A, epistate feeders; 2B, omnivore/predators; 2BS, specialised predators. 1A and 1B mostly feed on bacteria, 2A mostly on micro-algae, 2BS on other nematodes.

* Decraemer and Coomans (1978).

** Hodda and Nicholas (1985, 1986b).

in Europe, it is not surprising that tropical species are mostly different.

Although the species are different, the genera found in this preliminary study are typically found in marine and estuarine sediments elsewhere. There are marked differences when comparisons are made with the fauna of mangroves elsewhere in Australia. Thirteen of the 24 genera are also found in sediments under *Avicennia marina* (Forsk.) Vierh. mangroves in south-east Australia (Hodda and Nicholas 1985), however, most are different species. Twelve of the genera were also found in various species of mangroves at Lizard Island (Decraemer and Coomans 1978). Examination of the Lizard Island material is necessary to determine how many species are common to both sites.

There are many ecological similarities, despite the taxonomic differences. The number of species found is similar to that found in samples of a similar size in southern Australia. Unfortunately the number of species is difficult to compare with estuaries elsewhere in the world because published accounts state mean results for a number of cores only so comparisons with other areas are not possible. The genera present here, but absent from southern Australia, were generally closely related to genera found in the south, giving a similar distribution of species amongst the different families. For instance, members of the families Xyalidae, Desmodoridae and Chromadoridae are prominent both in the Darwin fauna and New South Wales (Hodda and Nicholas 1985, 1986b). The only major difference is the apparent absence of Monhysteridae and Linhomoeidae which are frequently present elsewhere (Decraemer and Coomans 1978; Hodda and Nicholas 1985, 1986b), but not much weight can be given to a single sample.

Much more extensive sampling will be necessary before a definitive inventory of the fauna from mangroves in the Darwin area can be made. The fauna of the Hunter estuary was quite variable over both space and time (Hodda and Nicholas 1986b) so considerable effort will be required to adequately cover the wider range of mangrove types in the north. Although there were no consistent seasonal patterns in the fauna of the Hunter estuary as there are in Europe (Heip, Vincx and Vranken 1985), there were significant changes over the seasons. Samples from Darwin in both wet and dry seasons could be taken to determine if there are any consistent changes in fauna between the seasons. Seasonal differences in salinity within mangroves may influence the composition of nematode fauna. An estimate of relative abundance for each species would also be useful as a means of assessing seasonal changes in fauna.

We conclude that the nematode fauna of mangroves around Darwin appears different to that so far studied elsewhere in Australia and warrants further study. We have now undertaken further sampling in an attempt to answer some of the outstanding questions.

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PORCELLANID CRABS FROM THE CORAL SEA*

JANET HAIG
Allan Hancock Foundation, University of Southern California,
Los Angeles, California 90089, U.S.A.

ABSTRACT

Nine species of Porcellanidae (Crustacea: Decapoda: Anomura) are reported from the Coral Sea east of Australia. The family was previously unknown in this area. Most of the species treated have broad geographic ranges, but only one has been recorded from the east Australian coast.

KEYWORDS: Porcellanidae, Coral Sea, Marion Reef, Chesterfield Islands.

INTRODUCTION

During a 1979 cruise of R.V. "*Lady Basten*" in the Coral Sea, N.L. Bruce collected nine species of the family Porcellanidae from six stations at Marion Reef and at Long Island, Chesterfield Islands. These are the first records to be published of porcellanids from the Coral Sea area.

Measurements in the text refer to carapace length. The material is deposited in the Northern Territory Museum of Arts and Sciences (NTM), Darwin, Australia.

ACCOUNT OF SPECIES

Pachycheles johnsoni Haig

Pachycheles johnsoni Haig, 1965: 102, Fig. 1; Nakasone and Miyake 1968: 70, Fig. 5, Pl. 5 Fig. 4, Pl. 6 Fig. 1.

Material examined. Stn. LB/10, Marion Reef, south cay, 19°17'S, 152° 13'E, 12 May 1979, reef flat at low water, coll. N.L. Bruce, 1 ♂, 1 ♀, NTM Cr. 004435.

Measurements. Male 3.2 mm, ovigerous female 2.9 mm.

Remarks. In the ornamentation of the chelipeds, these specimens are typical of the Oceanic, rather than the Australian, population of *P. johnsoni* (see Haig 1965: 104).

Distribution. Australia: Western Australia and Northern Territory. Pacific Ocean: Xisha (off Chinese mainland), Palau, Caroline, and Marshall Islands.

Pachycheles pisoides (Heller)

Porcellana pisoides Heller, 1865: 73, Pl.6 Fig. 3.
Pachycheles lifuensis Borradaile, 1900: 397, 424; Grant and McCulloch 1907: 155, Pl. 1 Figs 2, 2a.
Pachycheles fronto Melin, 1939: 114, Figs 69-71.
Pisosoma fronto - Miyake 1943: 113, Figs 40, 41.
Pachycheles pisoides - Nakasone and Miyake 1968: 72, Fig. 6, Pl. 6 Fig. 2.

Material examined. Stn. LB/10, Marion Reef, south cay, 19°17'S, 152°13'E, 12 May 1979, reef flat at low water, coll. N.L. Bruce, 3 ♀ and 1 detached cheliped, NTM Cr. 004436.

Measurements. Non-ovigerous female 2.3 mm, ovigerous females 2.9 and 3.7 mm. The detached cheliped was from a still larger specimen.

Distribution. Indian Ocean: Madagascar, Seychelles, Nicobar Islands, and Western Australia. Pacific Ocean: several island groups, Ryukyu Islands E. to Hawaiian and Society Islands.

Pachycheles sculptus (H. Milne-Edwards)

Porcellana sculpta H. Milne-Edwards, 1837: 253.
Porcellana pisum H. Milne-Edwards, 1837: 254.
Porcellana pulchella Haswell, 1882: 758.
Pachycheles pulchellus - Miers 1884: 273, Pl. 30 Fig. A.
Pachycheles sculptus - Nakasone and Miyake 1968: 61, Fig. 1, Pl. 5 Figs 1-3.

Material examined. Stn. LB/17, Marion Reef, 19°14.1'S, 152°15.7'E, 13 May 1979, 2 m, lagoon pinnacle, coll. N.L. Bruce, 1 ♂, NTM Cr. 004437.

Measurements. Male 2.6 mm.

Remarks. Each longitudinal ridge of the chelae is obliquely grooved to form a row of closely set tubercles, as in the specimen depicted by Nakasone and Miyake (1968: Pl. 5 Fig. 3).

Distribution. Indian Ocean: Seychelles and Mergui Archipelago. Western Australia, Northern Territory, and Queensland.

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Indonesia, Philippines, and Asian mainland from Singapore N. to Hong Kong. Pacific Ocean: several island groups, Palau Islands E. to Tuamotu Archipelago.

Petrolisthes carinipes (Heller)

Porcellana carinipes Heller, 1861: 24.

Petrolisthes carinipes - De Man 1893: 299, Pl. 7 Figs 5, 5a: Miyake and Nakasone 1966: 177, Figs 4, 5; Lewinsohn 1974: 249 *et seq.*, Figs 1-19.

Petrolisthes melini Miyake and Nakasone, 1966: 181.

Material examined. Stn. LB/10, Marion Reef, south cay, 19°17′S, 152°13′E, 12 May 1979, reef flat at low water, coll. N.L. Bruce, 1 ♀, 3 juv., NTM Cr. 004438; Stn. LB/12, unnamed cay N. of Long Island, Chesterfield Islands, 9 May 1979, 0.5 m, bommie on top of back reef, coll. N.L. Bruce, 1 ♂, 3 ♀, NTM Cr. 004439.

Measurements. Male 2.6 mm, non-ovigerous females 3.1 to 4.0 mm, ovigerous female 4.8 mm, juveniles 1.9 to 2.5 mm.

Distribution. Indian Ocean: Red Sea, Gulf of Aden, Seychelles, and Mauritius. Pacific Ocean: Bonin, Ryukyu, and Mariana Islands.

Petrolisthes decacanthus Ortmann

Petrolisthes decacanthus Ortmann, 1897: 285, Pl. 17 Fig. 2.

Material examined. Stn. LB/10, Marion Reef, south cay, 19°17′S, 152°13′E, 12 May 1979, reef flat at low water, coll. N.L. Bruce, 1 ♀, NTM Cr. 004440.

Measurements. Ovigerous female 4.4 mm.

Distribution. Indian Ocean: Glorioso, Seychelle, and Maldive Islands. Pacific Ocean: several island groups, Palau Islands eastward to Society Islands (Haig and Kropp, in press).

Petrolisthes elegans Haig

Petrolisthes elegans Haig, 1981: 266, Fig. 2.

Material examined. Stn. LB/12, unnamed cay N. of Long Island, Chesterfield Islands, 9 May 1979, 0.5 m, bommie on top of back reef, coll. N.L. Bruce, 1 ♂, 1 ♀, NTM Cr. 004441.

Measurements. Male 3.3 mm, ovigerous female 4.4 mm.

Distribution. Pacific Ocean: Mariana, Caroline, Marshall, Samoa, Society, and Gambier Islands.

Petrolisthes heterochrous Kropp

Petrolisthes heterochrous Kropp, 1986: 458, Fig. 3.

Material examined. Stn. LB/8, Long Island Chesterfield Islands, 19°52.2′S, 158°19.8′E, 5 May 1979, coral rock, 12 m, from seaward reef face, coll. N.L. Bruce, 1 ♂, 1 ♀, NTM Cr. 004442.

Measurements. Male 3.7 mm, juvenile female 2.3 mm.

Distribution. Reported only from the Mariana Islands. The specimens from the Coral Sea represent a considerable range extension southward.

Petrolisthes moluccensis (De Man)

Porcellana (Petrolisthes) moluccensis De Man, 1888: 411, Pl. 18 Fig. 5.

Petrolisthes moluccensis - Miyake 1942: 337, Figs 3, 4; 1943: 97, Fig. 28; Lewinsohn 1969: 136, Fig. 28.

Material examined. Stn. LB/12, unnamed cay N. of Long Island, Chesterfield Islands, 9 May 1979, 0.5 m, bommie on top of back reef, coll. N.L. Bruce, 2 ♂, 1 ♀, NTM Cr. 004443; Stn. LB/13, data same as Stn. LB/12, 7 ♂, 4 ♀, 2 juv., NTM Cr. 004444.

Measurements. Males 2.2 to 4.6 mm, non-ovigerous females 2.5 to 4.1 mm, ovigerous female 3.5 mm, juveniles 1.9 mm.

Distribution. Indian Ocean: Persian Gulf and Red Sea to Abrolhos Islands, Western Australia. Eastern Indonesia. Pacific Ocean: Palau and Ryukyu Islands.

Petrolisthes tomentosus (Dana)

Porcellana tomentosa Dana, 1852: 420; 1855: Pl. 26 Fig. 10.

Porcellana penicillata Heller, 1862: 523.

Porcellana villosa Richters, 1880: 160, Pl. 17 Figs 11, 12.

Petrolisthes penicillatus - Miyake 1942: 347, Figs 11, 12; 1943: 83, Fig. 18; Lewinsohn 1979: 45, Fig. 1.

Petrolisthes tomentosus - Kropp 1986: 453, Fig. 1.

Material examined. Stn. LB/10, Marion Reef, south cay, 19°17′S, 152°13′E, 12 May 1979, reef flat at low water, coll. N.L. Bruce, 1 ♂ with bopyrid, NTM Cr. 004445; Stn. LB/19, Long Island, Chesterfield Islands, 19°52.2'S, 158°19.8'E, 4 May 1979, reef platform at low water, coral rubble, coll. N.L. Bruce, 1 ♂, NTM Cr. 004446.

Measurements. Males 3.0 and 3.8 mm.

Remarks. There has been considerable confusion concerning the nomenclature of this species and its close relative, *P. pubescens* Stimpson. Because of uncertainty about the status of *Porcellana tomentosa*, Dana's name has been applied to both taxa. Kropp (1986) recently reviewed the history of this problem. He stabilized the nomenclature by designating a neotype of Dana's species, selected from the taxon that has most frequently appeared in the literature as *Petrolisthes penicillatus* (Heller).

Distribution. Indian Ocean: east coast of Africa to Abrolhos Islands, Western Australia. Pacific Ocean: Xisha, Ryukyu, Palau, Mariana, Fiji, Society, and Tuamotu Islands.

DISCUSSION

Most of the species collected during the "*Lady Basten*" cruise have broad geographic distributions. *Pachycheles pisoides*, *P. sculptus*, *Petrolisthes decacanthus* and *P. tomentosus* occur from the western Indian Ocean to the eastern part of the Indo-west Pacific region. *Petrolisthes carinipes* and *P. moluccensis* are found in the western Indian Ocean and eastward to islands of the western Pacific Ocean. *Pachycheles johnsoni* is known from western and northern Australia and western Pacific islands. *Petrolisthes elegans* and *P. heterochrous* occur only in the Pacific Ocean: the former extending across the Pacific, the latter confined to its western part.

Although the areas (particularly Marion Island) where the "*Lady Basten*" porcellanids were collected are relatively close to the Great Barrier Reef, it is interesting to note that only one of the species, *Pachycheles sculptus*, is known to occur in eastern Australia. None of the other eight species has been recorded from either the mainland of Queensland or from the Barrier Reef.

Key to Porcellanidae Known to Occur in the Coral Sea

1. Chelipeds robust, usually one distinctly larger than the other; telson five-plated.. 2
— Chelipeds flattened, subequal; telson seven-plated 4
2. Carapace and chelipeds covered with long and short bristles; males with a pair of pleopods.................................... .... *Pachycheles pisoides* (Heller)
— Carapace and chelipeds devoid of setae; no pleopods in males 3
3. Anterior regions of carapace smooth; chelae smooth, tuberculate, or with four longitudinal ridges .... *Pachycheles sculptus* (H. Milne-Edwards)
— Anterior regions of carapace roughened by grooves; chelae with closely set tubercles, latter flat or convex and with scalloped edges...*Pachycheles johnsoni* Haig
4. Dorsal surface of carapace with five rounded elevations and with short setae.. .... *Petrolisthes tomentosus* (Dana)
— Dorsal surface of carapace with transverse striations 5
5. Carapace with two epibranchial spines and a supraocular spine on either side . 6
— Carapace with a single epibranchial spine on either side 7
6. Carapace armed laterally with mesobranchial spines .... *Petrolisthes heterochrous* Kropp
— No mesobranchial spines on lateral carapace margins .... *Petrolisthes decacanthus* Ortmann
7. Carapace with supraocular spine on either side .... *Petrolisthes carinipes* (Heller)
— No supraocular spine 8
8. Frontal area of carapace distinctly trilobate, lobes separated by deep U-shaped notches .... *Petrolisthes elegans* Haig
— Front sinuously triangular .... *Petrolisthes moluccensis* (De Man)

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CARIDEAN SHRIMPS OBTAINED BY R.V. "SOELA" FROM NORTH-WEST AUSTRALIA, WITH DESCRIPTION OF A NEW SPECIES OF *LEPTOCHELA* (CRUSTACEA: DECAPODA: PASIPHAEIDAE)

YUKIO HANAMURA
Enkai Chosa Kaihatsu
Hokkai Building, Chuo-ku S-2 W-13, Sapporo, Japan.

ABSTRACT

A small collection of caridean shrimps obtained by various benthic gears from north-west Australian shelf is reported. Among the 12 species, a new pasiphaeid shrimp is described under the name of *Leptochela (Proboloura) soelae.* This species is related to *L.(P.) carinata* Stimpson, but the distinction from the latter species is evidently made by having the fifth abdominal somite terminating in a long posterodorsal projection. All species have not been reliably reported before from the area.

KEYWORDS: Crustacea, Decapoda, Caridea, Pasiphaeidae, Oplophoridae, Thalassocarididae, North-West Australia.

INTRODUCTION

The caridean decapod crustacean fauna in the north-west Australian shelf has been little studied. Through the courtesy of Dr A.J. Bruce, Northern Territory Museum, Australia, interesting shrimp specimens collected by various benthic gears, on the recent cruises of the R.V. "Soela", Division of Fisheries, CSIRO, in north-west Australian waters were made available. In this paper, 12 species of caridean shrimp of the families Pasiphaeidae, Oplophoridae and Thalassocarididae are reported, of which one pasiphaeid shrimp is described as a new species.

The following abbreviations are used: NTM, Northern Territory Museum, Darwin; NSMT, National Science Museum, Tokyo; USNM, National Museum of Natural History, Smithsonian Institution, Washington DC; cl, carapace length, measured from orbital margin to posteromedian margin.

SYSTEMATICS

Family Pasiphaeidae

Genus *Pasiphaea* Savigny

Pasiphaea orientalis Schmitt

(Fig. 1)

Pasiphaea orientalis Schmitt, 1931: 267, Pl. 32, Figs 1,5; Burukovsky 1976: 20 (in key).

Material. CSIRO 0184-42, 1 ♀ cl 15.6 mm, (ovig.), 5 February 1984, 16°51.9′S, 119° 54.0′E, 499 m depth; CSIRO 0184-44, 1 ♂, cl ca. 18.6 mm, 2 ♀, cl 18.0, 20.3 mm (ovig. cl 20.3 mm), 5 February 1984, 16° 18.1′S, 120° 18.7′E, 498 m depth.

Description. Rostrum procurved, not extending beyond anterior margin of carapace. Branchiostegal spine extending beyond anterolateral margin of carapace. Carapace dorsally rounded, without carina or ridge. Abdomen dorsally rounded except sixth somite. Third and sixth abdominal somites ending in posterodorsal spine.

Telson dorsally grooved, apex nearly rounded, with four pairs of marginal spines and pair of subterminal spines.

First pereiopod with 7-13, and second pereiopod with 11-19 meral spines.

Remarks. *P. orientalis* is most similar to *P. semispinosa* Holthuis, 1951, but it differs from the latter by having posterodorsal spines on the third and sixth instead of fourth and sixth abdominal somites.

Distribution. Previously known only from Kaushiung (Takao), Taiwan. New to the Australian fauna.

Pasiphaea sinensis Hayashi and Miyake

(Fig. 2)

Pasiphaea sinensis Hayashi and Miyake, 1971: 39, Fig. 1; Toriyama and Hayashi 1982: 90, 92, 105 (in list).

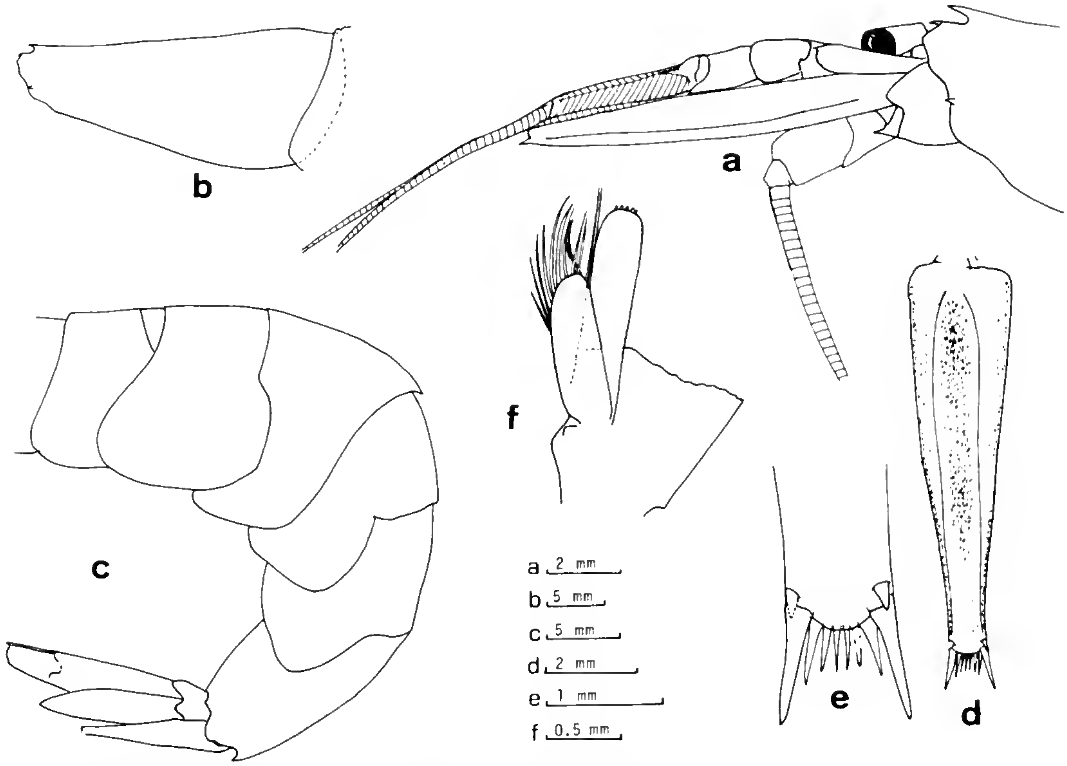

Fig. 1. *Pasiphaea orientalis* ♂ cl ca. 18.6 mm: **a**, anterior part of body, lateral; **b**, carapace, lateral; **c**, posterior part of body, lateral; **d**, telson; **e**, apex of telson; **f**, appendix masculina.

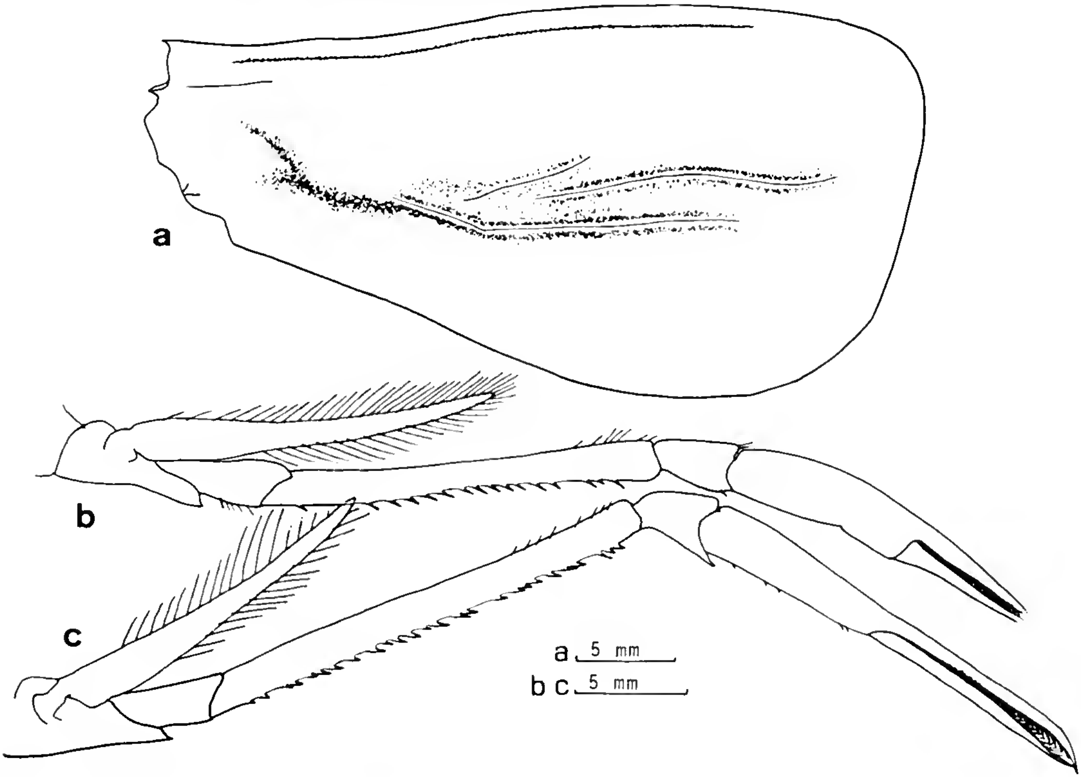

Fig. 2. *Pasiphaea sinensis* ♀ cl 35.1 mm: **a**, carapace, lateral; **b**, 1st pereiopod, right; **c**, 2nd pereiopod, right.

Material. CSIRO 0184-42, 1 ♀, cl 35.1 mm, 5 February 1984, 16°51.9′S, 119°54.0′E, 449 m depth.

Description. Carapace carinate along nearly whole length, with suprabranchial ridge and obtuse carina on gastrohepatic portion. Branchiostegal spine somewhat damaged in female at hand, but placed near anterolateral margin of carapace. Rostrum produced as forward extension of anterodorsal elevation of dorsal carina, with apical spine not reaching end of anterodorsal margin of carapace, anterior margin of rostrum slightly convex.

First abdominal somite without carina, but feebly ridged. Second to fifth somites with sharp dorsal carina. Sixth somite slightly carinate on anterior two-thirds, but on posterior third, with shallow longitudinal groove on lateral surface.

Telson as long as sixth somite, dorsally grooved, apex forked, with posterior sinus shallow, possibly damaged, and armed with seven pairs of fragile marginal spines.

First and second pereiopods with 16 and 26 meral spines, respectively.

Remarks. In the genus *Pasiphaea*, the following four of some 35 species are characterized by having the carapace and abdomen carinate, the telson with a forked apex, and the basis of the second pereiopod unarmed except for the terminal spine: *P. acutifrons* Bate, 1888, *P. pacifica* Rathbun, 1902, *P. barnardi* Yaldwyn, 1971, and *P. sinensis* Hayashi and Miyake, 1971. The number of spines on the meri of the first two pereiopods varies in each species, but it may have taxonomic importance, as shown on Table 1.

The present material agrees well with the description of *P. sinensis*. But the ratio of palmar length to fingers, especially in the second pereiopod, is smaller than the value given for *P. sinensis* by the original authors, being about 0.83 times as long as the fingers, instead of 1.23 times. As the "Soela" specimen is much smaller than the type specimens of *P. sinensis*, the disparity is probably due to the difference in body size.

In adult stage, *P. emarginata* Rathbun, 1902, has the carapace and abdomen carinate and the telson weakly emarginate at apex, but not forked as in the *P. acutifrons* species group. The spination of the meri of the first and second pereiopods in *P. emarginata* has not been described in literature with certitude. Dr F.A. Chace has kindly informed me that, as yet unpublished review by Dr Yaldwyn, the ovigerous female holotype of that species has six meral spines on the first pereiopod and 14 on the second (Chace, pers. comm.). The rostral shape of *P. emarginata*, however, is noticeably different from that of *P. sinensis*.

Distribution. Previously known from the East China Sea and Tosa Bay, Japan. New to the Australian fauna.

Genus *Leptochela* Stimpson
key to north-west Australian species

1. Sixth abdominal somite with movable lappet, fifth somite dorsally uneven, with prominent elevations and posterodorsal spine .... *soelae*

   Sixth abdominal somite without movable lappet 2
2. Fifth abdominal somite with distinct dorsal elevations .... *japonica*

   Fifth abdominal somite without dorsal elevation 3
3. Telson with one pair of dorsomesial and two pairs of dorsolateral spines 4

   Telson with one pair of dorsomesial and one pair of dorsolateral spines 5
4. Rostrum relatively short, not reaching end of cornea, appendix masculina distinctly overreaching appendix interna .... *robusta*

   Rostrum relatively long, often overreaching end of cornea, appendix masculina

Table 1. Number of meral spines on the first and second pereiopods in four *Pasiphaea* species.

Species	*Pp1*	*Pp2*	*Sources*
P. acutifrons	4-6	8-11	Holthuis (1952)
P. pacifica	0-4	8-11	Rathbun (1902, 1904); Butler (1980)
P. barnardi	1-3	12-13	Yaldwyn (1971)
P. sinensis	6-22	19-27	Hayashi and Miyake (1971)

reaching as far as end of appendix interna .... (irrobusta)

5. Suborbital angle with spine ... (pugnax)
   Suborbital angle without spine .... *aculeocaudata*?

Leptochela (Leptochela) aculeocaudata? Paulson

(Fig. 3)

Leptochela aculeocaudata Paulson, 1875: 100, Pl. 16, Fig. 1-1s (translation, 1961: 106, Pl. 16, Fig. 1-1s); Gurney 1939: 428, 429, 433.

Leptochela aculeocaudata hainanensis - Armstrong 1941: 1.

Leptochela (Leptochela) aculeocaudata - Chace 1976: 4, Figs 2-4.

Material. CSIRO 0283, 1 ♀, cl 2.6 mm (definite data unknown).

Description. Distal part of rostrum broken off, rest of rostrum relatively high. Carapace with three longitudinal dorsal carinae along nearly whole length of carapace. Orbital margin entire, without serrated spines. Suborbital angle rounded, without spine.

Fifth abdominal somite dorsally rounded. Sixth somite nearly twice as long as high.

Telson nearly 1.5 times as long as sixth somite, slightly more than 3.0 times as long as wide, bearing pair of dorsomesial and pair of dorsolateral spines in addition to usual five pairs of distal spines, without minute distomesial pair of spines.

Eye with cornea nearly as long as width of stalk, ocular tubercle low and small.

Antennal scale about 0.4 times as long as carapace, and about 3.0 times as long as wide, lateral margin concave.

First pereiopod overreaching antennal scale by more than length of fingers, armed with at least 18 spines on opposable margin of dactylus.

Remarks. *L. (L.) aculeocaudata* is so closely related to *L. (L.) sydniensis* Dakin and Colefax that these two species have often been confused (cf. Chace 1976).

The present female specimen appears to be closely related to *L. (L.) aculeocaudata* but differs slightly from the typical form shown by Chace (1976) in some external features.

In my specimen the basal segment of the antennal peduncular segment is not entirely concealed by the carapace. A similar form was observed by Chace in material from the Samoa Islands reported by Armstrong (1941), but the former author believed this to be an artifact resulting from faulty preservation. However, I cannot abandon the assumption that the failure of the carapace to conceal the basal segment of second antenna may be rather frequently observed among individuals of *L. (L.) aculeocaudata*.

The pair of dorsolateral ridges on the carapace does not conceal the median ridge,

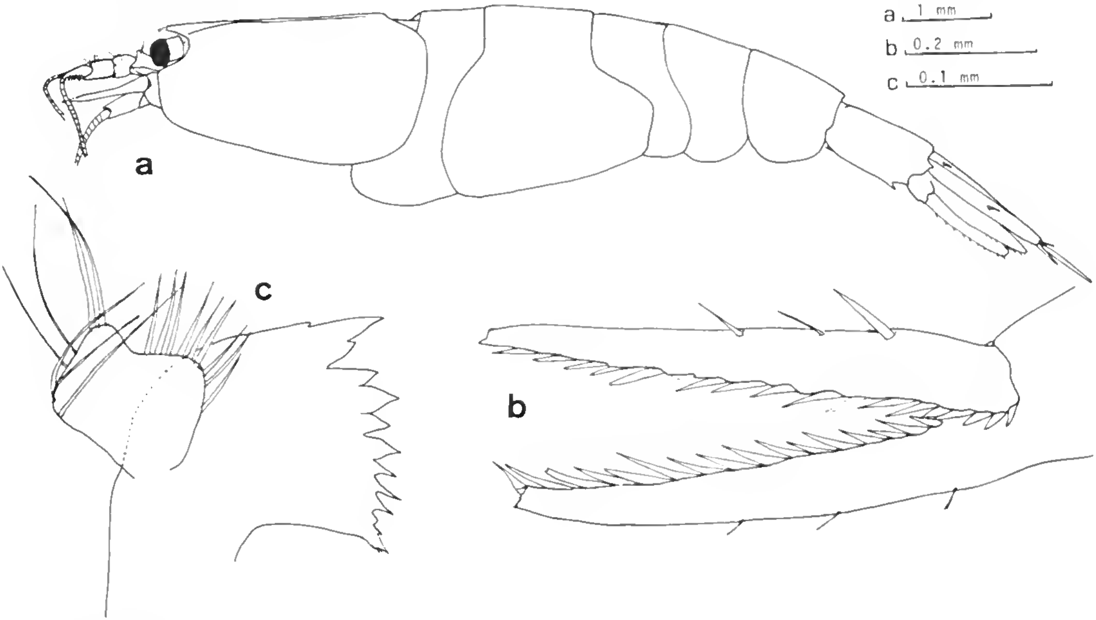

Fig. 3. *Leptochela (Leptochela) aculeocaudata*? ♀cl 2.6 mm: **a**, body, lateral; **b**, fingers of 1st pereiopod, left; **c**, mandible, left.

though the former pair is higher than it is in the material ascribed to *L. (L.) sydniensis* from the northern part of the Sea of Japan.

The fingers of the present specimen are more or less broken off, and the exact number of spines on the dactylus is uncertain. If the finger to palm ratio of 1.8-2.0, which Chace noted for *L. (L.) aculeocaudata* (this is also useful for *L. (L.) sydniensis)*, is adapted to the present case, about 20-22 spines on the opposable margin of the dactylus of the first pereiopod is quite reasonably supposed.

The specimen is assumed to be adult by the pleura of the first and second abdominal somites are obviously enlarged and somewhat fragile, a condition usually seen in breeding females. I suppose, therefore, that this female was either nearly in breeding condition or had just released its eggs. If my assumption is correct, the size of female is much smaller than the size range known for adult *L. (L.) sydniensis*, but falls within that of *L. (L.) aculeocaudata*.

The identification is tentative, even if I am inclined to believe that the material is identifiable with *L. (L.) aculeocaudata*.

Distribution. Reliable records of the species are: Red Sea; Samoa Islands. Previously reported in Australia from Queensland.

Leptochela (Leptochela) japonica Hayashi and Miyake

(Fig. 4)

Leptochela japonica Hayashi and Miyake, 1969b: 1, Figs 1,2; Fujino and Miyake 1970: 242.

Leptochela (Leptochela) japonica-Chace 1976: 23, Figs 19-21.

Material. CSIRO 0283, 2 ♀, cl 4.6, 4.9 mm (definite data unknown); CSIRO 0283, 2 ♀, cl 4.6, 5.0 mm (definite data unknown); CSIRO 0283-121, 1 ♀, cl 5.0 mm (ovig.), 28 April 1983, 19°03.5′S, 119°03.6′E, 80 m depth; CSIRO 0283-129, 1 ♀, cl 4.3 mm (ovig.), 28 April 1983, 19°05.0′S, 118°57.5′E, 82 m depth.

Description. Rostrum with dorsal margin nearly straight, or slightly concave. Carapace with three longitudinal dorsal ridges, lateral pair distinctly carinate in breeding females, somewhat obscure in non-breeding females. Orbital margin smooth, not serrate, and no mesially directed spine on ventral portion. Suborbital angle without spines.

Fourth abdominal somite with three dorsal elevations, slightly increasing in height post-

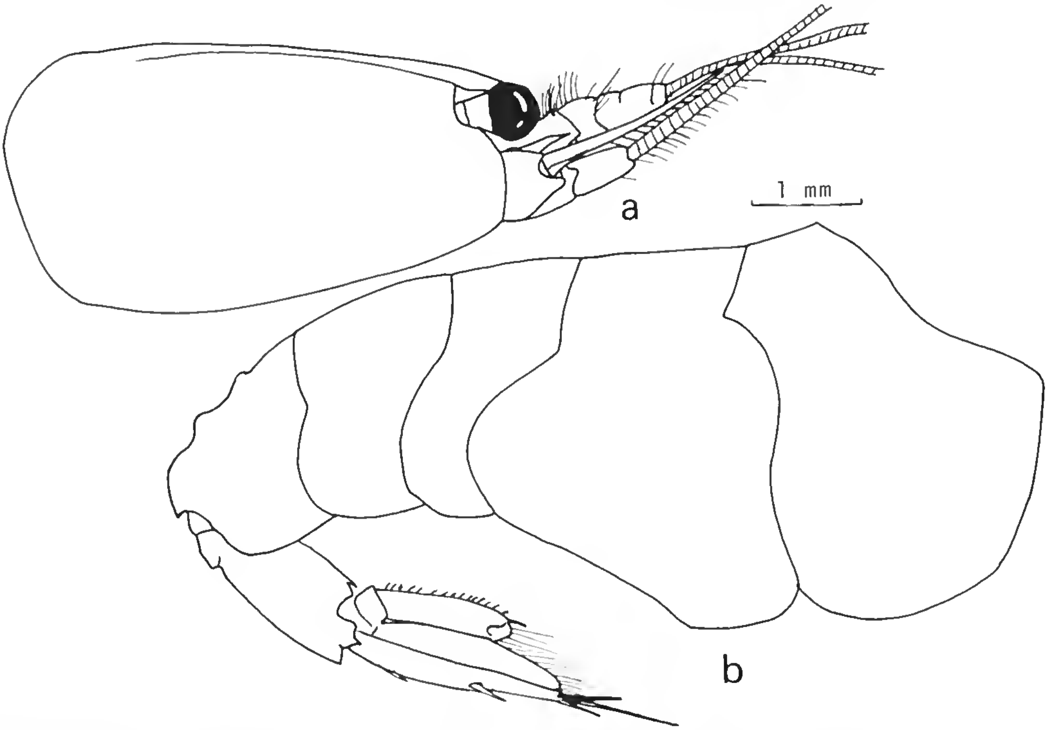

Fig. 4. *Leptochela (Leptochela) japonica* ♀ (ovig.) cl 4.3 mm: **a**, anterior part of body, lateral; **b**, posterior part of body, lateral.

eriorly, and blunt posterodorsal projection. Sixth somite without dorsal movable lappet.

Telson with pair of dorsomesial and pair of dorsolateral spines in addition to usual five pairs of posterior marginal spines.

Antennal scale 0.50-0.58 times as long as carapace.

Distribution. Gulf of Thailand; southern Japan. Previously known in Australia from Queensland.

Leptochela (Leptochela) robusta Stimpson
(Fig. 5)

Leptochela robusta Stimpson, 1860: 43; de Man 1916: 148 (in part); - 1920: 20 (in part), pls 3, 4, Fig. 7-7w.

Leptochela (Leptochela) robusta- Chace 1976: 34, Fig. 28.

Material. CSIRO 0283 2♂, cl 3.0, 3.3 mm, 1♀, cl 4.0 mm (definite data unknown); CSIRO 0283, 2♂, cl 2.7, 4.0 mm, 4♀, cl 3.0-5.0 mm (definite data unknown); CSIRO 0283-104, 1♂, cl, 5.2 mm, 1♀, cl 4.9 mm (ovig.), 27 April 1983, 19°05.3′S, 118°53.8′E, 80 m depth; CSIRO 0283-121, 1♂, cl 5.1 mm, 28 April 1983, 19°03.5′S, 119°03.6′E, 80 m depth; CSIRO 0283-129, 1♂, cl ca 5.5 mm, 28 April 1983, 19°05.0′S, 118°57.5′E, 82 m depth; CSIRO 0283-132, 1♀, cl 4.9 mm (ovig.), 28 April 1983, 19°04.4′S, 118°47.3′S, 82 m depth.

Description. Rostrum short, usually not reaching end of cornea. Carapace with three longitudinal dorsal ridges in breeding females, nearly rounded dorsally in males and non-breeding females. Orbital margin smooth, not serrate, armed with mesially directed tooth or projection on ventral portion. Suborbital angle rounded, without spine.

Fifth abdominal somite without carination or ridge. Sixth somite without movable dorsal lappet.

Telson with pair of dorsomesial and two pairs of dorsolateral spines in addition to usual five pairs of posterior marginal spines, no minute mesial spines on distal margin.

Antennal scale 0.53-0.65 (mean: 0.60) times as long as carapace, 2.8-3.2 (mean: 2.96) times as long as wide.

Appendix masculina distinctly overreaching appendix interna.

Remarks. This species is closely related to *L. (L.) irrobusta* Chace so that early records of this species may have been confused with the latter. In the present material, the rostrum is relatively short, and the appendix masculina distinctly overreaches the appendix interna. These characters make the identification clear.

The present study revealed that females of *L. (L.) robusta* could become mature when they reach at least 4.9 mm in carapace length. This value is much smaller than that suggested by Chace (1976).

Kensley (1969, 1981b) recorded *L. (L.) robusta* from South African waters. This record is far removed from the known range of this species (see Chace 1976). As the author did not describe or figure his material, it is therefore uncertain, at the present time, whether either *L. (L.) robusta* or *L. (L.) irrobusta* lives in South African waters. However the latter species is known to be widely distributed in the Indo-West Pacific region (cf. Chace 1976).

Distribution. Reliable records are: South China Sea; Philippine Islands; Indonesia. First record of occurrence in Australia with reasonable certitude.

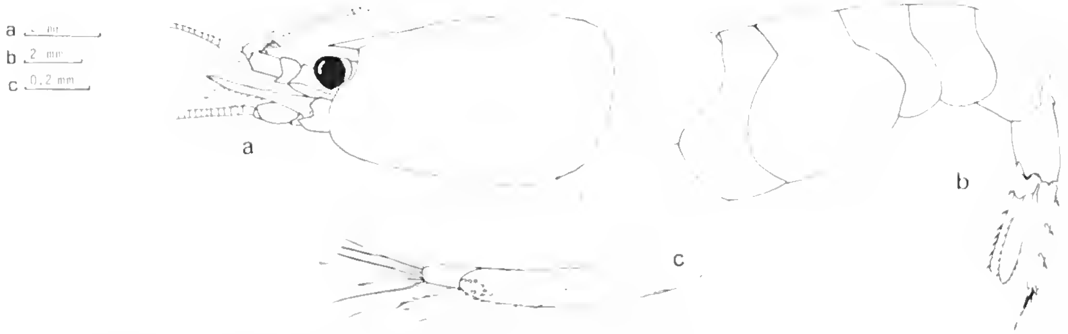

Fig. 5. *Leptochela (Leptochela) robusta:* **a-b**, ♀ (ovig.) cl 4.9 mm: **a**, anterior part of body, lateral; **b**, posterior part of body, lateral; **c**, ♂ cl 5.1 mm, appendix masculina.

Leptochela (Proboloura) soelae sp. nov.

(Figs 6-8)

Type material. HOLOTYPE - ♀, NTM Cr. 003605, cl 8.6 mm, CSIRO 0283-122, 28 April 1983, 19°05.0′S, 118°53.8′E, 82 m depth; PARATYPES - 1 ♂, NTM Cr. 003606, cl 5.9 mm, CSIRO 0283-137, 28 April 1983, 19°03.5′S, 119°03.1′E, 82 m depth; 1 juv. NTM Cr. 003607, cl 4.1 mm, CSIRO 0283 Fish larvae Stn 7(1), 18°.45′S, 119°05′E (date unknown); 1 ♀ (ovig.), NSMT Cr-9205, cl 9.1 mm, CSIRO 0283-85, 27 April 1983, 19°05.4′S, 118°53.5′E, 80 m depth; 1 ♂, NSMT Cr-9206, cl 6.0 mm, CSIRO 0283-129, 28 April 1983, 19°05.0′S, 118°57.5′E, 82 m depth; 1 ♀, cl 7.1 mm, CSIRO 0283-121, 28 April 1983, 19°03.5′S, 119°03.6′E, 80 m depth (USNM 233802).

Diagnosis. Carapace with three longitudinal dorsal carinae in both males and females. Orbital margin entire, not serrate, with mesially directed tooth at lower portion. Rostrum long, nearly reaching end of antennular peduncle, dorsal margin slightly concave. Fifth abdominal somite with three dorsal projections and prominent posterodorsal tooth. Sixth abdominal somite with movable lappet, basally wide and distally narrow. Telson with pair of dorsomesial and two pairs of dorsolateral spines in addition to usual five pairs of distal spines. Antennal scale 0.5-0.6 times as long as carapace.

Description. Body moderately stout. Rostrum nearly or quite reaching as far as end of antennular peduncle segment, dorsal margin concave.

Carapace dorsally tricarinate over most of carapace length in males and females, lateral pair beginning just behind orbital margin and disappearing just before posterior margin. Orbital margin smooth, not serrate, but with small, mesially directed tooth on lower margin. Suborbital angle rounded, without spine.

Abdominal terga dorsally rounded on anterior three somites. Fourth somite also dorsally rounded, but rarely on posterior half, and posterodorsal portion with deep rift. Pleuron of first somite with 4-6 spines on lower margin, except in ovigerous female. Fifth somite with three prominent dorsal elevations and sharp posterior projection, latter nearly reaching base of lappet. Sixth somite about 2.2 times as long as high, and provided with movable lappet on dorsal margin, elliptical in shape, basally wide and distally narrow; ventrolateral margin with acute tooth.

Telson 2.1-2.3 times as long as sixth somite and 2.5-2.8 times as long as wide, dorsal margin deeply grooved, bearing pair of dorsomesial and two pairs of dorsolateral spines, anterior pair of latter spines placed nearly in line of dorosomesial spines and posterior pair at distal third, distal margin armed with usual five pairs of spines only. Exopod of uropod shorter than endopod, with a series of spines on outer margin. Endopod of uropod slightly shorter than telson, with stout spines on distal fourth of outer margin.

Eye with cornea wider than stalk, with distinct ocular tubercle on distal inner margin of stalk.

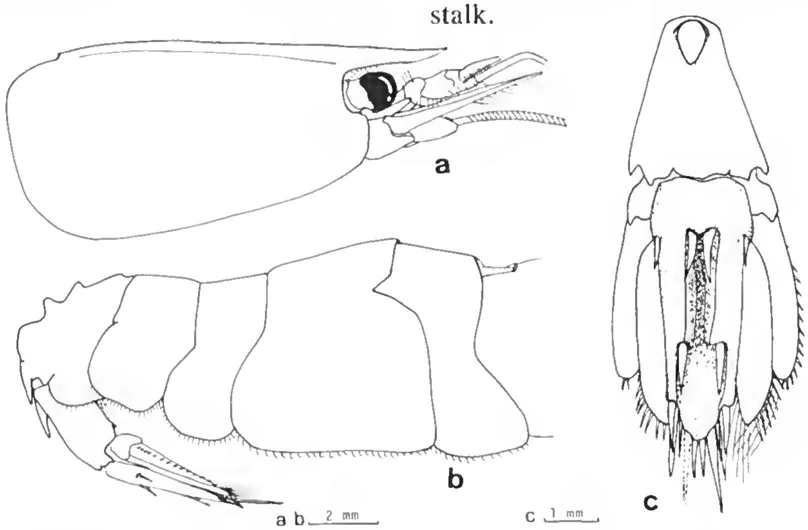

Fig. 6. *Leptochela (Proboloura) soelae* holotype, ♀ cl 8.6 mm: **a**, anterior part of body, lateral; **b**, posterior part of body, lateral; **c**, telson.

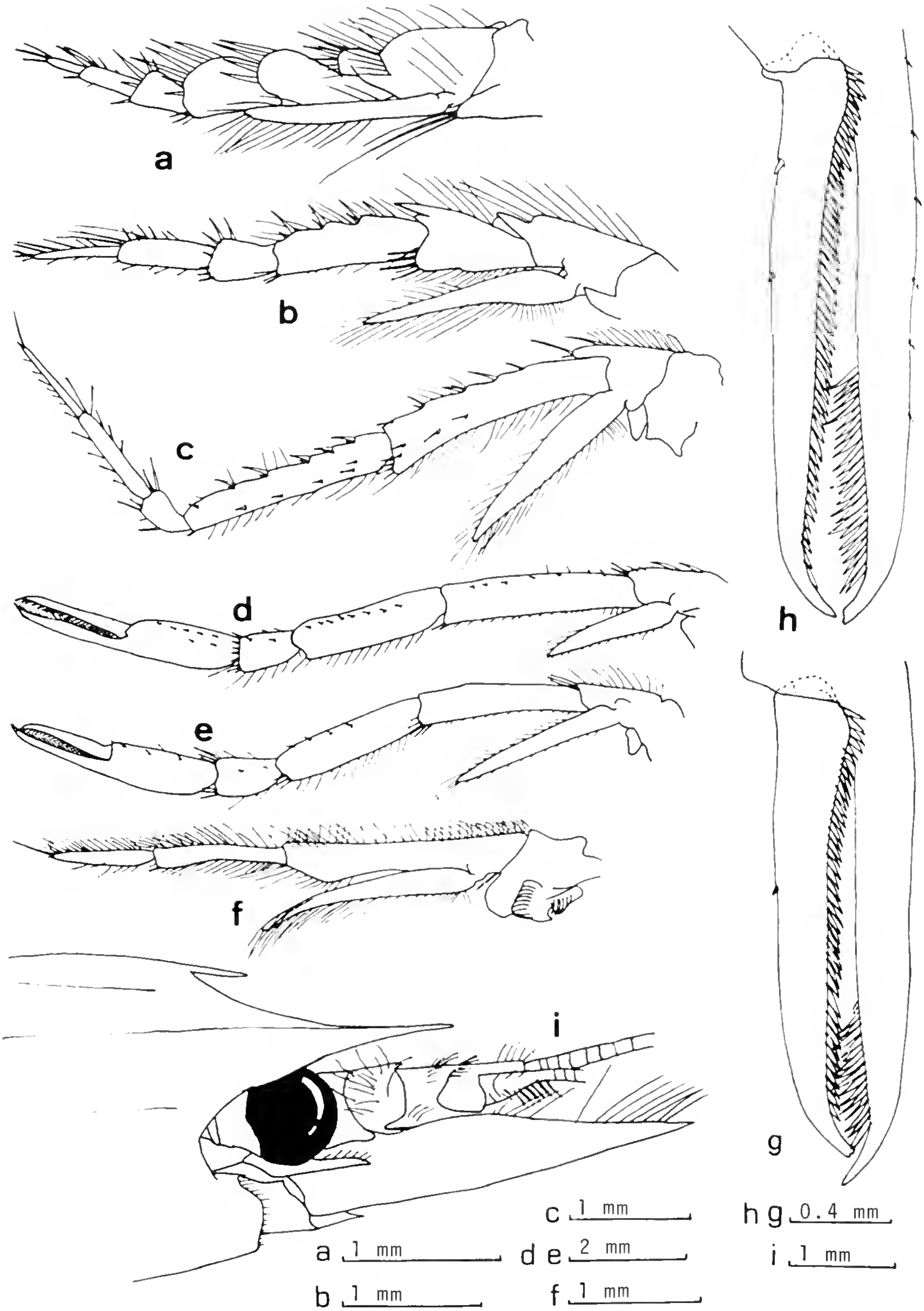

Fig. 7. *Leptochela (Proboloura) soelae* holotype, ♀ cl 8.6 mm: **a**, 5th pereiopod, right; **b**, 4th pereiopod, right; **c**, 3rd pereiopod, right; **d**, 2nd pereiopod, right; **e**, 1st pereiopod, right; **f**, 3rd maxilliped, right; **g**, fingers of 1st pereiopod, right; **h**, fingers of 2nd pereiopod, right; **i**, anterior part of bodys oblique.

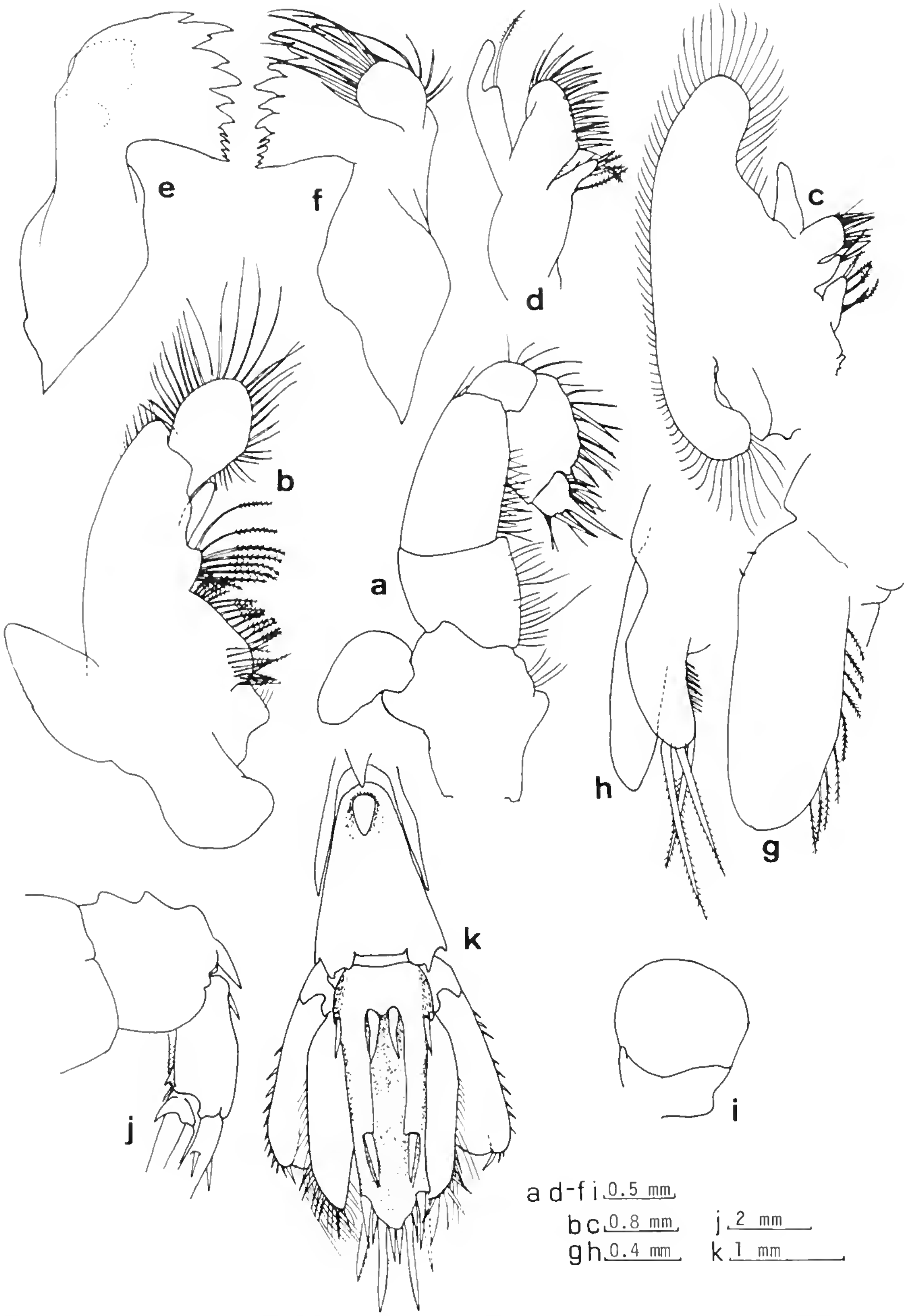

Fig. 8. *Leptochela (Proboloura) soelae:* **a-f**, holotype, ♀ cl 8.6 mm: **a**, 2nd maxilliped, right; **b**, 1st maxilliped, right; **c**, 2nd maxilla, right; **d**, 1st maxilla, right; **e**, mandible, right (ventral view); **f**, same (dorsal view); **g-i**, paratype, ♂ cl 6.0 mm: **g**, endopod of 1st pleopod, right; **h**, appendix masculina, right; **i**, eye, right; **j-k**, paratype, ♀ (ovig.) cl 9.1 mm: **j**, 5th and 6th abdominal somites, lateral; **k**, 6th abdominal somite and telson.

Antennular peduncle with stylocerite overreaching first segment.

Antennal scale 0.5-0.6 times as long as carapace and 3.8-4.0 times as long as wide, outer margin usually convex or nearly straight, inner margin slightly concave near midlength, with distinct outer spine and distal margin of blade usually indistinct, rarely forming shallow sinus. Distal segment of antennal peduncle about half as wide as antennal scale, and reaching nearly two-fifths of scale.

Mouth parts as follows: mandible with 12 teeth on cutting edge in right half, palp short, nearly rounded; first maxilla as in genus, with lower endite narrow and slender, palp with long seta on midportion; second maxilla with upper endite deeply cleft near posterior third, lower endite narrow, with several setae, palp without setae, scaphognite developed; first maxilliped with exopod fully developed, and divided into two parts, distal part small and bearing long plumose setae, epipod long, endopod divided into two segments; second maxilliped with long epipod, nearly leaf-shaped, no exopod present, distal segment terminating in strong spine.

Third maxilliped extending nearly to distal third of antennal scale, or nearly to level of end of antennular peduncle.

First pereiopod overreaching antennal scale by more than half length of fingers, fingers 1.0-1.1 times as long as palm and bearing 32-48 spines on opposable margin of dactylus. Second pereiopod overreaching antennal scale by about length of fingers (only two-fifths in left appendages in holotype), dactylus 1.0-1.1 times as long as palm and bearing 46 spines on opposable margin of dactylus (only one specimen is available). Third pereiopod reaching as far as anterolateral margin of carapace; ischium with four or five spines on flexor margin and three or four spines on exterior margin; merus with six or seven spines on flexor margin and four or five spines on exterior margin; dactylus about 0.9 times as long as propodus. Fourth pereiopod overreaching end of ischium of third pereiopod by half to one-third length of dactylus; dactylus 0.87-0.91 as long as propodus; exopod reaching to midlength of merus. Fifth pereiopod overreaching Ischium of fourth pereiopod by length of dactylus and half or more length of propodus; coxa with oblong exterior projection bearing stout spines on distal margin; dactylus shorter than propodus, about 0.7 times as long as latter leg; exopod overreaching end of ischium.

Remarks. The genus *Leptochela* is divided into two subgenera, *Leptochela* and *Ploboloura*, the latter of which has been represented by *L. (P.) carinata* Ortmann, 1893, from the Atlantic Ocean. The new species differs strikingly from the Atlantic species by having a prominent posterodorsal projection on the fifth abdominal somite. Other remarkable features distinguishing the present species from the latter are as follows: 1) the rostrum is long, nearly reaching the end of the second antennular peduncle, instead of not overreaching the cornea; 2) the carapace has three longitudinal ridges both in males and females, instead of such condition in ovigerous females only; 3) the antennal scale is short, about half the length of the carapace, instead of relatively long, about three-fourths or more as long as the carapace; 4) the movable lappet on sixth abdominal somite is nearly ovate, basally wide and distally narrow, instead of subtriangular-shaped, basally narrow and distally wide; 5) the size of mature individuals is greater, attaining 9.1 mm in carapace length (ovigerous female), instead of 7.7 mm in the largest recorded female of *L. (P.) carinata*.

This species is also similar to *L. (L.) japonica* Hayashi and Miyake in the dorsal carination of the fifth abdominal somite, but it is distinguishable from the latter by the prominent posterodorsal projection on the fifth abdominal somite, the presence of movable lappet on the sixth somite and by arrangement of the spines on the telson.

The name "soelae" is derived from the R.V. "Soela".

Distribution. Known only from north-west Australian shelf.

Family Oplophoridae
Genus *Acanthephyra* A. Milne Edwards
Acanthephyra smithi Kemp
(Fig. 9a, b)

Acanthephyra smithi Kemp, 1939: 577; Hayashi and Miyake 1969a: 61, Fig. 2; Aizawa 1974: 32; Ziemann 1975: 30; Chace 1986: 31, Figs 3k, 4w, 5w, 7j, 10f.

Material. CSIRO 0184-92, 1 ♀, cl 16.8 mm, 18 February 1984, 16°08.5'S, 120°09.4'E, 598 m depth.

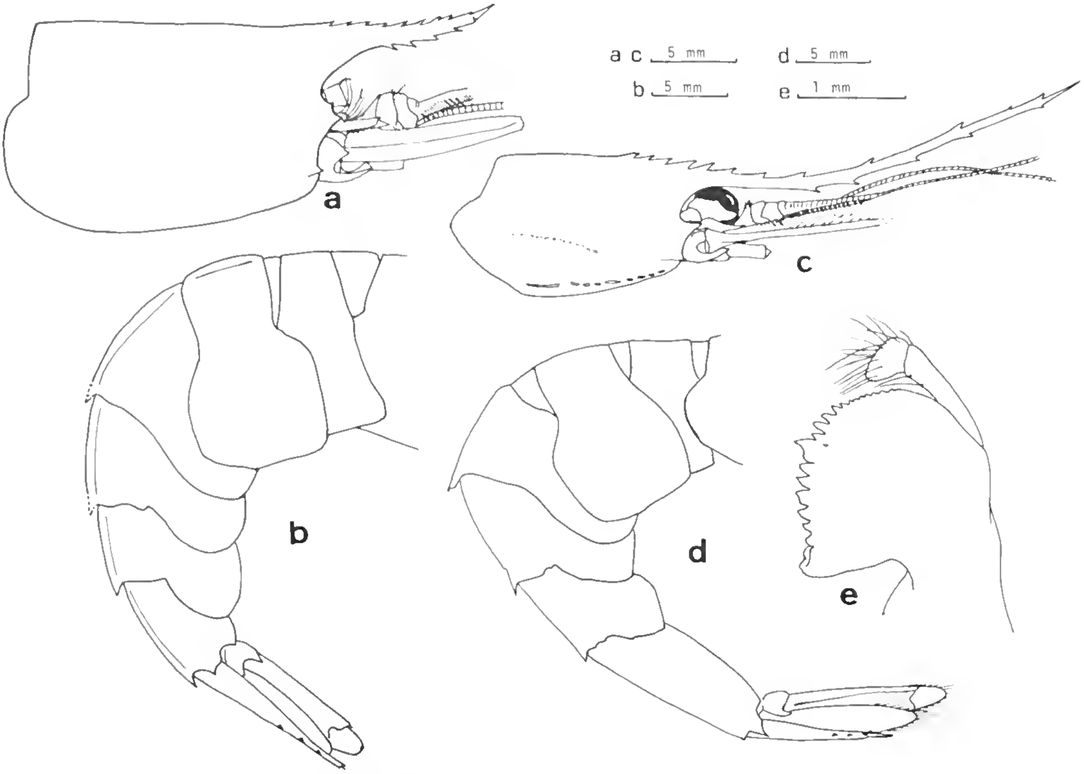

Fig. 9. *Acanthephyra smithi* ♀ cl 16.8 mm: **a**, anterior part of body, lateral; **b**, posterior part of body, lateral. *Systellaspis pellucida* ♀ cl 11.4 mm: **c**, anterior part of body, lateral; **d**, posterior part of body, lateral; **e**, mandible, left.

Description. Carapace without dorsal carina. Rostrum shorter than carapace, armed with nine dorsal and five ventral spines throughout its length. Branchiostegal spine supported by very short carina.

Abdomen with relatively high carinae on second to sixth somites, and armed with posterodorsal spines on third to sixth somites (some of them are broken off in this specimen).

Telson grooved dorsally, apex broken off, but rest armed with three pairs of dorsolateral spines.

Distribution. Tropical and subtropical regions of Indo-West Pacific. Not previously reported in the north-west Australia.

Genus *Systellaspis* Bate
Systellaspis pellucida (Filhol)
(Fig. 9c-e)

Acanthephyra pellucida Filhol, 1884:199; Figueira 1957: 33 (in text); Holthuis 1980: 188.

Acanthephyra affinis Faxon, 1896: 162, Pl. 2, Figs 1-3.

Systellaspis lanceocaudata- (not Bate) Balss 1925: 243, Figs 12, 13.

Systellaspis affinis- Chace 1947: 39, Fig. 3; Crosnier and Forest 1968: 1133.

Systellaspis pellucida- Crosnier and Firest 1973: 92, Figs 26e, 27c; Chace 1986: 67, Figs 34m- o, 35g, h.

Material. CSIRO 0184-32, 1 ♂, cl -mm, 1 ♀, cl 12.1 mm, 3 February 1984, 17°35.2'S, 118°42.0'E, 450 m depth; CSIRO 0184-51, 2 ♀, cl 11.4, 13.2 mm, 10 February 1984, 15°41.5'S, 120°35.9'E, 502 m depth; CSIRO 0184-70, 2 ♂, cl 8.4, 8.6 mm, 7 ♀ , cl 8.9-12.1 mm, 13 February 1984, 13°43. 1'S, 122°14.0'E, 495 m depth; CSIRO 0184 NWS-58 T/34, 1 ♂, cl 11.8 mm, 3 February 1984, 17°16.3'S, 119°01.5'E, 456-460 m depth (NTM Cr. 000681).

Description. Body moderately slender. Rostrum slender, distinctly longer than carapace, bearing 10-12 dorsal and 5-7 ventral spines. Branchiostegal spine supported by short, but high carina. No longitudinal carina or ridge on lateral surface of carapace.

Abdomen with dorsal carina on third and fourth somites.

Pleuron of fifth somite usually with a shallow notch on posterolateral margin. Sixth somite rounded dorsally, without groove. Telson shorter than endopod of uropod, armed with three pairs of dorsolateral spines, sharp pointed end-piece bearing about four pairs of lateral spines.

Remarks. Crosnier and Forest (1973) reasonably suggested that the material recorded by Balss (1925) as *S. lanceocaudata* from the Zanzibar area would be probably identifiable with this species. The mandible of Balss's specimen, as figured by him, differs slightly from that of *S. pellucida* in the present series in the number of teeth on cutting edge, but agrees with that of *S. lanceocaudata* taken from Suruga Bay, Japan (Tokai University, IORDIN 79-89; - 115; - 123; - 126). *S. pellucida* usually has 19 and 14 teeth respectively on left and right mandibles, instead of 21 and 15 teeth as in *S. lanceocaudata*, though I have not been able to check the variation, if any, among individuals of both species.

The rostrum of *S. lanceocaudata*, however, has 16-19 dorsal and 7-10 ventral spines. The number shown by Balss appears to be small for *S. lanceocaudata*.

The pleuron of the fifth somite figured by Balss is, as pointed out by Crosnier and Forest, agreeable with *S. pellucida*. Thus, Balss's material is, despite the slight disagreement in the mandible, quite similar to this species. I think it is highly probable that the number of teeth of the mandible was figured somewhat inaccurately.

A full synonymy may be found in Crosnier and Forest (1973), and Holthuis (1980).

Distribution. South China Sea; Philippines; Malay Archipelago; Zanzibar; coasts along west Africa; West Indies; Bahamas; Gulf of Mexico. New to north-west Australian shelf fauna.

Genus *Janicella* Chace

Janicella spinicauda (A. Milne Edwards)

(Figs 10, 11)

Oplophorus spinicauda A. Milne Edwards, 1883, Pl. 30; Chace 1936: 30; -1940: 184, Fig. 54; Springer and Bullis 1956: 11; Bullis and Thompson 1965: 7; Hayashi and Miyake 1969a: 68; Kensley 1969: 169, Fig. 11; - 1972: 38, Fig. 17d, e; -1977: 19 (in list); - 1981a: 58 (in list); -1981b: 22; Wasmer 1972: 83; Aizawa 1974: 36; Ziemann 1975: 58; Hanamura 1979: 171.

Oplophorus foliaceus Rathbun, 1906: 922, Pl. 20, Fig. 8.

Hoplophorus foliaceus-Kemp 1913: 64; de Man 1920: 48 (in key); Balss 1925: 249.

Hoplophorus spinicauda- de Man 1920:48 (in key).

Acanthephyra anomala Boone, 1927:104, Fig. 21.

Janicella spinicauda-Chace 1986:44, Figs 23,24.

Material. CSIRO 0184-76, 1 ♂, cl 11.3 mm, 14 February 1984, 13°42.6′S, 122°57.9′E, 349 m depth.

Description. Rostrum slender, longer than carapace, with 12 dorsal and seven ventral spines. Carapace with dorsal carina. Branchiostegal spine small, projecting from just behind anterolateral margin, no carina supporting spine.

Abdomen with posterodorsal spines on second to fourth somites.

Telson broken off at tip.

Antennal scale slightly shorter than carapace, armed with three lateral spines. Basicerite with shorter ventrolateral process, not greatly long.

Exopods on second and third maxillipeds and on first pereiopod not so rigid as in genus *Oplophorus*.

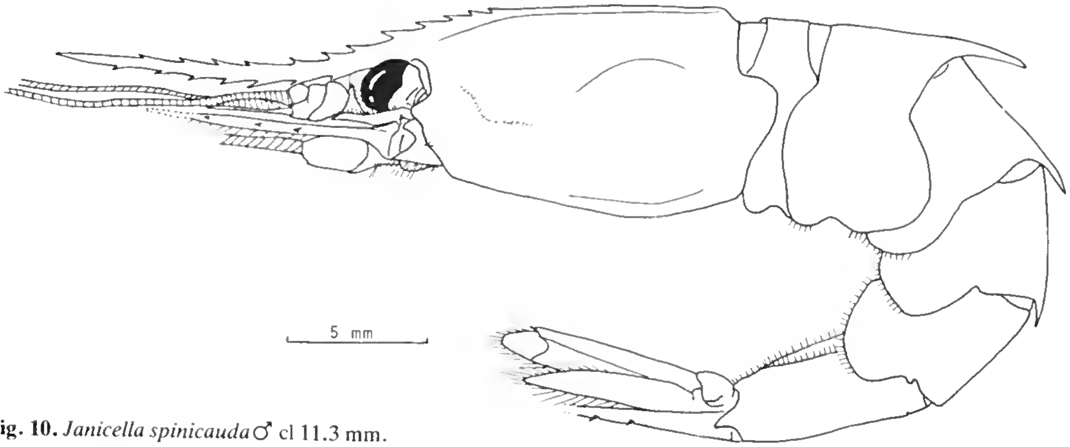

Fig. 10. *Janicella spinicauda* ♂ cl 11.3 mm.

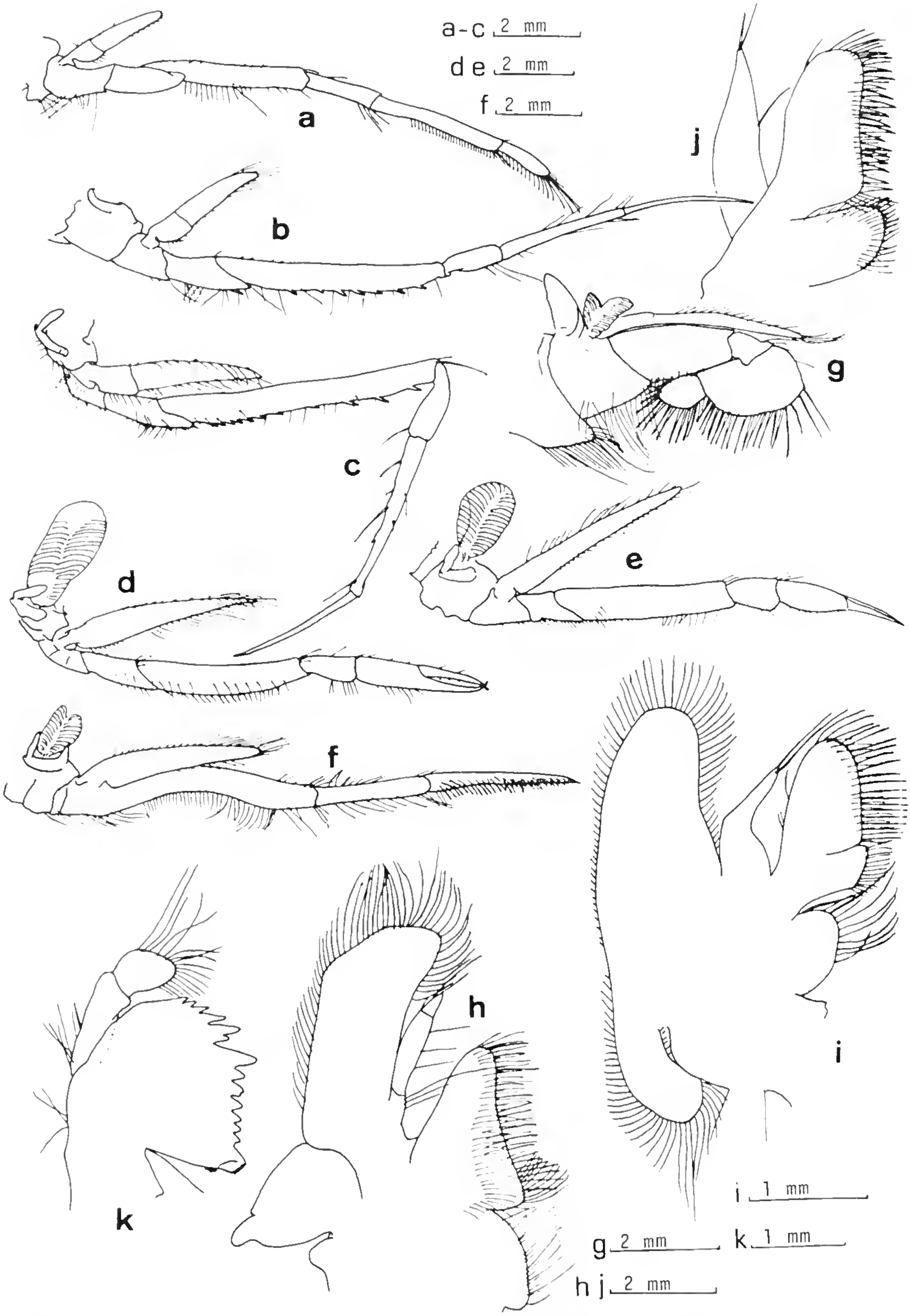

Fig. 11. *Janicella spinicauda* ♂ cl 11.3 mm: **a**, 5th pereiopod, right; **b**, 4th pereiopod, right; **c**, 3rd pereiopod, right; **d**, 2nd pereiopod, right; **e**, 1st pereiopod, right; **f**, 3rd maxilliped, right; **g**, 2nd maxilliped, right; **h**, 1st maxilliped, right; **i**, 2nd maxilla, right; **j**, 1st maxilla, right; **k**, mandible, right.

Remarks. The currently accepted recognition of the species, *O. spinicauda*, has some reason to doubt about the systematic position. As Chace mentioned (1940, 1986), this species shows some resemblance to *Systellaspis*. Certain morphological characters of the species are quite distinct from those of the typical species of *Oplophorus*, such as: 1) the placement of branchiostegal spine, 2) the ventral portion of the carapace not concealing the lower part of the branchial chamber, 3) the sixth abdominal somite being relatively slender, 4) the distal end-piece of the telson armed with lateral spines, 5) the basicerite ventrolateral spine not so long, 6) the mouth parts, 7) the exopods of certain maxillipeds and first pereiopod not so rigid, and 8) the form of certain pereiopods.

The shape of the antennal scale, however, shows a fairly close relationship to the species of *Oplophorus*, though the distal margin of the lamella in this species is different from the *Oplophorus* species. The spination on lateral margin of the antennal scale may not be of taxonomic importance for the genus *Oplophorus*, since *O. novaezeelandiae* de Man, 1931, does not possess such spines. The absence of the appendix masculina is a unique feature of this species and as such condition is found in no species of either in *Oplophorus* or in *Systellaspis*. The mouth parts also differ slightly from those of the *Systellaspis* species.

Recently Chace (1986) proposed a new monotypic genus *Janicella* for *O. spinicauda*. His proposal seems to me to have more merit than the early recognition for reasons mentioned above.

Distribution. Hawaiian Islands; Japan; Philippines; eastern Indian Ocean; east of Farquhar; south of India; Southern Africa; coast of Morocco; Bermuda; off Florida; Bahamas; Carribean Sea; Gulf of Mexico. New to northwestern Australian shelf fauna.

Genus *Oplophorus* H. Milne Edwards

Oplophorus gracilirostris A. Milne Edwards

(Fig. 12a-e)

Oplophorus gracilirostris A. Milne Edwards, 1881: 6; -1883, Pl. 30; Alcock 1901: 73; Rathbun 1906: 921; Yokoya 1933: 29, Fig. 12; Chace 1936: 30; -1947: 44, Figs 4-7; -1986: 59, Fig. 32a-e; Bullis and Thompson 1965: 7; Kensley 1972: 38, Fig. 17f; -1981a: 58 (in list); -1981b: 22; Monod 1973: 121, Figs 19,20; Aizawa 1974: 35; Ziemann 1975: 51; Hanamura 1979: 171; Takeda 1983: 54, 1 Fig.

Oplophorus longirostris Bate, 1888: 765, Pl. 127, Fig. 2.

Hoplophorus smithi Wood Mason *in* Wood Mason and Alcock 1891: 194.

Hoplophorus gracilirostris- Faxon 1896: 161; Wood Mason and Alcock 1892: 365; Kemp 1913: 63.

Hoplophorus typus- (not H. Milne Edwards) Balss 1925: 248 (in part); Calman 1939: 188 (in part).

Material. CSIRO 0184-16, 1 ♂, cl 16.5 mm, 31 January 1984, 18°37.4'S, 117°02.4'E, 506 m depth; CSIRO 0184-23, 1 ♂, cl 12.0 mm, 1 February 1984, 18°34.7'S, 117°32.7'E, 357 m depth; CSIRO 0184 NWS-43 T/18, 1 ♂, cl 8.8 mm, 31 January 1984, 18°43.7'S, 117°02.2'E, 454 m depth (NTM Cr. 001166); CSIRO 0184 NWS-44 T/19, 1 juv. cl 6.8 mm, 1 January 1984, 18°46.9'S, 117°06.9'E, 350-354 m depth (NTM Cr. 000698); CSIRO 0184 NWS-46 T/21, 1 ♂, cl 9.0 mm, 1 February 1984, 18°30.1'S, 117°31.3'E, 446-452 m depth (NTM Cr. 000697); CSIRO 0184 NWS-48 T/23, 1 ♂, 8.7 mm, 1 February 1984, 18°34.7'S, 117°32.8'E, 356-358 m

Table 2. Number of telson spines in *Oplophorus* species

Species	*No. of spines*	*Sources*
O. typus	1-2 (in adult)	Bate (1888)
	3 (at least cl 10 mm)	present work
O. gracilirostris	2 (>cl 12 mm)	Monod (1973); present work
	3 (<cl 9 mm)	present work
O. novaezeelandiae	3 (in adult)	de Man (1931); Hayashi and Miyake (1968); Crosnier and Forest (1968, 1973)
O. spinosus	3 (in adult)	Hanamura (unpubl.)

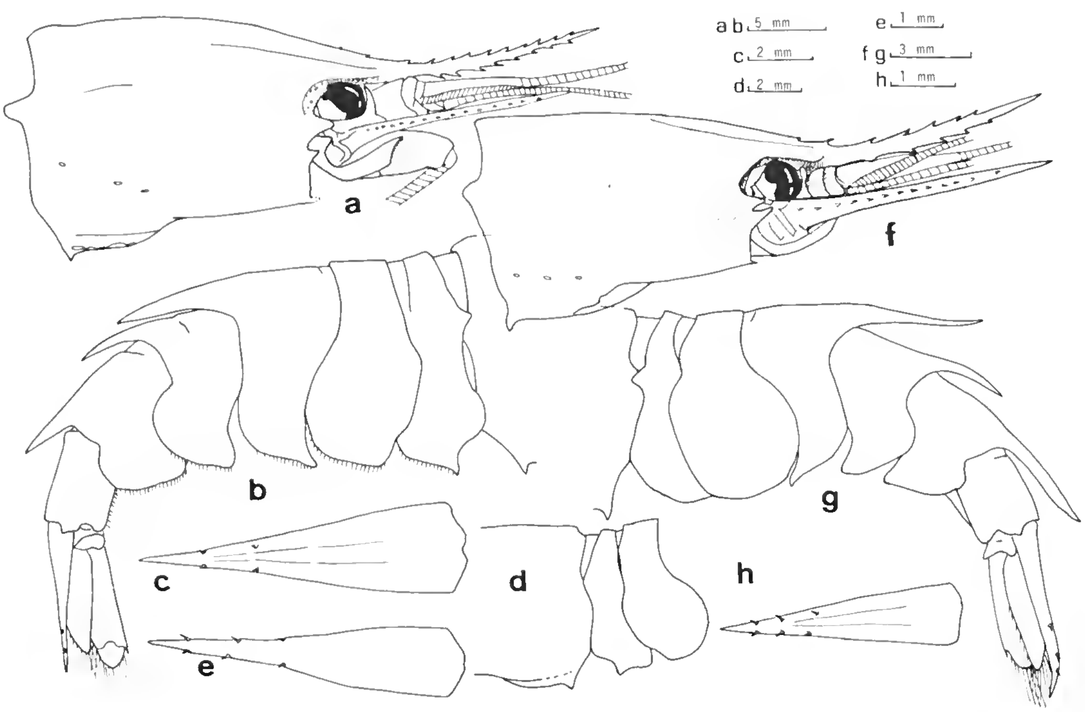

Fig. 12. *Oplophorus gracilirostris*: **a-c**, ♂ cl 16.5 mm: **a**, anterior part of body, lateral; **b**, posterior part of body, lateral; **c**, telson; **d-e**, young cl 6.8 mm: **d**, posterior part of carapace and 1st and 2nd abdominal somites; **e**, telson. *Oplophorus typus* young cl 10.0 mm: **f**, anterior part of body, lateral; **g**, posterior part of body, lateral; **h**, telson.

depth (NTM Cr. 000696); CSIRO 0184 NWS-67 T/44, 1 ♂, cl 17.8 mm, 5 February 1984, 16°18.1'S, 120°18.7'E, 496-500 m depth (NTM Cr. 001185); CSIRO 0184 NWS-68 T/45, 1 ♂, cl 16.0 mm, 5 February 1984, 16°24.0'S, 120°20.4'E, 452-456 m depth (NTM Cr. 000591).

Description. Carapace with paired longitudinal dorsal carinae on anterior portion, parallel to median carina. Branchiostegal spine projecting from anterolateral margin of carapace.

Abdomen terminating in long spine on third to fifth somites. Pleuron of first somite with distinct spine on ventral margin.

Telson with two pairs of dorsolateral spines in larger specimens at least more than 12 mm in carapace length, and three spines at least in those less than 9 mm in carapace length, sharp pointed end-piece without lateral spines.

Antennal scale usually with, rarely without, barb on inner margin near distal portion, bearing series of spines on lateral margin. Basicerite with ventrolateral process extending distinctly anteriorly.

Exopods on second and third maxillipeds and on first pereiopod distinctly rigid.

Remarks. For the identification of this species, I follow Chace (1947) and Hayashi and Miyake (1969).

The telson spines vary in number with increase in body size. But adult *O. gracilirostris* (larger than about 12 mm in cl) has two pairs of spines, whereas *O. spinosus* and *O. novaezeelandiae* have three pairs of spines in the adult size. If this condition has taxonomic importance, it may be desirable to reproduce here the available data (Table 2).

Distribution. Hawaiian Islands; Japan; Philippines; New Caledonia; Fiji Islands; Andaman Sea; Indonesia; eastern part of Indian Ocean; Arabian Sea; Bay of Bengal; Desroches Atoll; Southern Africa; West Indies; Gulf of Mexico; Suriname and French Guiana. Not previously recorded from north-west Australian shelf.

Oplophorus typus H. Milne Edwards
(Fig. 12f-h)

Oplophorus typus H. Milne Edwards, 1837: 424, Pl. 25, Fig. 6; Bate 1888: 762, Pl. 127, Fig. 1; de Man 1920: 48 (in key); Chace 1936: 30; -1947, Figs 8-11; -1986: 60, Figs 32p-t, 33; Hayashi and Miyake 1969a: 71; Aizawa 1974: 37; Kensley 1981a: 58 (in list); -1981b: 22.

Hoplophorus typus-Balss 1925: 248, Figs 21-23 (in part); Calman 1939: 188 (in part).

Material. CSIRO 0184-23, 1 ♀ cl 10.0 mm, 1 February 1984, 18°34.7′S, 117°32.7′E, 357 m depth.

Description. Rostrum about 1.3 times as long as carapace, with six dorsal and five ventral spines. Carapace with paired longitudinal ridges on anterior portion converging posteriorly both in dorsal and lateral aspects. Branchiostegal spine projecting from anterolateral margin of carapace.

Abdomen terminating in long spine on third to fifth somites. Pleuron of first somite nearly smooth, without spine on ventral margin.

Telson about 2.5 times as long as sixth somite, with three pairs of dorsolateral spines, sharp pointed end-piece without lateral spines.

Antennal scale nearly smooth on inner margin near distal portion, with series of spines on lateral margin.

Exopods on second and third maxillipeds and on first pereiopod distinctly rigid.

Remarks. Only one specimen is referred to this species. The number of telson spines in fully mature individuals has not yet been confirmed by myself, but Bate (1888) stated that this species has one or two spines. Thus it is highly probable that the telson spines, as in *O. gracilirostris*, may change with increasing body size.

Distribution. Tropical western Pacific; New Guinea; Philippines; Malay Archipelago; Andaman Sea; eastern Indian Ocean; Maldives; Arabian Sea; Gulf of Aden; Madagascar; Southern Africa. New to north-west Australian shelf.

Family Thalassocarididae

Genus *Thalassocaris* Stimpson

Thalassocaris crinita (Dana)

(Fig. 13)

Regulus crinitus- Dana 1852: 599, Pl. 39, Fig. 6a-h.

Thalassocaris crinitus- Balss 1914: 28

?*Thalassocaris affinis* Borradaile, 1915: 208 (in part).

Thalassocaris crinita - de Man 1920: 95, Pl. 9, Fig. 22-22o; Kemp 1925: 284; Menon and Williamson 1971: 33, Figs 1b, 3, 5b, 6c, d: Chace 1985: 7, Figs 3-5.

Thalassocaris crinita var.? - de Man 1920: 100, Pl. 10, Fig. 23-23c.

Material. CSIRO 0283, 1 ♂, cl 3.4 mm (definite data unknown).

Description. Rostrum widest at level of front of eyes in dorsal view, with eight stout dorsal and three stout ventral spines. Supraorbital spine well developed. Antennal and branchiostegal spines developed, placed close together.

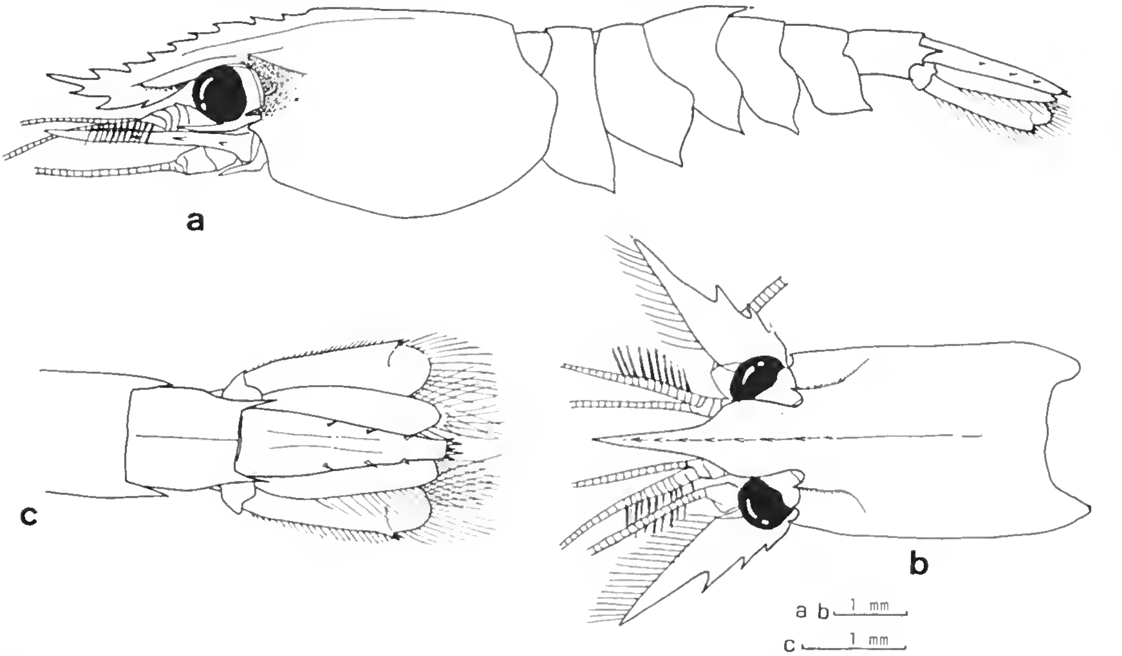

Fig. 13. *Thalassocaris crinita* ♂ cl 3.4 mm: **a**, body, lateral; **b**, anterior part of body, dorsal; **c**, telson.

Abdomen dorsally rounded, third somite ending with large dorsal spine. Pleura of first to fifth somites with acute tooth on ventral margin. Telson nearly twice as long as sixth somite, armed with three pairs of dorsolateral spines and three terminal spines.

Antennal scale shorter than carapace, with three stout lateral spines.

Second pereiopod with distinctly large chela, carpal segment unjointed. First pereiopod without chela.

Distribution. Marshall Island; Japan; Sulu Sea; Philippines; Malay Archipelago; Bay of Bengal; Sri Lanka (Ceylon); northwest India; Arabian Sea; Red Sea; Maldive Islands; Amirante Islands; Seychelle Islands; Cargodos Carajos; west coast of northern Africa; Madagascar. New to the Australian fauna.

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PLATYPILUMNUS SOELAE, A NEW SPECIES OF GONEPLACID CRAB FROM THE NORTH WEST SHELF OF AUSTRALIA (CRUSTACEA: DECAPODA: BRACHYURA)*

JOHN S. GARTH
Allan Hancock Foundation, University of Southern California,
Los Angeles, California 90089, U.S.A.

ABSTRACT

Platypilumnus soelae sp. nov. is described from specimens taken in from 178 to 454m from the North West Shelf of Australia. The new species is differentiated from *P. gracilipes* Alcock, 1894, Andaman Sea, and from *P. inermis* Guinot, 1985, Réunion Island, western Indian Ocean.

KEYWORDS: Brachyura, Crustacea, Decapoda, goneplacid crab, Australia, North West Shelf, Indian Ocean, benthic fauna, barnacle.

INTRODUCTION

Based primarily on the R.V. *"Soela"*, the Fisheries Division of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) conducted a detailed survey of the benthic fauna of the Australian North West Shelf (N.W.S.) slope, from off Dampier to the Bonaparte Archipelago, in depths of 300-700m (some less), using trawls, epibenthic sledges, dredges, and other gear. These operations, conducted in March-April 1982 and in January-February 1984, produced a wealth of information on this little studied area, including many records of crustaceans and other invertebrates new to the Australian fauna.

Among crustacean material collected from deeper offshore areas were several medium-sized grapsoid or catometopous crabs that attracted attention. These were sent to the author for identification by Dr A.J. Bruce of the Northern Territory Museum of Arts and Sciences (NTM). At first believed to be *Platypilumnus gracilipes* Alcock (1894: 401), described from a single female from the Andaman Sea, they were subsequently found to be distinguishable from Alcock's species, using the same criteria employed by Guinot, 1985 in distinguishing *P. inermis* (Guinot, 1985: 16, Pl. 2, Figs E-J) from Réunion Island in the western Indian Ocean. Illustrations are by Matilde Méndez G.

SYSTEMATICS

Platypilumnus soelae sp. nov.

(Figs 1, 2)

Type material. HOLOTYPE ♂, Stn. NWS-29, T/3, 17°55.5'S, 118°19.5'E, 450-454m, 27 January 1984, NTM Cr. 000588. PARATYPES - 1 ♂, Stn. NWS-63, 14°44.0'S, 121°32.2'E, 409m, 12 February 1984, AHF type number 481: 1 ♂, Stn. NWS-64, 14°49.4'S, 121°32.3'E, 178m, 12 February 1984, NTM Cr. 002024.

Measurements. NTM Cr. 000588: CL 24.0mm, CB 27.4mm; AHF 481: CL 30.7mm, CB 35.5mm; NTM Cr. 002024: (largest) CL 33.0mm, CB 39.4mm, LC 48.0mm, LD 28.8mm, HP 23.0mm. (LC length of chela; LD length of dactyl; HP height of palm).

Description. Carapace depressed, very flat, areas distinctly defined, surface finely granulose. Anterolateral margin bearing numerous spiniform teeth, flanked by spinules; posterolateral margin spinulose anteriorly, tuberculate posteriorly. Front lamellate, advanced, bimarginate, free margin spinulate, spinule at external angle not larger than others; lower frontal margin with three spinules on either side of a broad U-notch. Supraorbital margin with three or four spinules on either side of fissure. Subhepatic and pterygostomian regions swollen.

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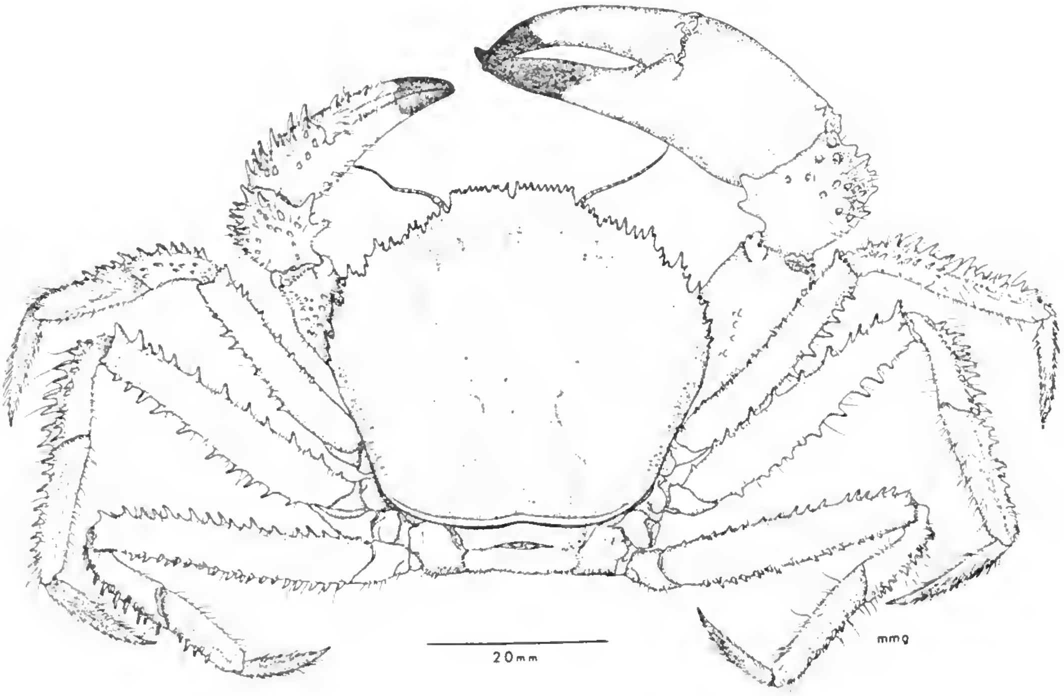

Fig. 1. *Platypilumnus soelae* holotype ♂, dorsal view.

Major chela of male grossly enlarged, inner surface smooth, bulging at center, outer surface smooth and bare except for a few scattered sharp granules proximally; palm high, lower border obtusely angled, fixed finger with lower margin straight, tip sharply upturned, recurving; dactyl long, slender, straight, tip downturned, tips crossing, their brownish colour extending inward along margins of gape; a low tooth at midpoint on pollex, dactyl weakly denticulate. Minor chela much smaller, spinulate, fingers long, thin, not crossing at extremity.

Walking legs long and slender, bearing spines on superior and inferior margins of merus and on superior margin of carpus and propodus.

Male abdomen composed of seven distinct segments. No portion of sternite 8 visible at level of coxa of pereiopod 5.

Pleopod 1 of male nearly straight, apex scarcely narrowed, opening distally.

Pleopod 2 of male longer than pleopod 1, flagellum elongate, recurved at extremity.

Remarks. The new species can be distinguished from its congeners, *P. gracilipes* Alcock, 1894 and *P. inermis* Guinot, 1985, as follows:

1. The front has 7 or 8 spinules on each side, instead of 5 in *P. gracilis* and granules only in *P. inermis*.
2. The lower margin of the front has a narrow U-shape and one or more spinules on either side.
3. The supraborital border has 4 spines internal to and 3 spines external to the median notch, plus a larger exorbital spine, instead of 2 plus 3 plus the exorbital in *gracilipes* and 2 plus 2 and spinules plus the exorbital in *inermis*.
4. Anterolateral spines 2-5 (= 1-4 of Guinot) are not much larger than the supplementary spinules, giving the appearance of continuous but irregular spinulation.
5. The inner surface of the minor chela of the male lacks the cluster of spinules on the inner surface at midpoint of the female in *gracilipes* (of which the male is unknown, as is the female of *soelae*).
6. The flagellum of the male pleopod 2 lacks the cluster of spinules at midpoint shown for *P. inermis* (Guinot, 1985, Fig. 2H).

For these having access to Guinot, 1985, the following detailed comparisons of points 1-4 above, in which reference is made to numbered illustrations for *P. gracilipes* and *P. inermis* corresponding to those given here for *P. soelae*, should be useful:

1. The front, bimargined in all three species, is armed, on the free superior margin, with about five spiniform teeth on either side in *P. gracilipes* (Guinot, Fig. 2A); this margin is only crenulate with a spine at each latero-external angle in *P. inermis* (Guinot, Fig. 2B); whereas it is furnished with numerous (8 to 10 on each side) blunt teeth of equal size in *P. soelae* (Fig. 2A, herewith).
2. The inferior frontal margin bears two median spines, separated by a narrow, U-shaped notch in *P. gracilipes* (Guinot,

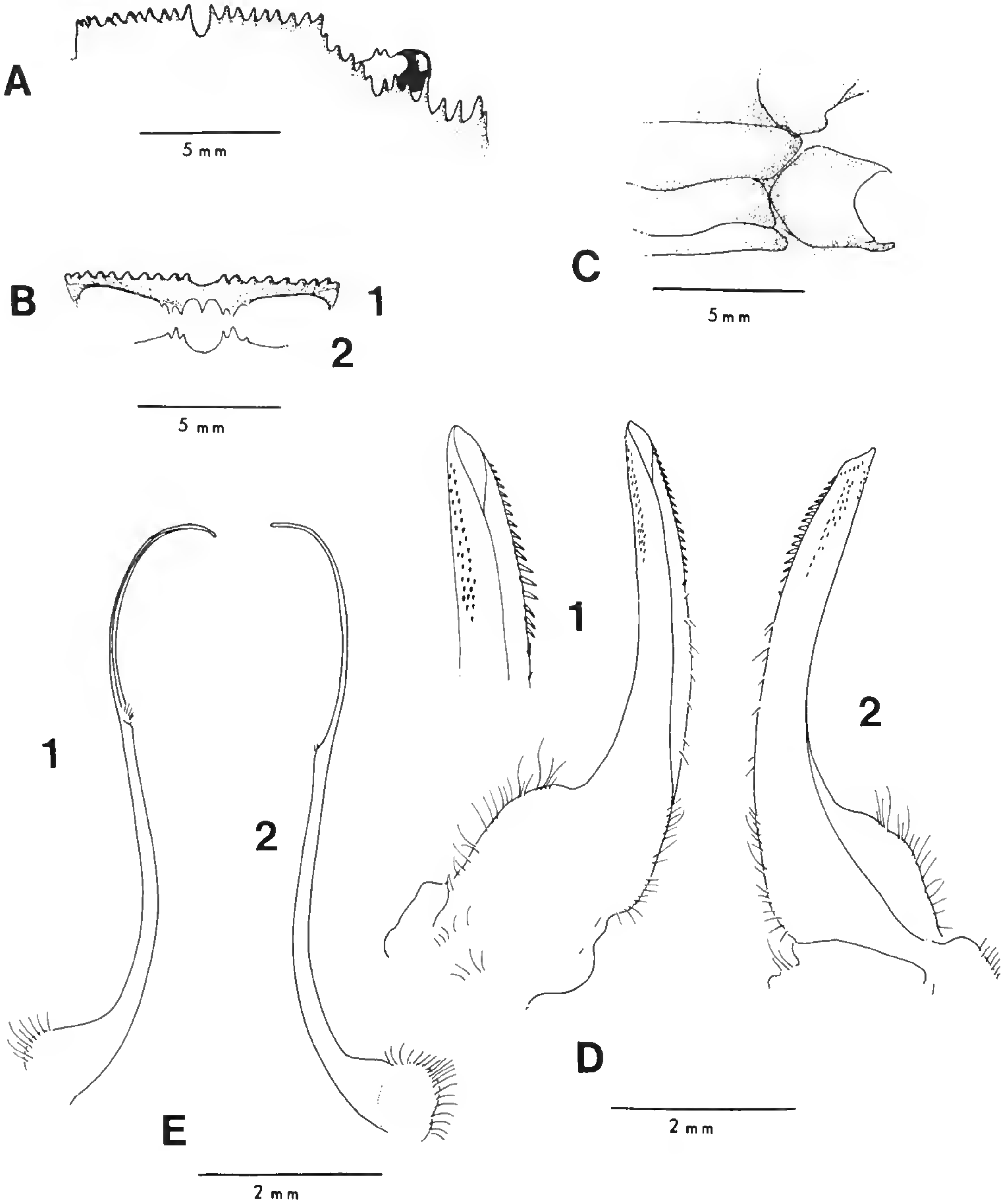

Fig. 2. *Platypilumnus soelae* holotype ♂: **A**, front, dorsal view; **B**, front, **1**, frontal view, **2**, same, ventral view; **C**, abdomen at level of 5th pereiopod; **D**, first pleopod, **1**, anterior view, **2**, same, posterior view; **E**, second pleopod, **1**, anterior view, **2**, same, posterior view.

Fig. 2C2); these spines are more widely spaced in *P. inermis* (Guinot, Fig. 2D2); whereas these spines, again narrowly spaced, are each accompanied by a spinule on either side in *P. soelae* (Fig. 2B2, herewith).

3. The supraorbital margin is split by a notch flanked on the inner side by two spines, and on the outer side by three spines, followed by a fourth spine behind the orbital angle preceding the first large anterolateral spine in *P. gracilis* (Guinot, Fig. 2A); the supraorbital margin bears four long spines (two on each side of the fissure) and only very small spinules in front of the first large anterolateral spine in *P. inermis* (Guinot, Fig. 2B); there are four small spinules on the inner side of the median notch, three spinules outside the median notch, followed by the exorbital spine, followed by two more spinules inside the first anterolateral spine, in *P.soelae* (Fig. 2A, herein).
4. If the exorbital spine be considered the first anterolateral as in previous work by this writer, the first anterolateral spine of Guinot (above) becomes the second anterolateral, making it possible to count 5 larger anterolateral spines, about which the spinules cluster, on each of the three specimens of *P. soelae*.

Although the smaller specimen, selected as the holotype, is in all respects "typical" of the species, on the two larger male paratypes the number of frontal spines is reduced from as many as 8 to 10 to as few as 5 on each side of the median V, a condition resembling the Andaman Sea, rather than the Réunion Island, species. The fixed finger of the major chela is more strongly curved in the larger specimens. The dentition of the major chela, apparent in all three specimens, is not shown in the illustrations of the holotype. Mentioned in descriptions of *P. gracilis* and *P. inermis*, lepadomorph barnacles were attached to all specimens of *P. soelae*. These have been identified by William A. Newman, Scripps Institution of Oceanography, La Jolla, California, as belonging to a group represented by *Poecilasma (Temnaspis) excavatum* Hoek (1907).

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A NEW SPECIES OF *OXYCARENUS* FIEBER FROM AUSTRALIA (HEMIPTERA: LYGAEIDAE)

M.B. MALIPATIL
Northern Territory Museum of Arts and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

Oxycarenus westraliensis sp. nov. is described and illustrated from Western Australia and compared with other congeneric species recorded from Australia.

KEYWORDS: Taxonomy, Hemiptera, Lygaeidae, *Oxycarenus*, new species, Australia.

INTRODUCTION

The predominantly Palaearctic lygacid subfamily Oxycareninae is represented in Australia by 3 species of *Oxycarenus* Fieber: *O. bicolor* Fieber, 1851; *O. arctatus* (Walker, 1872) and *O. luctuosus* (Montrouzier, 1861). The last two species are endemic to Australia — *arctatus* having a primarily southern distribution and *luctuosus* widespread all over Australia but common in the north. Whereas *bicolor*, recorded in Australia from the Torres Strait islands (Queensland), is widespread in the Oriental Region. Gross (1959) reviewed the known Australian species and provided a key for their separation.

The present contribution describes an additional species of the genus *Oxycarenus* and compares it with other Australian recorded species of this genus. All measurements are in millimetres.

SYSTEMATICS

Oxycarenus westraliensis sp. nov.
(Figs 1-4)

Type material. HOLOTYPE - ♂, Western Australia, Walpole, 16 km W., 34.57°S 116.44°E, 11 November 1969, E.B. Britton and F.H. Uther Baker, in Australian National Insect Collection, CSIRO, Canberra (ANIC). PARATYPE - 1♀, same data as holotype (distal 2 segments of left and distal 3 segments of right antennae missing), in ANIC.

Description. Generally stramineous with dark brown areas of pronotum, hemelytra and scutellum as in Fig. 1; most of head, femora except distal ends, antennae excluding 2nd segment, most of thoracic pleura, and labium dark reddish brown to black; bases of tibiae, distal segment of tarsi and claws dark brown; spot at apex of corium not distinct; abdomen almost black except for posterior areas of metapleura and posterior abdominal segments which are pale.

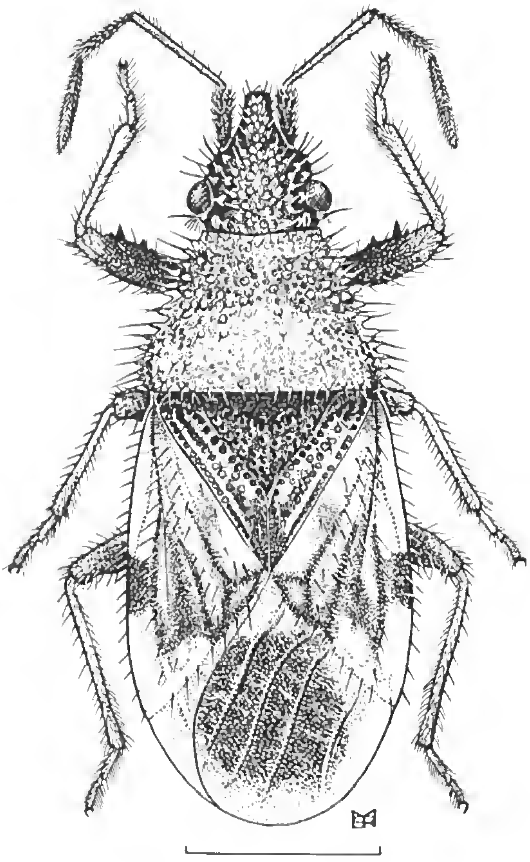


Fig. 1. *Oxycarenus westraliensis* holotype ♂, dorsal view. Scale line 1.0mm.

Body above excluding membrane covered with erect golden yellow bristles; appendages covered with decumbent setae in additon to sparse semierect bristles.

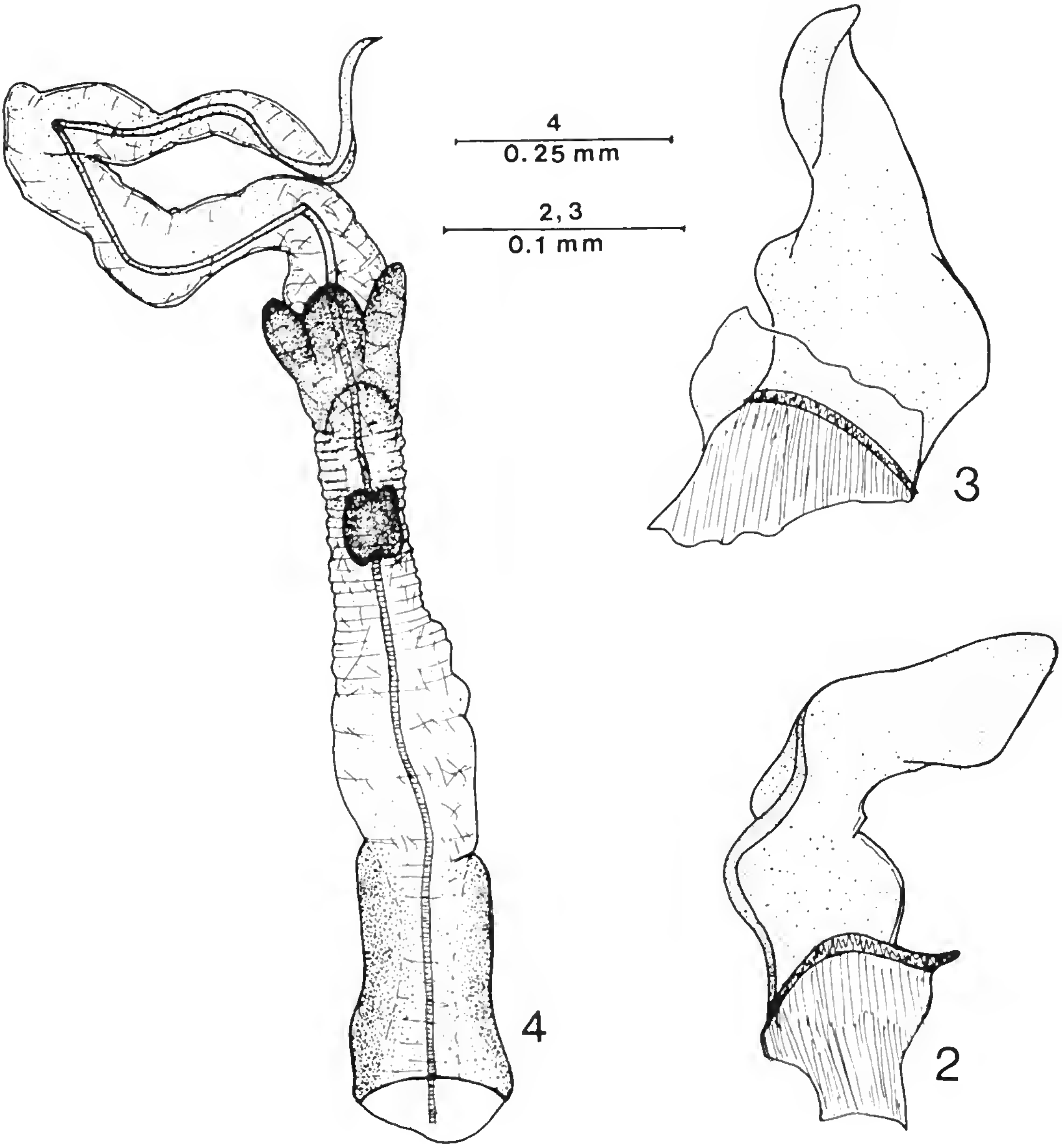
Body elongate ovate.

Measurements are of holotype ♂, followed by those of paratype, when different, in parentheses.

Total length 3.8 (3.9); maximum width 1.51.

Head: Slightly swollen above between eyes and anterior to eyes, covered with setigerous tubercles, coarsely punctate, jugum slightly exceeding tylus, length of head 0.75 (0.72), width across eyes 0.74 (0.75), interocular space 0.50, interocellar space 0.31 (0.32), eye-ocellar space 0.07 (0.06), eye length 0.16 (0.15), eye width 0.12 (0.11); antenna with 1st segment exceeding apex of head by 1/3, length of segments: I 0.30 (0.27); II 0.62 (0.66); III 0.34 (segments 3 and 4 missing in paratype); IV 0.49; labium reaching to hind coxae, not exceeding hind coxae, length of segments: I 0.47 (0.40); II 0.54 (0.55); III 0.42 (0.44); IV 0.44.

Thorax: Pronotum with lateral margins



Figs 2-4. *Oxycarenus westraliensis* holotype ♂: **2**, right paramere, dorsal view; **3**, same, ventral view; **4**, aedeagus.

sinuate, anterior and posterior margins almost straight, covered with coarse punctures, lateral margins and disc covered with conspicuous setigerous tubercles, tubercles less developed on disc of posterior lobe, length 0.79 (0.78), width anterior margin 0.58 (0.61), width posterior margin 1.14 (1.24); scutellum covered with coarse punctures, transversely depressed near base, length 0.39 (0.44), width 0.54 (0.60); femora incrassate, fore femora armed ventrally with 4 spines, distal most smallest; hemelytra well exceeding abdomen, clavus with 3 rows of coarse punctures, middle row incomplete towards distal end, a few irregular punctures in between inner and middle rows, corial distal margin straight, distal angle not rounded but fairly acute, length hemelytra 2.2 (2.3), length of corium 1.55 (1.50), length claval commissure 0.38 (0.42), width membrane 0.89 (1.00).

Abdomen: Dorsal scent gland scars between terga 4-5 and 5-6 subequal, abdominal terga 3-5 membranous with only light sclerotization medially.

Female genitalia: Ovipositor with ramus traversing to most length of 1st gonapophysis.

Male genitalia: Pygophore posteriorly rounded; paramere (Figs 2,3), shank with dorsal (outer) and ventral (inner) lobes, blade strongly curved and broadened (Fig. 2); aedeagus (Fig. 4) long, phallotheca lightly sclerotized, conjunctiva without lobes, ejaculatory reservoir with well developed body, wings apparently absent, vesica with sclerotized processes near base, vesica distal to processes narrow, elongate and looped as in Fig. 4, gradually narrowed to form short pointed gonoporal process.

Notes. This species may be readily distinguished from all the other species of the genus *Oxycarenus* recorded from Australia by the presence of conspicuous tubercles on the pronotum and head, the slightly more swollen head between and anterior of eyes, the shorter labium which does not exceed the hind coxae, the coarsely punctate head, pronotum, scutellum and the clavus, and the general colouration of body and appendages.

Samy (1969) distinguished 3 subgenera within the genus *Oxycarenus* and the present species falls in the subgenus *Oxycarenus*, except for the following rather minor characteristics: spot at distal angle of corium not distinct and the distal angle of corium somewhat pointed but not rounded.

ACKNOWLEDGEMENTS

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THE OCCURRENCE OF *LEMNIUS* DISTANT (HEMIPTERA:LYGAEIDAE) IN AUSTRALIA, WITH DESCRIPTIONS OF TWO NEW SPECIES

T.E. WOODWARD[1] AND M.B. MALIPATIL[2]
[1] *Deceased; Queensland Museum, PO Box 300, South Brisbane, Qld 4101, Australia.*
[2]*Northern Territory Museum of Arts and Sciences,*
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

The genus *Lemnius* (Rhyparochrominae:Drymini), previously known from Sri Lanka, Burma and the Philippines, is recorded from Queensland, Australia, with the description of *L. monteithi* sp. nov. and *L. terraereginae* sp. nov. A key is provided to the species of *Lemnius*.

KEYWORDS: Hemiptera, Lygaeidae, *Lemnius*, new species, Australia.

INTRODUCTION

Lemnius Distant belongs to the tribe Drymini Stål. Characters distinguishing the Drymini from the apparently related Targaremini Ashlock were given by Ashlock (1964) and from the other tribes of Rhyparochrominae in the key by Sweet (1967). The type-species of *Lemnius, L. ovatus* Distant, 1904, was described from Sri Lanka; the other species currently placed in this genus are *L. nigrinus* (Distant, 1918) (Burma) (transferred from *Thebanus* Distant by Scudder (1967)) and *L. bakeri* Bergroth, 1918 (Philippines). Slater (1964) listed the references to the genus and its species.

Lemnius is here recorded from north-eastern Australia. *L. monteithi* sp.nov. is known only from Cape York Peninsula, *L. terraereginae* sp.nov. from Queensland and northern New South Wales.

In the following description all measurements are in millimetres. CC = distance between apex of claval commissure and apex of corium, CM = distance between apex of corium and apex of membrane, both measured parallel to median axis of body. Length of labial segment I is measured from the clypeolabral suture.

Abbreviations for institutions and collections: ANIC Australian National Insect Collection, CSIRO, Canberra; BMNH British Museum (Natural History), London; NTM Northern Territory Museum, Darwin; QM Queensland Museum, Brisbane; SAM South Australian Museum, Adelaide; UQIC University of Queensland Insect Collection, Brisbane.

SYSTEMATICS

Lemnius Distant

Lemnius Distant, 1904: 66-67; Slater 1964:944 (literature references) (type-species *Lemnius ovatus* Distant, 1904:67, monobasic).

Diagnosis. Body not dorsoventrally flattened, with length ♂ *ca* 2.7-3.8, ♀ *ca* 2.2-2.5 × maximum width. Head wider than long, punctate above and below; eyes not prominent; antennae with semirecumbent pubescence and with erect hairs longer than diameter of segments, segment I swollen in distal ½, other segments slender, linear. Pronotum, scutellum and hemelytra with semierect hairs. Pronotum with anterior and posterior lobes not sharply demarcated, both deeply punctate; lateral margins narrowly carinate, anteriorly convergent, slightly to distinctly concave near middle. Fore femur with ventral row of bristle-like spines. Scutellum with punctures similar to those of pronotum; with a dark, narrow, Y-shaped carina. Metapleural evaporative area and scent gland peritreme very small; peritreme angulate, with apical part directed obliquely posterolaterally. Clavus with with 3 rows of fine punctures. Corium with fine punctures similar to those of clavus, 2 rows parallel to claval suture and separated from each other by a broad impunctate area, outer row separated from remaining punctures by another impunctate area widening apically, a third impunctate subcostal area greatly expanded in *ca* apical ½-⅔; costal margins narrowly carinate.

Notes. *Lemnius* is very close to *Thebanus* Distant, 1904, differing mainly in having a narrower and more raised scutellar carina. The structure of this carina varies among the species of both genera and it is possible that the latter should be synonymised. However, it is felt that a decision on this matter should be left to workers in the Oriental region, where probably many more species in this complex remain to be discovered, and where extensive series are available.

In the key to Australian and New Guinea Drymini genera by Gross (1965) the *Lemnius* keys out to *Mizaldus* Distant. However it differs from the latter in lacking a distinct dorsal transverse constriction separating fore and hind lobes of pronotum.

Key to Species of *Lemnius*

1. Antennae wholly or at least with segments I and II infuscated. Femora dark reddish brown to black. Scutellum entirely black, or reddish brown posteriorly 2

Antennae wholly yellowish brown. Femora stramineous to light reddish brown, scutellum yellow or orange-brown posterolaterally on each side of dark median carina 3

2. Pronotum with lateral margins very shallowly concave (similar to Fig. 4). Antennae with all segments dark testaceous. Pronotum and scutellum black. Philippines .... *bakeri* Bergroth

Pronotum with lateral margins deeply concave (as in Fig. 1). Antennae with segment II and segment IV except at extreme base yellowish brown; remainder infuscated reddish brown. Pronotum and scutellum reddish brown posteriorly, paler than anteriorly. Sri Lanka .... *ovatus* Distant

3. Pronotum (Fig. 4) with lateral margins very slightly concave near middle; with fine punctures mostly more than 1 puncture-width apart. Australia .... *terraereginae* sp. nov.

Pronotum with coarse punctures mostly about or less than 1 puncture-width apart (as in Fig. 1); with lateral margins more deeply concave than in Fig. 4 4

4. Pronotum with lateral margins deeply concave (Fig. 1). Males with body length 2.67-3-10; maximum width 1.02-1.22; posterior width of pronotum 1.00-1.28. Australia .... *monteithi* sp. nov.

Pronotum with lateral margins shallowly concave (intermediate between conditions shown in Figs 1 and 4). Male lectotype with body length 3.38; maximum width 1.45; posterior width of pronotum 1.67. Burma .... *nigrinus* (Distant)

Lemnius monteithi sp. nov.

(Figs 1-3)

Type material. HOLOTYPE - ♂ (T10770), Iron Range, Cape York Pen., Queensland, 27.iv-4.v.1973, G.B. Monteith, in QM. PARATYPES - 12 ♂, 17 ♀ same data as holotype, in ANIC, BMNH. NTM, QM, SAM, UQIC; 1 ♂, 1 ♀ , same data except 13-14. xi. 1965, in QM; 2 ♂. 5 ♀ , same data except 16-23. xi. 1965, in QM, UQIC; 5 ♀ , same data except 28. iv - 4. v. 1968, in QM, UQIC; 1 ♂, 1 ♀ , West Claudie R., Iron Range, 30. ix. 1974, G.B. Monteith, in QM; 1 ♀ , Rocky R., via Coen. Cape York Pen., 14-16. xii. 1964, G.B. Monteith, in QM; 1 ♀ , Upper Lankelly Creek,

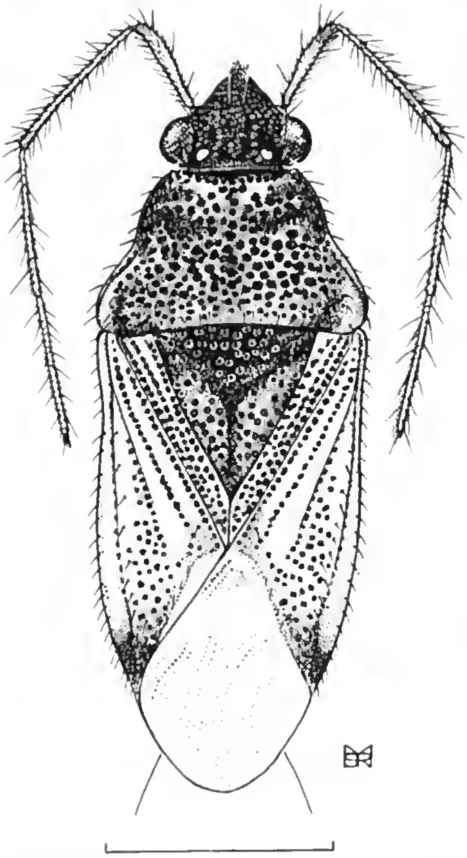


Fig. 1. *Lemnius monteithi* holotype ♂, dorsal aspect. Scale line 1.0mm.

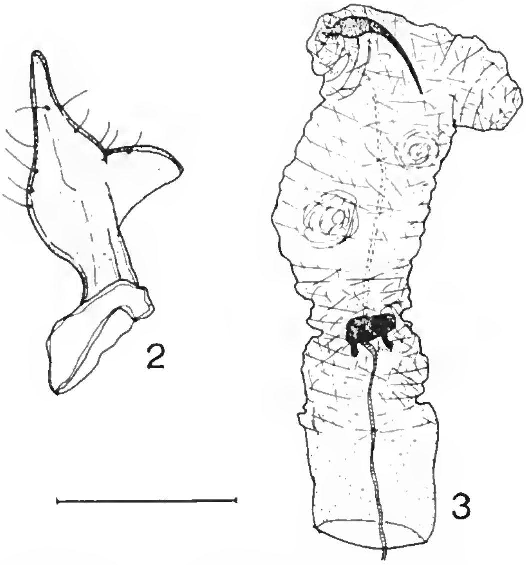
Coen district, Queensland, 10-11. vi. 1971, G.B. Monteith, in QM.

Description. *Coloration:* Head above and below dark reddish brown. Antennae yellowish brown. Labium stramineous to pale reddish brown. Eyes reddish brown to black. Ocelli red. Pronotum nearly uniformly yellowish brown or brown; anterior margin and calli darker brown; punctures dark brown. Scutellum yellow to orange-brown posterolaterally; carina and entire base between its anterior arms reddish brown; punctures dark brown. Corium and clavus greyish cream to light greyish brown; impunctate subcostal area opaque, usually off-white to cream; apex and apical margin of corium narrowly brown; punctures brown. Membrane colourless, translucent; veins pale. Ventral surface of thorax dark reddish brown; abdomen lighter reddish brown. Legs stramineous to light reddish brown.

Body: Total length 3.10 (♂ 2.67-3.10, ♀ 2.95-3.43); maximum width behind scutellum 1.22 (♂ 1.02-1.22, ♀ 1.18-1.37).

Head: Length 0.63 (♂ 0.55-0.63, ♀ 0.55-0.67); width across eyes 0.70 (♂ 0.61-0.71, ♀ 0.67-0.75); interocular space 0.39 (♂ 0.33-0.39, ♀ 0.35-0.41); width of eye 0.16 (♂ 0.14-0.17, ♀ 0.16-0.17). Dorsal surface deeply, closely, and rather coarsely punctate, with a median shagreened area interrupted by very coarse punctures; with erect and suberect hairs, a particularly long pair of erect hairs on each side lateral to ocelli. Ventral surface with punctures finer, sparser and more shallow. Length of antennal segments I 0.47 (♂ 0.38-0.49, ♀ 0.43-0.49), II 0.78 (♂ 0.69-0.78, ♀ 0.73-0.86); III 0.73 (♂ 0.65-0.73, ♀ 0.69-0.78), IV 0.71 (♂ 0.57-0.71, ♀ 0.63-0.71). Length of labial segments I 0.49 (♂ 0.41-0.49, ♀ 0.47-0.49), II 0.53 (♂ 0.45-0.53, ♀ 0.51-0.57), III 0.29 (♂ 0.27-0.31, ♀ 0.29-0.33), IV 0.26 (♂ 0.24-0.26, ♀ 0.24-0.25).

Thorax: Pronotum coarsely and closely punctate throughout, punctures mostly separated by less than one puncture-width; lateral margins deeply concave near middle; median length 0.73 (♂ 0.55-0.73, ♀ 0.65-0.82); posterior width 1.28 (♂ 1.00-1.28, ♀ 1.18-1.41). Scutellum finely and closely punctate anteriorly and along lateral margins, more coarsely and usually more sparsely punctate on each side of median carina; median length 0.96 (♂ 0.71-0.96, ♀ 0.80-1.00); anterior width 0.75 (♂ 0.59- 0.75, ♀ 0.65-0.84). Punctures of clavus and corium finer than most of those on pronotum and posterolateral areas of scutellum. Length of claval commissure 0.20 (♂ 0.14-0.22, ♀ 0.18-0.23), corium 1.71 (♂ 1.37-1.71, ♀ 1.55-1.95), CC 0.69 (♂ 0.55-0.69, ♀ 0.65-0.73), CM 0.47 (♂ 0.43-0.49, ♀ 0.47-0.61). Fore femur with anteroventral row of 3 or 4 long, dark, needle-like spines and a posteroventral row of 5-7 finer, pale long hairs.



Figs 2-3. *Lemnius monteithi* paratype ♂: **2**, left paramere, dorsal aspect; **3**, aedeagus. Scale line 0.01 mm.

Abdomen: Ventral surface with a covering of short, fine, depressed hairs. Ventral trichobothria on sterna III and IV arranged in triangle. Scent gland scar between terga III-Iv about 1½× as wide as those between terga IV-V and V-VI which are subequal.

Male genitalia: pygophore posterior margin rounded; paramere short, flat, with well developed inner lobe at about half length (Fig. 2); aedeagus (Fig. 3), phallotheca lightly sclerotized, conjunctiva and vesica with membranous lobes, ejaculatory reservoir reduced, complete with body and wings as in Fig. 3, helicoid process indistinct, gonoporal process short, heavily sclerotized as in Fig. 3.

Female genitalia: ovipositor well developed, 1st ramus traversing to about ¾ length of 1st gonapophysis; spermatheca indistinct, possibly absent.

Lemnius terraereginae sp.nov.
(Fig. 4)

Type material. HOLOTYPE - ♂ (T10771), Lockerbie area, Cape York, Queensland, 13-27. i.v. 1973, G.B. Monteith, in QM. PARATYPES - 18 ♂,17 ♀, same data as holotype, in ANIC, BMNH, NTM, SAM, UQIC; 7♂, 5 ♀, Lockerbie Scrub, Cape York, 14-18. iv. 1973, G.B. Monteith, in QM, UQIC; 2 ♂, same data except 19-21. iv. 1973, in QM.

Additional material. QUEENSLAND: 1 ♂, Kenilworth State Forest, 17. viii. 1970, G.B. Monteith, in QM; 2 ♀, Granite Creek, 700′ [214 m], Bulburin State Forest, via Many Peaks, 1.iv. 1972, S.R. Monteith, in QM; 1 ♂, 1 ♀, Lake Placid nr Cairns, 18. xii. 1974, M.B. Malipatil, in QM; 1 ♂, Kuranda, 20. i 1962, E.B. Britton, in BMNH. NEW SOUTH WALES: 1 ♀, Richmond Gap, via Grevillea, 1700′ [517 m], 7.i 1978, G.B. Monteith, in QM.

Description. In the following description B = Bulburin S.F., K = Kenilworth S.F.

Coloration: Head above dark reddish brown to black, below reddish brown. Antennae yellowish brown. Labium stramineous. Eyes reddish brown to black. Ocelli red. Pronotum with anterior lobe dark reddish brown, paler anteriorly and on lateral carinae; posterior lobe broadly paler reddish brown in middle (sometimes diffusely) and inside humeral angles, pale yellow laterally; punctures dark brown. Scutellum pale yellow posterolaterally; carina and entire base between its anterior arms reddish brown; apex on each side of median stem of carina variably and diffusely paler reddish brown; punctures dark brown. Corium and clavus silvery grey to off-white; impunctate area outside second row of corial punctures, at least apically, and impunctate subcostal area translucent; apex and apical margin of corium narrowly brown; punctures brown. Membrane colourless, translucent; veins pale. Ventral surface of thorax dark reddish brown; abdomen lighter reddish brown. Legs stramineous; coxae, acetabula and scent gland peritreme ochreous.

Body: Total length 2.86 (♂ 2.81-3.19, K 3.29; ♀ 3.00-3.76, B 3.95-4.05); maximum width behind scutellum 1.24 (♂ 1.24-1.39, K 1.41; ♀ 1.29-1.57, B 1.69-1.76).

Head: Length 0.59 (♂ 0.59-0.65, K 0.61; ♀ 0.59-0.67, B 0.67); width across eyes 0.70 (♂ 0.69-0.76, K 0.73; ♀ 0.71-0.78, B 0.81); interocular space 0.41 (♂0.39-0.43, K 0.43; ♀ 0.39-0.47, B 0.49; width of eye 0.15 (♂ 0.14-0.17, K 0.15; ♀ 0.16-0.18, B 0.16). Dorsal punctation and setation similar to those of *L. monteithi* except punctures much finer. Ventral surface with punctures more closely and much more finely punctate than in *L. monteithi*, giving granulate appearance. Length of antennal segments I 0.37 (♂ 0.37-0.39, K. 0.41; ♀ 0.34-0.41, B 0.43-0.47), II 0.67 (♂ 0.67-0.75, K 0.76; ♀ 0.63-0.76, B 0.82-0.84), III 0.67 (♂ 0.65-0.73, K 0.73; ♀ 0.61-0.75, B 0.78-0.80), IV 0.69 (♂0.65-0.71, K 0.73; ♀ 0.61-0.69, B 0.73-0.74). Length of labial segments I 0.45 (♂ 0.43-0.47, K 0.47; ♀ 0.45-0.51, B 0.51-0.53), II 0.49 (♂ 0.47-0.53, K 0.53; ♀ 0.53-0.59, B 0.59), III 0.29 (♂ 0.27-0.29, K 0.29; ♀ 0.29-0.37, B 0.33), IV 0.24 (♂0.24-0.25, K 0.25; ♀0.24-0.27, B 0.29).

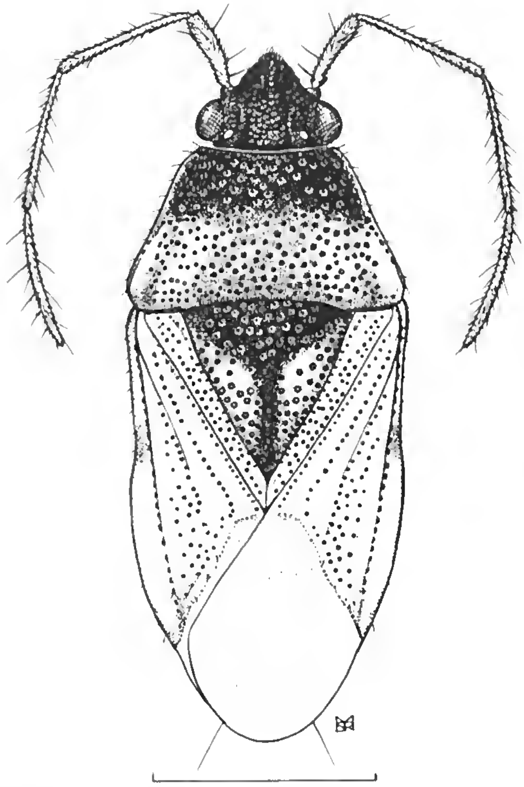


Fig. 4. *Lemnius terraereginae* holotype ♂, dorsal aspect. Scale line 1.0mm.

Thorax: Pronotum (Fig. 4) with fine punctures mostly more than 1 puncture width apart, closer on median part of posterior lobe, sparser on anterior than on posterior lobe; with lateral margins very slightly concave near middle; median length 0.71 (♂ 0.71-0.76, K 0.73; ♀ 0.71-0.92, B 0.92); posterior width 1.29 (♂ 1.29-1.41, K 1.39; ♀ 1.33-1.59, B 1.71-1.72). Scutellum with punctation similar to that of *L. monteithi*; median length 0.92 (♂ 0.92-1.00, K 0.96; ♀ 0.94-1.20, B 1.20-1.25); anterior width 0.78 (♂ 0.78-0.86, K 0.83; ♀ 0.82-1.02, B 1.08-1.12). Corium and clavus with punctation similar to that of *L. monteithi*, but rather finer. Length of claval commissure 0.16 (♂ 0.14-0.18, K 0.18; ♀ 0.16-0.20, B 0.25), corium 1.57 (♂ 1.57-1.75, K 1.76; ♀ 1.67-1.98, B 2.12-2.16), CC 0.59 (♂ 0.59-0.67, K 0.65; ♀ 0.61-0.75, B 0.80-0.84), CM 0.53 (♂ 0.51-0.57, K 0.65; ♀ 0.55-0.65, B 0.78-0.82). Fore femur with spination similar to that of *L. monteithi*.

Abdomen: Ventral surface with hairs longer than in *L. monteithi*.

Other details as in *L. monteithi*.

Comments. *L. terraereginae* is readily distinguished from *L. monteithi* by the characters given in the key and the other differences noted in the description. The non-type specimens from south-east Queensland resemble the north Queensland type series in all structural features, but their measurements except for eye width, fall in the top range of or in most instances exceed those of the latter. The occurrence of an otherwide northern species in the Kenilworth and Bulburin State Forests is interesting; some species of Aradidae have a similar disjunct distribution, involving both these southern areas (G. B. Monteith, pers. comm.).

ACKNOWLEDGEMENTS

We thank Mr W. R. Dolling, BMNH, for the loan of type specimens of *Lemnius ovatus* and *L. nigrinus* and of other material. We are indebted to Mrs S Monteith for preparing Figs 1 and 4.

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TYPTON NANUS SP. NOV., A NEW COMMENSAL SHRIMP (CRUSTACEA:DECAPODA:PALAEMONIDAE) FROM THE AUSTRALIAN NORTH-WEST SHELF

A.J. BRUCE
Northern Territory Museum of Arts and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

A new species of commensal shrimp, *Typton nanus* sp. nov., (Decapoda:Palaemonidae) from the Australian North-west Shelf, is described and illustrated. The single example was collected from 40-46m from an unidentified sponge host. Seven species of *Typton* Costa are now known from the Indo-West Pacific region, all also occurring in Australian waters. The present report represents the greatest depth record for an Indo-West species of the genus.

KEYWORDS: Taxonomy, Crustacea, Palaemonidae, new species, commensal, sponge associate, Timor Sea.

INTRODUCTION

A single example of a small commensal shrimp was found in a sponge collected from the catch of a Thai stern trawler by Dr B.C. Russell, as part of a study of the commercial fish catch in northern Australian waters. The species could not be identified with any of the previously reported species and is now described as new, raising to seven the numbers of species of *Typton* Costa, 1844, known from the Indo-West Pacific region, and also from Australian waters. The species is remarkable particularly for its small size, and it also indicates the greatest depth at which species of this genus have so far been recorded in the Indo-West Pacific Region.

SYSTEMATICS

Typton nanus sp. nov.

(Figs 1-5)

Type material. HOLOTYPE - ♀, stn. BCR 85-2, Australian North-West Shelf, 16° 34′S, 121° 27′E, 40-46m, Thai stern trawler BYLA, 7 April 1985, coll. B.C. Russell, Northern Territory Museum NTM Cr. 005204.

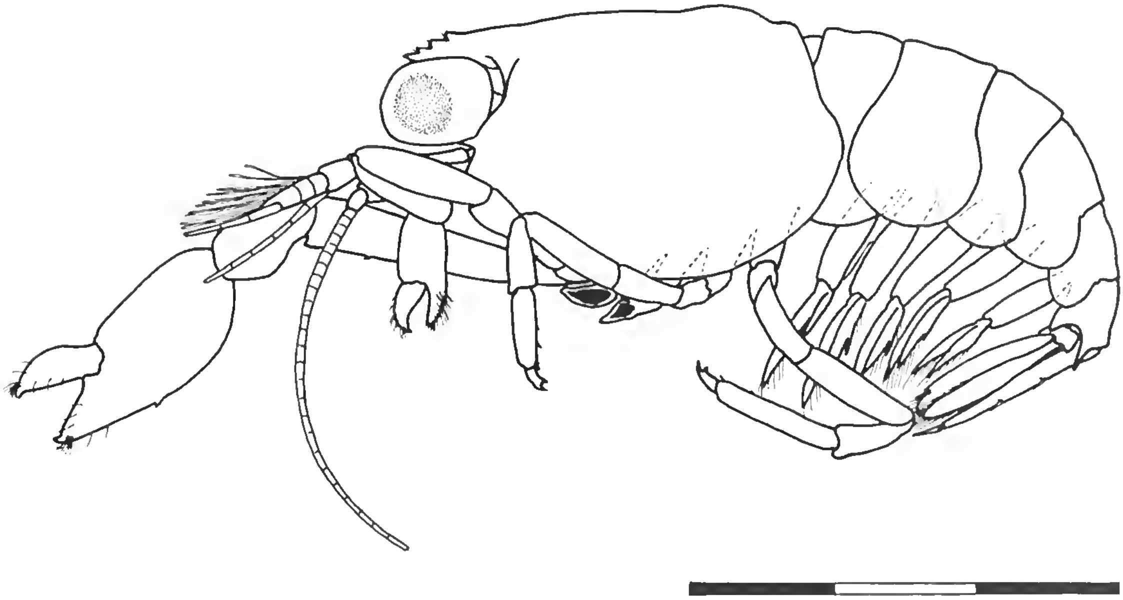

Fig. 1. *Typton nanus* holotype ♀, Timor Sea. Scale divisions, 0.5 millimetres.

Description. A very small shrimp of slightly compressed or subcylindrical body form.

Carapace slightly compressed, glabrous, smooth; rostrum short, acute, compressed, horizontal, not exceeding anterior margin of cornea, with three small acute teeth on distal half, lateral carinae obsolete, ventral margin convex, unarmed, non-setose; orbit and inferior orbital angle obsolete, supraorbital and hepatic spines absent, antennal spine small, acute, marginal, anterolateral angle of branchiostegite obtusely rounded.

Abdomen subcylindrical, slightly depressed posteriorly; sixth segment as long as fifth, 0.6 times longer than anterior depth, depressed, with large acute, broad posteroventral angle and slender, acute posterolateral angle, posterior margin unarmed; pleura of first three segments broadly rounded, fourth and fifth pleura slightly posteriorly produced, rounded. Telson about 2.5 times sixth segment length, about 2.3 times longer than anterior width, lateral margins convex, convergent, posterior margin about 0.45 of anterior width, two pairs of dorsal spines,

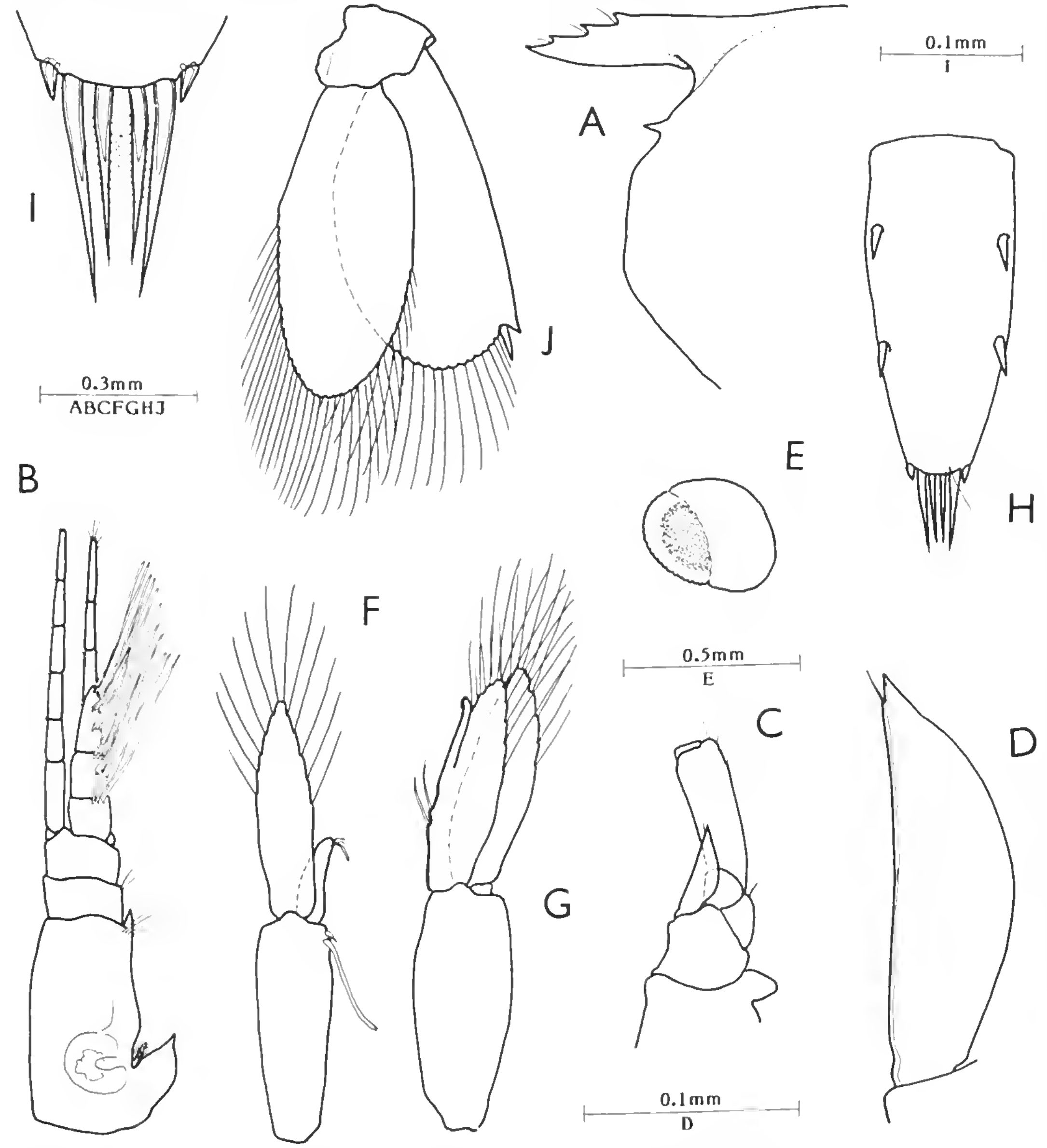

Fig. 2. *Typton nanus* holotype ♀: **A**, anterior carapace and rostrum, lateral; **B**, antennule; **C**, antenna; **D**, scaphocerite; **E**, eye; **F**, first pleopod; **G**, second pleopod; **H**, telson; **I**, same, posterior spines; **J**, uropod.

anterior pair submarginal at 0.25 of telson length, posterior pair marginal at 0.6, spines about 0.12 of telson length, posterior margin convex without median point; three pairs of posterior spines, lateral spines short and stout, intermediate spines long and slender, about 0.25 of telson length, submedian spines slightly shorter and more slender than intermediate spines, setulose.

Antennule reduced, peduncle exceeding cornea by two distal segments, proximal segment of peduncle 2.0 times longer than broad, without small ventral tooth on medial margin, distolateral angle with small acute tooth, stylocerite broad, acute distally, projecting, reaching to about 0.33 of segment length, statocyst normal, with granular statolith; distal segments subequal, about 2.0 times longer than wide, together equal to about 0.4 of proximal segment length, distal segment slightly longer and narrower than proximal; upper flagellum subequal to peduncle length, feebly biramous, shorter ramus with three segments and six groups of aesthetases, almost completely fused to longer ramus, longer ramus with three free segments only; lower flagellum subequal to upper, six segments only.

Antenna reduced; basicerite robust, laterally unarmed, with conspicuous antennal gland tubercle medially, ischiocerite and merocerite normal; carpocerite reaching to about distal margin of intermediate segment of antennular peduncle, about 3.3 times longer than broad, flagellum short, about 1.5 times carapace length; scaphocerite reduced, reaching to about middle of carpocerite, 3.5 times longer than wide, acutely pointed distally, medial margin convex, devoid of setae, lateral margin very feebly concave, with short preterminal seta.

Eye well developed, globular; cornea oblique, about 1.8 times longer than deep, peduncle about 1.4 times longer than corneal diameter, about 1.8 times longer than wide.

Mandible (left) with slender corpus, without palp; molar process slender, tapering, obliquely truncate distally, with several very acute teeth and several spines; incisor process completely lacking. Maxillula with feebly bilobed palp, upper lobe greatly reduced, lower lobe larger with single short simple seta ventrally; upper lacinia well developed, with seven long slender spines distally, setulose proximally, serrulate distally, becoming spiniform setae proximally, with numerous setae submarginally; lower lacinia slender, with five long serrulate distal spines and several shorter setae. Maxilla damaged in dissection, palp simple, with two short plumose setae laterally; basal endite well developed, bilobed, upper lobe larger and broader than lower, lobes with 9 and 5 slender, feebly setulose setae respectively; coxal endite obsolete; scaphognathite well developed, broad; posterior lobe 3.0 times longer than wide. First maxilliped with slender, subcylindrical, non-setose palp; basal endite broad, medial margin sparsely setose with slender feebly setulose setae; coxal endite reduced, rounded medially, non-setose; exopod well developed with moderately large caridean lobe, flagellum with four plumose setae distally; epipod small, feebly bilobed. Second maxilliped of normal form, dactylar segment broad, 3.0 times longer than wide, with marginal row of long serrulate setae and submarginal row of short serrulate setae; propodal segment feebly armed, with two slender serrulate setae only; carpus, merus and ischiobasis normal; exopod flagellum with four plumose setae distally; coxa with small rounded process medially with single short simple seta, damaged in dissection laterally, with small simple epipod without podobranch. Third maxilliped with small endopod, reaching to about middle of carpocerite; ischiomerus completely fused to basis, antepenultimate segment about 2.5 times longer than proximal width, compressed, slightly tapering distally, sparsely setose medially, basal region broadly rounded; penultimate segment about 0.33 of antepenultimate segment length, about 1.5 times longer than broad, expanded distomedially, bearing seven long slender serrulate spines; terminal segment short, about 0.6 of penultimate segment length, tapered, about 1.5 times longer than proximal width, with about 12 slender serrulate spines, longer spines distally, shorter proximally; exopod with four plumose distal setae; coxa robust, medially excavate, with low rounded lateral plate and small rudimentary arthrobranch. Paragnath very large, broad and bilobed.

Thoracic sternites narrow and unarmed.

First pereiopod robust, exceeding carpocerite by distal distal fourth of merus. Chela with palm about 1.2 times longer than deep, moderately compressed; dactylus subspatulate, stout, tapering, about 1.7 times longer than proximal width, with stout, acute, narrow distal tip with similar shorter and stouter tooth medially and smaller tooth with short blunt cutting edge proximally, with dense group of short simple setae distodorsally; fixed finger similar, with transverse rows of short setae proximally; carpus short and stout, about 0.9 of chela length, 2.4 times longer than distal width, moderately excavate distally, tapering proximally, with few distoventral cleaning setae; merus robust, about 1.35 times carpus length, 2.7 times longer than wide, slightly swollen centrally;

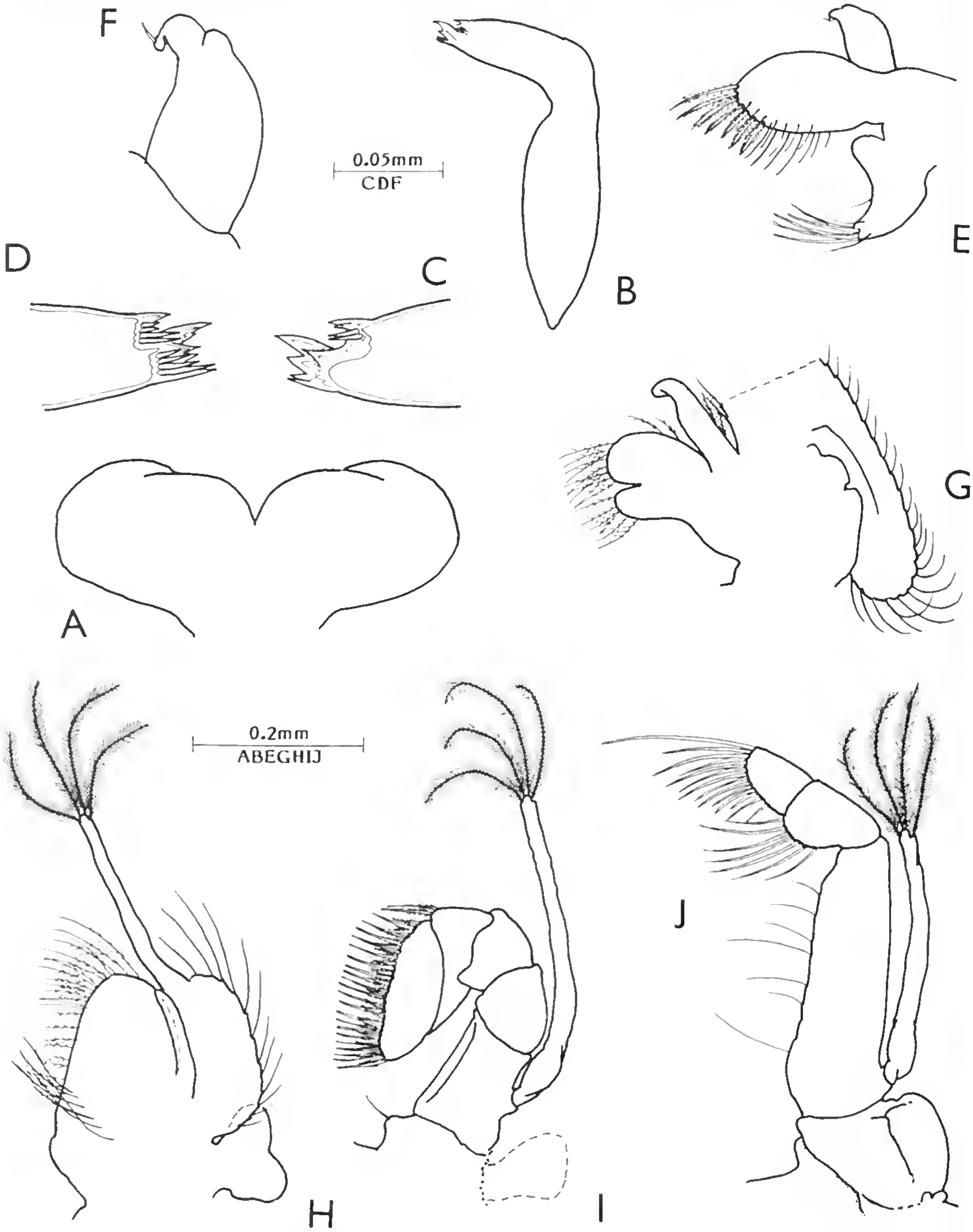

Fig. 3. *Typton nanus* holotype ♀: **A**, paragnath; **B**, mandible; **C**, **D**, same, molar process; **E**, maxillula; **F**, same, palp; **G**, maxilla; **H**, first maxilliped; **I**, second maxilliped; **J**, third maxilliped.

ischium about 0.6 of merus length, centrally swollen, obliquely articulated with basis; basis about 0.8 of ischium length, robust; coxa stout, without ventral process.

Right second pereiopod well developed, left pereiopod missing; chela slightly compressed, smooth, glabrous, about 1.65 times longer than deep, moderately swollen with single small acute distoventral tooth; dactylus strongly compressed, about 2.0 times longer than proximal depth, outer margin curved with dense tuft of short setae subterminally, with small acute hooked distal tooth, cutting edge straight, entire, with small rounded tooth proximally bearing three small stout denticulate spines; fixed finger deeply cannulate, medial lip elevated, with larger acute proximal tooth, bearing

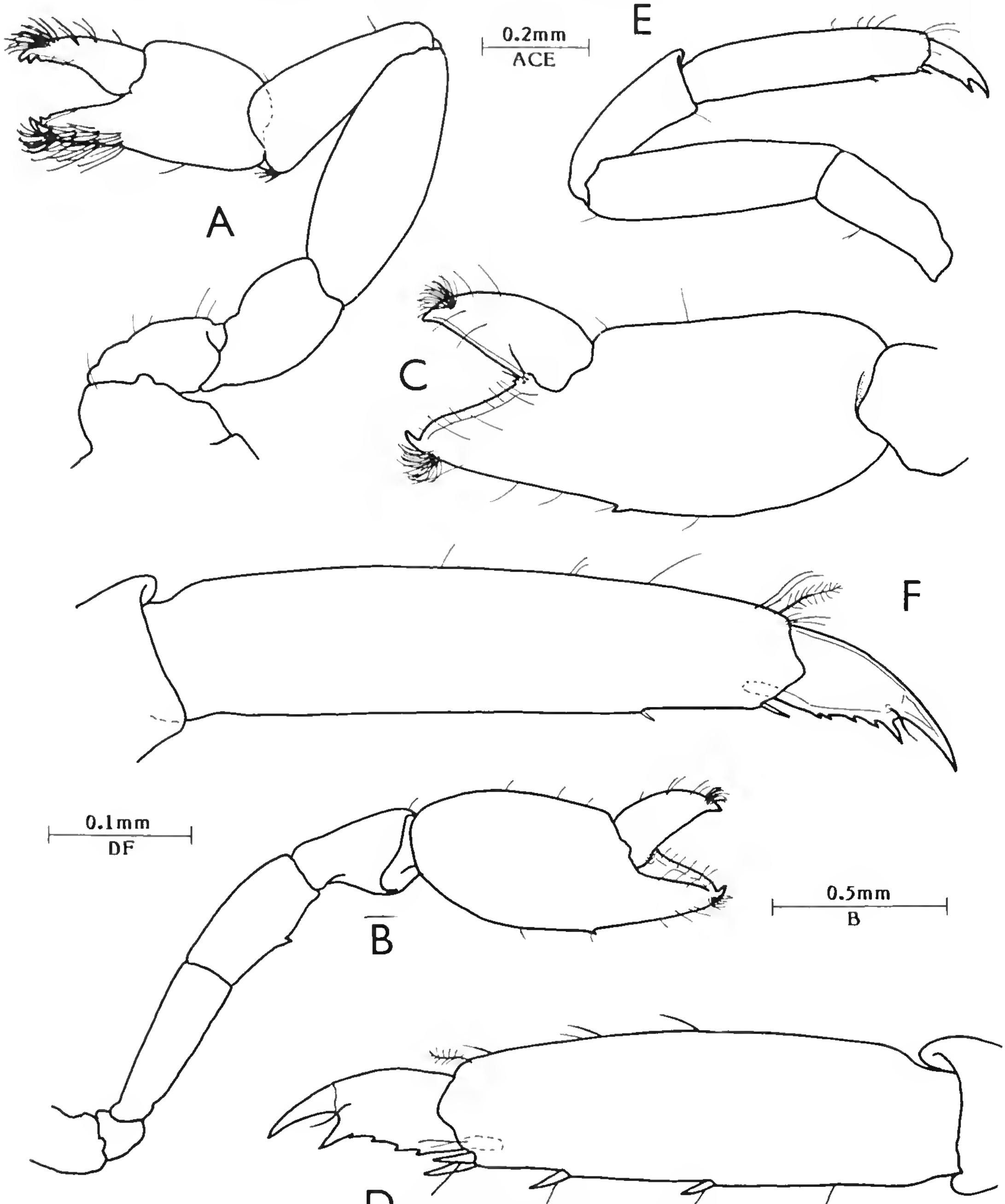

Fig. 4. *Typton nanus* holotype ♀ : **A**, first pereiopod; **B**, right second pereiopod; **C**, same, chela; **D**, fourth pereiopod, propod and dactyl; **E**, fifth pereiopod; **F**, same, propod and dactyl.

small acute distal denticle, dorsal edge sharp, appearing finely milled, lateral lip thickened, unarmed, with stout hooked distal tooth, dense tuft of short setae distoventrally; carpus about 0.6 of palm length, robust, expanded distally, excavate with small rounded distomedial lobe; merus subequal to carpus length, about 2.0 times longer than wide, broadest centrally, with single small acute tooth at 0.5 of ventral margin; ischium about 1.2 times merus length, 3.3 times longer than distal width, broadest distally, unarmed; basis short, about 0.31 of ischium length; coxa robust, without special features.

Third pereiopods missing. Fourth pereiopod robust, reaching to about level of intermediate segment of antennular peduncle; dactylus compressed with well developed unguis, about 3.2 times longer than basal width, simple, curved , corpus about 1.8 times longer than proximal depth, about 1.5 of unguis length, with large acute distoventral accessory tooth, about half size of unguis, ventral margin sharp, convex with four small, acute denticles, with single distolateral sensory seta; propod robust, slightly swollen, about 3.5 times longer than central width, with two stout distoventral spines and single similar spines at 0.45 and 0.75 of the ventral margin; carpus about 0.85 of propod length, 2.5 times longer than distal width, unarmed; merus 1.3 times propod length, 3.0 times longer than wide, unarmed; ischium 0.6 of merus length, proximally narrowed; basis and coxa without special features. Fifth pereiopod similar to fourth; dactyl with corpus about 1.9 times longer than deep, unguis about 0.6 of corpus length, ventral margin with four acute denticles and large distal accessory tooth; propod about 1.25 times length of fourth propod, about 4.5 times longer than deep, with single small distoventral spine and smaller spine at 0.75 of ventral margin, without distolateral cleaning setae.

First pleopod with basipodite 3.0 times longer than broad, with single short (? broken) ovigerous seta distomedially; exopod subequal to basipodite length, about 4.0 times longer than broad; endopod about 0.38 of exopod length, about 3.0 times longer than proximal width, tapering, distally rounded, with one long plumose seta and two short simple setae distomedially. Second pleopod with basipodite 1.1 times longer than first pleopod, 2.5 times longer than wide, without ovigerous setae,; exopod about 1.1. times length of first pleoped exopod; endopod subequal to exopod length, with appendix interna at about 0.55 of length.

Uropod with protopodite broad and unarmed posterolaterally; exopod broad, 2.0 times longer than wide, broadest centrally, lateral margin feebly convex, glabrous, with small acute distolateral tooth with larger mobile spine medially; endopod subequal to exopod length, narrower, about 2.35 times longer than wide.

Measurements. Total length, (approx.), 3.75mm; carapace and rostrum, 1.4mm; postorbital carapace, 1.05mm; second pereiopod chela, 0.9mm.

Colouration and habitat. No data.

Systematic position. *Typton nanus* is most closely related to *T. wasini* Bruce, 1977, the only other Indo-West Pacific species of the genus in which the incisor process of the mandible is completely absent. *T. nanus* may be distinguished from *T. wasini* by (i) its smaller size, (ii) three small dorsal rostral teeth and (iii) the presence of small acute teeth on the ventral palm and merus of the second pereiopod.

DISCUSSION

Typton nanus sp. nov., raises to seven the number of species now known from the Indo-West Pacific region, all of which have been reported from Australian waters. The species fall into two distinct groups on the basis of the morphology of the mouthparts. One group, all of which have the incisor process of the mandible present, has the endites of the maxilla and first maxilliped broadened and provided with a dense medial band of the fine setae, which is absent from the second group. The former group includes *T. dentatus* Fujino and Miyake, 1969, *T. anomalus* (Bruce, 1979), and *T. dimorphus* Bruce, 1986. In addition to *T. nanus*, the latter group includes *T. bawii* Bruce, 1972, *T. australis* Bruce, 1973, and *T. wasini* Bruce, 1977.

A key to the Indo-West Pacific species of *Typton* has been provided by Bruce (1986). *T. nanus* may be readily included in this key by the insertion of the following couplets.

3. Dorsal rostrum with 3-4 teeth 3a
— Dorsal rostrum with 1-2 teeth 4

3a Larger species, rostrum with four dorsal teeth; ventral border of palm and merus of second pereiopods unarmed
……… *wasini* Bruce (Kenya and Great Barrier Reef)

— Small species, rostrum with three dorsal teeth; ventral border of palm and merus of minor second pereiopod with small acute tooth (major second pereiopod unknown….*nanus* sp. nov., (Timor Sea)

Although very small, the single specimen of *T. nanus* is considered to be adult on account of the presence of a single ovigerous seta on the first pleopod. The size of the ova in palaemonid shrimps is consistently about 0.45-0.5mm, where abbreviated development does not occur. Small species therefore carry relatively few ova and *T. nanus* could probably only accommodate about 6-8 ova beneath the abdomen. A single ovigerous setae would probably be capable of providing enough adhesive secretions to attach such a small number of ova.

Two of the Indo-West Pacific *Typton* species have been found in association with sponge hosts. *T. dentatus* and *T. wasini* both occur in association with demospongid sponges of the genus *Reniera* Nardo. All other species have been obtained from unidentified sponges or pulverized coral washings, but are probably obligatory associates of sponges, possibly including taxa of an encrusting or even boring habitus.

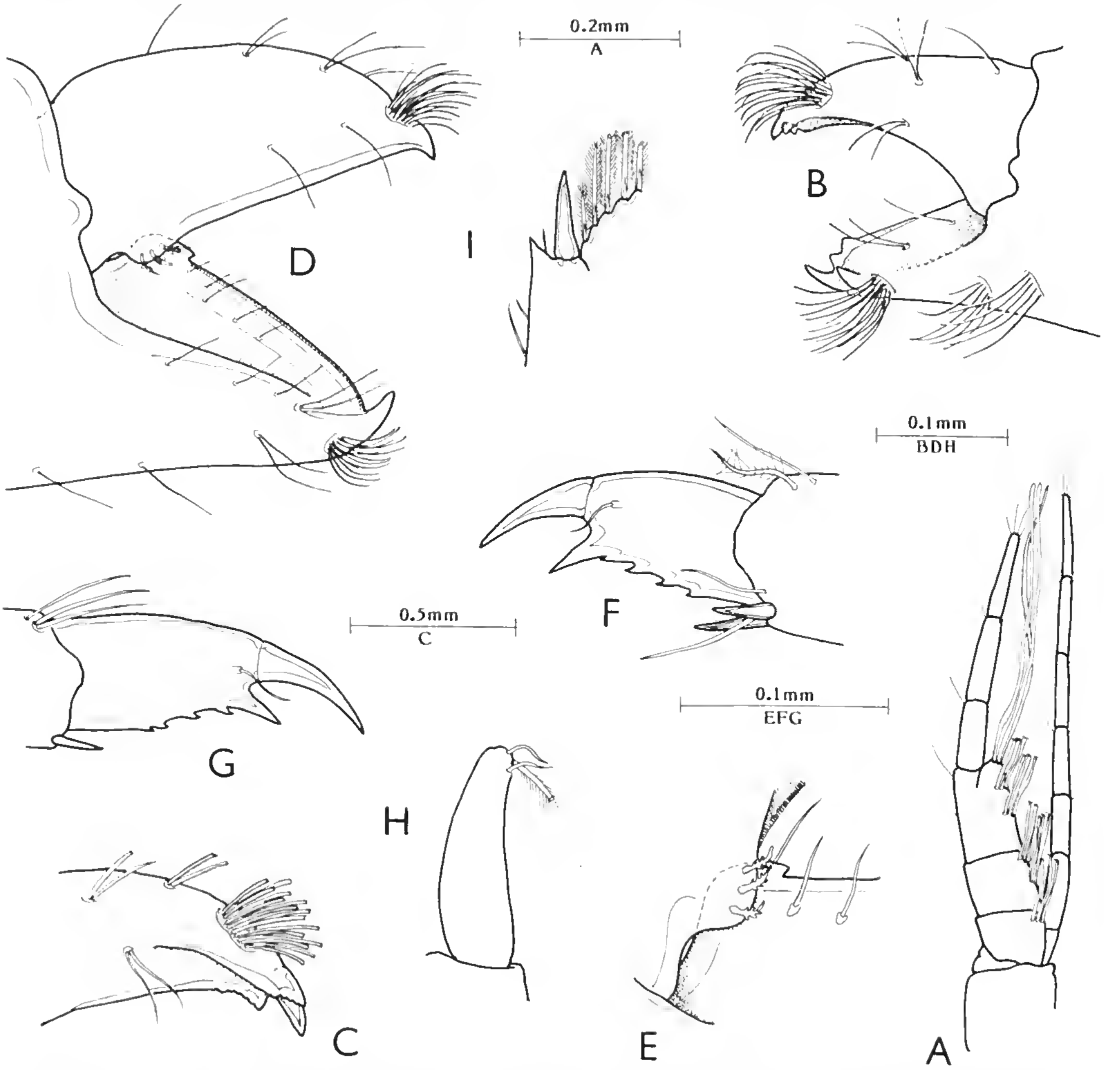

Fig. 5. *Typton nanus* holotype ♀ : **A**, antennule, flagella, lateral; **B**, first pereiopod, fingers; **C**, same, tip of dactyl; **D**, second pereiopod, fingers, lateral; **E**, same, detail of hinge region; **F**, fourth pereiopod, dactyl; **G**, fifth pereiopod, dactyl; **H**, first pleopod, endopod.

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RECORDS OF THREE PALAEMONID SHRIMPS NEW TO THE AUSTRALIAN FAUNA

A.J. BRUCE
Northern Territory Museum of Arts and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

Three species of palaemonid shrimps, *Palaemon serrifer* (Stimpson), *P. semmelinkii* (De Man) and *Leandrites celebenensis* (De Man) are reported from Australian waters for the first time. These records from the Northern Territory, increase to six the number of species of *Palaemon* known from Australia, and a key is provided for their identification.

KEYWORDS: Zoogeography, Crustacea, Palaemonidae, marine, *Palaemon, Leandrites.*

INTRODUCTION

Recent collections around Darwin, the Cobourg Peninsula and in the Gulf of Carpentaria have revealed the presence of three species of free-living palaemonid shrimps in shallow coastal waters. The Darwin specimens occur on the foreshore of of the Northern Territory Museum and the Gulf of Carpentaria. Specimens were made available through the kindness of R.A. Kenyon, of the Fisheries Research Division of the Commonwealth Scientific and Industrial Research Organization, who obtained the specimens in the course of sampling seagrass beds for commercial prawn juveniles.

SYSTEMATICS

Palaemon serrifer (Stimpson)
(Fig. 1)

Leander serrifer Stimpson, 1860 : 41; Kemp 1925 : 305.
Palaemon serrifer — Holthuis 1950 : 83-86, Fig. 18 (Synonymy).

Material. 3 spms. (1 ovig. ♀), stn. CP/12, Coral Bay, Port Essington, Cobourg Peninsula, 11°11.3'S., 132°11.5'E., 0-0.5m, 4 May 1982, coll. A.J. Bruce, NTM Cr. 000909; 32 spms. (5 ovig. ♀), stn. AJB-23, Bullocky Point, Darwin, 12°26.0'S., 130°50'E., LWS, rotenone, coll. M. Burke, NTM Cr. 002701.

Diagnosis. Rostrum subequal to carapace length, with 9-16 dorsal and 2-5 ventral teeth, first 2-3 teeth situated on carapace, without elevated basal crest; carapace without supraorbital spines, with antennal and marginal branchiostegal spine, branchiostegal groove distinct anteriorly; upper antennular flagellum with fused portion half length of shorter free ramus; mandible with three segmented palp; carpus of second pereiopod slightly shorter than chela, fingers about 0.7 of palm length; dactyls of ambulatory pereiopods robust, about 0.3 of propod length, propod of fifth pereiopod with transverse rows of setae distolaterally.

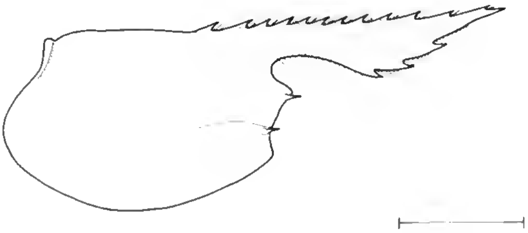

Fig. 1. *Palaemon serrifer* ♀ (ovig.), NTM Cr.002701, carapace and rostrum. Scale line, 3 millimetres.

Remarks. The ovigerous female specimens have postorbital carapace lengths of 5.0 -7.1mm and a rostral dentition of 12-14/4. In most specimens the dorsal rostral teeth, except for the 2-3 distal teeth, appear to be articulated with the carapace, as in material from the type locality, Hong Kong, recently redescribed by Bruce (in press).

Distribution. Type locality, Hong Kong. Also known from Bombay, India to Japan and from Java, Indonesia.

Palaemon semmelinkii (De Man)
(Fig. 2)

Leander semmelinkii De Man, 1881 : 137; Kemp 1925 : 304.1

Palaemon (Paleander) semmelinkii - Holthuis 1950 : 59-60, Fig. 11 (Synonomy).

Material. 1 juv., Deception Bay, Groote Eylandt, Gulf of Carpentaria, seagrass beds, trawl, 3 April, coll. R.A. Kenyon, NTM Cr. 004454; 1 ♀ , Deception Bay, Groote Eylandt, Gulf of Carpentaria, trawl, 17 April 1986, coll. R.A. Kenyon, NTM Cr. 004450; 2 ♀ (1 ovig.), stn. NW2, North West Bay, Groote Eylandt, Gulf of Carpentaria, 7m, trawl, coll. R.A. Kenyon, NTM Cr. 005104.

Diagnosis. Rostrum distinctly exceeding carapace length, without elevated basal crest, up-curved, with 7-10 dorsal and 2-5 ventral teeth, distal portion unarmed; carapace without supraorbital spines,with antennal and submarginal branchiostegal spine, branchiostegal groove distinct anteriorly; upper antennular flagellum with fused portion shorter than free part of shorter ramus; mandible with two-segmented palp; carpus of second pereiopod shorter than chela length, fingers shorter than half palm length; dactyls of ambulatory periopods about 0.3 of propod length, propod of fifth pereiopod with transverse rows of setae distolaterally.

Fig. 2. *Palaemon semmelinkii* ♀ (ovig.), NTM Cr.005104, carapace and rostrum. Scale line, 3 millimetres.

Remarks. The single ovigerous female has a postrostral carapace length of 5.4mm, the non-ovigerous females 5.8mm and the juvenile 2.6mm. The rostral dentition is 8-9/3, with a single tooth situated on the carapace and with a long toothless distal portion of the rostrum in all specimens. The post-rostral tooth and the first four rostral teeth appear feebly but completely articulated, the next two teeth distally partly articulated, and the more distal teeth non-articulate.

Distribution. Type locality, Makassar, Celebes, Indonesia. Also known from India, Burma, Nicobar Islands, Singapore, Sumatra, Java and Philippines.

Leandrites celebensis (De Man)
(Fig. 3)

Leander celebensis De Man, 1881 : 141.

Palaemonetes hornelli Kemp, 1925 : 318, Figs 14-15.

Leandrites celebensis - Holthuis 1950 : 36-37 (Synonomy).

Material. 5 spms., Drimmie Creek, Gove, scoop, security pond, mud samples, 1 April 1971, N.T. Fisheries Division, NTM Cr.000893; 2 ovig. ♀ , 1 ♂ , stn. HL 84-12, Woods Inlet, Darwin Harbour, 2m, mangrove run-off, rotenone, 16 March 1984, coll. H.K. Larson, NTM Cr. 002090; 1 ♂ , #1182, Groote Eylandt, salt lake (temp. 32.4°C, salinity 37.9 o/oo), 2.7m, 3 December 1984, coll. R.A. Kenyon, NTM Cr. 003321; 1 ♂ , 3 ♀ , 6 ovig. ♀ , #(5176, Myoola Bay, Groote Eylandt, 1.5m, (temp. 36.6°C, salinity 36.7 o/oo), 16 December 1984, coll. R.A. Kenyon, NTM Cr. 003331; 1 ovig. ♀ , Deception Bay, Groote Eylandt, seagrass beds, trawl, 19 February 1986, coll. R.A. Kenyon, NTM Cr. 005101; 2 ♀ , Deception Bay, Groote Eylandt, seagrass beds, trawl, 3 April 1986, coll. R.A. Kenyon, NTM Cr. 004453; 1 ♀ , Deception Bay, Groote Eylandt, trawl, 17 April 1986, coll. R.A. Kenyon, NTM Cr. 004451; 1 ♀ , stn. NW2, North West Bay, Groote Eylandt, 7m (temp. 30.5°C salinity 34.8o/oo), trawl, coll. R.A. Kenyon, NTM Cr. 005105.

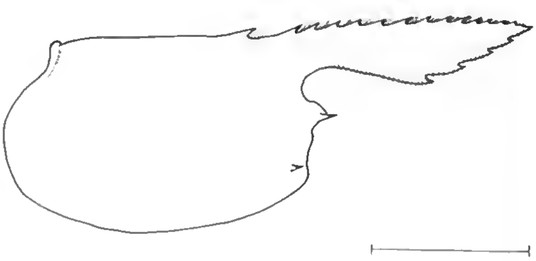

Fig. 3. *Leandrites celebensis* ♀ (ovig.), NTM Cr.003109, carapace and rostrum. Scale line, 3 millimetres.

Diagnosis. Rostrum subequal to carapace length, without elevated basal crest, with 13-17 dorsal and 3-5 ventral teeth, first two situated on carapace; carapace without supraorbital spines, with antennal and postmarginal branchiostegal spine, branchiostegal groove absent; upper antennular flagellum with fused portion about 0.3 of free part of shorter ramus; mandible without palp; carpus of second pereiopod subequal to chela length, fingers subequal to palm; dactyls of ambulatory pereiopods long, slender, about 0.5 of propod length; propod of fifth pereiopod without transverse rows of setae distolaterally; endopod of male first pleopod with distinct appendix interna.

Remarks. The eleven ovigerous females ranged in size from 2.5-4.9mm in postorbital carapace length, with rostral dentitions of 12/3 to 16/4, with the first two teeth situated on the carapace and separated by a larger gap than that between the more distal teeth. None of the rostal teeth showed signs of articulations with the rostrum. On the dorsal rostral carina the interstices between teeth bear several short median setae. The ventral carina bears a dense row of submarginal setae along the whole length of the carina, continuous across the sides ventral teeth. Non-ovigerous females and males have similar rostra. The ova are numerous and small, length ca. 0.43mm. The fourth thoracic sternite is armed with a small slender median process projecting between the coxa of the first pair of pereiopods.

Distribution Type locality, Makassar, Celebes, Indonesia. Also known from south India, Singapore and Java, Indonesia.

DISCUSSION

The genus *Leandrites*, has been previously represented in the Australian fauna only by the species *L. cyrtorhynchus* Miyake and Fujino, reported from Darwin harbour in the Northern Territory (Bruce 1983), although also known from Heron Island on the southern Great Barrier Reef (pers. obs.) *L. cyrtorhynchus* is not closely related to *L. celebensis* and is reported to be involved in fish cleaning associations.

The genus *Palaemon* is represented in Australian waters by two endemic species, *P. serenus* (Heller) and *P. litoreus* (McCulloch), both known only from the south and east of Australia (Holthuis 1952). Also known from the Low Isles, Great Barrier Reef, is *P. debilis* Dana (McNeil 1968), a wide ranging species recorded from the Gulf of Suez to the Hawaiian and Tuamotu Islands. It is interesting to note that the southern species are both endemic species and the tropical species well known, widely distributed Indo-West Pacific species.

Fig. 4. *Palaemon macrodactylus* ♀ (ovig.), Lake Mannering, N.S.W., carapace and rostrum. Scale lines, 3 millimetres.

The oriental species *P. macrodactylus* Rathbun, has also been reported from Australian waters by Holthuis (1980). This species normally occurs in Korean, Japanese and Chinese waters but it has also become established in San Francisco Bay (Newman 1963). In Australia it has been reported so far only in South Australia and from Lake Mannering, in the Lake Macquarie region, south of Newcastle, New South Wales. The Australian occurrences are discussed by Hutchings *et al.* (1987). For convenience, the carapace and rostrum are figured here (Fig. 4) for comparison with *P. serrifer* and *P. semmelinkii*. *P. macroductylus* closely resembles *P. serrifer* but may be readily distinguished by the presence of postmarginal branchiostegal spine. It should be noted that the mandibular palp has recently found to show some variation in the number of segments in some species of *Palaemon*. The following key may facilitate the separation of the species of *Palaemon* now known from Australia.

1. Mandibular palp with two segments only, distal rostrum unarmed ... *semmelinckii*
— Mandibular palp with three segments; distal rostrum with teeth 2
2. Branchiostegal spine distinctly postmarginal .... *macrodactylus*
— Branchiostegal spine marginal 3
3. Carpus of second pereiopod shorter than palm .... *litoreus*
— Carpus of second pereiopod longer than palm 4
4. Rostrum far exceeding scaphocerite, with 2-8 proximal teeth and subterminal dorsal

tooth, 3-10 (usually 6) ventral teeth .... *debilis*

— Rostrum not far exceeding scaphocerite, usually with 3-4 ventral teeth 5

5. Rostrum with 6-9 dorsal and 3-4 ventral teeth; antennular upper flagellum with fused portion half as long as shorter free ramus .... *serenus*

— Rostrum with 9-16 dorsal and 3-5 ventral teeth; antennular upper flagellum with fused portion distinctly less than half length of shorter free ramus ..... *serrifer*

ACKNOWLEDGEMENT

I am most grateful to Roger Springthorpe and Stephen Keable, of the Australian Museum, Sydney, for the loan of specimens and information on *Palaemon macrodactylus*.

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A NEW SPECIES OF ALPHEID SHRIMP, *ALPHEUS BANNERORUM* FROM NORTHERN AUSTRALIA

A.J. BRUCE
Northern Territory Museum of Arts and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

A new species of free living alpheid shrimp, *Alpheus bannerorum,* from the Northern Territory, Australia, is described and illustrated. Most closely related to *A. parvirostris* Dana, it is most easily distinguished by its ocellate colour pattern. The species is common in intertidal pools.

KEYWORDS: Taxonomy, Crustacea, Alpheidae, *Alpheus,* new species, colour pattern, zoogeography.

INTRODUCTION

Despite the extensive studies of the Australian alpheid shrimp fauna by D.M. Banner and A.H. Banner (1973, 1975, 1981), this subject has clearly not been exhausted. Considerable numbers of alpheid shrimp specimens from northern Australian waters, including a number of species new to the Australian fauna, were in their hands at the time of Professor Banner's recent death but his wife Dora decided not to continue with their study when their partnership was broken. One paper, describing two new Australian species, was subsequently completed (Banner and Banner 1986) and the rest of the specimens under study were returned to the Northern Territory Museum. One of these species is now described as new in the following report and is dedicated to the memory of Dora and Hank Banner in recognition of their major contribution to Australian alpheid shrimp studies. Professor Banner died on 17 August 1985, and Dora Banner on 15 December 1986.

SYSTEMATICS

Alpheus bannerorum sp. nov.

(Figs 1-6, Plate 1)

Type material. HOLOTYPE - ♀ (ovig.), Dudley Point, Darwin, Northern Territory, Stn. AJB-30, 6 November 1986, NTM Cr.004429A. ALLOTYPE - ♂, same data as holotype, NTM Cr.004429B. PARATYPES - NTM Cr. 004429 C-E. Paratypes are also deposited in the National Museum of Natural History, Washington, catalogue number USNM 234208; the Bishop Museum, Honolulu, catalogue number 1987. 283 S-10805 and the Rijksmuseum van Natuurlijke Historie, Leiden, catalogue number 37181.

Additional material. Stn. AJB-19, Dudley Point, Darwin, NT., 12°25.1′S 130°49.0′E, intertidal, silty reef pools, LWS, 8 January 1985, coll. AJ Bruce, 7 (2 ovig. ♀), NTM. Cr.002512, 1 ovig. ♀, NTM. Cr.002513, 1 ♂, 1 ovig. ♀, NTM. Cr.002514, 1 ovig. ♀, NTM. Cr.004427; Stn. AJB-22, Channel Island, Darwin Harbour, N.T., 12°33.0′S 130°52.4′E, intertidal, sandy reef flat pool, 7 February 1985, coll. AJ Bruce, 8 (3 ovig. ♀), NTM. Cr.002682; Stn. AJB-24, Dudley Point, 8 March 1985, 1 ovig. ♀, NTM. Cr.004554; Stn. AJB-29, Dudley Point, 8 October 1985, 2 ♂, NTM. Cr.003704.

Description. A small sized, slenderly built alpheid shrimp of the "*edwardsii*" group.

Carapace moderately compressed, smooth and glabrous; rostrum acute, straight, slightly depressed, about 2.0 times longer than width across base, slightly exceeding proximal segment of antennular peduncle, with 1-2 lateral setae, lateral margins blended with slightly expanded anterior margin of orbital grooves, forming flattened convex prominence, orbital grooves shallow, short, rostral carina absent; orbital hoods rounded, without supraorbital teeth; pterygostomial angle broadly rounded; cardiac notch distinct.

Abdominal segments slightly compressed, smooth and glabrous; sixth segment about 1.4 times length of fifth, about 1.4 times longer than deep, posteroventral angle produced, acute, posterolateral angle produced, posteriorly angularly truncate; pleura of first

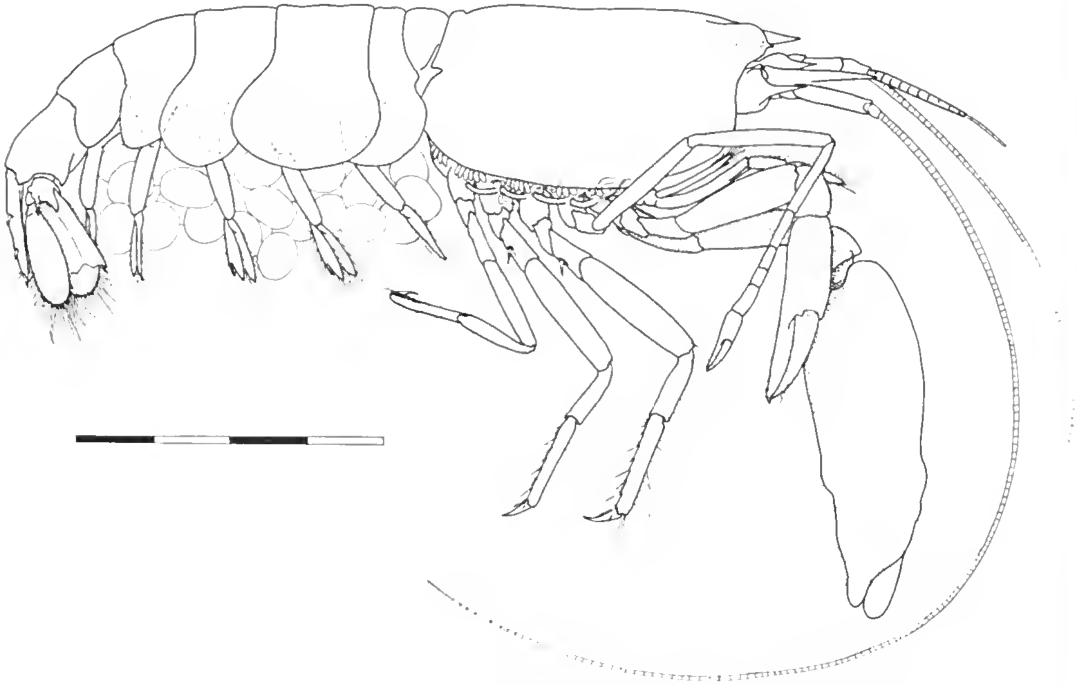

Fig. 1. *Alpheus bannerorum* holotype ♀ (ovig.), Dudley Point, Darwin. Scale divisions in millimetres.

three segments broadly rounded, larger in females than males, fourth and fifth slightly produced posteriorly, bluntly angular in females, angular or feebly acute in males; telson about 1.25 times length of sixth abdominal segment, broad, about 1.75 times longer than anterior width, posterior width 0.5 of anterior width, sides straight, posteriorly convergent, with two pairs of medium sized, subequal dorsal spines at 0.43 and 0.72 of telson length, posterior pair closer to midline than anterior, posterior margin convex, with median spinule in dissected specimen, with 12 long segmented plumose marginal setae and two pairs of lateral spines, small outer spine with larger inner spine, about 0.13 of telson length, and 1.3 times dorsal spine length, dorsal surface of telson with numerous short simple setae laterally and long erect setae posteriorly.

Antennular peduncle with proximal segment about 2.6 times longer than distal width, with acute distoventral tooth medially, distodorsal margin unarmed, with several long simple setae; statocyst well developed with granular statolith; stylocerite acute, distinctly exceeding distal margin of segment; intermediate segment subcylindrical, about 1.75 times longer than broad, about 0.6 of proximal segment length, with several long setae distodorsally; distal segment subcylindrical, about 1.6 times longer than wide, 0.8 of intermediate segment length; upper flagellum feebly biramous, robust, with 8-9 proximal segments fused, short ramus with single segment, longer ramus filiform, eight segments, eight groups of aesthetases; lower flagellum about 1.5 of postorbital carapace length, slender, with several long lateral setae proximally.

Antenna with robust basicerite with long slender lateral tooth generally exceeding proximal segment of antennular peduncle or reaching to middle of intermediate segment; carpocerite robust, about 3.5 times longer than wide, reaching to about distal end of scaphocerite lamella, flagellum well developed, robust, about 3.5 times postorbital carapace length.

Eyes with well pigmented cornea, completely covered by orbital hood, without anteromedial processes.

Mandible (right) with robust corpus; incisor process stout, broad, distally angular with five acute teeth medially and three blunt teeth laterally; molar process subcylindrical, distally truncate, with feeble teeth ringed with short setae; palp well developed, proximal segment subcylindrical, expanded distally, with setose distomedial angle, distal segment flattened, ovate, about 1.8 times longer than broad, 1.25 times length of proximal segment, with feebly plumose setae distomedially, simple setae distolaterally. Maxillula with short, stout, feebly bilobed palp, lower lobe with distally denticulate spine; upper lacinia broad, lateral margin convex, distal margin oblique, straight, with about 25 short, stout, simple spines; lower lacinia slender, curved, with several

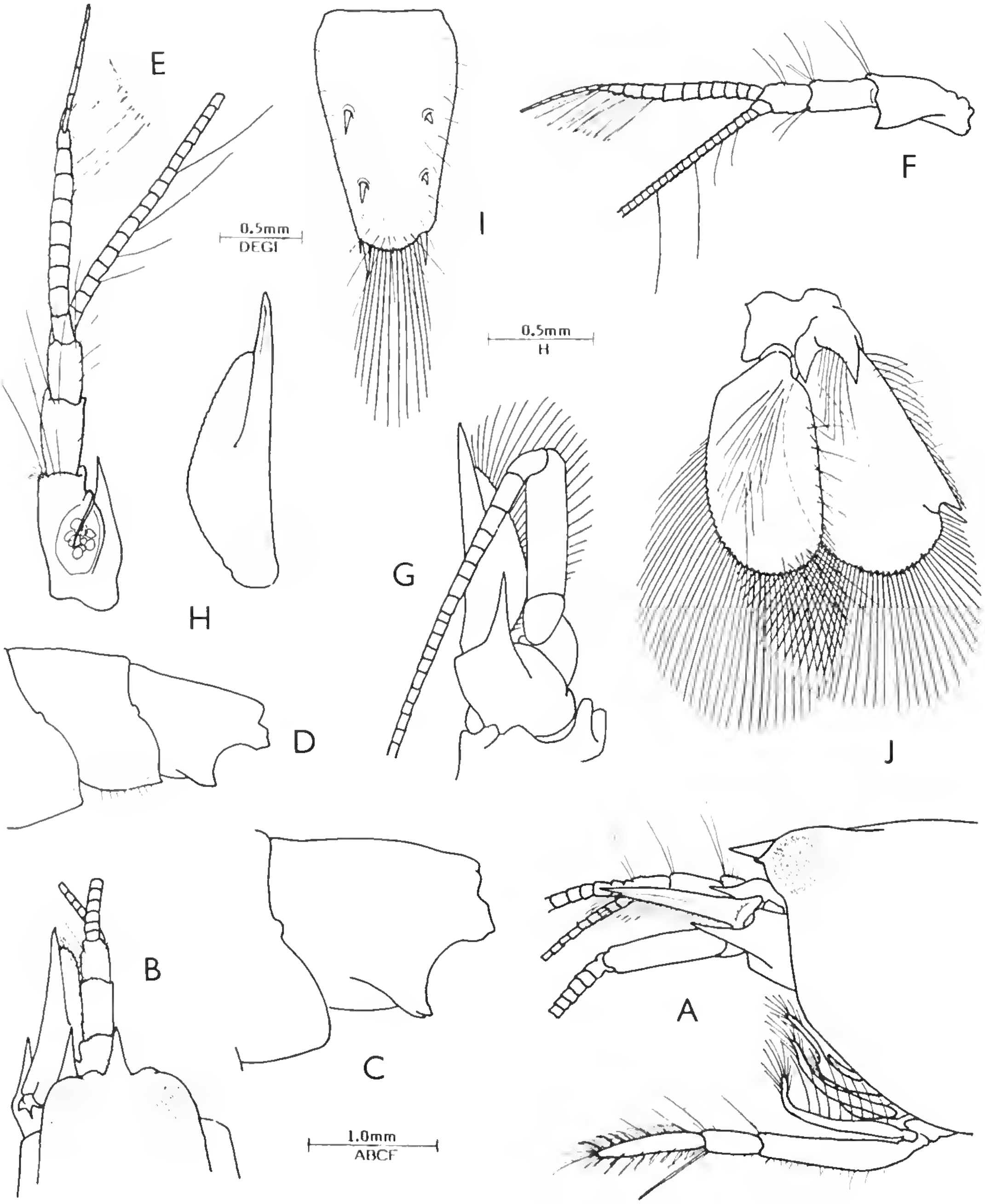

Fig. 2. *Alpheus bannerorum* paratypes (**A-B**, **D-J**, ♀ (ovig.), **C**, ♂): **A**, anterior carapace and appendages, lateral; **B** anterior carapace and left antennal peduncles, dorsal; **C**, posterior fifth and sixth abdominal segment; **D**, posterior fourth, fifth and sixth abdominal segments; **E**, antennule, dorsal; F, same, medial; **G**, antenna, ventral; **H**, scaphocerite, dorsal; **I**, telson; J, uropod.

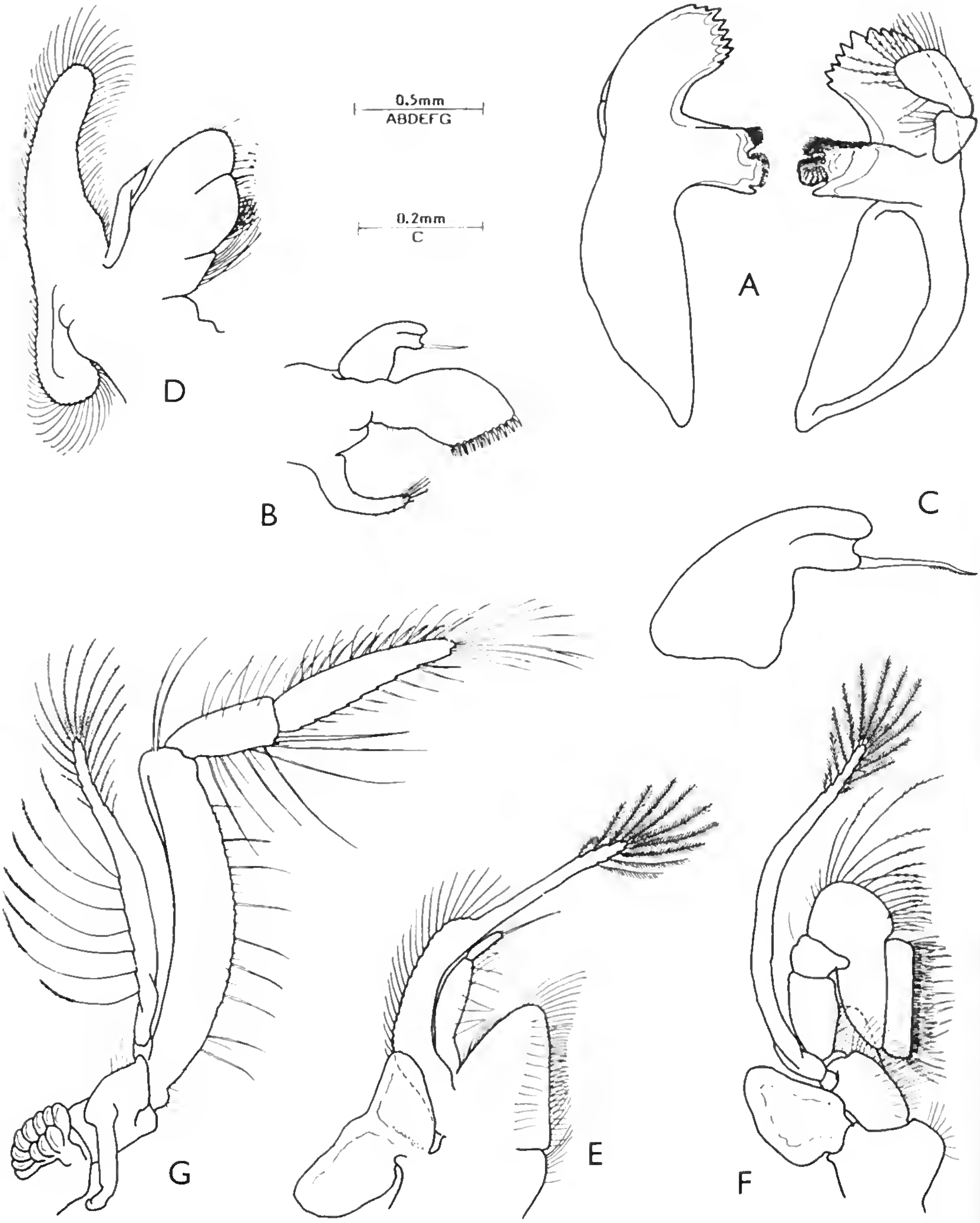

Fig. 3. *Alpheus bannerorum* paratype ♀ (ovig.): **A**, mandible, right, dorsal and ventral aspects; **B**, maxillula; **C**, same, palp; **D**, maxilla; **E**, first maxilliped; **F**, second maxilliped; **G**, third maxilliped.

spiniform setae distally. Maxilla with slender, distally acute palp with single short terminal spinule; basal endite broad, deeply bilobed, densely setose medially; coxal endite simple, small, with numerous long setae medially; scaphognathite slender, about 4.3 times longer than broad, posterior lobe short, rounded, anterior lobe 2.5 times longer than proximal width, medial margin concave. First maxilliped with elongate flattened two-segmented palp, proximal segment about 4.5 times longer than wide, sparsely setose medially, distal segment about 0.38 of proximal segment length, with long distal setae and several short medial setae; basal endite broad, angular, sparsely setose laterally, densely setose medially, basal endite with several distomedial setae only; exopod well developed, caridean lobe narrow, flagellum with numerous plumose setae distally; epipod large, triangular. Second maxilliped with dactylar segment of endopod narrow, about 5.0 times longer than broad, with dense palisade of short unarmed blunt peg-like spines ventrally, with longer serrulate spines dorsally; propod expanded distally with numerous finely plumose setae on anteromedial margin; carpus and ischiomerus normal; basis distodorsally expanded, medially excavate; exopod with slender flagellum with numerous plumose setae; coxa medially convex, sparsely setose, with oval epipod without podobranch laterally. Third maxilliped with endopod extending to middle of carpocerite; ischiomerus incompletely fused to basis, distally flattened, about 3.25 times longer than broad, subuniform, with distinct setose distolateral angle, ventromedial border setose, dorsal lateral margin sparsely setose; penultimate segment about 2.0 times longer than distal width, feebly tapered proximally, with sev-

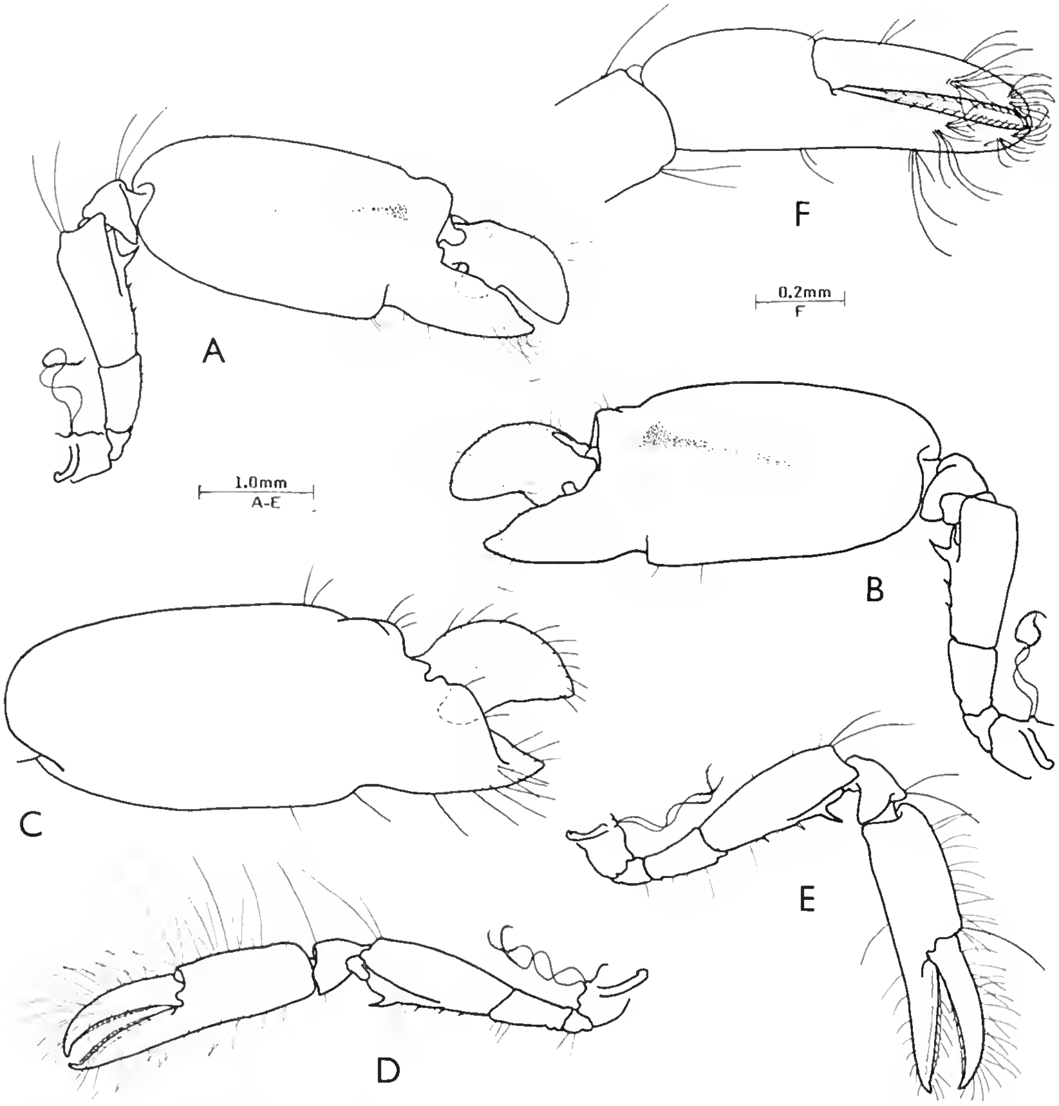

Fig. 4. *Alpheus bannerorum* paratypes (**A**, **D**, ♂, **B**-**C**, **E**-**F**, ♀): **A**, major first pereiopod, lateral; **B**, same; **C**, major chela, medial; **D**, minor chela; **E**, same; **F**, second pereiopod chela.

eral long finely serrulate spiniform ventrolateral setae and one very long finely serrulate distal ventrolateral spine, obliquely truncate at tip, with subterminal pore, equal to segment length; terminal segment about 1.7 times penultimate segment length, feebly tapered distally, about 4.5 times longer than proximal width, with 11 transverse rows of

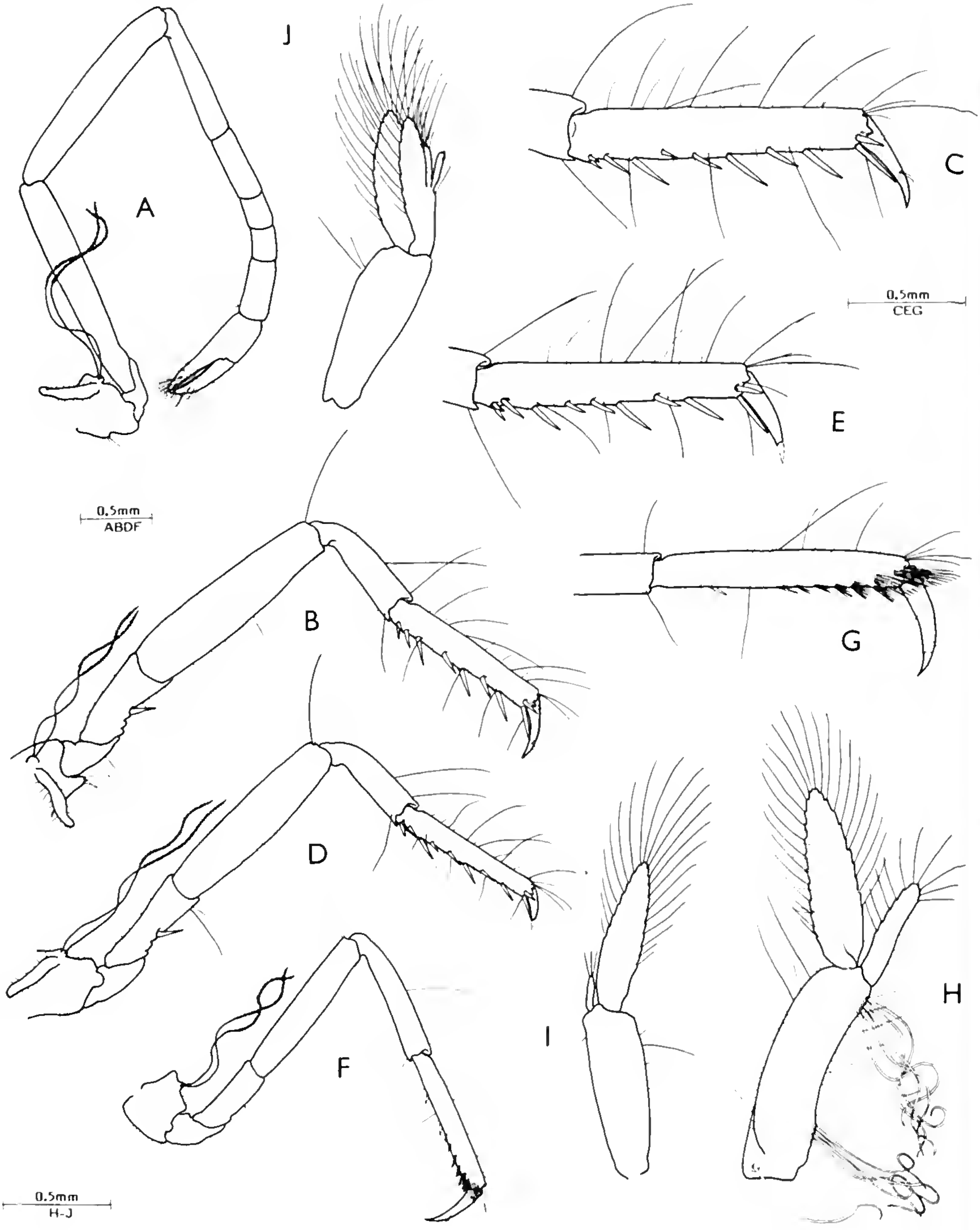

Fig. 5. *Alpheus bannerorum* paratype (**A-H**, ♀(ovig.), **I-J**, ♂): **A**, second pereiopod; **B**, third pereiopod; **C**, same, propod and dactyl; **D**, fourth pereiopod; **E**, same, propod and dactyl; **F**, fifth periopod; **G**, same, propod and dactyl; **H**, first pleopod; **I**, first pleopod; **J**, second pleopod.

short coarsely serrulate spines medially and numerous long slender finely serrulate setae distally, subequal to segment length, without distal spines, dorsolaterally sparsely setose; basis with medial margin straight, sparsely setose, with well developed exopod laterally, flagellum with numerous plumose setae on distal fifth, eight very long setae, mainly non-setulose, with fine serrulations distally; coxa not medially produced, with large oval plate laterally, distolateral angle acutely produced, lateral border with short setae, with simple epipod and small arthrobranch.

First pereiopod with major chela similar in male and female, relatively smaller in latter, with palm smooth, slightly compressed, with numerous long setae dorsally, about 2.0 times longer than central depth; transverse groove on superior margin feebly developed; transverse groove on inferior margin more marked laterally, with proximal shoulder low, rounded; dactylus robust, compressed, about 0.4-0.45 of palm length, with plunger well developed, posterior rim setose; carpus short and stout, deeply excavate distally, about 0.2 of palm length, unarmed; merus robust, about 0.4-0.45 of palm length, about 2.1 times longer than distal width, concave ventrally, with large, very acute preterminal tooth on inner ventral margin, with two small spines proximally; ischium about half of merus length, 1.3 times longer than distal width, tapered and compressed proximally, unarmed; basis small, short, ventral length about 0.3 of meral length, unarmed, without exopod; coxa robust, with epipod laterally and bisetose setobranch dorsally.

Minor chela similar in male and female, palm with numerous long setae, about 2.0 times longer than wide, subcylindrical, smooth, dactyl subequal to palm length in male, slightly shorter in female, slender, tapering, about 4.0 times longer than proximal depth, with numerous long simple setae, lacking balaeniceps setae in both sexes, cutting edges entire, sharp, unarmed, tip hooked, fixed finger similar; merus as in major chela, more slender, about 1.15 times palm length, 2.6 times longer than wide; ischium about 0.4 of merus length in female, 0.5 in male.

Second pereiopod slender, exceeding carpocerite by whole of carpus and chela. Chela with palm subcylindrical, slightly compressed, about 1.6 times longer than deep, sparsely setose, dactyl slender, compressed, about 4.4 times longer than proximal depth, with small hooked tip, cutting edge straight, entire, fixed finger similar, both with numerous groups of short setae; carpus five segmented, slender, about 3.0 times chela length, segments in ratio 1.8:1:1:2:4, proximal segment longest; merus about 6.3 times longer than central width, equal to length of first two carpal segments; ischium about 1.1 times meral length, subcylindrical, about 7.0 times longer than wide, widest at about 0.6 of length, unarmed; basis short, ventral margin about 0.28 of ischial length; coxa with lateral epipod and dorsal setobranch.

Third pereiopod moderately slender, exceeding carpocerite by distal third of propod; dactyl compressed, about 4.3 times longer than proximal depth, 0.38 of propod length, unguis distinctly demarkated, about 0.3 of corpus length, corpus simple, without accessory teeth, with distal dorsolateral group of three short serrulate setae; propod with numerous long simple setae, about 6.0 times longer than wide, subuniform, slightly tapering distally, about 5.8 times longer than proximal width, with long distoventral spine and shorter distolateral spine and nine rather irregular ventral spines, some long, some short, basically in single row; carpus about 0.6 of propod length, about 3.5 times longer than broad, unarmed; 4.0 times longer than wide, distoventral angle unarmed, sparsely setose; ischium about 0.4 of merus length, with acute ventrolateral spine at 0.5 of length; basis with ventral margin about 0.28 of meral length; coxa with lateral and dorsal setobranch.

Fourth pereiopod similar, less robust, dactyl about 0.36 of propod length, propod about 0.9 of third propod length, 0.15 times longer than wide, merus about 0.22 times longer than wide, 0.9 of third merus length, ischium with ventrolateral spine, coxa with epipod and setobranch. Fifth pereiopod slender; dactyl about 0.4 of propod length; propod about 7.0 times longer than wide, with seven transverse rows of serrulate setae along distal half of ventrolateral margin, with 2-3 ventromedial spines; merus distoventrally unarmed; ischium unarmed; coxa with dorsal setobranch, epipod absent.

Pleopods normally developed. In female, basipodite of first pleopod about 3.75 times longer than wide, with distomedial and prox-

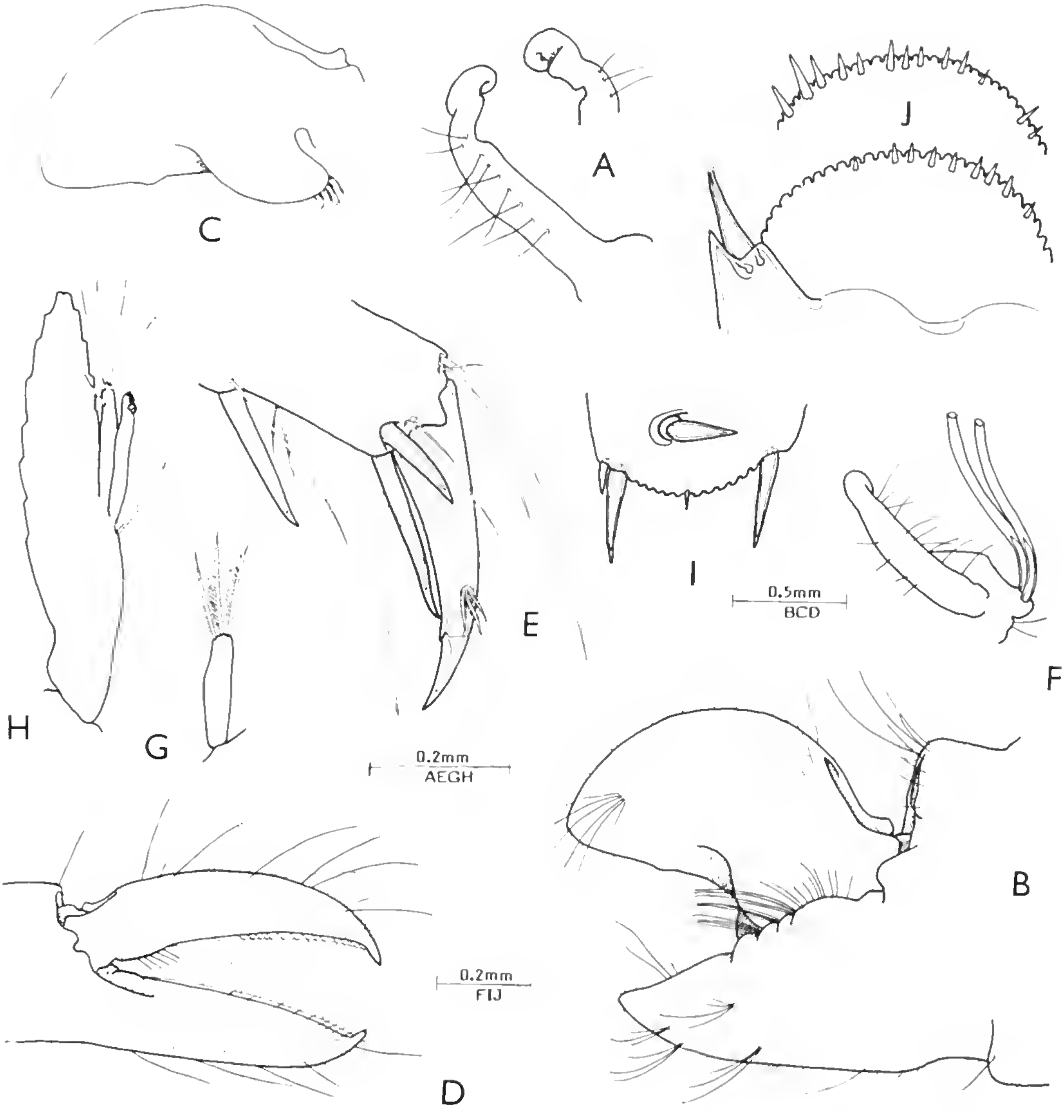

Fig. 6. *Alpheus bannerorum* paratypes (**A-F**, **I**, **J**, ♀. **G**, **H**, ♂): **A**, epipod of third maxilliped, lateral and distal end, medial; **B**, fingers of major chela, medial; **C**, dactyl of major chela; **D**, fingers of minor chela, medial; **E**, third pereiopod, dactyl and distal propod; **F**, same, epipod and setobranch; **G**, endopod of first pleopod; **H**, endopod of second pleopod; **I**, telson, posterior margin; inset of dorsal spine; **J**, uropod, posterior margins of exopod (lower) and endopod (upper).

imomedial groups of ovigerous setae, with single proximal lateral ovigerous seta; endopod half length of basipodite, 4.0 times longer than broad, with longer plumose setae distally and laterally and shorter simple setae medially. In male, basipodite of first pleopod 3.0 times longer than broad, sparsely setose; endopod small, about 0.2 of basipodite length, 4.0 times longer than wide, slightly expanded centrally, with three distal plumose setae, subequal to endopod length. Second pleopod with endopod well developed, about 5.0 times longer than broad, appendices at about 0.5 of medial margin length; appendix masculina slender, subcylindrical about 6.5 times longer than wide, 0.43 of endopod length, slightly exceeding appendix interna, with five long simple distal spines, subequal to appendix length; appendix interna slender, subequal

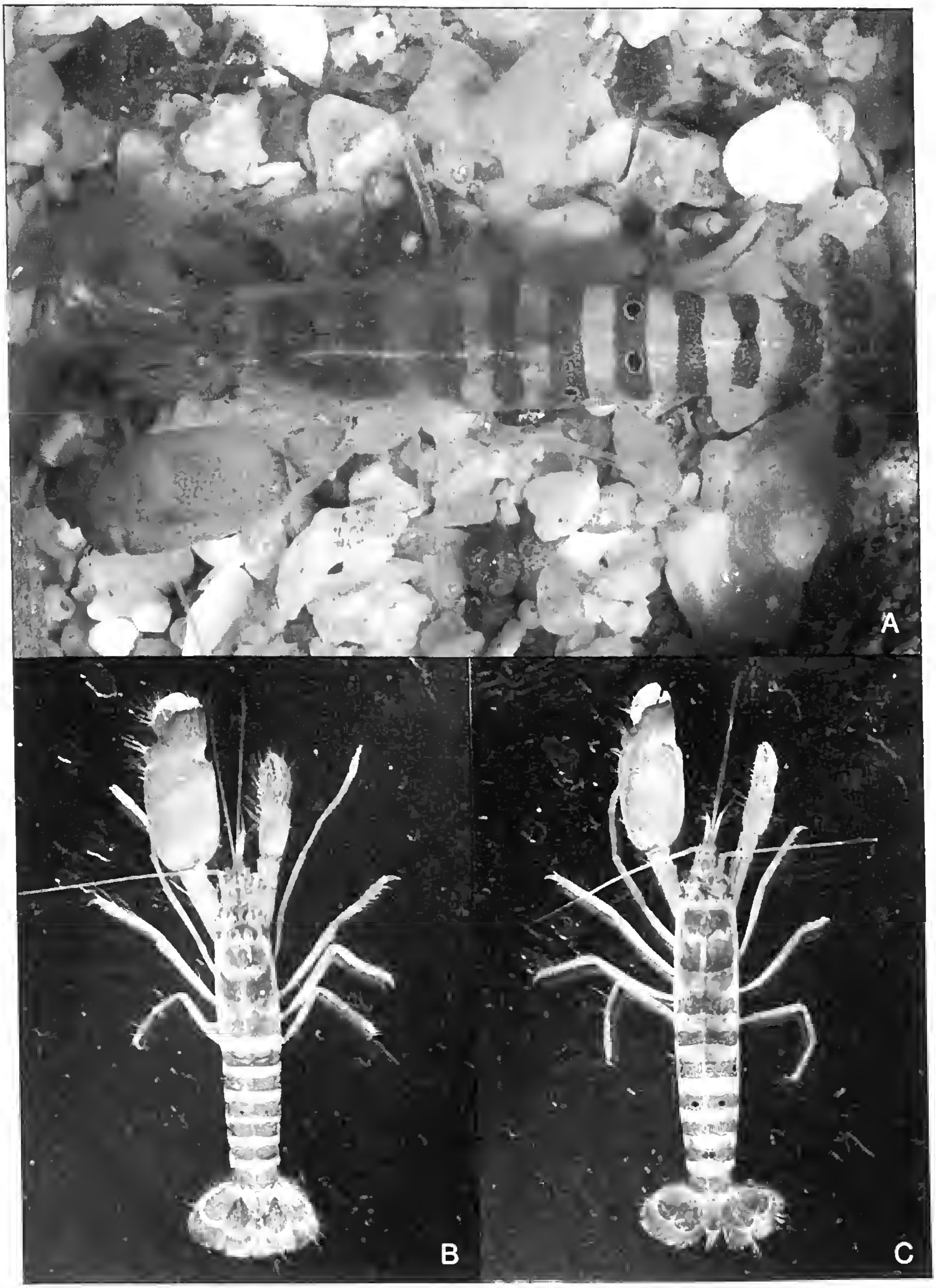

Plate 1. *Alpheus* spp. from, Dudley Point, Darwin, Australia: **A**, **B**, *A. bannerorum* paratype, **C**, *A. parvirostris.*

to appendix masculina length, with few distal cincinnuli.

Uropod with protopodite with two large acute dorsal teeth and numerous long simple setae; endopod broad, about 1.7 times longer than broad, lateral margin straight, with dense row of submarginal ventral setae, large acute tooth distally, with large mobile spine medially, distal margin broadly rounded with 8-10 submarginal dorsal spinules, diaeresis well marked; endopod slightly shorter than exopod, 2.0 times longer than broad, distally rounded with 13-15 submarginal spinules, dorsal surface with numerous long erect setae.

Ova numerous and small.

Measurements. Holotype ♀, total length, (approx.) 11.5 mm; carapace length 4.4 mm; major chela 4.7 mm; minor chela 2.6 mm. Allotype ♂, total length (approx.) 9.0 mm; carapace length 3.45 mm; major chela 3.75 mm; minor chela 2.25 mm; Length of ova 0.8 mm.

Colouration. Body generally translucent, antennal peduncles and frontal region brownish, hepatopancreas dark brown, ovary bright green, posterior carapace and posterior half of each abdominal tergite with transverse dark red-brown bar, second with small dorsolateral eye spot, third with larger submedian eyespot, with black centre surrounded by thin yellow ring, fifth with transverse band constricted and darkened centrally with yellow patch anteriorly and posteriorly, caudal fan red brown except for anterior telson and anterolateral areas of uropod rami; chelae pale brown, dark brown on fixed finger of major chela, dactyl pale horn distally, proximally white, ambulatory pereiopods pale pinkish.

Systematic Position. *A. bannerorum* is most closely related to the common, well known and widely distributed species, *A. parvirostris* Dana, 1852, and is of very similar size and general morphology, but may be readily distinguished by the lack of an acute distoventral tooth on the merus of the third pereiopod. *A. bannerorum* may be readily confused with *A. parvirostris* on account of the conspicuously long distoventral process of the basicerite that occurs in both species but not in any other Indo-West Pacific species of *Alpheus*. Also shared, is the conspicuous transversely barred colour pattern of the abdominal segments but on closer examination, *A. bannerorum* may be readily distinguished from *A. parvirostris* by the two pairs of well developed ocellate spots on the second and third segments, which provides an easy method of separation in the field. Other characteristic morphological features shared with *A. parvirostris* are the flattened extensions of the anterior margin of the carapace between the rostrum and the orbital hoods and the deep, narrow and oblique groove proximal to the dactylus of the large chela noted by Banner and Banner (1966).

Banner and Banner (1966) note that an acute tooth is present on the palm above the dactylar articulations in the male minor chela. This has not been noted in *A. bannerorum*. Similarly, in *A. bannerorum*, the ventral border of the minor chela lacks an inferior shoulder, noted as present but not heavy, in *A. parvirostris* by Banner and Banner (1981).

Remarks. Banner and Banner (1981) noted that some Australian specimens that they referred to *A. parvirostris* varied in the teeth on the meri of the third and fourth pereiopods. As they were working mainly on preserved material and lacking colour patterns, it is possible that these specimens should also be referred to *A. bannerorum*. Two specimens of *A. bannerorum* from Darwin, in which the colour pattern was known but had been lost in preservation, were examined by the Banners and subsequently referred to *A.. parvirostris*. It is most probable that this new species is of widespread occurrence in Australia and beyond, as the colour pattern has been noted in specimens from Heron Island on the Great Barrier Reef and also in material from the South China Sea (pers. obs.). The two species appear to commonly occur together in shallow intertidal pools. At Dudley Point, *A. bannerorum* is more numerous. On Heron Island, *A. parvirostris* was the most abundant reef flat shrimp, up to 86 individuals in a square metre. *A. bannerorum* did not occur in the area sampled, but was found on small numbers elsewhere on the reef flat, in similar situations. Banner and Banners (1981) noted that specimens from the Houtman Abrolhos Islands, Western Australia, lacked distoventral teeth on the meri of the ambulatory pereiopod, so these specimens may also belong to *A. bannerorum*.

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A NEW SPECIES OF MONITOR (PLATYNOTA: REPTILIA) FROM NORTHERN AUSTRALIA AND A NOTE ON THE STATUS OF *VARANUS ACANTHURUS INSULANICUS* MERTENS

MAX KING AND PAUL HORNER
Northern Territory Museum of Arts and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

A new species of *Varanus* Merrem (Varanidae: Reptilia), *V. baritji* sp.nov., from the tropical north of the Northern Territory is described. It most closely resembles *V. acanthurus* Boulenger but colour and pattern easily distinguish the species. Recently collected specimens of *V. acanthurus insulanicus* Mertens from the Wessel island chain confirm the status of this subspecies

KEYWORDS: taxonomy, Reptilia, Varanidae, *Varanus*, new species, subspecies, northern Australia.

INTRODUCTION

The monitors or goannas of the genus *Varanus* Merrem, 1820 remain as one of the most interesting reptilian taxa. There are only thirty five described species (see Cogger 1986; Storr *et al.* 1983) yet these animals display considerable variation in their size and form. The varanids can range in size from the Komodo dragon *V. komodoensis* (Ouwens, 1912) which weighs up to 50 kg and may be 3 metres long (Auffenberg 1980), to animals as small as *V. brevicauda* Boulenger, 1898, which reach a maximum of 10 gm. and 23 cm long. Despite this range in size and the particular specializations in morphology exhibited by some species, these animals are always unmistakedly varanid in their form.

The monitors have an enormous distribution encompassing Africa, the Middle East, the U.S.S.R., south east Asia and Australia. Nevertheless, it is in Australia where the greatest diversity exist, and over 25 of the varanids are found in this continent. Indeed, three major radiations have been established, each of which has led to the formation of numerous species complexes (King and King 1975).

Perhaps the most successful of the Australian radiations is seen in the subgenus *Odatria* Gray, 1838. These generally small varanids include *V. acanthurus* Boulenger, 1885, *V. brevicauda* Boulenger, 1898, *V. caudolineatus* Boulenger, 1885, *V. eremius* Lucas and Frost, 1895, *V. gilleni* Lucas and Frost, 1895, *V. glauerti* Mertens, 1957, *V. glebopalma* Mitchell, 1955, *V. kingorum* Storr, 1980, *V. mitchelli* Mertens, 1958, *V. prasinus* (Schlegel, 1839), *V. primordius* Mertens, 1942, *V. pilbarensis* Storr, 1980, *V. scalaris* Mertens, 1941, *V. semiremex* Peters, 1869, *V. storri* Mertens, 1966 and *V. tristis* (Schlegel, 1839). Several of these species exhibit clinal variations in their morphology and some have been subdivided into subspecies.

The spiny tailed monitors *V. acanthurus*, *V. primordius*, *V. storri* and *V. storri ocreatus* are one of the more morphologically confusing complexes within the *Odatria*. For example, *V. acanthurus* which is distributed across the northern half of Australia has at times included the subspecies *V. a. brachyurus* Sternfield, 1919, and *V. a. insulanicus* Mertens, 1958. These subspecies are recognised by Cogger (1986), whereas, Storr (1980) only recognizes *V. acanthurus*. On the other hand, *V. primordius* (which has also at one time been a subspecies of *V. acanthurus*) has a more restricted distribution, and is only found in the northern Northern Territory. Similarly, *V. storri* is found in north western Queensland and *V. storri ocreatus* occurs in the Kimberley and the north western Northern Territory.

This paper describes a new species of spiny tailed monitor from the *V. acanthurus* complex which is restricted in its distribution to the far north of the Northern Territory. The status of *V. acanthurus insulanicus* is also examined.

MATERIALS AND METHODS

A total of 12 specimens of an undescribed species of *Varanus* were compared to 54 adult specimens of *V. acanthurus* collected from twenty-seven localities throughout the Northern Territory. A series of 22 scale counts, colouration sites and measurements were taken, and where necessary micrometer adjusted calipers and a steel rule were used.

SYSTEMATICS

Varanus baritji sp. nov.

(Fig. 1)

Type material. HOLOTYPE - NTM R.13192, ♀, Mirrngadja, N.T., a rock outcrop on the Arafura Swamp, 12° 39′S 135° 12′E, 5 June 1985, coll. Dr N.G. White. This specimen laid three eggs in captivity. PARATYPES - NORTHERN TERRITORY: NTM R.13150, ♀, Donydji outstation, 12° 24′S 135°28′E, 28 August 1985, coll. Bambalmir, at a rock outcrop called Marrpinydjan; NTM R.13151, ♂, Donydji outstation, 12° 24′S 135° 28′E, 27 August 1985, coll. Warnamal, at a stony outcrop west of the outstation; NTM R.8346-8, ♀, ♀, ♂, 10km S. Adelaide River township, 13° 21′S 131° 09′E, 7 February 1980, coll. G. Husband, N. Oakes and M. Anthony, under flat rocks on soil; NTM R.8931, ♂, 20km S. Adelaide River township, 13° 27′S 131° 11′E, 10 August 1980, coll. G. Husband and G. Armstrong under rock on hillside; NTM R.3107, ♀, 8.0km N. Pine Creek, 13° 47′S 131° 47′E, 20 February 1977, coll. R. Wells, K. Martin and D. Metcalfe, beneath granite exfoliation on soil; NTM R.6531, ♀, Katherine, 14° 28′S 132° 16′E, December 1978, coll. I. McKinna; NTM R.8364, ♂, Daly River road, 13° 30′S 131° 03′E, 5 February 1980, coll. G. Husband, N. Oakes and M. Anthony in limestone outcrop; AM R.51912, ♂, Daly River road turn off, Stuart Highway, 13° 29′S 131° 11′E, 30 September 1975, coll. P. Rankin; AM R.88844, ♂, Jabiluka, 12° 34′S 132° 55′E, coll. R. Sadlier.

Diagnosis. A moderately sized member of the *V. acanthurus* species complex. *V. baritji* is distinguished from *V. primordius* by its larger size (95-110 mm SVL, compared to 121-252 mm SVL), greater number of midbody scales (60-66 compared to 80-112) and an ochre back colouration with black spotting compared to an olive brown back in *V. primordius*. *V. baritji* is distinguished from *V. storri* by its greater size (49-132 mm SVL) and greater number of midbody scales (70-94) although these characters overlap (Table 1). Further differences are seen between these species in colouration and back pattern with *V. baritji* having distinct lateral facial stripes not present in *V. storri* which has a relatively uniform sandy colouration. *V. baritji* is similar to *V. acanthurus* in general scalation, but is markedly different in colouration and pattern. *V. acanthurus* is characterized by a back pattern showing numerous ocelli i.e. black or dark brown spots surrounded by a white or light coloured ring further surrounded by a dark brown ring. These outer rings form a reticulate back pattern. These ocelli are characteristically absent in *V. baritji* although in some specimens the black spots on the uniform ochre back pattern aggregate to form a series of rings which may also form a reticulate pattern. An additional diagnostic characteristic is the presence of a series of longitudinally

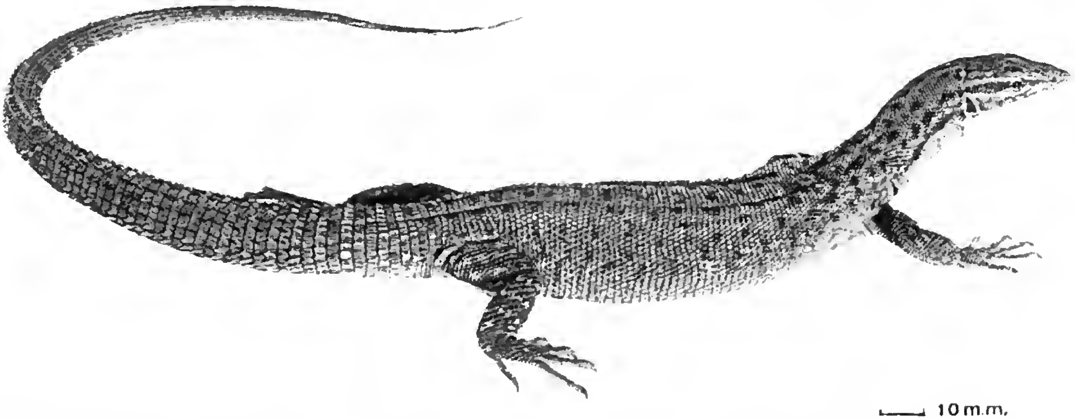

Fig. 1. The holotype of *Varanus baritji* in life. Note the distinctive patterning of this species, and compare to Fig. 2.

arrayed yellow (or off white) and black (or dark brown) dorsal neck stripes in *V. acanthurus*. These markings are either completely absent in *V. baritji*, where the dorsal surface of neck and head are mid brown, or in occasional specimens, black spots from the dorsal pattern extend on to the neck or head. *V. baritji* also has a distinct lemon yellow gular region.

Description. The holotype has the following combination of characteristics.

Head: Width 15.6 mm, depth 11.5 mm, 5.8 mm long from tip of rostral scale to anterior margin of nostril. 6.4 mm long from nostril to anterior margin of orbit; 21.9 mm long from anterior margin of ear to tip of rostral scale. 7 interorbital scales on dorsal surface of head on a line between orbits, not including supraorbitals, if these are included 23 interorbitals. Interorbitals much larger than supraorbitals. 26 supralabials (L and R). 5 rows of suborbital scales, (L and R). 5 loreal scales between nostril and eye (L and R). Head scales small and smooth, nostril dorsolateral. Ear opening oblique, partially covered by skinfold, 3 times long as wide.

Body: Elongate and slender body, oval in section with moderate dorso ventral compression. Neck long slender, anterior edge of ear to forelimb 38.3 mm. Snout-vent length 168 mm. Tail length 286 mm. Long tail round in section anteriorly, to triangular in section along midlength with dorsal apex. Dorsal and lateral caudal scales with strong spinose keel. Tail with two keeled crest. Dorsal body scales occur in bands. Scales oval shape with flat posterior-anterior aligned keel which is parallel sided and surrounded by small granules. Laterally, keel enlarges to dominate the scale. Ventrally, scales are larger, hexagonal and smooth, black spot on posterior angle. Midbody scale rows 80 (around abdomen in midline), ventral scale rows 57 from gular fold to opposite middle of hind leg. Cluster of 12 enlarged caudal spines (L and R) in rows on ventral surface, posteriorly adjacent to cloaca. Rows directed from lateral surface to midline.

Limbs: Pentadactylic with long pointed toes. Forelimb shorter (45.6 mm) than hindlimb (62.3 mm). Fourth toe very long with 21 scales (L and R) on under surface excluding claw.

Colouration (in life).

Head: Dorsal surface mottled mid brown with few black spots. Pronounced black eyestripe extends laterally from nostril through eye to above ear where it breaks up into black spots. Narrow white borders to eyestripe ventrally. Dark brown supralabials (Fig. 1). Ventral surface of head and chin, bone coloured. Gular region of throat lemon yellow.

Body: Dorsal surface red ochre with irregular black spots each 3-4 scales across. Black spots tend to form broken bars laterally. Ventral surface buff coloured with irregular dark brown single scales. Occasional bone coloured scales scattered in anterior lateral area emanating from whitish facial stripes. (Fig. 1).

Forelimbs: Midbrown with irregular bone and black spotting. Dorsal surface of feet dark brown, ventral surface bone coloured with dark brown calli.

Hindlimbs: Dark brown with bands and spots of off-white scales. Dorsal surface of

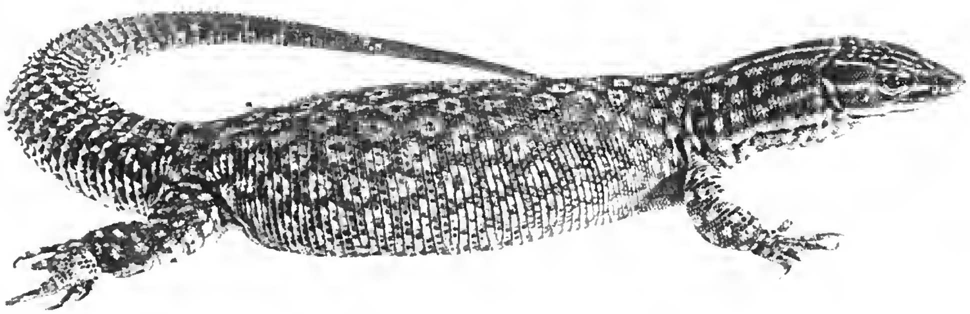

Fig. 2. A typical specimen of *Varanus acanthurus acanthurus*. Note the clearly defined ocelli in the back pattern and the contrasting black and yellow striping of the neck and head.

feet dark brown, ventral surface bone coloured with dark brown calli.

Tail: Anterior dorsal surface has alternate bands of black and light brown scales gradually becoming mid brown posteriorly. Bone to light brown on ventral surface.

Distribution. The known distribution of *V. baritji* is the "Top End" of the Northern Territory, north of 15° South (Fig. 3). Specimens from the western sector of the distribution are sympatric with *V. primordius*. Populations of *V. acanthurus* occur to the south and west of the *V. baritji* distribution and contact it at both Adelaide River and Katherine.

Etymology. The species name *V. baritji* is derived from the word "Baritj". "Baritj" is a word from the Ritharrju-Wagilak language group used by the aboriginal people from the Donydji area of northern Arnhemland. "Baritj" means white, and the species *V. baritji* is named after Dr Neville White who has worked extensively with the people from this region and who brought the holotype to Darwin for our examination.

Variation and Comparison to *V. acanthurus*. The most significant difference between these morphologically similar species is the distinctive colouration and patterning. In his description of the "eyed *Odatria*" Gray (1845) defined the species from N.W. Australia as being "Black, with rather large yellow rings". Although this nomenclature is invalid and Boulenger's (1885) name of *Varanus acanthurus* applies, this outstanding characteristic remains. *V. acanthurus* has a very dark background colouration which forms a reticulate pattern around a series of yellow to off white ocelli which include a black spot in their centre. In addition, *V. acanthurus* has a dark brown to black head and neck with a series of yellow to off white longitudinal stripes extending from the shoulder, up the dorsal and lateral surfaces of the neck, then on to the head (Fig. 2). In some specimens the dorsal surface of the head is immaculate. These stripes were always encountered and appear to be a more reliable character than the ocelli, which are absent in certain Western Australian specimens (see also Storr, 1980). Both presence of ocelli and neck stripes should be used as a corroborative characteristic which diagnosing *V. acanthurus*.

In contrast, specimens of *V. baritji* have an immaculate brown head or on occasions with several black spots (Fig. 1). Black spots are also present on the neck in some specimens, but this area is generally unmarked. Yellow and black stripes were not observed on the neck. A distinctive black facial mask bordered in white is present on all specimens and contrasts with the brown face (Fig. 1).

The back pattern of *V. baritji* is most distinctive. A series of irregular black spots are scattered across a red ochre background. In some individuals the black spots intermesh to produce occasional black rings. In other specimens the complete dorsal surface is covered by a reticulate pattern of black rings. These differ from the ocelli seen in *V. acanthurus* in that the rings do not include a white or yellow area with a black spot in the middle. In some individuals of *V. baritji* off white flecking occurs on the back and sides of the thoracic region and generally extends from

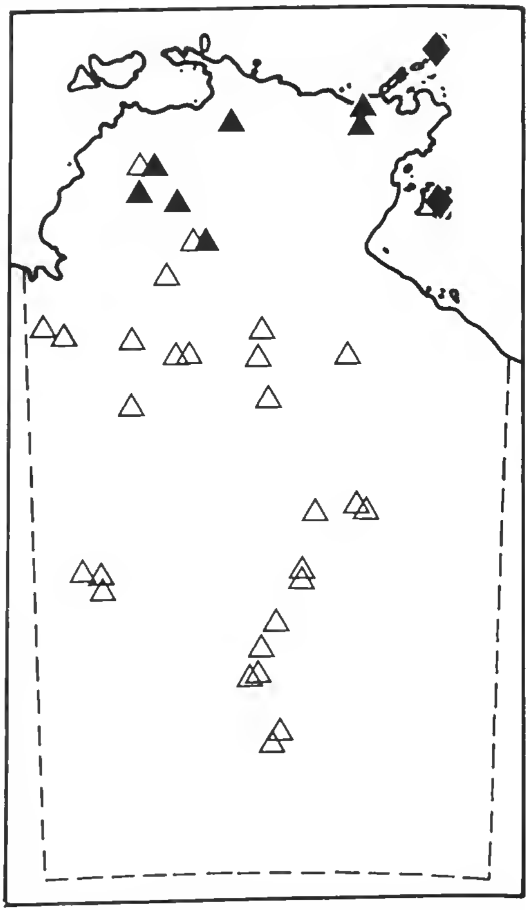

Fig. 3. The distribution of *Varanus baritji* specimens (solid triangles), compared to that of the specimens of *V. ananthurus acanthurus* (hollow triangles), and *V. acanthurus insulanicus* (solid diamonds) in the Northern Territory.

Table 1. Comparison of some morphometric and meristic characteristics which are diagnostic for members of the *Varanus acanthurus* species complex.

Character	*V. storri*	*V. primordius*	*V. a.acanthurus*	*V. a.insulanicus*	*V. baritji*
Snout-Vent length in mm.	49-132	95-110	65-240	226-250	121-252
Number of midbody scales	70-94	60-66	88-112	91-98	80-112
Ocelli in back pattern	-	-	+	+	-
Striping on neck	-	-	+	+	-

the white stripes in the facial mask. These are individually pigmented scales and they sometimes appear as rows giving the impression of being lateral stripes.

A summary of measurable and meristic characteristics for *V. baritji, V. acanthurus acanthurus* and *V. acanthurus insulanicus* are shown in (Table 2).

Comparative *Varanus acanthurus acanthurus* material. NORTHERN TERRITORY: NTM R.9850, 20km S. Adelaide River, 13° 25′S 131° 09′E, 10 August 1980, coll. G. Husband and G. Armstrong; NTM R.0895, R.3827, Manbulloo, 14° 31′S 132° 12′E, 4 June 1974, coll. N. Boyd; NTM R.6888-9, 112km W. Katherine, 15° 14′S 131° 36′E, 17 April 1979, coll. P. Horner, B. Miller, D. and G. Armstrong; NTM R.7082, Victoria Highway, 16° 03′S 129° 16′E, coll. G. Gow and P. Horner; NTM R.5679, Keep River National Park, 16° 08′S 129° 39′E, 1 November 1981, coll. R. Pengilley; NTM R.2125-6, R.2147-8, 2ml. W. Victoria River Downs, 16° 22′S 130° 59′E, 22-24 April 1976, coll. G. Gow and N. Boyd; NTM R.3606, 1.2km S. Dunmarra, 16° 22′S 133° 25′E, 18 May 1977, coll. G. Gow and P. Horner; NTM R.3379-80, 17km E. Top Springs, 16° 37′S 131° 56′E, 10 April 1977, coll. R. Wells and P. Horner; NTM R.6604-5, 11.2km S. Top Springs, 16° 39′S 131° 46′E, 10 April 1979, coll. P. Horner, B. Miller, D. and G. Armstrong; NTM R.2591-2, 4.5km S. Dunmarra, 16°44′S 133° 24′E, 3 December 1976, coll. R. Wells and D. Metcalfe; NTM R.3337-8, 4.5km S. Dunmarra, 16° 44′S 133° 24′E, 10 April 1977, coll. R. Wells and P. Horner; NTM R.3336, 215km W. Borroloola, 16° 45′S 135° 03′E, 10 April 1977, coll. R. Wells and P. Horner; NTM R.6698-701, Wave Hill Station, 17°29′S 130° 57′E, 12 April 1979, coll. P. Horner, B. Miller, D. and G. Armstrong; NTM R.12795-6, Wave Hill Station, 17° 29′S 130° 57′E, 14 November 1984, coll. P. Horner; NTM R.5312-3, Elliot, 17° 33′S 133° 32′E, 25 May 1978, coll. G. Gow and P. Horner; NTM R.9318, Barkly Highway, 19° 23′S 135° 17′E, 27 September 1976, coll. R. Pengilley and S. Raskin; NTM R.2580-2, 32km E. Three Ways, 19° 24′S 134° 30′E, 3 December 1076, coll. R. Wells and D. Metcalfe; NTM R.5768, Frewena, 19° 25′S 135° 24′E, 1 January 1978, coll. G. Gow, P. Horner and K. Roth; NTM R.6440, Frewena, 19° 25′S 135° 24′E, 18 March 1979, coll. P. Horner, J. Griffiths and K. O'Brian; NTM R.8511, Frewena, 19° 25′S 135° 24′E, 2 March 1980, coll. G. Gow, P. Horner and K. Roth; NTM R.9771, Frewena, 19° 25′S 135° 24′E, 10 February 1981, coll. G. Gow and P. Horner; NTM R.1525-6, Rabbit Flat, 20° 34′S 130° 16′E, 13 October 1975, coll. G. Gow; NTM R.0894, Devils Marbles, 20° 34′S 134° 16′E, 6 September 1974, coll. G. Gow; NTM R.9277, Devils Marbles, 20° 34′S 134° 16′E, 28 March 1979, coll. B. Miller; NTM R.1486, The Granites, 20° 35′S 130° 21′E, 11 October 1975, coll. P. Rankin; NTM R.1547-8, Horden Hill, 20° 39′S 130° 19′E, 14 October 1975, coll. P. Rankin and P. Horner; NTM R.1295, Wauchope, 20° 39′S 134° 13′E, 4 October 1975, coll. G. Gow; NTM R.5748, Wauchope, 20° 39′S 134° 13′E, 31 May 1978, coll. G. Gow, P. Horner and K. Roth; NTM R.1324, Barrow Creek, 21° 31′S 133° 53′E, 5 October 1975, coll. P. Horner; NTM R.1777, Barrow Creek, 21° 31′S 133° 53′E, 28 October 1975, coll. G. Gow; NTM R.5366, Barrow Creek, 21° 31′S 133° 53′E, 28 May 1978, coll. G. Gow and P. Horner; NTM R.12706, Hanson River, 22° 00′S 133° 24′E, 10 September 1984, coll. P. Horner and H. Larson; NTM R.1340, 27km S. Ti-Tree, 22° 26′S 133° 24′E, 5 October 1975, coll. G. Gow; NTM R.0415, Prowse Gap, 22° 34′S 133° 20′E, 13 September 1974, coll. K. Roth; NTM R.0768, 11ml N. Alice Springs, 23° 33′S 133° 51′E, 14 February 1975, coll. K. Roth; NTM R.5418, Mt. Gillen, 23° 43′S 133° 48′E, 10 August 1976, coll. K. Roth.

The status of *Varanus acanthurus insulanicus*. Mertens (1958) described the subspecies *Varanus acanthurus insulanicus* from two specimens collected on Groote Eylandt, N.T. These animals were distinguished from *V. a. acanthurus* by their large size and melanistic colouration (S.V.L. 226mm (our measurements) and 230mm).

We have examined two additional specimens of *V. a. insulanicus* from Marchinbar Island in the Wessel Island chain. These are NTM R. 8937 from Two Island bay and NTM R. 8939 from Red Point. These specimens are also very large in comparison to *V. a. acanthurus* being 235mm S.V.L. and 250mm S.V.L. respectively. It should be noted that the largest specimen of a series of 54 *V. a. acanthurus* from the Northern Territory was 240mm S.V.L., whereas, the largest of a series of 111 measured by Storr (1980) from Western Australia was 237mm S.V.L.

Mertens (1958) describes *V. a. insulanicus* as being melanistic and examination of the holotype indicates that this is so. The specimens from Marchinbar island are also very melanistic and are similar in most respects to the holotype. All of these specimens have retained the black and yellow longitudinal neck stripes and head patterning found in *V. a. acanthurus*. The back pattern consists of black centred off white to yellow ocelli surrounded by an irregular black matrix. Many of the ocelli have broken down with the white areas interconnecting and amplifying to produce a roughly black and white banded effect. Clearly, the variation in size and colouration exhibited by these island specimens could be a reflection of their isolation and local adaptation. It should be noted that Storr (1980) documented significant differences in back pattern and colouration in *V. a. acanthurus* from different regions of Western Australia and also found that the northern specimens were distinctly melanistic.

The island distribution of *V. a. insulanicus* is bisected by an eastern extension of Arnhem Land incorporating the Gove Peninsula. It seems reasonable to expect that *V. a. insulanicus* might be found in this region. It is also worth noting that the known populations of *V. a. insulanicus* are separated from the mainland population of *V. a. acanthurus* by the intervening range of *V. baritji* in the northern part of its distribution

Table 2. Morphometric and meristic characteristics of *Varanus baritji*, *V. acanthurus acanthurus* and *V. a insulanicus*

	V. baritji N=12		*V. a acanthurus* N=16		*V. a insulanicus* N=3	
	$\bar{X}$	R	$\bar{X}$	R	$\bar{X}$	R
Snout-Vent length in mm	171.50	(121-252)	179.69	(120-240)	237.00	(226-250)
Tail length in mm	296.90	(206-472)	280.29	(182-366)	422.00	(-422)
Forelimb length in mm	47.88	(33.4-70.8)	46.79	(31.4-67.3)	66.87	(62-69.5)
Hindlimb length in mm	63.26	(45.3-95.2)	64.90	(43.6-87.3)	93.07	(82.8-99.2)
Head width in mm	16.15	(10.8-23.8)	18.13	(12.4-26.1)	23.07	(22.7-23.5)
Head depth in mm	12.17	(7.5-18.2)	13.86	(8.8-20.2)	18.72	(18.3-19.2)
Nostril-snout length in mm	5.58	(4.3-8.1)	5.45	(4.1-7.9)	7.63	(7.3-8.3)
Nostril-orbit length in mm	6.38	(4.7-9.3)	6.57	(4.8-8.9)	9.37	(9.0-9.7)
Ear-snout length in mm	27.07	(21.4-39.5)	29.14	(21.9-39.6)	33.67	(28.3-37.5)
Forelimb-ear length in mm	38.81	(29.3-59.7)	38.53	(24.3-54.0)	54.30	(51.5-59.6)
Number of enlarged interorbitals	6.83	(6-8)	6.19	(5-8)	6.33	(6.0-7.0)
Number of scales between eyes	25.67	(21-29)	25.13	(22-30)	24.33	(23-26)
Number of supralabials	27.67	(26-31)	27.31	(24-31)	27.17	(26-29)
Number of scales below orbit	5.04	(4-6)	4.66	(4-6)	5.50	(5-7)
Number of scales between nostril-eye	5.36	(4-7)	5.47	(4-7)	5.33	(4-7)
Number of mid body scale rows	96.42	(80-112)	98.94	(91-108)	94.33	(91-98)
Number of ventral scale rows	60.92	(56-67)	64.38	(58-71)	59.33	(58-60)
Number of subdigital lamellae	21.25	(18-23)	20.81	(19-24)	21.66	(20-24)
Number of caudal scale rows	30.42	(28-34)	31.50	(28-35)	29.67	(29-30)
Snout-vent length to tail length ratio	0.58	(0.53-0.64)	0.62	(0.58-0.66)	-	(-0.54)
Head width to head depth ratios	1.34	(1.18-1.44)	1.32	(1.17-1.51)	1.23	(1.18-1.26)
Head depth to head length ratios	2.27	(1.85-2.85)	2.14	(1.74-2.49)	1.80	(1.52-1.95)

(Fig. 2) although the situation in the south western sector of the Gulf of Carpentaria is unknown.

In summary, we feel that *V. a. insulanicus* is an isolated island form of *V. a. acanthurus* which has differentiated from the norm in both size, and to a degree, in back pattern. However, both of these characteristics intergrade to some extent in the two subspecies. We therefore recognize this as a valid subspecies, but are reluctant to elevate it to the species level at this stage.

Comparative *Varanus acanthurus insulanicus* Type material. HOLOTYPE - AM R.11037, Groote Eylandt, 13° 49′S 136° 38′E, 1934, Northern Territory, coll. H. Perryman.

Comparative *Varanus acanthurus insulanicus* Additional material. NORTHERN TERRITORY: NTM R.8937, Two Island Bay, Marchinbar Island, 11° 05′S 136° 43′E, 8 October 1972, coll. D. Lindner; NTM R.8939, Red Point, Marchinbar Island, 11°17′S 136° 35′E, 18 October 1972, coll. D. Lindner.

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AN ADDITIONAL VARANID SPECIES IN THE NORTHERN TERRITORY

PETER RANKIN[1], PAUL HORNER[2] AND MAX KING[2]
[1]Deceased; Australian Museum, PO Box 285A, Sydney, NSW 2000, Australia.
[2]Northern Territory Museum of Arts and Sciences, GPO Box 4646,
Darwin, NT 5794, Australia.

ABSTRACT

An additional species of varanid lizard, *Varanus glauerti* Mertens, has been recorded in the tropical north of the Northern Territory.

KEYWORDS: Reptilia, Varanidae, *Varanus glauerti*, Northern Territory.

INTRODUCTION

The Varanidae is a widely distributed group of generally large tetrapod reptiles which range throughout Africa, Asia, Russia, the Middle East, South East Asia and Australia. The greatest diversity occurs within Australia where some 26 species are now recognized. In the Northern Territory, 20 species and subspecies of *Varanus* have been described and new species are still being encountered.

The Northern Territory varanids include: *V. a. acanthurus* Boulenger, 1885, *V.a. insulanicus* Mertens, 1958, *V. baritji* King and Horner, 1987, *V. brevicauda* Boulenger, 1898, *V. eremius* Lucas and Frost, 1895, *V. giganteus* (Gray, 1845), *V. gilleni* Lucas and Frost, 1895; *V. glebopalma* Mitchell, 1955, *V. gouldii* (Gray, 1838), *V. indicus* (Daudin, 1802), *V. kingorum* Storr, 1980, *V. mertensi* Glauert, 1951, *V. mitchelli* Mertens, 1958, *V. panoptes* Storr, 1980, *V. primordius* Mertens, 1942, *V. spenceri* Lucas and Frost, 1903, *V. storri ocreatus* Storr, 1980, *V. scalaris* Mertens 1941, *V. t. tristis* Fry (1913) and *V. t. orientalis* (Schlegel, 1839).

SYSTEMATICS

Varanus glauerti Mertens

(Figs 1, 2)

Material. A.M. R.59,658, Deaf Adder Gorge, 13°03'S 132°52'E, Northern Territory, 1972, coll. W. Bolton and D. Lindner.

Notes. Mertens (1957) described an attractive and relatively large rock dwelling monitor from the Kimberley division of Western Australia and named it *Varanus timorensis glauerti*. Subsequently, this subspecies was elevated to species level (Storr 1980). The presence of this species within the Northern Territory is under some debate. Cogger (1986) describes *V. glauerti* as being restricted in its distribution to the Kimberley region of Western Australia, whereas, Storr *et al* . (1983) allude to its' occurrence in the Northern Territory, but do not list their reasons for doing so.

Peter Rankin, a young Australian herpetologist who was tragically killed on a collecting trip in New Caledonia, found a specimen of *V. glauerti* in the Australian Museum collection. The animal (Fig. 1) had been collected at Deaf Adder Gorge, western Arnhem Land (additional details given above). A.M. R59,658 was compared to the holotype of *V. glauerti* (WAM R12,337) by P. Rankin and was determined to be this species.

A second specimen of *V. glauerti* was photographed by G. Chaloupka (Northern Territory Museum) in April 1980, while it was foraging in leaf litter amongst boulders, at Mount Gilruth 13°12'S 133°05'E, which is the highest point on the Arnhem Land escarpment, and about 10km from the first observation. This specimen (Fig. 2) is also unambiguously *V. glauerti*. The proximity of these animals suggests that the distribution of *V. glauerti* includes at least a portion of the Arnhem Land escarpment in the Northern Territory. The specimens of *V. glauerti* from the western Kimberley have an ocellated back pattern (Storr *et al.* 1983), whereas those from the eastern Kimberley have a barred back pattern. As one might expect, on the basis of geographic proximity the specimens encountered in the Northern Territory are of the barred variety.

Fig. 1. *Varanus glauerti* A.M. R.59,658 from Deaf Adder Gorge, N.T.

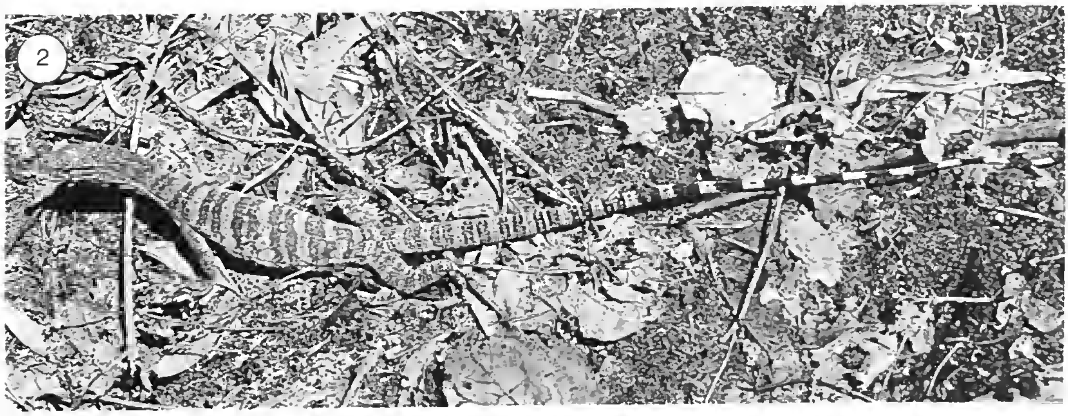

Fig. 2. *Varanus glauerti* photographed at Mount Gilruth, N.T.

ACKNOWLEDGEMENTS

Thanks to G. Chaloupka for providing us with a photograph of *V. glauerti* and to M. Gillam for giving us the use of Peter Rankin's notes.

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AN ADDITIONAL FRESHWATER TURTLE SPECIES AND THE CONFIRMATION OF *CHELODINA NOVAEGUINEAE* IN THE NORTHERN TERRITORY, AUSTRALIA

MAX KING AND PAUL HORNER
Northern Territory Museum of Arts and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

An additional species of *Elseya* Gray (Chelidae: Reptilia), *E. latisternum* Gray is recorded from the tropical north of the Northern Territory, and the presence of *Chelodina novaeguineae* Boulenger in the Northern Territory is confirmed.

KEYWORDS: Reptilia, Chelidae, *Elseya, Chelodina,* Northern Territory.

INTRODUCTION

There are four freshwater turtle species currently recognised as occurring in the Northern Territory. The aquatic pig-nosed turtle *Carettochelys insculpta* Ramsay, 1866, is the sole member of the monotypic Carettochelydidae, whereas the remaining species are semi-aquatic Chelidae: *Chelodina rugosa* Ogilby, 1890, *E. victoriae* (Gray, 1842) and *Elseya dentata* (Gray, 1863).

SYSTEMATICS

Elseya latisternum Gray

Northern Territory Material. N.T.M. R13,316, Mann River, 13° 01′S 133° 58′E, 1 ♂, coll. F. Woerle, 1985, (alcohol preserved); N.T.M. R13,516-7, Liverpool River, 12°35′S 133° 53′E, 2 ♀, coll. A. Georges, 22 October, 1986, (alcohol preserved); N.T.M. R13,524, same data but 1 ♂; A.M. R123,721, upstream from Jim Jim Falls, 13° 17′S 132° 50′E, sex unknown, coll. A. Pickering, (dry preserved).

Notes. The saw-shelled turtle *Elseya latisternum* Gray, 1867 was previously restricted in its known distribution to a narrow area along the east coast of Australia ranging from Cape York Peninsula to northern New South Wales. Although Goode (1967) and Cann (1978) reported specimens from the Flinders River on the eastern edge of the Gulf of Carpentaria. More recently a specimen of *E. latisternum* (QMJ 47,076) was collected from the Gergory river near Riversleigh in Queensland (J. Covacevich pers. comm.). In this paper we have been able to extend this species distribution over a considerable area of the north-eastern Northern Territory.

A total of five specimens of *E. latisternum* have been collected in the headwaters of the Mann River, Liverpool River and Jim Jim Creek in Arnhem Land. It would be reasonable to deduce from the widely separated localities, that these turtles occupy watercourses throughout the entire Arnhem Land plateau and its heavily dissected escarpment. This distribution is markedly isolated from the eastern populations. However, it is difficult to determine whether this is due to ineffective collecting in the Gulf of Carpentaria basin, or whether there is an unpopulated gap bisecting the two separate regions of this species distribution.

The specimens of *E. latisternum* collected were all adult and of both sexes. The animals were unambiguously *E. latisternum,* having an intergular shield which is as wide as or wider than the gular shields. All specimens have conical tubercles on the neck, and show a distinctive lateral demarcation between the dark grey dorsal surface and light coloured venter. Indeed, the only unusual characteristic of the the live specimens examined was that the ventral skin surfaces of neck, arms and legs were distinctly pinkish. In some specimens pinkish red spots (which were arrayed in lateral lines), were present on the dark gray tail. *E. latisternum* from eastern populations generally have cream to white ventral colouration on these appendages. (Cogger, 1986)

Chelodina novaeguineae Boulenger

Northern Territory Material. N.T.M. A/S R5,753, Maria Island, 14°53′S 135°43′E, 1 ♀

, coll. D. Howe and L. Joshua, 11 July 1972, (alcohol preserved); N.T.M. A/S R5,898, Maria island, 14° 53′S 135° 43′E, coll. C.W. Dodd, 26 July 1972 (shell only).

Notes. There is some controversy about the status of this species. The New Guinean long necked turtle *Chelodina novaeguineae* Boulenger, 1888 is reported as occurring in Australia by Cogger (1986). It is found on the Cape York Peninsula and extends south to the Bowen area in Queensland. Cogger makes no mention of this species occurring in the Northern Territory, whereas, Cann (1978) claims *C. novaeguineae* is present in all river systems that enter into the Gulf of Carpentaria, and that it is also found in semipermanent lagoons near Daly waters and Newcastle waters in the central Northern Territory. Goode (1967) claims that these animals occur in Arnhem Land and extend as far south as Katherine. Both of these statements remain unsubstantiated in terms of museum specimens; no Australian specimens of *C. novaeguineae* are present in the extensive Australian Museum collection (R. Sadlier pers. comm.).

Two specimens of *C. novaeguineae* have been collected from Maria Island in the south-western Gulf of Carpentaria (additional details given above). The specimens were determined to be *C. novaeguineae* on the basis of the following characters:

1. The anteriorly expanded plastron is less than 1.9 times longer than broad.
2. The intergular shield is markedly more than twice as long as the suture between the pectoral shields.
3. The tubercles on the neck are large and rounded in NTM A/S R 5753.
4. Both animals have an oval shaped carapace.

These specimens confirm the presence of *C. novaeguineae* in the Northern Territory. The locality from which the collection was made is of some significance, for Maria island is adjacent to the mouths of the Roper, Towns and Limmen-Bight rivers. It is possible that this population was established by specimens washed out to sea during flooding. Such animals may have taken refuge on the island. It is worth noting that the Hodgson River, a tributary of the Roper, arises in the vicinity of Daly Waters. This is the precise area from which Cann (1978) described a population of *C. novaeguineae*. Nevertheless, there is no evidence to support the occurrence of *C. novaeguineae* in the Arnhem Land to Katherine region as proposed by Goode (1967).

The occurrence of population isolates of both *E. latisternum* and *C. novaeguineae* in the east and central/west of northern Australia, suggests that these are relics of a once continuously distributed species. That is, ancestral *E. latisternum* may have been distributed from east to west across the north of Australia. It is also possible that C. novaeguineae isolates were once continuous and connected to the core populations in Papua New Guinea and West Irian.

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A NEW SPECIES OF SINULARIA (COELENTERATA: OCTOCORALLIA) FROM WESTERN AUSTRALIA, WITH EXTRAORDINARY MASSIVE SCLERITES

PHILIP ALDERSLADE
Northern Territory Museum of Arts and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

A new species of soft coral, *Sinularia megalosclera* (Family Alcyoniidae) is described from material collected off Rottnest Island, Western Australia. The species has four types of interior coenchymal sclerites, the most conspicuous being lumpy shapeless masses, mostly less than 5-6mm in diameter, that are recorded to attain a size of 12mm x 5mm x 5mm with a weight of 0.36gm.

KEYWORDS: *Sinularia*, Coelenterata, Octocorallia, Australia.

INTRODUCTION

Although the majority of octocoral genera have species with sclerites less than 1mm in length there are many species with sclerites of larger dimensions. Amongst the Octocorallia loosely referred to as soft corals, the sclerites of *Siphonogorgia macrospiculata* (Thomson and Henderson, 1906), over 8mm long, and those of *Studeriotes longiramus* Kükenthal, 1910, and *Sinularia larsonae* Verseveldt and Alderslade, 1982, up to 10mm long, must rank amongst the largest recorded. The sclerites of the latter two species are spindle shaped, but those of *S. macrospiculata* are more massive being stouter and irregularly shaped. Amongst the octocorals referred to as gorgonians, the sclerites of *Paracis squamata* (Nutting, 1910) were reported to be flat plates up to 5mm x 2mm in size, whilst amongst the sea pens *Pteroeides caledonicum* Kölliker, 1872, can have sclerites between 13mm and 14mm in length (Hickson 1916). There are, however, no reports in the literature of octocorals showing calcification of non-axial sclerite material to the extent displayed by the species described below, where maceration of a portion of the colony leaves a residue resembling white gravel. The nature of the sclerites of the surface layers and the colony morphology also serve to distinguish the species from other members of the genus.

SYSTEMATICS

Sinularia megalosclera sp.nov.
(Figs 1-9)

Type Material. HOLOTYPE - NTM (Northern Territory Museum, Darwin) C1050, Rottnest Island, Western Australia, 32°00'S, 115°30'E, 10m depth, April 1979, K. Harada.

Diagnosis. Encrusting *Sinularia* May, 1898, with a thick spreading base and erect lobes that look somewhat like molar teeth. Sclerites of the surface layer are predominantly clubs of many shapes together with branched forms and small rods. Most of these sclerites are 0.11 - 0.17mm long, but many clubs are larger, up to 0.25mm in the lobes and up to 0.34mm in the surface of the base. Spindles up to 0.5mm also occur in the surface layers. In the interior of the base and the lobes four styles of sclerite occur, the most conspicuous being large lumpy masses up to 12mm x 5mm x 5mm in size, although they are usually less than 5-6mm in diameter. The other interior coenenchymal sclerites are: small, waisted spindles with conical processes, coarsely warted spindles often irregularly branched or stout, and elongate-oval to pear-shaped masses with low evenly distributed warting.

Description. The specimen is a low encrusting piece of the original colony that has been broken into three portions which joined together measure about 165mm x 115mm (Figs 1 and 2). The thickness of the specimen varies from about 10mm to (measured through a lobe) 50mm. The side of the base, which is relatively smooth, slightly undulates over the contours of some large subsurface sclerites and forms a distinct rim around the upper edge of the specimen. The lobes arise vertically from the upper surface and are up to 25mm high. Their summits are divided into several somewhat pointed prominences which give the lobes an appearance

Fig. 1. *Sinularia megalosclera* holotype. Natural size.

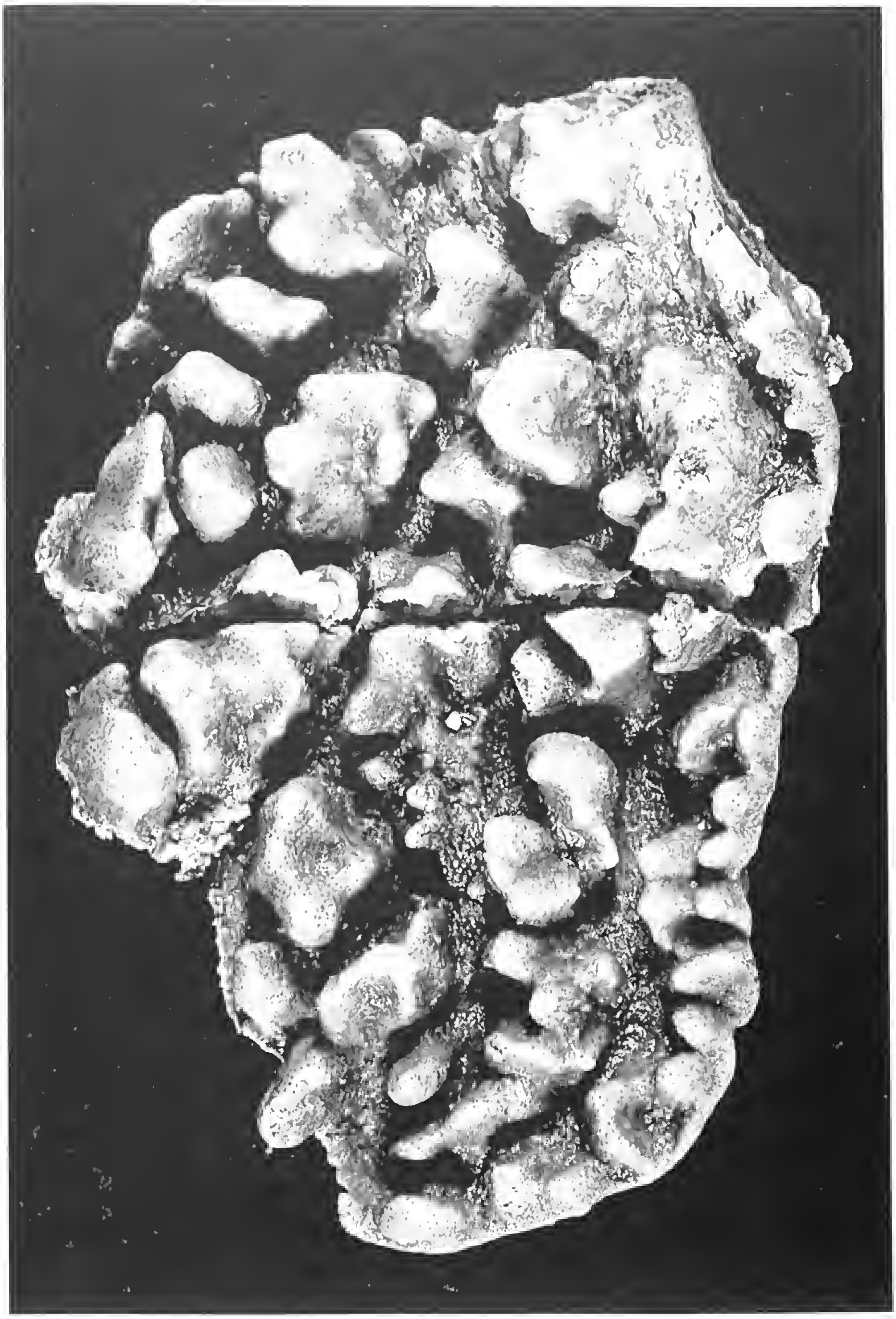

Fig. 2. *Sinularia megalosclera* holotype. Natural size.

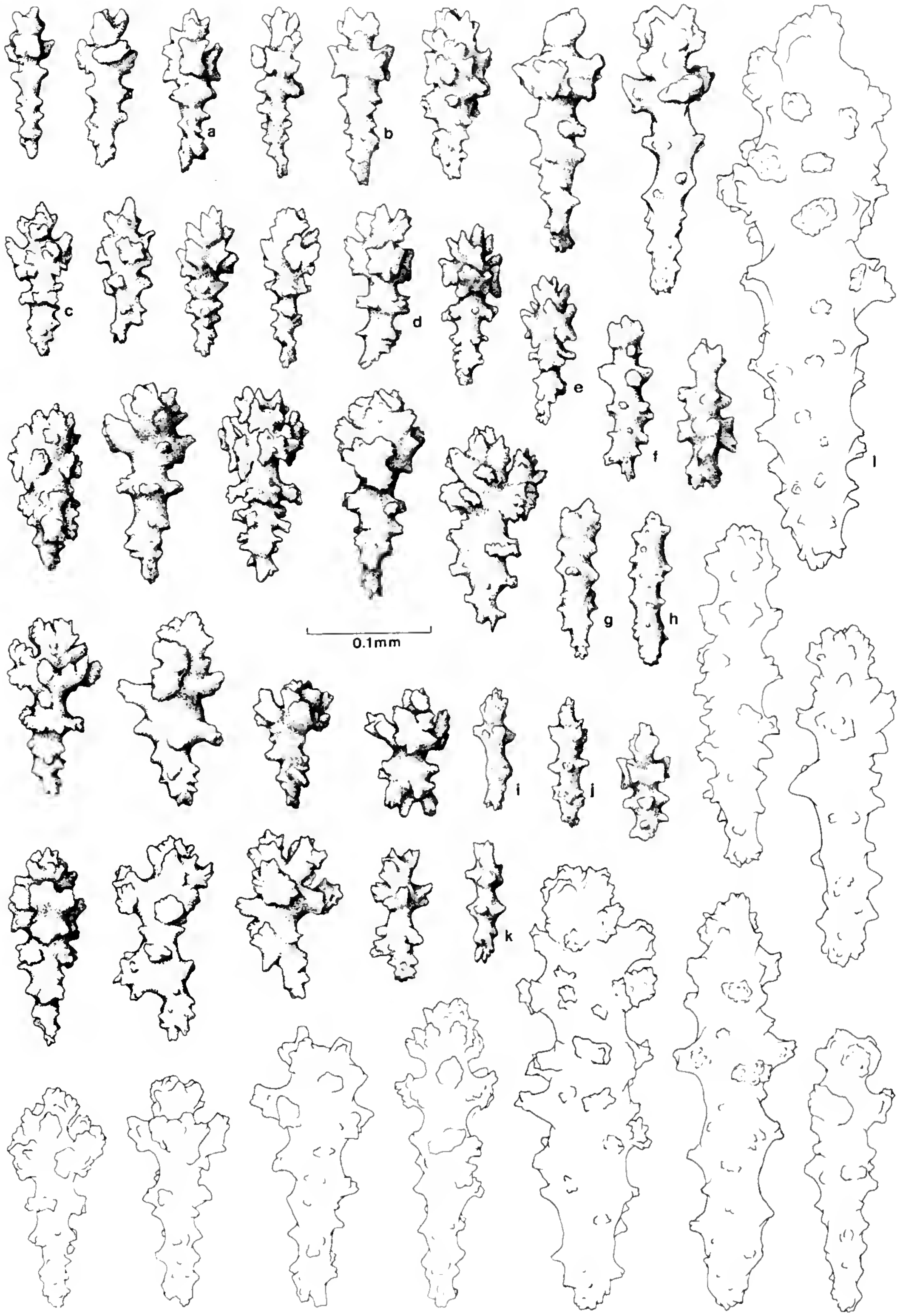

Fig. 3. *Sinularia megalosclera* holotype, sclerites from the surface layer of the lobes.

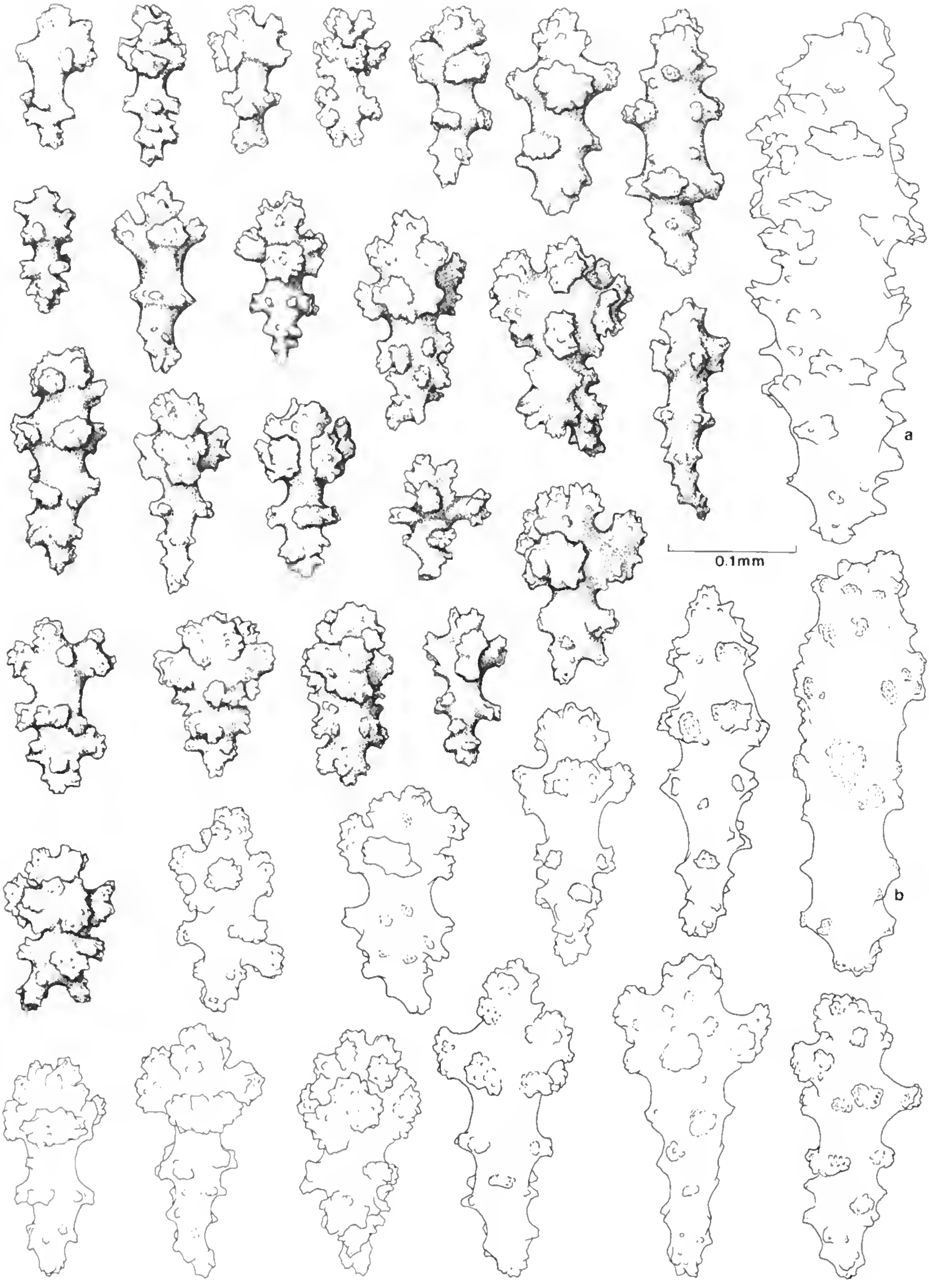

Fig. 4. *Sinularia megalosclera* holotype, sclerites from the surface layer of the the base.

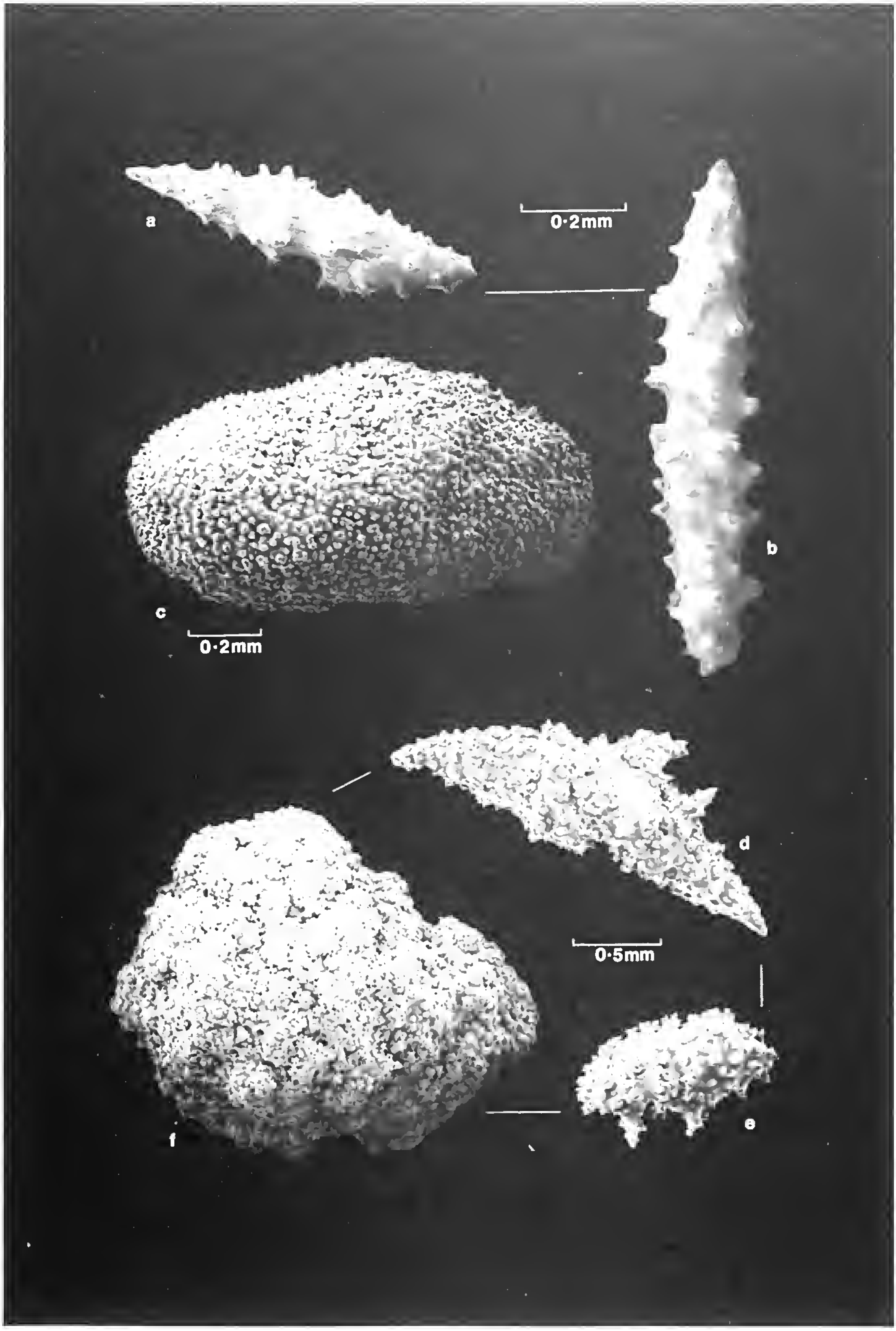

Fig. 5. *Sinularia megalosclera* holotype, interior sclerites.

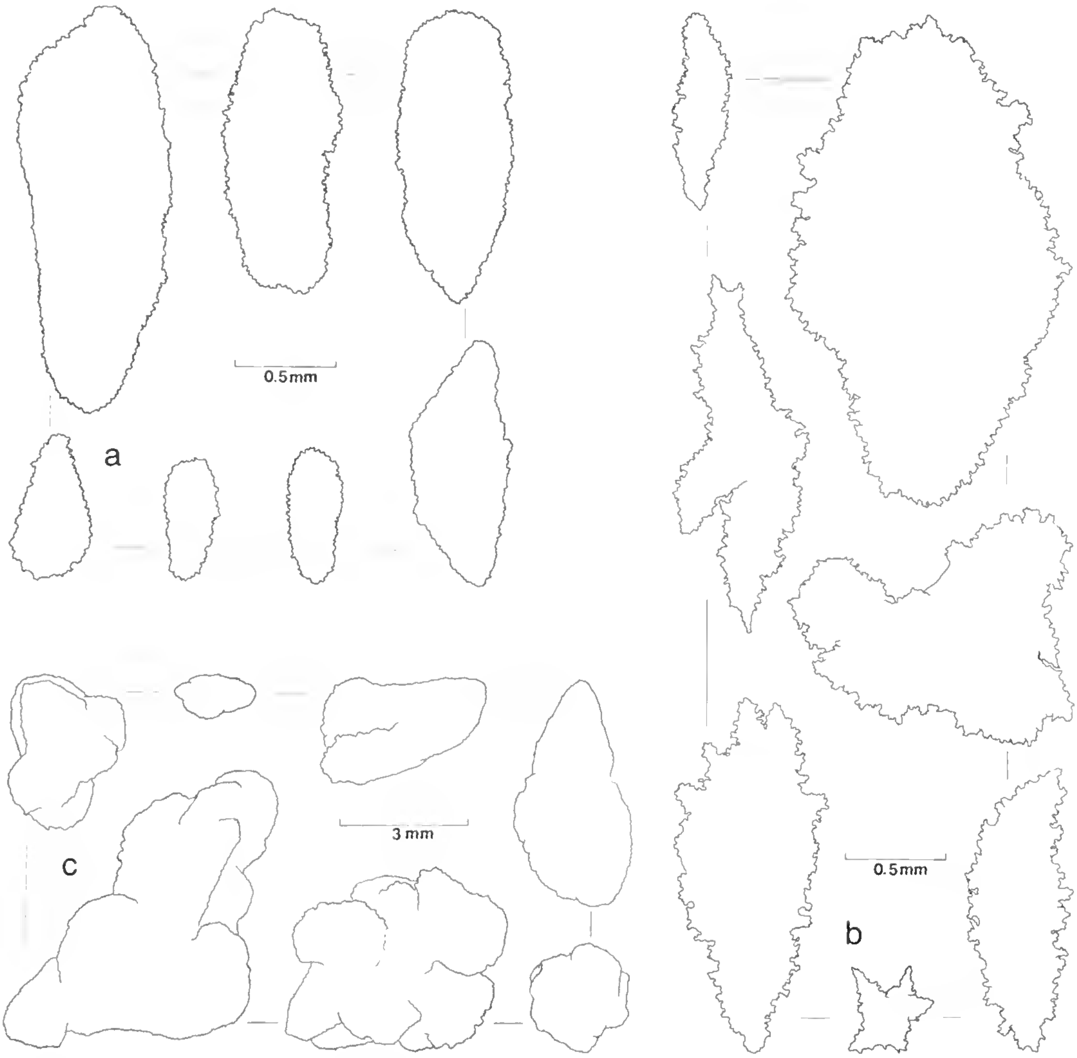

Fig. 6. *Sinularia megalosclera* holotype, interior sclerites.

suggestive of molar teeth. The polyps are all retracted leaving shallow pits 1-2mm apart all over the upper surface.

The sclerites of the surface layer of the lobes are predominantly clubs (Fig. 3). Most have well defined heads and many different types of architecture are present. Perhaps the most characteristic are those with a central wart and whorl of large warts below which tend to appear "wing-like" in plan view (for example, Fig. 3, a-e). There are also many irregularly branched sclerites and some small rod-like forms. Some of the rods are polyp sclerites (Fig. 3, f-k). Most of the clubs are 0.11 - 0.17mm in length but there are many larger clubs up to 0.25mm long. There are also some sclerites, to about 0.5mm long, that approach spindle form and which grade into the interior sclerites (Fig. 3, l).

The sclerites of the surface layer of the sides of the base are also mostly clubs (Fig. 4). There are many different types present, including branched forms, and most are stouter than those found in the lobes. The majority of clubs are 0.11 - 0.17mm in length, but many larger forms occur, occasionally up to 0.34mm long. There are also some sclerites which are spindle-like, up to 0.5mm long, and similar to those found in the surface of the lobes (Fig. 4, a, b).

The sclerites of the interior of the lobes and the base are the same, and are of basically four types: 1, pointed spindles with cone-like prominences and commonly a distinct waist, up to about 1mm in length (Fig. 5,a,b); 2, sclerites with complex irregular warting, that may be spindle-like, stout, or irregularly branched, up to 3.5mm x 1.7mm (Fig. 5,d,e and Fig. 6b); 3, sclerites with finer warting that is relatively evenly distributed, commonly elongate - oval to pear shaped and from 0.5mm x 0.3mm to (rarely) 3.7mm to 1.6mm (Fig. 5,c and Fig. 6a); 4, extremely conspicuous lumpy shapeless masses with low dense warting, usually 1-6mm through the longest diameter but occurring at least to 12mm (Fig. 5,f and Fig. 6c). In Fig. 8, to the right of upper centre, a large sclerite can seen in the colonial coenenchyme. When that sclerite was removed it was found to measure 12mm x 5mm x 5mm and weighed 0.36gm when chemically cleaned. There may be larger ones within the colony. Occasionally sclerites are found that are intermediate between different forms, and some occur that possess fine warting on one side/end and coarse high warting on the other. High magnification photographs of the warting on the sclerites shown in Fig. 5,c,d,f, are shown in Fig. 7A,B,C, respectively.

Some polyps dissected out of the coenenchyme were found to be armed with small numbers of rods grouped loosely at the base of each tentacle (Fig. 9). The rods are mostly about 0.13mm long but can vary from 0.07 - 0.21mm.

Remarks. There are a number of species of *Sinularia* with large interior sclerites. In *S. corpulenta* Li, 1982, they may be up to 8.1mm long, and in *S. larsonae* up to 10mm. In both these species the sclerites are spindle shaped. Thick sclerites, up to 7mm in length and sometimes irregularly shaped, are found in *S. foveolata* Verseveldt, 1974, and *S. brassica* May, 1898. The sclerites in the interior of the stalk of *S. loyai* Verseveldt and Benayahu, 1983, are described as "unbranched, strikingly wide, blunt or pointed", but they are only up to 3.3mm long.

In general, species of *Sinularia* have more than one type of coenenchymal sclerite. Amongst the large "normal" type of spindles there are virtually always small coarsely warted forms, as well as some smoother forms that are most probably developing sclerites. A few species are reported as having the larger coenenchymal sclerites in more than one style; for example, *S. anomala* Verseveldt and Benayahu, 1983, *S. humesi* (see Verseveldt 1971) and *S. peculiaris* Tixier-Durivault, 1970. However, no species of *Sinularia* are reported to have as many distinctly recognisable forms of coenenchymal sclerites as are found in *S. megalosclera*.

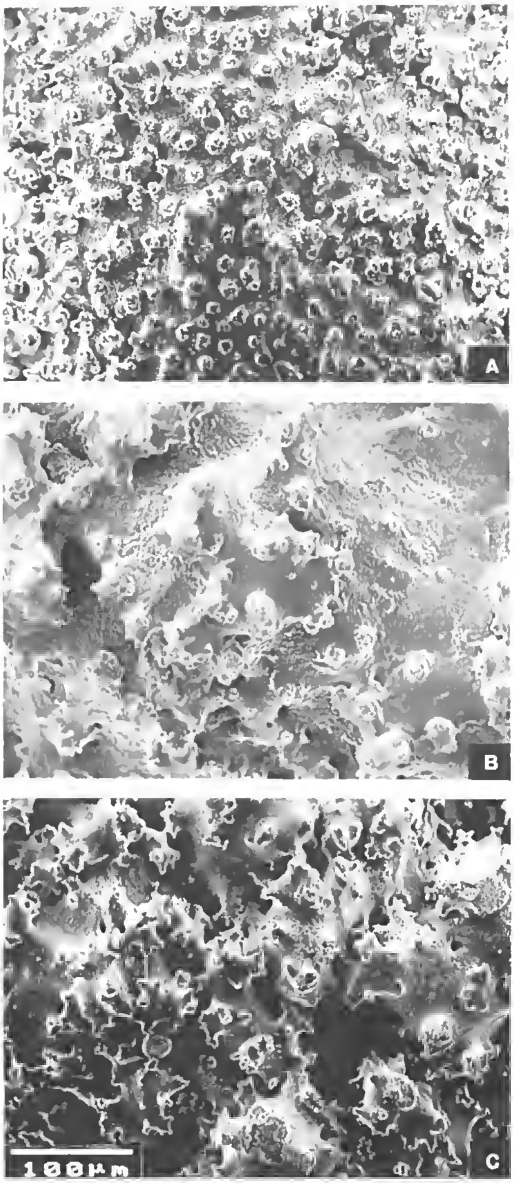

Fig. 7. *Sinularia megalosclera* holotype, warting of interior sclerites: **A**, sclerite from Fig. 5,c; **B**, sclerite from Fig. 5,d; **C**, sclerite from Fig. 5,f. All to same scale.

Fig. 8. *Sinularia megalosclera* holotype, cut surface.

Similarly there are no reports in the literature of species with sclerites as massive as those found in the specimen described above.

It is difficult to make comparisons between the surface sclerites of other species of the genus and those of *S. megalosclera* because of the many different forms that are present in this new species. Within a sample of sclerites from the surface layer, clubs characteristic of many different species can be found mixed together. Perhaps the closest species is *S. foveolata* which has clubs of a similar nature to some of those found in *S. megalosclera*. *S. foveolata* also has thick interior coenenchymal sclerites up to 7mm long, but it does not have the same forms of interior sclerites found in *S. megalosclera* nor the same colonial morphology.

Because many of the clubs of the surface layers have a central wart, *S. megalosclera* could be included in Verseveldt's (1980) Group II.

Etymology. The specific epithet makes obvious reference to the massive coenenchymal sclerites found in this species.

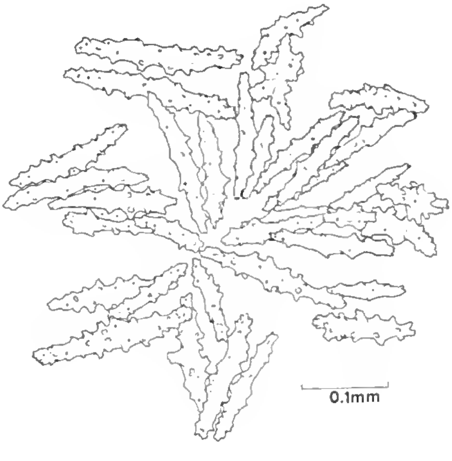

Fig. 9. *Sinularia megalosclera* holotype, polyp armature.

ACKNOWLEDGEMENTS

My thanks to Ann-Marie Mussig for her assistance in making up the plates, to Charles Webb and Jan Holland for taking the scanning electron micrographs at the University College of the Northern Territory, and to Alan Howard for photography and darkroom work.

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PLESIOSAURS FROM ALBIAN AGED BATHURST ISLAND FORMATION SILTSTONES NEAR DARWIN, NORTHERN TERRITORY, AUSTRALIA

PETER F. MURRAY
Northern Territory Museum of Arts and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

Eroded, fragmentary remains of a large elasmosaurid plesiosaur extends the range of Australian sauropterygians to the shallow Upper Albian seas of the central north of the continent. The plesiosaur is associated with abundant ichthyosaur *(Platypterygius* Von Heune) material which is also briefly described. The elasmosaurid affinity of the specimens is based on the morphology of a cervical vertebra and the large dimensions of the propodials. It resembles but can not be positively identified as *Woolungasaurus* Persson.

KEYWORDS: Lower Cretaceous, Upper Albian, Plesiosaur, Bathurst Island Formation, Australian ichthyosaurs, Elasmosauridae.

INTRODUCTION

Seven unassociated postcranial fragments of a large plesiosaur were recovered during a single collecting trip to the Casuarina siltstone reef locality during a spring tide in 1985. This shore-hugging reef of dissected and slumped Lower Cretaceous Bathurst Island Formation contains an abundance of ichthyosaur vertebral centra (Murray 1985). The purpose of the outing was to attempt to locate some of the elusive appendicular material that was assumed to be present but not easily found. A conscious attempt to change the search pattern resulted not only in the recovery of some ichthyosaur limb and girdle elements but the larger plesiosaur remains to be described. The key to locating this material was in recognition of the texture of the fossil bone in contrast to the shape-oriented search pattern determined by the distinctive disc-like form of ichthyosaur vertebral centra. It is extremely difficult to discriminate fossilized bone from the complexly eroded surface of the Casuarina siltstone unit which contains an abundance of reworked clasts or concretions that weather into organic shapes. Moreover, these are obscured by encrustations of bryozoans, calcareous tube worms, oysters and algae. Fewer ichthyosaur girdle and appendicular elements were found than the more massive

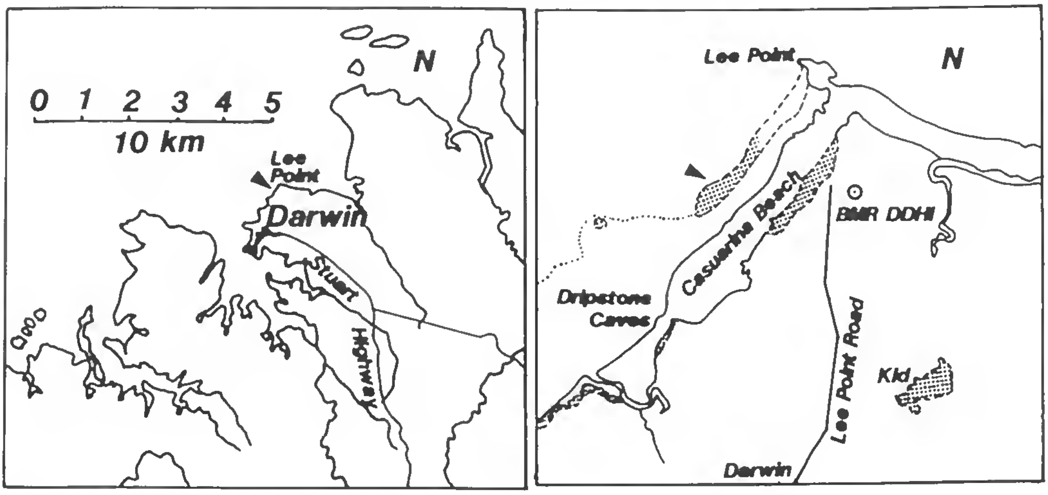

Fig. 1. Plesiosaur and ichthyosaur locality map.

plesiosaur remains despite the approximately 50 to 1 ratio of ichthyosaur vertebral centra to all other elements. Thus the collection is biased towards the size of the elements. This is clearly related to the durability of the bone because it is principally through the recognition of its eroded surface texture that it can discriminated. Ichthyosaurs from the Darwin region were noted previously by Teichert and Matheson (1944) and Murray (1985). However, no mention of plesiosaurs from the Bathurst Island Formation could be found except for speculations in the Sydney newspapers dating back to 1924 (Murray 1985).

CASUARINA PLESIOSAUR AND ICHTHYOSAUR LOCALITY

The Casuarina Beach locality outcrops in the area of 130 degrees 52.5 minutes E. longitude, 12 degrees 20.6 minutes S. latitude. A brief description of the locality is given by Murray (1985). The main outcrop of the Darwin Member (Bathurst Island Formation) at Casuarina beach is depicted on NTGS DARWIN sheet 5073 as a long, narrow band (Kld) lying a considerable distance behind the intertidal reef exposures from which the fossils were collected. The reefs also differ lithologically from the cliff exposures of claystone and may represent underlying siltstone beds within the unit (Fig. 1).

The low, slumped, deeply weathered and dissected reef system was given an alphanumerical designation for each segment. The fossiliferous exposures extend for approximately 750 metres in a northwesterly direction, parallel to the beach. The reefs are adequately exposed for collecting on spring tides of <1.2 metres low water. The fossiliferous sediment consists of a massive bed of fine silty claystone containing stratified or concretionary clasts of similar material which is slightly more resistant, resulting in numerous weathered irregularities that project from two to five centimetres above the surface. The claystone is soft and brittle with an unpredictable fracture plane, although it occassionally follows a horizontal weathered surface and detaches in the form of an irregular slab. Internally, the fossilized bone is surprisingly well preserved in contrast to its eroded and nodular exterior. The vertebral centra appear to be partially encased in concretionary structures and larger bones have irregular nodules of silicified claystone adherant to or continuous with the outer surface of the bone. The interface between the bone and the matrix is consequently often poorly defined, and I have resorted to sectioning some specimens on a rock saw to determine their shape.

The fossiliferous horizon is approximately 0.3 metres thick and appears to be associated with the clastic material contained within it. A more homogeneous, darker silty claystone lies conformably below where it is exposed up to a metre or more in depth. This horizon contains long deep cracks that have been infilled with a more durable sediment. These project above the eroded surface in the form of linear structures that extend for 10 to 20 metres in some exposures. At first glance they resemble logs or even segments of pipe (the Darwin intertidal zone is littered with remnants of defensive structures installed in the harbour during World War II). It does not appear to contain an abundance of fossils of any kind.

CASUARINA PLESIOSAURS

Subclass Sauropterygia
Superfamily Plesiosauroidea Welles 1943
Family Elasmosauridae Cope 1869
Genus et species indeterminate

Geological horizon - Albian, Darwin Member Bathurst Island Fm.

Seven identifiable fragments of postcranial skeleton are assignable to the Sauropterygia. A number of additional large bone fragments were also found, that while unidentifiable, are too massive to have belonged to the ichthyosaur *Platypterygius* Von Huene. The identifiable material includes a proximal fragment of left scapula (Fig. 2 a,b) the anterodistal portion of a right humerus (Fig. 2c) a left ilium (Fig. 2 d,e) an epipodial (Fig. 4f,g) a proximal right femur (Fig. 2 g,h) a cervical vertebra, a proximal femur fragment and an epipodial which were found closer together, but as ichthyosaur vertebral centra were also present, it cannot be said that the material is associated *sensu strictu*.

Femur. The basic shape and proportions of this specimen conform to the description of *Woolungasaurus* Persson femora given by Persson (1960). The original outline shape and dimensions are restored in Fig. 4. The breadth across the damaged distal end is 157.0mm; diameter of the shaft, 70mm. The

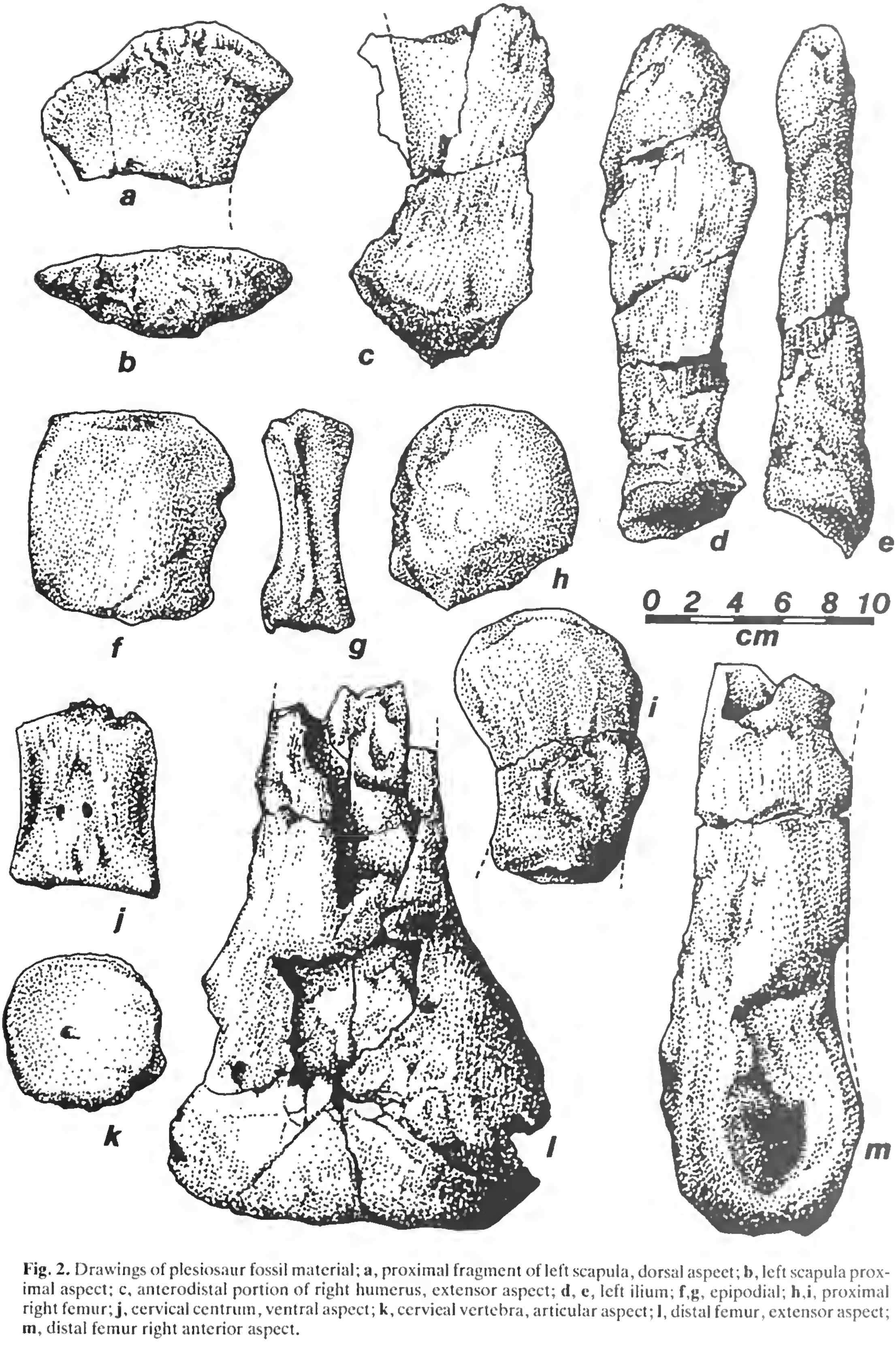

Fig. 2. Drawings of plesiosaur fossil material; **a**, proximal fragment of left scapula, dorsal aspect; **b**, left scapula proximal aspect; **c**, anterodistal portion of right humerus, extensor aspect; **d**, **e**, left ilium; **f**,**g**, epipodial; **h**,**i**, proximal right femur; **j**, cervical centrum, ventral aspect; **k**, cervical vertebra, articular aspect; **l**, distal femur, extensor aspect; **m**, distal femur right anterior aspect.

total length of the fragment is 230.0 mm. A damaged proximal femur fragment from the same (right) side preserves a portion of the shaft and about 80% of the circumference of the capitulum is 71.0mm anteroposteriorly and the diameter of the diaphysis is 66.5mm. This specimen is slightly smaller in the dimensions of its shaft, which also overlaps the break in the shaft of the first specimen.

Humerus. This is a fragment of the extensor face of a large propodial, probably a right humerus.

Epipodial. A specimen of a well preserved tibia or fibula. length, 94.0mm. width 85.0mm; proximal thickness, 35.0mm; distal thickness, 34.0mm.

Ilium. This is a poorly preserved slightly curved, elongated, flat girdle element. Proximally, the shaft becomes more robust and oval in section. A border of the actabulum appears to present. The fragment is 235.0mm long and 30.0mm thick in the mid-region. Its maximum width is 72.0mm.

Vertebral centrum. An elongated cervical vertebra with a pair of ventrally situated nutrient foramina lead into a central cavity within the body of the centrum as determined from sectioning the specimen. This distinctive vertebral chamber in plesiosaurs was first noted by Molnar (1982). A ventral keel separating the foramina is not visible, but the specimen is so badly eroded that a narrow crest may have once been present. There is partial preservation of an elongated dorsolateral crest on one side of the specimen. The outline shapes of the articular surfaces are ovoid, broader ventrally and slightly flattened dorsally. The articular facets are shallowly concave. An oval foramen-like structure is present near the centre of the best preserved face. The quality of the specimen is extremely poor but sufficient to indicate its affinity with the dolichodiran plesiosaurs. The dimensions of the specimen suggest that it is not *Woolungasaurus glendowerensis* Persson, but an elasmosaurid form with longer and narrower cervical centra. The length of the centrum is 80.5mm; height 61.0mm and width, approximately 75.0mm. Persson (1960) described a specimen in the Queensland Museum with similar proportions (QM, F. 2386) which he considered to be specifically and possibly generically distinct from *W. glendowerensis*. Unfortunately both assemblages are too poorly preserved and represented to form the basis of a description (Fig. 4, Table 1).

The elasmosaurid affinity of this material is expressed by the presence of a cervical centrum, longer than high, with a lateral longitudinal ridge. The propodials are short and stout as in elasmosaurids and closely match those figured by Persson (1960) for *Woolungasaurus*. The epipodial is eroded and damaged on one side but would appear to have been as broad as or broader than long.

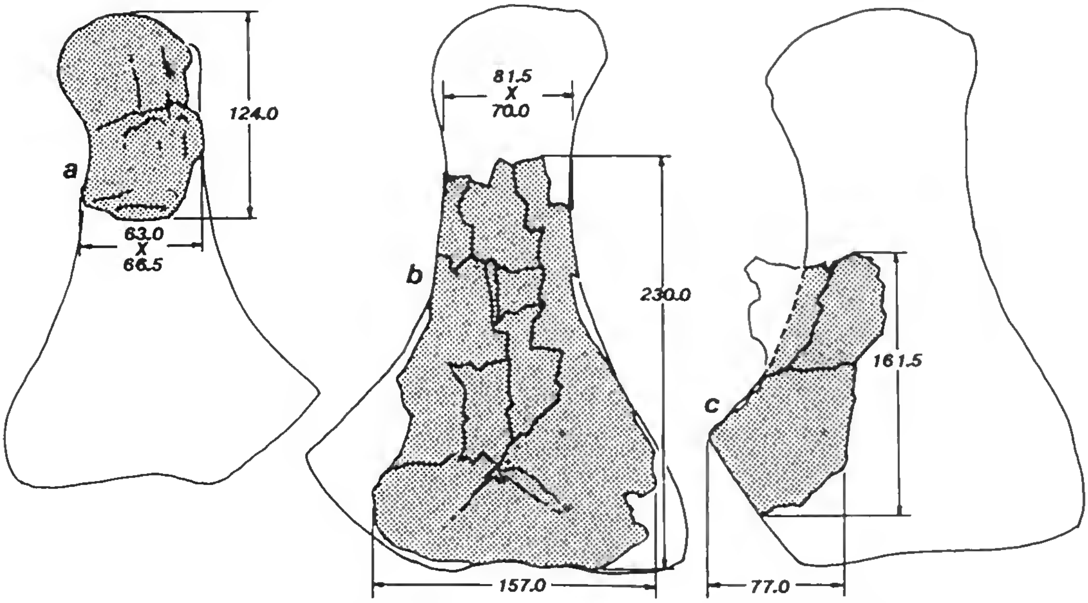

Fig. 3. Restoration of plesiosaur propodial fragments: **a**, proximal femur; **b**, distal femur; **c** distal humerus.

CASUARINA ICHTHYOSAURS

Subclass Icthyopterygia
Genus *Platypterygius* Von Huene 1932
Species Indeterminate

Geological horizon - Albian, Darwin
Member Bathurst Island Fm.

Some fragments of ichthyosaur appendicular and limb girdle elements are figured as a supplement to a previous description of indeterminate ichthyosaurs of the Darwin Member (Murray 1985). Identifiable material includes a proximal humerus fragment (Fig. 5 a, b) and two fragments of scapulae (Fig. 5c,d,e). As anticipated, these are morphologically compatible with the genus *Platypterygius* , but lacking the diagnostic distal end of the humerus, the species remains undetermined. Dimensions and restorations of the fragments are given in Figures 6,7,8.

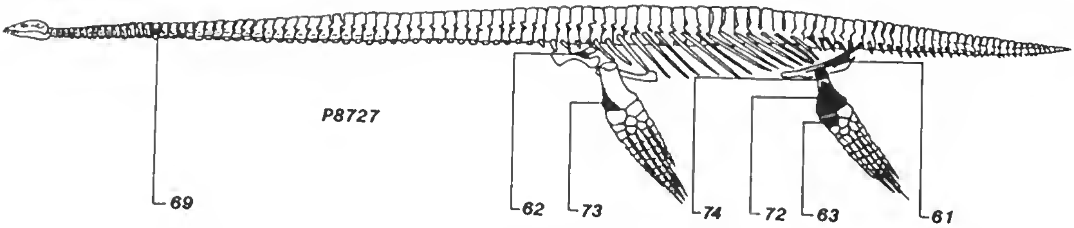

Fig. 4. Diagram showing representation of fossil plesiosaur material from the Casuarina Beach locality, P87 27-69, (cervical vertebra-62) scapula, -73) humerus, 74) femur-72) femur, -63) epipodial -61) ilium.

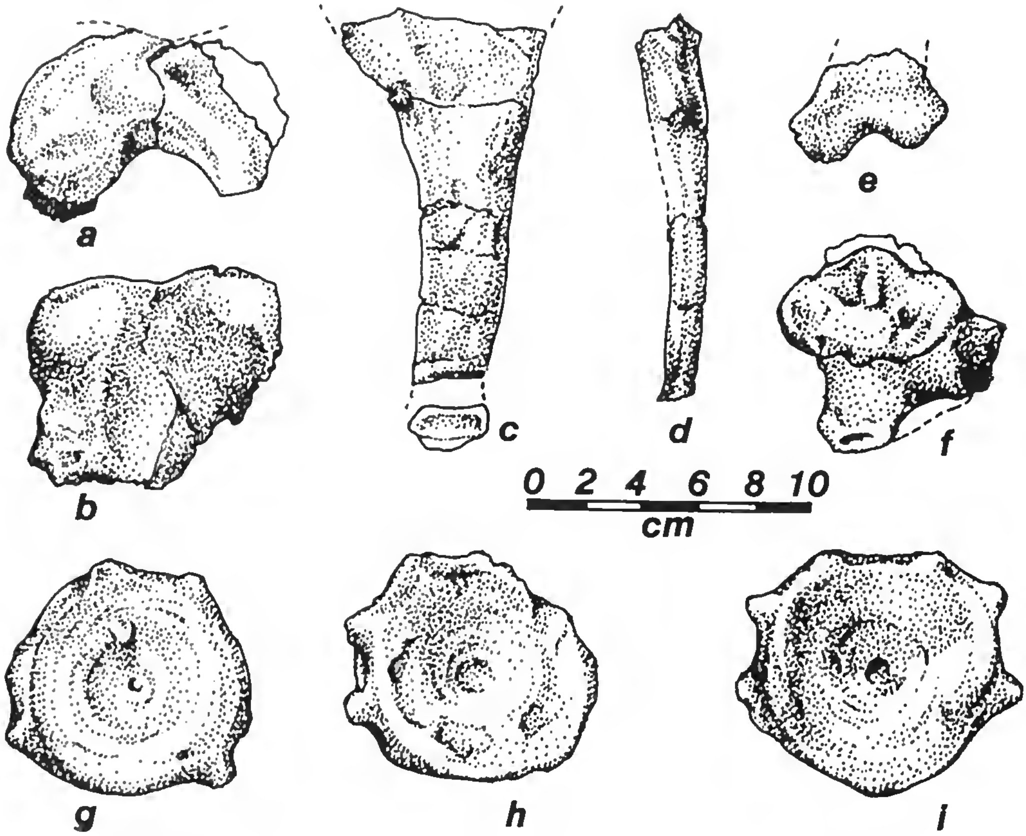

Fig. 5. Ichthyosaur fossils from the Casuarina Beach Locality: **a**, proximal humerus; **b**, proximal humerus, dorsal aspect; **c**, scapular blade, lateral aspect; **d**, scapular blade, axillary aspect, **e**, proximal scapula fragment, **f**, example of one of many unidentified weathered fragments of ichthyosaur bone; **g**,**h**,**i**, well preserved vertebral centra.

Humerus. This is a proximal fragment of a left humerus with a low, gently rounded capitulum and a prominent dorsal trochanter which is partially damaged and obscured by matrix. Its proportions and outline shape are similar to the University of Wyoming *P. americanus* Nace specimen (UW 2421) described by McGowan (1972) and QM F 2573 figured in Wade (1984).

Scapulae. Two scapula fragments represent a right scapular blade missing its posterior border and a heavily scoured left proximal portion. The dorsal border of the blade shows no evidence of the thickening or development of a crest as illustrated by Broili (1907) for *P. platydactylus* although the curvature of the axillary border and its relative proportions are apparently much alike. The acromial process appears to be narrower and deflected more dorsally than that of *P. platydactylus* and the dorsal surface appears to have been narrower and either only slightly expanded or straight. Because of its small size, I initially thought the fragment was a portion of neural arch but the broken end is too wide and was clearly continuous with a broad, flat bone.

In addition to the new postcranial material, a more comprehensive collection of ichthyosaur vertebral centra was made with many of the specimens in fairly good condition (Table 1; Fig. 5g,h,i). Some examples have quite large diameters (NTM, P87270-25 is 109.0mm. dorsoventrally) but all appear to lie within the known range of *Platypterygius australis* McCoy; none attain the large sizes reported for some New Zealand Upper Albian ichthyosaurs (Fleming, Gregg and Welles, 1971).

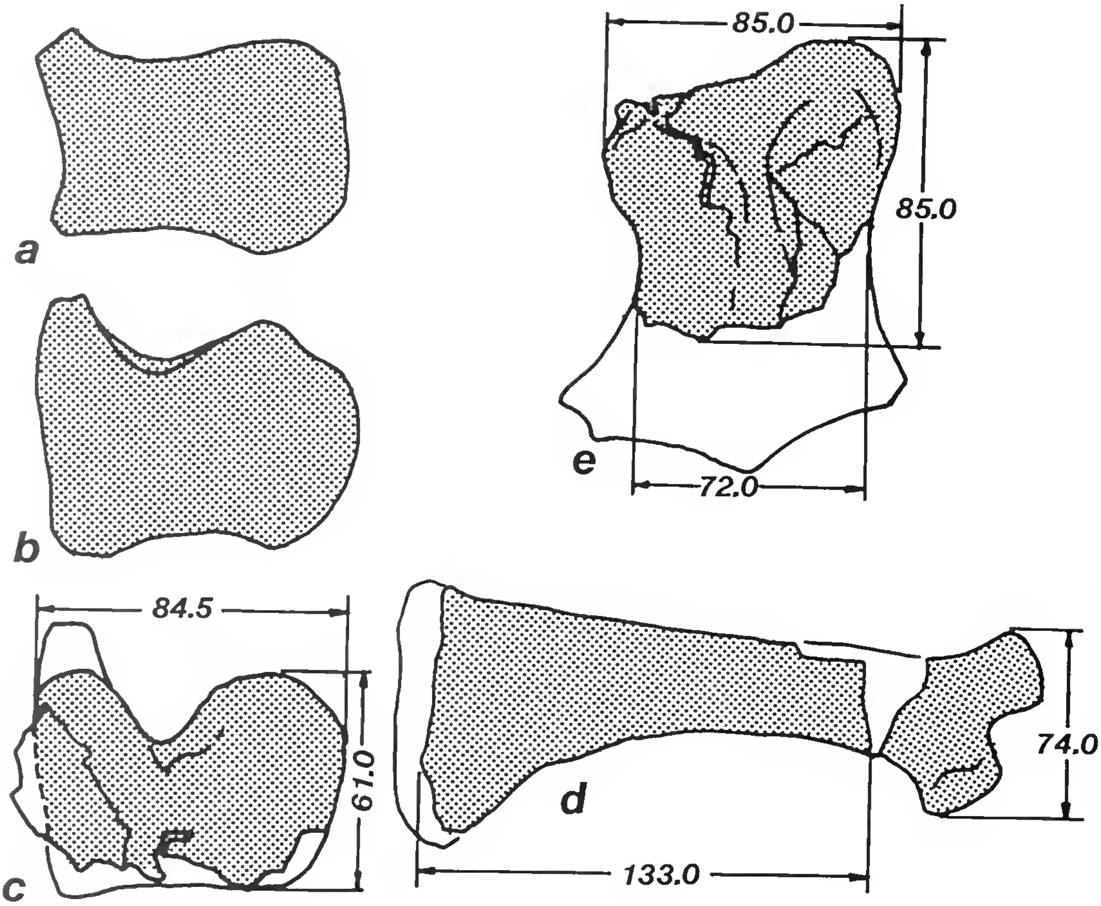

Fig. 6. Restoration of ichthyosaur girdle and limb bone fragments: **a**, proximal humerus after Wade (1984); **b**, proximal humerus after McGowan (1972) **c**, proximal humerus, articular aspect; **d**, scapula, lateral aspect; **e**, dorsal aspect.

Table 1. Measurements (mm) of ichthyosaur and plesiosaur vertebral centra. D = diameter; H = Height; L = length

				Ichthyosaur			
Cat. No.	*Length*	*Diameter*	$\frac{L}{D}$	*Cat. No.*	*Length*	*Diameter*	$\frac{L}{D}$
P8727-39	33.0	79.0	.42	P8727-26	26.0	70.0	.37
61	33.0	74.0	.45	19	30.5	102.5	.29
47	32.5	91.0	.36	23	27.5	63.5	.43
46	34.0	94.0	.36	15	37.5	92.0	.41
48	23.0	86.0	.27	21	34.5	82.0	.42
51	32.5	84.0	.38	22	16.0	50.0	.32
49	31.5	71.0	.44	17	38.0	99.5	.38
50	27.5	93.5	.29	2	28.0	72.5	.38
54	21.0	97.5	.21	1	25.5	75.0	.34
52	35.0	91.0	.38	16	36.0	80.5	.45
53	34.0	-	-	41	39.5	-	-
57	37.0	102.0	.36	7	38.5	78.5	.49
59	29.0	82.0	.35	6	27.0	88.0	.31
58	32.0	80.5	.40	4	35.5	98.0	.36
38	34.0	85.0	.40	12	34.0	86.0	.39
44	26.0	82.0	.32	11	33.5	75.0	.45
43	36.5	75.0	.49	10	41.0	-	-
24	29.5	82.5	.35	14	42.5	82.0	.51
33	35.5	90.0	.39	5	38.0	88.0	.43
35	36.0	-	-	20	42.0	95.5	.43
36	22.0	-	-	-	42.5	105.0	.40
34	27.5	-	-	-	41.5	93.0	.44
31	33.0	87.0	.38	-	40.5	107.0	.38
28	24.5	78.0	.31				
29	25.5	-	-				
30	25.5	-	-				
32	25.5	-	-			*Plesiosaur*	*H*
37	*40.5*	*75.0*	*.54*	*Cat. No.*	*Length*	*Diameter*	*L index*
42	*23.0*	*77.0*	*.30*	*P8727-70*	*80.5*	*61.0*	*.75*
27	*33.0*	*75.5*	*.44*				

DISCUSSION

This and the previous note (Murray 1985) conclude a preliminary investigation of the Cretaceous rocks in the immediate area of Darwin for fossil vertebrate material. Probably no more than the equivalent of two or three days searching over a very small portion of the known distribution of local outcrops of equivalent age have resulted in a substantial collection of material representing at least two genera of large marine reptiles. While there is no doubt as to the relative abundance of such material, the difficulty of discerning the fossils, the limitations placed by the tides on collection time and the possibility that much of the skeletal material has been scattered and damaged by depositional agencies must be taken into balance against overly optomistic view of the prospects. Having stated the obligatory cautions, systematic and detailed work on the problem will commence in 1987-88. The major projects are 1) a revised stratigraphic correlation of the vertebrate bearing unit (2) detailed sedimentalogical and petrographic analysis of the vertebrate-bearing rocks and modes of fossilization 3) assessment of the invertebrate fossils associated with vertebrate material 4) identification of fossil wood and other organic traces including a study of trace fossils, in conjunction with the Museum's Curator of Worms, 5) bulk collecting from known localities and survey for new sites extending to Cox peninsula to the west of Darwin and Gunn Point to the East.

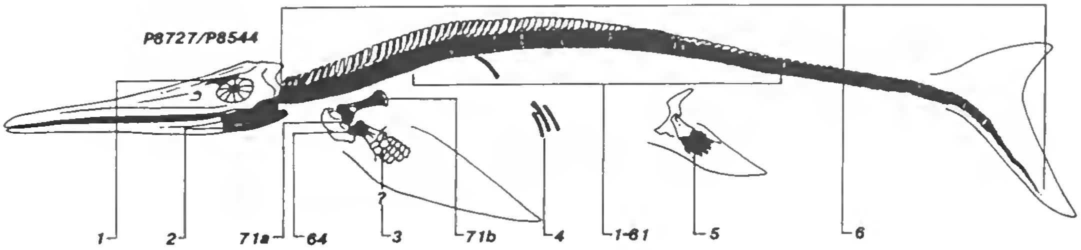

Fig. 7. Representation of Darwin area ichthyosaur fossils, including the articulated specimen from Nighcliff (Murray 1985). P8544-1) prefrontal fragment -2) angular and surangular P8727-71a proximal scapula P8727-64) proximal humerus P8544 ?-3) paddle trace, P8727-71b) scapular blade P8544-4) ribs, P8727-1-61) vertebral centra, P8544-5) hind paddle trace, P8544-6) centra

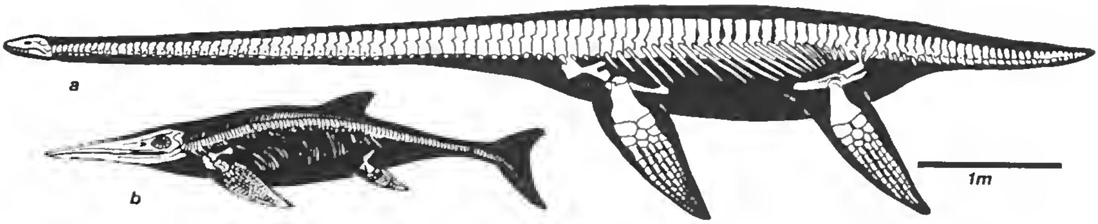

Fig. 8. Scale restorations of Darwin Area plesiosaur and ichthyosaur, based on sizes of representative fragments: **a**, Elasmosauridae *gen. et sp. indet.*, **b**, *Platypterygius* sp.

SUMMARY

Dolichodiran plesiosaurs (elasmosauridae) and ichthyosaurs, *Platypterygius* sp. occur in the Albian Darwin Member of the Bathurst (= Mullaman Beds, Skwarko 1966) Formation Island as scattered and partially articulated material in a generally poor state of external preservation. Internally, the material retains finely detailed structure, suggesting that bulk sampling and careful preparation may produce some fine specimens. Whether or not the vertebrate fossils are derived from equivalent horizons within the member is yet to be determined. The Casuarina locality is lithologically distinct and possibly lower in the sequence than the Nightcliff ichthyosaur (phosphorite nodule) bed.

Sufficient appendicular material has been found to indicate that the ichthyosaur is genus *Platypterygius*. The plesiosaur material is indeterminate below family designation (Elasmosauridae).

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Drs Ralph Molnar's and Andrew Rozenfeld's comments on the manuscript are greatly appreciated. Thanks are also extended to Dirk Megirian and Russ Hanley who participated in the collecting trips and discussions of the material and to Lorna Watt for her usual keyboard finesse and patience.

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RECONSTRUCTION OF A NINETEENTH CENTURY MAKASSAN *PERAHU*

NICK BURNINGHAM
Northern Territory Museums of Arts and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

Research undertaken to reconstruct the design of a 19th century Makassan (South Sulawesi) traditional sailing vessel is described. This research draws on historical sources, interviews with contemporary Indonesian boat-builders and sailors, and the personal observations of the author. Two sets of line drawings and three sketches are presented to indicate the general proportions and arrangements of a typical 19th century Makassan *perahu padewakang*

KEYWORDS: *perahu*, sailing boat, reconstruction, maritime technology, 19th century, *Makassan/Macassan*, South Sulawesi, Indonesia.

INTRODUCTION

This paper provides an account of research undertaken to reconstruct the appearance and design of a 19th century Makassan sailing boat or *perahu*, such as those that formerly frequented the coast of north Australia in search of *teripang* (otherwise known as sea cucumber or beche-de-mer). This research was initially conducted in order to build a model for the collections of the Museums and Art Galleries of the Northern Territory. Further research was later conducted as part of an Australian Bicentennial Celebration project which will involve the construction of a full-sized replica of a Makassan *teripang perahu*. This vessel will be built by South Sulawesi boat-builders using traditional methods, and will be sailed from Ujung Pandang (Makassar) to the Northern Territory in 1988.

For detailed information on the history of north Australi's *teripang* industry, and on the varieties of traditional and contemporary Indonesian sailing vessels, the reader is referred to the work of Macknight (1976,1980) and Horridge (1981,1985,1986).

NOMENCLATURE

The word *Makassan* is used here as an adjective and equates with *Macassan* as defined by Macknight (1976:1-2). The Makassan language is here called *bahasa Makassar*. The use of *k* in both these instances conforms to current Indonesian orthography.

Similarly, the contemporary Indonesian spelling of the word *perahu* is used in preference to the English derivative *prahu*. In Indonesian usage, *perahu* is used to indicate both single and plural forms, and this practice is followed here.

The spelling of contemporary *perahu* types is taken from the registration papers of perahu seen by the author. *Padewakang* is a transliteration of Bugis spelling (Macknight 1980:119).

Except where specifically ascribed to a particular language, the foreign nautical terms used in this article are those commonly employed by speakers of both *bahasa Makassar* and *Bugis,* and in use in *Bahasa Indonesia,* the national language of Indonesia. No attempt is made to identify the language from which the terms originate.

RESEARCH METHOD

The first program of research dealt mainly with the general arrangement and appearance of 19th century *teripang perahu,* in order to abstract a generalised design. The subsequent research attempted to analyse the relative proportions of 19th century *perahu,* and to then compare these with the proportions of contemporary South Sulawesi *perahu* displaying the closest degree of similarity to their 19th century counterparts. This latter research was undertaken in order to yield comparative data that could be clearly communicated to and discussed with present-day traditional boat-builders in South Sulawesi who are familiar with relative proportions but do not work from scaled plans.

The results of these two programs of research are presented in this paper in combined form.

Research material was drawn from a number of sources. These included 19th century written descriptions, drawings and paintings; modern photographs and drawings of 19th century models; and early 20th century descriptions and depictions. Although the information provided in these sources is sometimes incomplete and in some cases contradictory, these deficiences were overcome where necessary by recourse to 20th century boat construction and design practices, and inference based on practical seamanship. In the following section, the major pictorial sources employed in the analysis are itemised. It should be noted that a number of other pictorial sources available were rejected on the grounds of unclear or unlikely detail. A case in point is the drawing by L. Le Breton which dates to 1838 and is reproduced in Macknight (1976:Pl. 33). This shows a vessel with a bipod instead of tripod mast, and no sign of the usual double rudders which characterise these boats.

PICTORIAL SOURCES USED IN ANALYSIS OF NINETEENTH CENTURY PERAHU PROPORTIONS.

Items A and B. 2 pencil drawings entitled *The English Company's Islands: Malay Proas* by William Westall, landscape artist on board H.M.S. *Investigator* during the circumnavigation of Australia by Captain Mathew Flinders RN between 1801-1803; held in the collection of the Royal Commonwealth Society, London, and reproduced in Perry and Simpson (1962:Plates 109-110). These vessels originated from South Sulawesi and were part of a *teripang* collecting fleet encountered by the *Investigator* off the English Company's Islands in 1803 (see Flinders 1814 (1966):230 for further details).

These sketches are detailed and apparently accurate representations of the *perahu padewakang*-type, and display all the distinctive features of traditional South Sulawesi sailing vessels. They have low bluff bows with a bulkhead just abaft the bow to raise the freeboard; the masts are tripod-form; the sails are of the tilted rectangular variety (*layar tanja*); and the rudders are clearly shown mounted on the quarters, fitted with the tillers pointing aft. The two vessels are also depicted with different styles of prow finial, styles which are still found in South Sulawesi and which can be ascribed to particular areas. The low simple prow in **A**, is similar to the older *perahu lete* from several islands in the Makassar Strait while **B** shows the high curving prow popular on the mainland around Tanah Beru.

Item C. Ink drawing by Chris Snoek from a photograph of a model dated ca. 1840 (Horridge 1979:29) of a *perahu* of the *padewakang abi jawa* type, held in the collections of the Prins Hendrik Museum at Rotterdam (Catalogue number:29568) and reproduced in Horridge (1979:Fig. 21). This model was recently severely damaged in the Museum (personal communication from Horridge 23.7.87). A photograph of this model is also produced in Mulia and Hidding (n.d.:1027).

This is a well constructed planked model. The accuracy of its plank pattern has been confirmed by Horridge (1979:16) in the course of interviews with South Sulawesi boat builders. The vessel is very high-sided, with a top gallant deck built over the whole hull. Modern boat builders have identified it as a war vessel (personal communication with builders in Ujung Pandang, 1986).

Item D. Pencil drawing by Chris Snoek from a photograph of a late nineteenth century *padewakang abi tarus* model held in the collections of the National Museum, Jakarta (Catalogue number: 27170), and published in Horridge (1979: Fig. 26).

This item is easily recognisable as a South Sulawesi *perahu* for stylistic and design reasons, in as far as they can be assessed by projection from the oblique bow-on view of the vessel provided by Snoek. It is probably a model carved by a *perahu* sailor, and credence is lent to this view by reference to the several 20th century *perahu* models carved by *perahu* sailors that are housed in the collections of the Museums and Art Galleries of the Northern Territory (Catalogue numbers: IND 26,28,29,30 and 435.) While some are fine models, all show remarkable disregard for accuracy of relative proportions.

Item E. Black and white photograph entitled *Segelboot von Aloresen, den Vermittlern des Verkehrs mit Flores und Wetar* [Alorese sailing boat, the means of commerce with Flores and Wetar], published in Elbert (1912: Fig. 138). While there is nothing to positively connect this boat with South

Sulawesi, its design is very much in the South Sulawesi tradition, which is hardly unusual when one considers that there are established communities of South Sulawesi maritime peoples on Alor, notably the community of Kampung Makassar at Kalabahi. The styling and position of the large decorated board on this Alorese *perahu* is very similar to that found on a model of a *perahu padewakang* originally illustrated in Matthes' Atlas dated 1885, and reproduced in Horridge (1979: Fig. 22).

Item F. Sketch of a *padewakang*-type *perahu* by Alfred Russell Wallace, *ca.* ? 1860, unpublished. The provenance of this item is not recorded, but it is derived from material collected by Peter Spillett (Research Associate with the N.T. Museum) in Great Britain. This sketch, while rather crude and difficult to interpret, is particularly useful when interpreted in conjunction with Wallace's written description (see Wallace 1869:310-317) .

Item G. Plan drawings of the construction details and lines of a Bugis *perahu palari, Bintang Satoe* ("One Star" according to the source but probably "First Star"), taken off by William M. Blake in October 1928 in Singapore harbour, and published in Blake (1929:74). This vessel was part of the freight traffic of the Indonesian archipelago, and was described as 30 years old at the time of Blake's documentation, which gives it a construction date of *ca*. 1898.

The *perahu palari* or *palari pinis*, as it is otherwise called, is considered to be a recent development resulting from the modification of traditional *perahu* to accommodate the European standing gaff ketch rig (see Horridge 1979:30; Macknight 1976:149). With respect to this, it might be significant that *Bintang Satoe* has her main mast positioned as if for a traditional *tanja* rig, which is usually positioned further aft than is normal for the *pinis*-style ketch rig.

Item H. Line drawing by C.A. Gibson-Hill entitled *Profile of a ketch-rigged Palari from Southern Celebes*, published in Gibson-Hill (1950:11). Gibson-Hill notes (ibid): "The drawing shows a boat with the older pattern bows and a tripod foremast".

Item I. Photograph of a row of four beached *perahu* taken *ca.* 1910 in South Sulawesi, held in the collections of the Royal Tropical Institute, Rotterdam. A copy of this photograph was kindly provided by Professor Adrian Horridge. The vessels shown in this photograph are probably *perahu palari* rather than *padewakang* because they have heavy bowsprits with bobstays necessary to rig the forestays of a ketch but not required by *tanja* rigged vessels that have no forestay and jibs set "flying".

Item J. Watercolour by Lieut. Owen Stanley of H.M.S. *Britomart* entitled *Prows off Port Essington, February 1840*. This item is held in the collections of the State Library of New South Wales, Sydney, and has been published in black and white in Hawkins (1982:17) and in Macknight (1969: facing page 155).

Item K Black and white photograph of a relatively small *perahu of about the size of modern perahu patorani* under sail, taken in the vicinity of Ujung Pandang *ca.* 1900 and held in the collection of the Royal Tropical Institute, Rotterdam, The Netherlands.

Item L. Black and white photograph of a relatively small *perahu* (about the size of modern *perahu patorani*) moored in Ujung Pandang *ca*. 1920. This photograph is held in the collections of the I La Galigo Museum, Ujung Pandang, Sulawesi, Indonesia.

Item M. Black and white photograph of a model of a Butonese *perahu palari* entitled *Modell eines butonesischen Palari-Bootes als Kinderspielzeig* [Model of a Butonese palari boat, child's toy], published in Elbert (1911: Fig. 116). This is a very plausible and well-detailed model, although the rig is damaged and the rudders are mounted backwards.

GENERAL HULL FORM: COMMENTS

The large South Sulawesi *perahu* of the 19th century probably exhibited as much variation of hull form as do the 20th century vessels. It is possible for two vessels of the same type and the same length to vary in tonnage by as much as two to one. The various generic names for the 19th century vessels, *padewakang, bondeng, lambere, palari*, etc. are said to have been applied to various hull forms (Macknight 1976: 26; Elbert 1912: 221).

The *perahu* that came down to North Australia on *teripang* collecting voyages carried large crews, provisions for several months, materials for setting up camps on shore (including prefabricated houses), spare gear and a number of large canoes.

Each vessel carried six canoes of over two tons, plus a number of smaller canoes. According to the Northern Territory Government Resident's report of 1906 (1888-1911:381):

> "each of these proas have six large canoes each of which pays 20s for licence fee, being over 2 tons burden".

The *padewakang* that carried these canoes must have been fairly burdensome craft.

European observers saw Makassan *perahu* as vessels "with great beam and high sides" (Kolff 1840, quoted Horridge 1979: 27), and the contemporary illustrations tend to confirm this, although it must be remembered that by the mid-19th century, European sailing vessel design was changing towards an emphasis on very narrow and low relative proportions.

Many Makassan *perahu* had bamboo slatting in place of a permanent deck. They would have needed high freeboard to be seaworthy since they could not safely take seas over the rail.

ANALYSIS OF HULL FORM AND COMPARISON WITH A MODERN *PERAHU PATORANI*

The modern *perahu patorani* used here for comparison is *Sinar Galesong* from Galesong, South Sulawesi. Lines were taken off by the author and Dr Peter Murray of the Museums and Art Galleries of the Northern Territory, in November 1984 (Fig. 16).

Sinar Galesong appeared to be a typical example of a *patorani*, a type of *perahu* which has fairly uniform size and hull form. The *perahu patorani* retains most traditional 19th century features, including the *tanja* rig, tripod masts, double rudders, a low stepped down bow (*selompeng*), and a rockered keel curving into the stem and sternpost. Details of its construction are discussed further on.

The Stem. The stem and bow profiles were traced from pictorial items **A** to **I**, and these are shown in Figure 1. The angle of rake of the stem was measured from the tracings in Figure I by drawing a straight line from the forward edge of the stem at the waterline to a point on the forward edge of the stem at the height of the top of the rabbet; the angle between this line and a horizontal projection of the water-line was measured. This is shown in Figure 2. In some cases it was necessary to estimate a water-line, and this was done by eye. No measurement was taken from **D** because the drawing does not provide a profile view of the stem. The resulting stem rake angles are:

A: 53°
B: 55°
C: 56°
D: No measurement
E: 50°
F: 56°
G: 57°
H: 47°
I: 56°

The range of angles is small — only 10°, or 7° if **H**, the most recent example (1950), is discounted. The average angle is 53.75° or 54.75° if **H** is discounted. The angle for the modern *perahu patorani* is approximately 45°.

The Prow. All the pictorial sources show a projection of the stem above the rabbet and the foredeck. In each case this projection reaches a height just below the break of the sheer at the *selompeng* (Fig. 2). The only clear exception is **M** where the projection is higher. There are a variety of styles. In the 20th century *perahu patorani*, *pajala* or *bisean* the projection is considerably higher.

Cut-away in the Forefoot. Cut-away in the forefoot is the curving of the stem into the keel. All traditional South Sulawesi designs show considerable cut-away below the water-line, and this will be discussed later under the heading "Rocker". About half the pictorial sources **A** to **M** show the cut-away starting above the water-line, the other half show the stem (and the rabbet) straight from the water-line.

Perahu patorani all show very considerable cut-away at the water-line. Larger modern *perahu such as perahu bago*, *palari*, and *lete* are often straight stemmed at the water-line.

Foredeck or *Lapara*. The length of the foredeck was assessed as a proportion of the hull length measured between the top of the rabbet forward to the top of the rabbet aft (see Fig. 3), with the following results:

A: 0.048
B: 0.065
C: 0.077
D: 0.083
E: 0.083
F: 0.044
G: 0.070
H: 09.062
I: No measurement possible
J: 0.064
K: 0.068
L: No measurement
M: No measurement

These figures show moderate variation and give an average of approximately 0.066. The figure for the *perahu patorani* is much lower at 0.028.

The *lapara* is usually horizontal or parallel to the water-line on the *padewakang* and

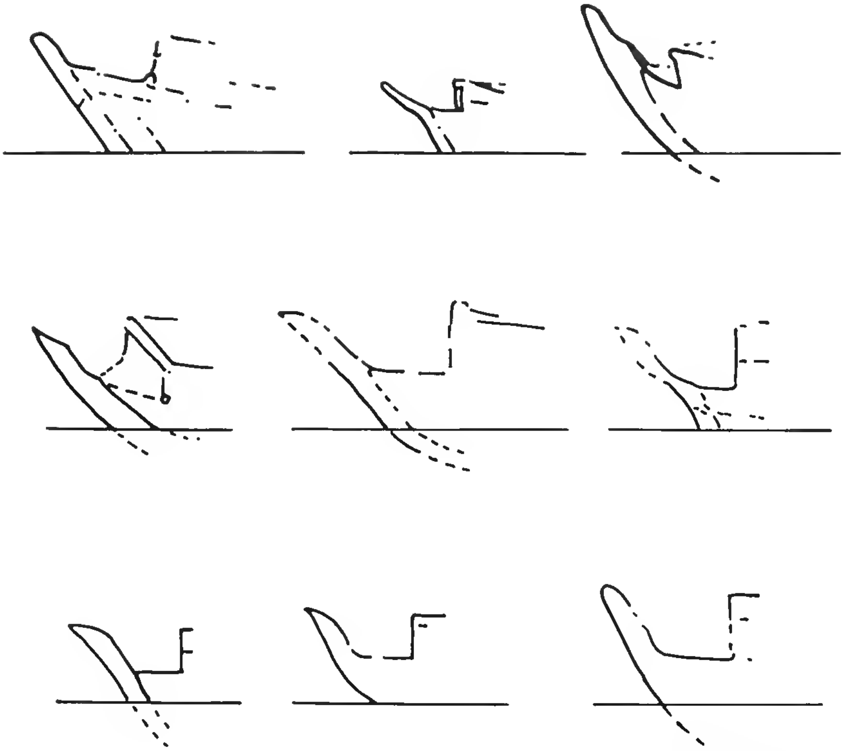

Fig. 1. Stem profiles of nine South Sulawesi *perahu* traced from the pictorial sources listed as examples **A** to **I**.

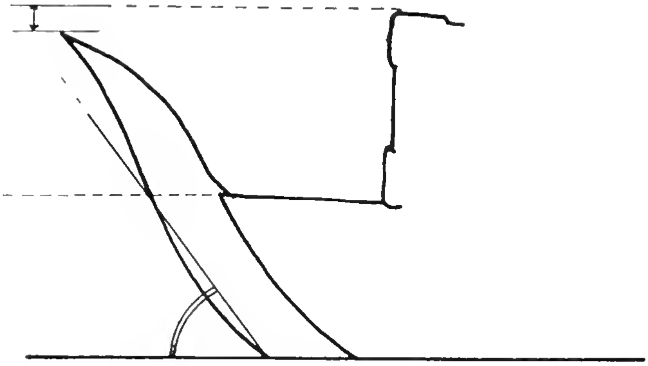

Fig. 2. Measurement of the stem rake angle and prow height.

does not follow the sheer as it does on *perahu patorani*.

The Selompeng. The height of the *selompeng* (the foreward bulkhead) above the *lapara* (Fig. 3) was analysed as a proportion of length measured between rabbets. This produced the following figures:

A: 0.048
B: 0.050
C: 0.043
D: 0.090
E: 0.048
F: 0.074
G: 0.062
H: 0.062
I: No measurement
J: 0.030
K: 0.066
M: 0.050

This gives an average of 0.055.

The figure for the *patorani Sinar Galesong* is lower at 0.048, and this figure is probably high for *perahu patorani*.

The height of the *selompeng* as a proportion of freeboard at the *lapara* (Fig. 3) was also calculated, in some cases using an arbitary water-line:

A: 0.75
B: 1.0
C: 0.9
D: 1.25
E: 1.27
F: 1.6
G: less than 0.10
H: 1.00
I: 0.95
J: 0.66
K: No measurement (vessel deep laden)
L: No measurement (bow obscured)
M: No measurement (bow obscured)

The average figure is approximately 1. This compares with a figure of less than 0.5 for *perahu patorani*.

Sheer. The sheer as formed by the rail or top plank is often obscured by *ambeng*, outboard planks, thatching or spare gear as in Westall's drawings (Items **A** and **B**). Some vessels clearly have high sterns while others have approximately equal height forward and aft, and therefore have the lowest point of their sheer approximately equidistant from bow and stern (Fig. 4).

Distance from the bow to the lowest point of sheer as a proportion of length was calculated as follows:

A: 0.45
B: 0.50
C: 0.25
D: 0.30
E: 0.50
F: less than 0.10
G: less than 0.10
H: 0.30
I: No measurement
J: No measurement (not clear)
K: 0.5 (deep laden)
L: No measurement
M: No measurement

These approximate figures give an average of 0.33, in no case is the lowest point of the sheer aft of midships. A *perahu patorani* in sailing trim has the low point of her sheer aft of midships, at approximately 0.55 of her length from the bow.

The Stern Post. Stern profiles were traced (Fig. 5) and the angle of rake measured in the same way as for the stems:

A: 63°
B: 65°
C: 70°
D: —
E: 62
F: 78°
G: 73°
H: 55°
I: —
J: —
K: —
L: —
M: —

Once again, the most recent example, **H**, showed the most rake. The average figure was 66.5° while an angle of around 60° seems standard for the *perahu patorani*. All stern-posts show some curve. There are no examples of stern-posts showing more rake than the stem.

The section of stern post above the rabbet and aft *lapara* is in most cases tall and near vertical. It is generally located outside the *ambeng*, and this is a very obvious difference between the 19th century *perahu* and recent types such as the *patorani*, *bago*, *palari* and *pinis* which all have long *ambeng* extending well aft of the stern post.

Position of the *sangkilang* rudder mounting beam. The *sangkilang* is a heavy beam that projects out-board on both sides of the hull. It is usually positioned at the level of the aft *lapara* and marks its forward end. The port and starboard rudders are mounted in

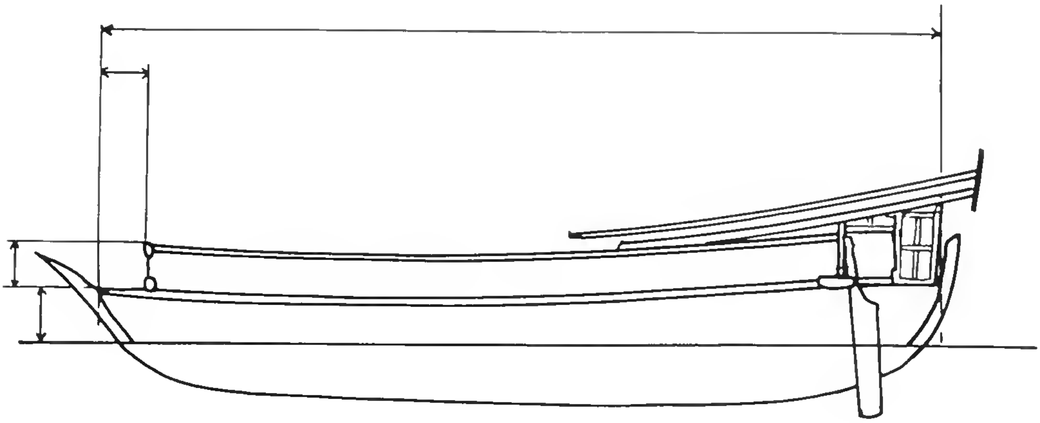

Fig. 3 Proportions of the hull's profile; hull length between rabbetts; foredeck length; *selompeng* height; freeboard at foredeck.

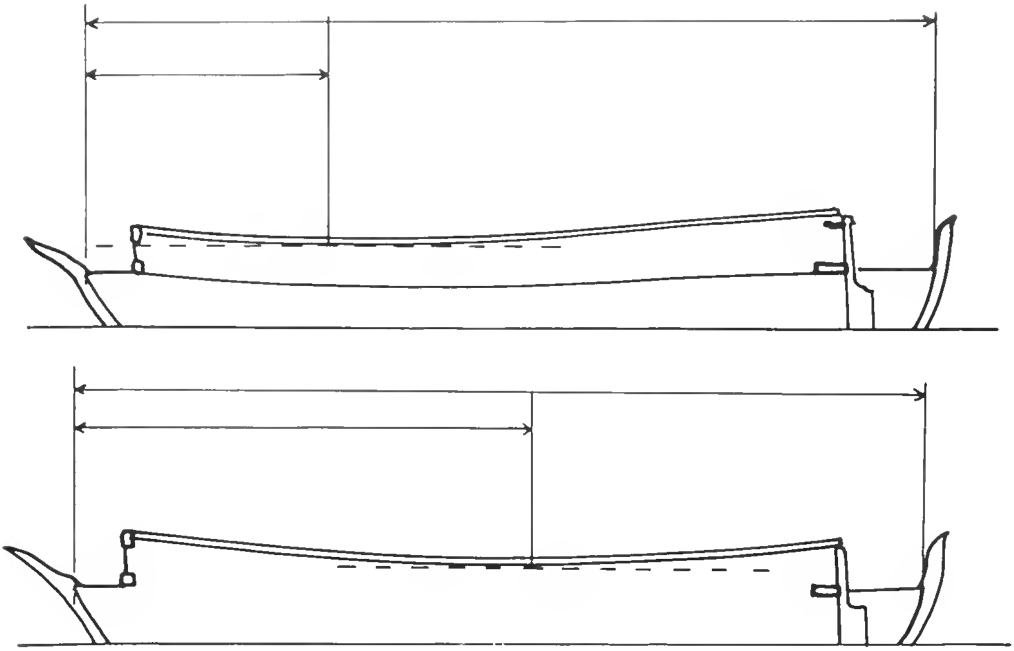

Fig. 4. Lowest point of the sheer; position measured from the bow.

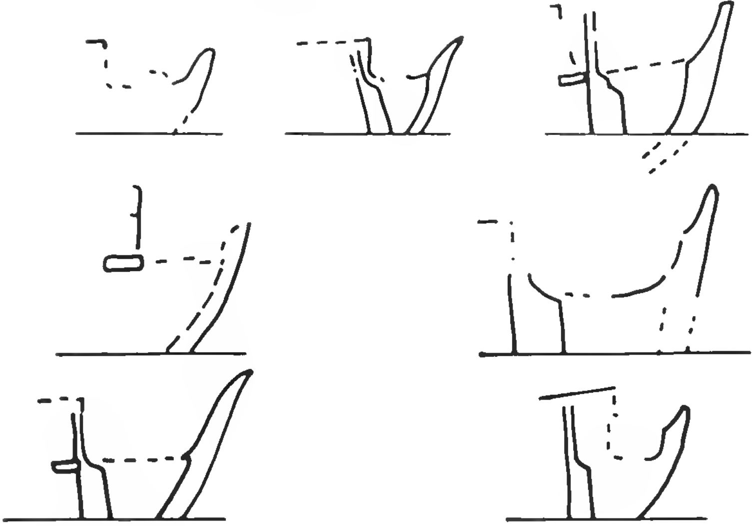

Fig. 5. Stern profiles traced from examples **A,B,C,E,F,G** and **H.**

notches on the aft side of the *sangkilang*, projecting on the port and starboard quarters. Aliskander Dembeatang, the owner and master of the *perahu patorani Sinar Galesong*, said that the correct positioning of the *sangkilang* is critical for the performance of a *perahu*. If the *sangkilang* is too far forward or too far aft, the performance will be spoiled. Aliskander said there is no formula for positioning the *sangkilang* but an experienced man could do it by eye.

The distance between the stern-post and the aft edge of the *sangkilang* was measured and calculated as a proportion of the vessel's length:

A: 0.050
B: 0.088
C: 0.133
D: 0.142
E: 0.079
F: 1.148
G: 0.102
H: 0.096
I: No measurement
J: 0.107
K: No measurement
L: 0.125
M: 0.145

In the case of **J** where no *sangkilang* is shown, the forward edge of the helmsman's opening in the side of the *ambeng* was taken to coincide with the *sangkilang* since this is normally the case.

The average figure is 0.11 but the figure for *Sinar Galesong* is 0.06. It seems that the *sangkilang* is now positioned further aft: probably this is only possible because the *ambeng* is no longer positioned between the *sangkilang* and stern-post.

Freeboard of the aft *lapara* calculated as a proportion of the freeboard of the *lapara* forward is shown below:

A: 0.88
B: 1.0
C: 1.25
D: —
E: 1.00
F: 1.50
G: 1.77
H: 1.0
I: —
J: —
K: —
L: —
M: —

The average is 1.2 which tends to confirm that 19th century *padewakang* were high sterned.

The figure for a *patorani*, based on measurements from *Sinar Galesong* and photographs of *patorani* in sailing trim (Hawkins 1982) is 0.8. The *patorani* is relatively low in the stern. *Perahu pinis* that still have a *lapara* aft hidden under the *ambeng* are high sterned.

Ratios of length, beam and depth. The essential proportions of a hull are length, beam and moulded depth or "depth in the hold". These proportions cannot be measured from drawings or photographs. Measurements taken from any model except an accurate scale model would be very suspect.

Quite probably *perahu padewakang* were regularly measured for tonnage which would require measurement of length, beam and depth but if any records exist they are not available. A survey entitled *Boats and Boat Building in the Malay Peninsula* (Warrington Smyth 1902:577, 580) gives dimensions for a large number of *perahu* types including the *bandong (bondeng)* and the *pedewak* (Bugis, Celebes). Unfortunately the dimensions given are clearly impossible; the *bandong* is given a beam of 6 feet and a depth of 3 feet and a freeboard of 13 feet (presumably it was a type of zeppelin). The *pedewak* dimensions are given as "99ft by 15ft by 12ft; 6 ft 3 in freeboard". The length to beam ratio is thus 6.6:1 which would be narrow even for a canoe.

The *perahu patorani Sinar Galesong* has a length to beam ratio of 2.65:1 which makes her a rather beamy craft. The lines of a *perahu pajala* (Horridge 1979: Fig. 5) show a length to beam ratio of 3.65:1. The *pajala* has very little moulded depth. If her hull were given greater depth, the flare of the topsides would increase the beam, and an extra straik would bring the length to beam ratio close to 3:1.

The *perahu palari pinis Bintang Satoe*, Item **G** (Blake 1929), has a length to beam ratio of 3.04:1; measured for length from the aft side of the stem to the fore side of the stern post at *lapara* deck level and measured for beam to the outside of the planking midships.

Gibson-Hill (1950:112) gives dimensions for six *palari pinis.* The lengths given are water line length and length overall which unfortunately includes the bowsprit. However Gibson-Hill *(ibid)* says: "The men themselves measure the hull internally, taking the distance from the aft surface of the head of the stem post to the forward surface of the head of the stern post". This figure is about 6-8% more than the external waterline measurement. So, increasing the waterline lengths by 7%, an average length to beam ratio for the six *palari* can be calculated. It is 3.4:1.

A Bugis Manuscript About Praus translated and interpreted by Macknight and Mukhlis (1975) offers a number of dimensions and ratios for building a *perahu*. There are however, some difficulties with the interpretation, which is in places very confusing.

Some of the confusion arises from doubtful translation of nautical terms. For example, the term *kalibiseang* is translated as hull, but it means keel (it is more likely that the aft part of the keel rather than the hull is one hand span wide). Similarly, *panyambung* is translated as hull extension (i.e. *lapara*), but it usually means a keel extension that joins the stem, and *pa'marru* is translated as bowsprit but this should be stem or stern post.

A section dealing with length and beam is translated (1975:276): "As for the hull of the prau [it should be] two fathoms with closed fists on either side and its length twelve fathoms with closed fists". During construction the beam is measured on each side of the keel in order to keep the vessel roughly symmetrical. This is because the hull is built up as a shell of planking from the keel with no frames or formers to build around. The formula gives a neat length to beam ratio; length twelve fathoms, beam four fathoms, hence a ratio of 3:1. Unfortunately the next sentence is translated "if the width of the hull is about one fathom then its length [should be] about nine fathoms". This gives a pencil thin 9:1 length to beam ratio.

Depth. Most drawings and photographs agree with Kolff's description (Kolff 1840, quoted Horridge 1979:27) of *padewakang* as having "high sides". He goes on to describe them as "having but little hold in water" which is true of *perahu patorani, bisean* and *pajala* and is true for most *perahu bago, palari* and *pinisi* when they are in ballast. Some do have much greater depth of hold in the water by virtue of having more deadrise.

A *perahu patorani* is usually trimmed so that her freeboard midships is a slightly greater measurement than her draught. The measured drawing of *Bintang Satoe* (Item G) shows lightly more freeboard midships than draught. The photograph of a beached *padewakang* at Alor (Item E) shows similar proportions, as do the beached *perahu* shown in item **I**. If one assumes that a *padewakang* will generally show slightly more freeboard midships than she has draught, then an approximate depth as a proportion of length can be calculated. This produces the following figures:

A: 0.096
B: 0.098
C: Model (0.16)
D: Model (0.16)
E: 0.097
F: 0.111
G: 0.107
H: 0.094
I: 0.109
J: 0.109
K: — (deep laden)
L: 0.095
M: — (model)

These figures show remarkably little variation although some are measured from photographs that are not true profiles and others are from rudimentary sketches. The lack of allometric variation in freeboard is surprising. The average figure is 0.10 and the figure for a *patorani* is almost exactly the same.

Sinar Galesong has a depth midships measured from the upper surface of the keel to the level of the rail of 1.5 meters of which 0.885 metres is freeboard. The ratio of depth to freeboard is 1.7:1. For *Bintang Satoe* the ratio is 1.79:1 measured to the rail (the normal convention is to measure to the underside of the deck of a vessel that has a permanent deck). Interpolating these figures, an approximate ratio of 1.75:1 for depth to freeboard is suggested. A vessel 15 meters in length would have a freeboard midships of 1.5 meters and a depth of 2.625 metres measured to the height of the rail. This is fairly deep and high-sided for a vessel with little deadrise. Without adequate beam or a considerable amount of ballast such a vessel would be unstable. Too narrow a vessel can capsize unless heavily ballasted as illustrated in Figure 6.

It seems unlikely that *padewakang* would carry more than two or three tons of ballast, and most *perahu* built in recent times are designed to sail with a fairly small amount of ballast relative to their tonnage. Ballast is normally discharged before loading a cargo and it is also usual to discharge ballast before beaching. Re-ballasting is an arduous and time consuming business, particularly in ports like Ujung Pandang where coral collected from the reef is often the only ballast available.

A vessel's ratio of beam to depth should be adequate to give it reasonable stability with a moderate amount of ballast. A *padewakang* would have had fairly light upper work, and the upper planks were apparently often made of lighter timber (Macknight and Mukhlis 1975: 279). *Bintangor (Callophyllum blancio)* is such a timber and is frequently used. The bamboo and thatch cabins would be light and so would the spars. The large matting sails, on the other hand, would have become extremely heavy when exposed to rain water. This is exemplified by the large salt carrying *perahu* of Kuala Trengganu in east coast peninsular Malaysia which, until a few years ago, were still carrying matting sails. When wet, their sails became so heavy that some vessels could not carry full sail even in a light breeze if there was drenching rain. Those *perahu* normally retained 20-25% of their salt cargo as ballast.

The beam to depth ratio of *Sinar Galesong* is 2.39:1; that of *Bintang Satoe* is 1.75:1. An 18th century American vessel with the same ratio as *Bintang Satoe* is described by Chap-

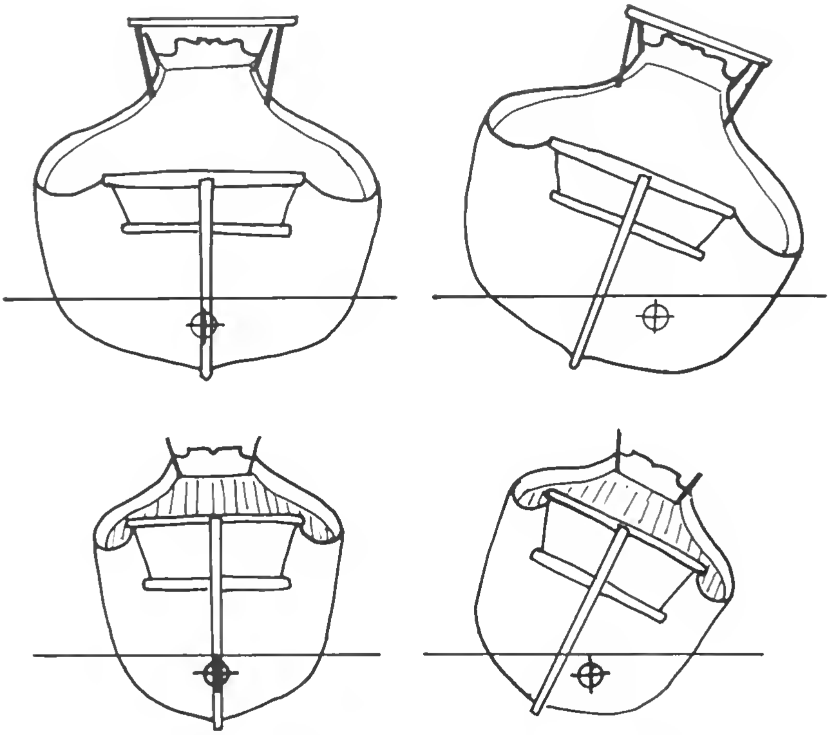

Fig. 6. Vessel heeling seen from the bow. When the vessel heels the centre of bouyancy is displaced to the lowered side and produces righting moment. The narrow vessel has less stability.

pele (1967:189) who comments: "Such a vessel would need ballast when sailing light, and unless properly loaded, had a tendency to sail with an uncomfortable angle of heel".

Similarly, a survey of late 18th century European vessels of approximately *padewakang* size (between about 12 metres and 20 metres long), plans of which appear in *Merchant Sailing Ships 1775-1815* (MacGregor 1980), produces an average beam to depth ratio of 1.85 (the range of figures is between 1.64 and 2.0).

So if we select a beam to depth ratio for the *padewakang* of, for instance 1.9:1, we can then calculate all the major hull dimensions as a proportion of the hull's length, as shown below:

Length = *15 meters*
Length : Freeboard ratio 10 : 1
Freeboard = *1.5m*
Freeboard : Depth ratio 1 : 1.75
Depth = *2.625m*
Depth : Beam ratio 1 : 1.9
Beam = *4.9875m*
Length : Beam ratio 3 : 1

Thwartship measurements such as beam at the *selompeng* can be calculated as a proportion of the midsection beam. Thus, the beam at the top of the forward *selompeng* as a proportion of the maximum beam is:

Sinar Galesong: 0.49
Bintang Satoe: 0.50

In both cases there is no *selompeng* aft but the beam at the aft edge of the *sangkilang* can be measured, with the following results:

Sinar Galesong: 0.50
Bintang Satoe: 0.54

It should be noted, however, that this measurement for *Bintang Satoe* may be inaccurate because the *sangkilang* goes not appear on the body plan or the half beam plan in Blake's drawings.

Hull form below the water line.

(a) The Midsection: Perahu are built without plans and with no frames set up to indicate the mid-section or any other section. The form of the midsection can be described or prescribed in terms of deadrise, hardness or slackness of the bilge, and flare of the topsides. These qualities are described in relative terms. Deadrise is not given as an angle but described relative to an understood local norm. Deadrise could be "absent", "nearly absent", "a little", "reasonable", "fast", etc

("tidak ada", "hampir tidak ada", "sedikit", "sedang", "cepat", etc.).

Sinar Galesong has about 7° deadrise, although it is difficult to estimate because the planking is not fair and the turn of the bilge starts very close to the keel. *Bintang Satoe,* on the other hand, has about 15° deadrise. By comparison a *pajala* (Horridge 1979:6) has only about 5°.

It seems reasonable that *Bintang Satoe,* a larger vessel employed on longer voyages would have slightly greater deadrise. This should confer slightly greater lateral resistance and potentially slightly better windward performance. *Palari* like *Bintang Satoe* were not weatherly craft; they made their longest voyages with a following trade wind although they also made voyages of two or three hundred miles eastwards along the Lesser Sunda Archipelago against the south-east trade winds (Gibson-Hill 1950:111; Collins 1936: abstract log in appendix).

The hardness or slackness of the bilge is described in terms of the number of straiks fitted before the planking must start to curve up through the turn of the bilge (*"berapa papan bangun"*). This depends on the width of the planks used which varies regionally and sometimes according to the size of the vessel.

Sinar Galesong with a slack bilge is only one or two *papan bangun. Bintang Satoe,* with a somewhat harder turn to the bilge, is four or five *papan bangun.* A modern *perahu lambo* of similar length would normally be at least seven or eight *papan bangun.*

(b) Rocker: Rocker is the curving up towards the ends of the keel. Not all vessels have rocker, some in fact have the opposite, which is called drag.

The keel (*lunas*) is usually made up of three pieces of timber the keel proper (*kalebiseang* in *bahasa Makassar*) and an extension at each end (*penyambung*) that usually curve up into the stem and stern post (*pemaru*) (refer Fig. 7). In modern building practice, the *kalebiseang* can be straight but often it shows a little rocker. With the *penyambung* added, the keel usually shows considerable rocker especially forward. *A Bugis Manuscript about Praus* (Macknight and Mukhlis 1975: 274) seems to offer contrary advice, for the translation reads: "As for the extension, it is made flat in front, although [there is] only one pump [and] hatch." The relevance of the information about the pump (or bailing hatch?) is probably that a vessel with a flat keel, having no rocker would have no low point in the bilge where water would collect and from whence it might be bailed. The result would be bilge water lying all along the length of the keel, and if there were no limbers in the floors to allow drainage, or if (as is normal) the limbers were blocked with grot, then she would need bailing or pumping from several points.

Bintang Satoe is an example of a vessel with no rocker in the keel. However, she was originally from Bau Bau, on the island of Buton, where boat building practices are not now identical to those in South Sulawesi. Modern hull forms with straight keels (*perahu lambo*) are currently much more common on Buton and in its surrounding areas than in South Sulawesi.

The 19th century models all show very considerable rocker right through the length of the keel, and rocker is now normal in most types of South Sulawesi perahu, even the large *perahu pinis.* Thus, *Sinar Galesong* has rocker right through the length of her keel, and a suitably scaled drawing of *Sinar Galesong* can be super-imposed on the photograph of a *padewakang* (Item **E**) to show that the rocker is virtually identical.

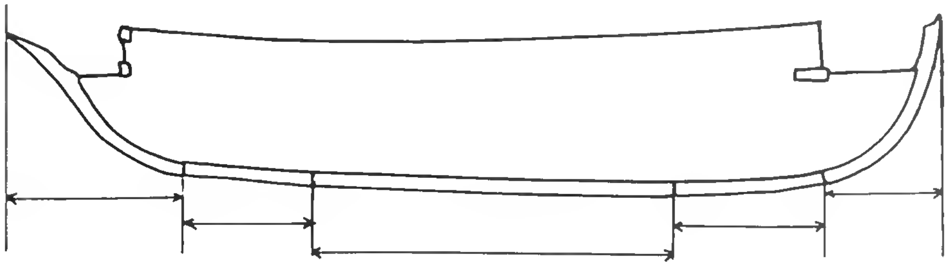

Fig. 7. The keel with keel extensions *(penyambung)* and the stem and stern post.

A set of conjectural lines for a 15 meter *peralu* were drawn using the foregoing analysis to modify the lines of *Sinar Galesong*. Using these lines a plank on frame model was constructed. The model was taken to South Sulawesi in 1986 by historian Peter Spillett where it was discussed with boat builders. Particularly fruitful discussions were had between Pak Rustam, Mr Spillett and the author. Some modifications of the hull form were suggested and these will be discussed later.

Construction of the Hull. In modern 20th century South Sulawesi boat-building, keels are sometimes a single timber without *penyambung* extensions, but this is regarded as a non-traditional practice. *Peralu patorani* are constructed with a keel made up of three timbers. The method of calculating the lengths of these pieces was described by a boat builder (personal communication, Sulawesi, 1986) from Lemo Lemo, who was at that time building a *patorani* at Galesong. He explained that all the measurements are based on an arbitary length called *ruang*, which is often the hand span (*jengkel*) of the builder. The length of each section of the keel is a multiple of this *ruang*, which must be an odd number. When the keel timbers are fashioned, the *ruang* are marked on the upper face of the keel. Alternate *ruang* are left slightly raised and are refered to as *tambugu* or *tembugu*. The *ruang* and *tambugu* (or *tembuku*) persist from an ancient lashed rib construction. Ribs were fastened by lashings to projecting nodes called *buku*, hence *tembuku* presumably from *tempat buku* (*bahasa Indonesia*) meaning place of the *buku*. *Ruang* simply means space in *bahasa Indonesia*. For a full discussion of this development the reader is referred to Horridge (1979).

Joins between sections of the keel must be at the point between *ruang* and *tambugu*. Typically a *patorani* keel would have its middle piece with three *ruang* and four *tambugu* while the extensions would have four *ruang* and three *tambugu*. The ends of the stem and stern post joining the keel would each have one *ruang* and three *tambugu*. This would make the three pieces of the keel the same length if *ruang* were equal. In fact one *ruang* just aft of midships is longer than the others because later it has a hole drilled through it as the vessel's navel (*pussi*). There seemed to be some variation of *ruang* because although the builder said all other *ruang* and *tambugu* were equal, he also stated that the aft *penyambung* was the longest part of the keel and the forward one the shortest.

Rib placement and spacing. In the construction of a *peralu* the shell of planking is built up first, straik by straik, and the ribs are fitted later. In traditional construction even the planks are grown timbers; they are selected with natural curves so the hull can be built as a shell with the planks edge-dowelled together.

Although the planking is assembled before the ribs are fitted, it is necessary for the builder to mark the positions of the frames on the keel before the planking can be started. This is because the scarfs in the planking must be backed by a rib and must be correctly staggered according to a strict planking pattern.

The position and spacing of the ribs is given by the *ruang* and *tambugu*. At each *tambugu*, a "floor" (*kilu*) crosses the keel. This floor is part of a complete frame or rib with bilge futtocks (*solor*) and top pieces (*taju*). Alternating with these frames and aligned with each *ruang* are frames comprising of first or bilge futtocks (**solor**) which start two or three straiks from the keel and connect with top pieces (*taju*).

In many smaller types of *peralu* — for example, South Sulawesi *pajala* and *patorani*, Ende (Flores) *soppe* and *jukut*, Paloe (off Flores) *palari* and Kangean Islands (off Java) *mayang* and *lete* — the floors span the whole bilge and do not connect with futtocks. The floors are alternated with frames comprised of either a single grown timber on each side, or a bilge futtock (*solor*) that starts two or three straiks out from the keel on each side, runs through the turn of the bilge and then connects with a top futtock (*taju*) (Fig. 8). The *taju* often project above the sheer straik to form stanchions. Boat builders say this arrangement is not appropriate for larger vessels which must have full frames with spacing of about 300 mm between centers.

The Plank Pattern. All planks are edge dowelled together. The dowels are usually at 200mm (one hand span) intervals in modern construction. The garboard straik (*penyepe*) is dowelled to the keel and because it is longer than the middle section of the keel it locks the sections of the keel together (fig

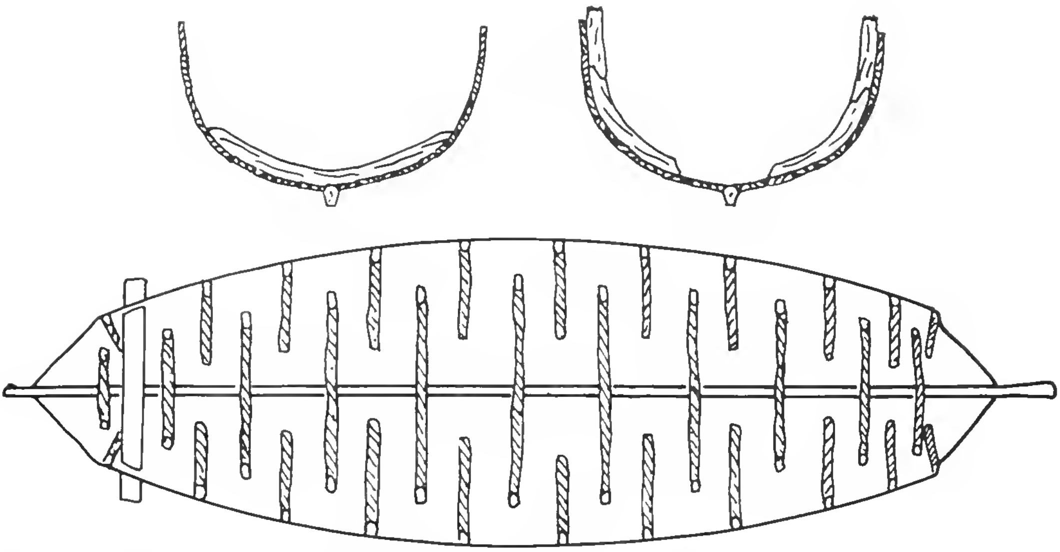

Fig. 8 An arrangement of rib spacing with alternating floors and bilge futtocks.

18). The stem and stern post are similarly locked on by unusual shaped planks at the ends of either the second or third straik depending on the size of the vessel.

COMMENTS ON TRADITIONAL FORMS OF DECK, SUPERSTRUCTURE AND RIG

Ambeng. The stern gallery or back verandah of South Sulawesi *perahu* is built on a number of projecting beams laid across the low aft deck. There seems to have been considerable variation and development in the form of this gallery, usually called *ambeng* or *ambing,* during the 19th century.

William Westall's drawings (Items **A** and *B*), made in the first decade of the 19th century, show vessels that either have no *ambeng* or have only a rudimentary platform *ambeng.*

The Rotterdam model (Item **C**), from the middle of the century, has a fine high *ambeng* structure with panel work and carved balustrades. It seems to be built in imitation of a European vessel's decorated stern, but such sterns were an anachronism in the west by the mid 19th century. The main *ambeng* structure is inside the stern post. The roof of the *ambeng* forms an upper deck which is extended aft outboard over the stern post as a second *ambeng.*

Mid-century examples, Items **F** and **J**, show *ambeng* with no upper *ambeng* extended aft.

The model dated circa 1880 (Item **D**) has an exaggerated, long and heavy *ambeng* of the double *ambeng* type. Unusually, it lacks an opening in the side from which the helmsmen could reach the rudders or tillers. This model shows a development from the earlier form of double and single *ambeng,* in

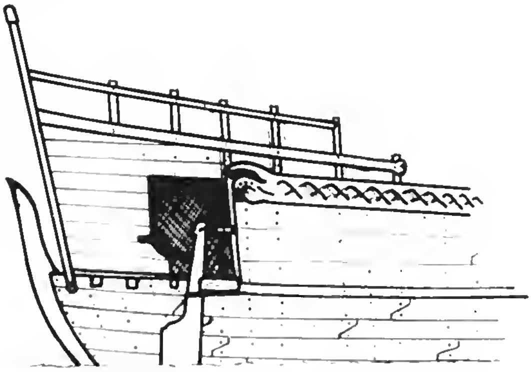

Fig. 9. Early style of *ambeng* built inside the stern post.

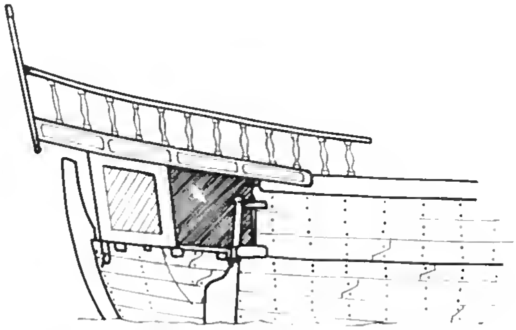

Fig. 10. Double *ambeng.*

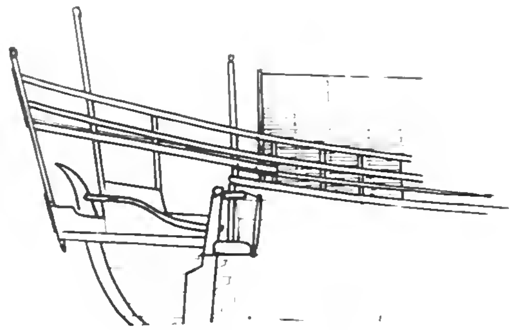

Fig. 11. Double *ambeng* with the lower *ambeng* extended aft of the stern post.

that its *ambeng* is a continuation of the lines of the topsides and does not interrupt the sheer.

The details of the *ambeng* in the photograph Item **E** are not all clear. Certainly it is a double *ambeng*. The sides and rail of the *ambeng* are formed by large finely carved planks that probably cover the projecting ends of upper deck beams. Very similar planks are seen on the late 19th century model used as an illustration in Matthes' Bugis dictionary (1885) and shown in Horridge (1979: Figs 22 and 23).

Bintang Satoe, built about 1900 has a double *ambeng* with an extended lower *ambeng*. There is a transom inside the stern post but the *ambeng* is continued aft past the post. This extension separated from the rest of the vessel by a transom might have been the "heads". The mid 20th century drawing, Item **H**, shows a similar arrangement. This form of double *ambeng* is still occasionally encountered on old *perahu palari*. In some cases the tillers reach back to the extension of the lower *ambeng* and the helmsman steers from there (for example as shown in Item **K**) but this is not always the case.

The *ambeng* that developed during the 19th century seems to have started as a simple box-like house on the stern of the vessel that was contained within the stern post (Fig. 9). The *ambeng* roof became an extension of the upper deck or spar deck and was extended aft over the stern post to form the second *ambeng* of the *ambeng dua kali* or double *ambeng* (Fig. 10). The *ambeng* then became moulded into the lines of the topsides and the sheer (**G** and **H**) and the lower *ambeng* gained an extension taking it outside the stern post (Fig. 11).

The Deck. There seem to have been a number of different deck arrangements used on *padewakang*. The vessels in the trepang fleet described by Searcy (1905:16) did not have proper planked decks: "The deck is of split bamboo worked together with wire or fibre and can be rolled up at pleasure". Obviously split bamboo decking could not be waterproof. Probably vessels decked in this manner had a roof over most of the hold and right up to the rail so that the cargo would not be spoiled by rain water. This arrangement is still very common on several types of medium-sized *perahu* including the modern *perahu lambo*.

The padewakang on which Alfred Russel Wallace sailed to the Aru Islands in 1856 had a planked deck which projected outboard by two or three feet amidships. There was a thatched house on deck which had a bamboo slat floor that was "raised six inches above the deck, so as to be quite dry" (Wallace 1869:370). Some models show the deck projecting outboard, and this would be a simple way of preventing water from leaking into the hold from the seam between the deck and the rail. The projecting deck and deck beam ends were hidden by a large plank which was sometimes carved as in the photograph, Item **E**, and the Leiden model illustrated in Horridge (1979: 28, Figs 22, 23).

The western style of deck that does not project outboard was also used, as displayed in Item **D** and **G**.

Decks are generally considered to be a modern development in Indonesian *perahu* (Horridge 1979: 24-30). The common use of the loan word *dek* is cited as evidence of this. The use of large flush decks certainly seems a recent development. There are, however, indigenous words meaning deck such as *katabang* in *bahasa Bugis*.

The Rig. All *padewakang* carried a large tilted rectangular mainsail. Western terminology has no name for these sails. They are not true lugsails because the halliard is rove from the forward side of the mast with the fall leading aft so that when changing tack the vessel turns downwind and the sail can be gybed over and inverted in front of the mast like a latteen or settee sail. In *bahasa Makassar* and *Bugis,* these sails are called *tanja* sail.

The *tanja* sail is set from a tripod mast stepped in tabernacles. Some *padewakang* seem to have carried a single mast while others were two-masted or occasionally three-masted. The mainmast was always furthest forward. Standing gaffs were sometimes carried particularly on the aft mast. One or more jibs could be set flying (with no stay) from a long bowsprit or jib boom.

The relative proportions of the rig can be assessed from the drawings and photographs. Mast heights were calculated as a proportion of hull length (height measured above sheer):

A: 0.83/0.7*
B: 0.61
C: 0.58
D: 0.73
E: No mast
F: 0.64
G: 0.71 (lower mast of early pinis rig)
H: Pinis rig
I: No mast
J: 0.56
K: 0.8
L:No mast
M: 0.66

*The second figure is measured to an imaginary truck just above the tanja spar because it is very unusual to have the mast project far above the spar in the way drawn by Westall.

The average figure is 0.68. The average for a *perahu patorani* is about 0.8. Possibly the mast height as a proportion of hull length is modified by the length to beam ratio so that a beamy vessel like the *patorani* carries a taller rig.

Mast placement. Calculations of the distance from the bow of the aft spars of the tripod mast as a proportion of hull length gave the following results:

A: 0.32
B: 0.32
C: 0.32
D: 0.35
E: 0.34
F: 0.34
G: 0.31
H: pinis ketch rig (0.26)
I: No mast
J: 0.35
K:0.32
L: 0.30 (?)
M: 0.32

The average is 0.33 or one third. The range of figures is very small and the figure for the *patorani* is the same.

Number of masts. Fifty percent of the *tanja* rigged examples appear single masted. Wallace (1869: 311) described the vessel he sailed on as having two masts; however he drew her at anchor with only one mast stepped. On modern *perahu patorani*, the mizzen mast is a standard part of the rig but it has no permanent tabernacle and it is frequently unstepped. The *tanja* sail that is carried on the mizzen mast is carried on the main in heavy weather when the large mainsail cannot be carried.

There are three drawings showing two *tanja* sails set on one mast: Item **J**, the watercolour by Owen Stanley; and 2 drawings by P.O. King and Le Breton reproduced in Macknight (1976: Figs 2,33). The details of this arrangement are puzzling. If the mast was a tripod, both halliards would have to be led to the mast head and the lower sail would then set rather poorly. The lower sail would have to be lowered and cleared out of the way before changing tack. The drawings are little help. Owen Stanley seems to have invented all sorts of superfluous rigging and King shows little detail, but the sails seem to be set like western square sails controlled by braces.

Perhaps the artists were drawing vessels that they saw carrying two sails on two masts but were later seen with only one mast stepped when they were at anchor. Alternatively, perhaps a smaller heavy weather mainsail was carried under the mainsail in light weather if no maneouvering was necessary (see Fig. 12). Another possibility is that a single sail was made in two panels and joined with a bamboo spar in the middle or bunt rather like the multipanelled Chinese lugsail. Other possibilities exist. For example some modern perahu lete lete carry a mizzen sail but they have no mizzen mast; the spar of the mizzen sail is suspended like a sprit by a jack stay to the main mast and stayed down aft. The same sail is set from the main mast in heavy weather.

Mast Construction: Timber or Bamboo? Modern *perahu patorani* have bamboo tripod masts constructed of a very strong type of bamboo from Pulau.Selayar called *bambu patung*. Sometimes the forward leg of the tripod is timber. Larger 20th century South Sulawesi *perahu* have timber masts. Tripod timber masts still exist while bipod and single pole masts are also used. Tabernacle stepped masts are still common.

Probably a *perahu padewakang* could have been fitted with either timber or bamboo masts. There are reasons to suppose that timber masts were in use. *Perahu padewakang* often carried gaff sails, particularly on the mizzen. These must have been rigged as a standing gaffs because it is not possible to hoist or lower a gaff on a tripod mast. It seems likely that in this case the mast would have been timber because it is difficult

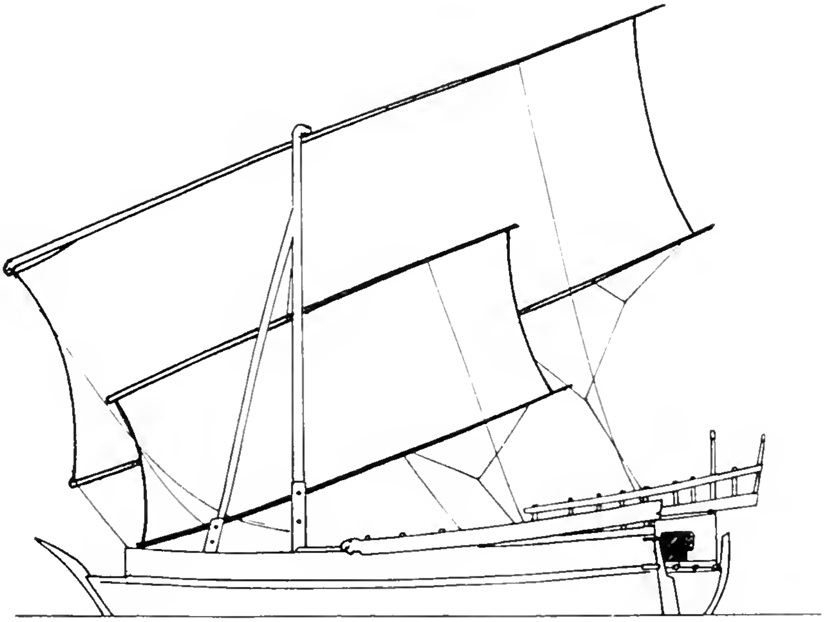

Fig. 12 Two *tanja* sails carried on one mast.

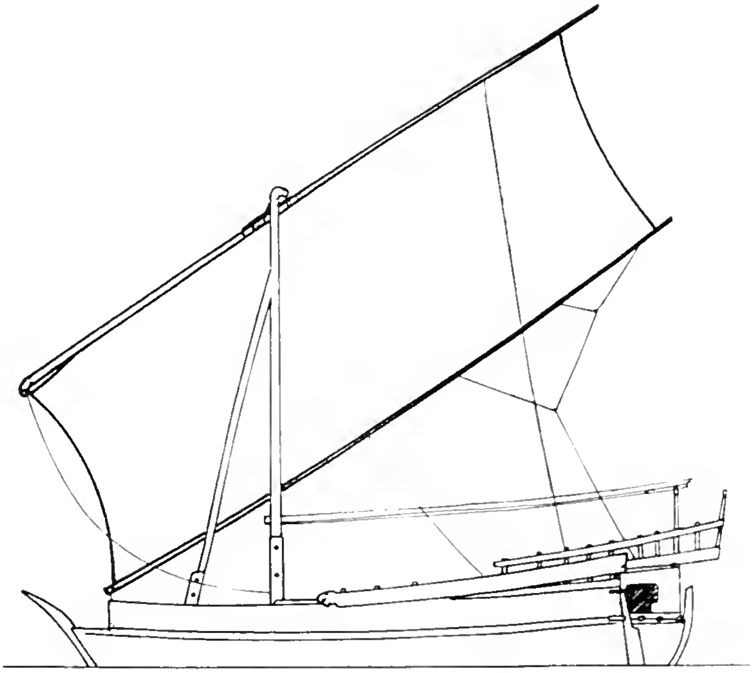

Fig. 13 Narrow *tanja* sail set with the tack hauled down to the *selompeng*.

to accommodate the jaws of a gaff on a bamboo tripod mast of the South Sulawesi type.

Early in this century the rig of the *padewakang* or *palari* was westernised or modernised. The traditional *tanja* sails were replaced with large standing gaff sails with jib headed topsails and headsails set on standing head stays. This transformation required the use of wire standing rigging, strong trestletrees and crosstrees, and the cap necessary for doubling a top mast. Such an arrangement necessarily used heavy timber masts. The tripod configuration was retained although the mast could no longer be easily lowered

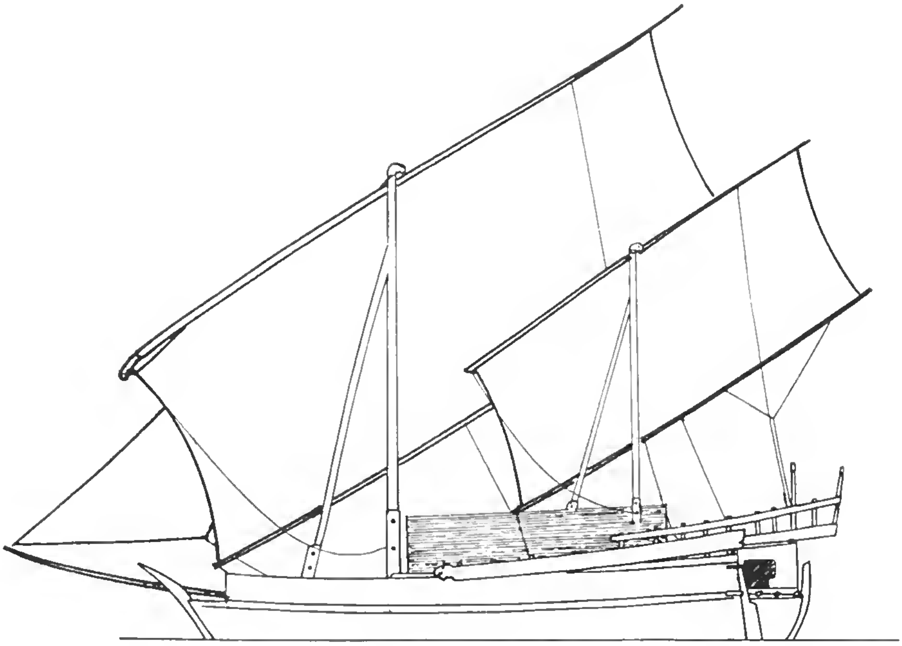

Fig. 14. Two masted rig.

and depended on standing rigging for its support. If the change to the modern *pinis* rig had entailed a change in mast material and mast building technology, then perhaps the redundant tripod mast might have been abandoned at the same time.

Proportions of the *layar tanja*. The proportions of a sail can normally be discussed in terms of aspect ratio; the ratio of height to breadth. The aspect ratio of a *tanja* rig varies according to the angle at which the sail is inclined. An equivalent of aspect ratio that will remain constant is the ratio of length along the spar and boom to the depth between spar and boom. It is effectively opposite to aspect ratio because a higher length depth ratio produces a lower aspect ratio. Only six of the examples can be measured in this way, as shown below:

B: 3.30
C: 3.44
D: 3.03
J: 2.65 (2 sails)
K: 2.78
M: 2.98
The average is 3.03.

For a patorani the figure is about 2.35: the sail is deeper because it is set from a taller mast. In most cases the spar is very long. On a patorani the spar is slightly longer than the hull — this proportion is very constant in the drawings and models (except Item C which is a three master). The proportion is also confirmed by Wallace (1869: 311).

An apparent difference between the 19th century rig and the modern layar tanja is the relatively long narrow sail of the 19th century. It is set on a somewhat shorter mast but the mast is not shorter by as great a proportion as the sail is narrower. The result is that the sail would seem to be set at a slightly higher angle when the tack is hauled down to the top of the selompeng (see Fig. 13). The sail is almost invariably set with the tack hauled down in this way in modern practice. Several 19th century drawings show layar tanja set with the tack well above the selompeng and in some cases well aft of the selompeng.

Either the technique of setting the sail has changed or the drawings reveal some confusion about the way the sails were set. If a long narrow sail was set fairly horizontal then it would be possible to set a smaller *tanja* sail under it with a separate halliard in the manner suggested by Le Breton's drawing and illustrated in Figure 12. This smaller sail would be the sail set in heavy weather. It would be necessary to drop this sail before changing tacks and it would be extremely awkward to get it around the mast to be set on the new tack.

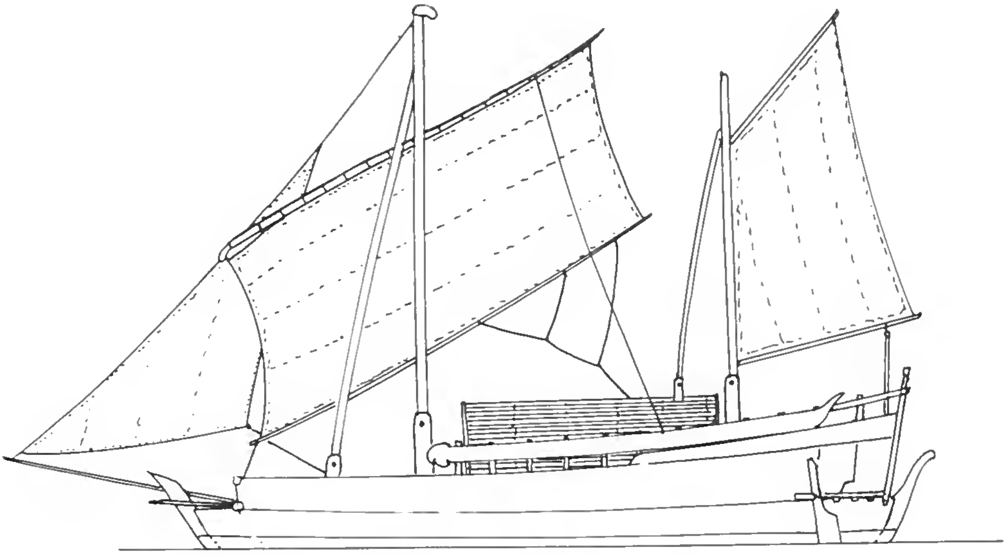

Fig. 15. An arrangement of reduced sail area for squally conditions.

COMMENTS AND SUGGESTIONS FROM 20th CENTURY SOUTH SULAWESI BOATBUILDERS

A planked model was constructed using the lines shown here in Figure 17. The model was shown to Rustam A.M. (the builder selected to build a full-size replica 19th century *perahu* for the Australian Bicentennial Celebration project cited earlier) by project officer Peter Spillet.

Rustam felt that the beam and depth were too great relative to length. The projected proportions were 15m L.O.A. x 5m extreme beam X 2.5m approx depth from sheer to keel midships. Rustam wanted to build a vessel with 4 metre beam and less than 2 metres depth.

The author was asked to go to South Sulawesi to confer with Rustam about this difference. *En route*, at the town of Bima on Sumbawa (which was formerly part of the territory of South Sulawesi's coastal sultanates), opinions about relative proportions were sought from builders, owners and sailors of traditional South Sulawesi *perahu*.

In Bima harbour at that time there were four *perahu palari/bago*: a type of vessel with an old, traditional hull form and a modern sloop rig. The two larger *palari* were from Pulau Sabalana in the Pulau Pulau Tengah group. One of them was unladen so it was possible to inspect her construction and hull form. This vessel was *Sinar Negara II*, owned and captained by Haji Samasuding. She was built in 1978 by *tukang Ara* (noted traditional boat-builders from Ara in South Sulawesi). All timbers were *aju bitti (Vitex pubescens)*, the timber of choice in South Sulawesi. The hull form showed a very heavy and bluff entry and run; the construction was very old fashioned with no sawn timbers used even in planking; and there was no apron on the stem or stern-post.

Her length was 12.5 metres, her beam a full 5 metres, and her depth in the hold approximately 2 metres measured to the sheer, or approximately 2.5 metres measured to the height of her sloping side decks.

Haji Samasuding laughed at the idea of building a 15 metre sailing vessel with only 4 meter beam. He suggested that such a proposal might be fraudulent in intent because such a vessel would necessarily be low and light and very cheap to construct.

On the western shore of Bima harbour there are a number of villages where traditional types of boat are built. Until recently some were still rigged with traditional tanja sails, in which case they were called waka. Nearly all are now sloop rigged and most have been given decks and deck house so they resemble South Sulawesi perahu palari. They are usually called lopi, and lopi means boat in Bugis.

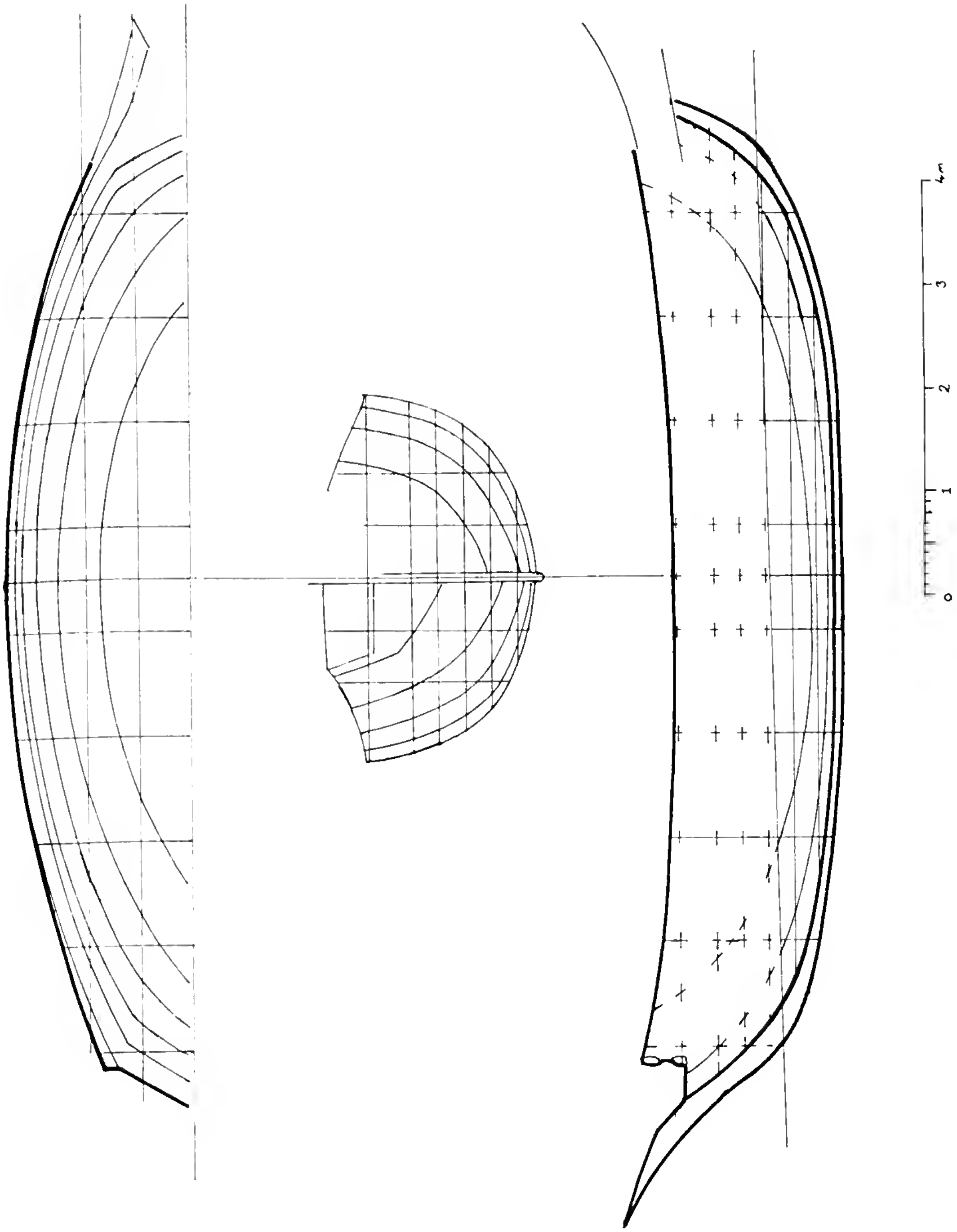

Fig. 16. The lines of the *perahu patorani Sinar Galesong.*

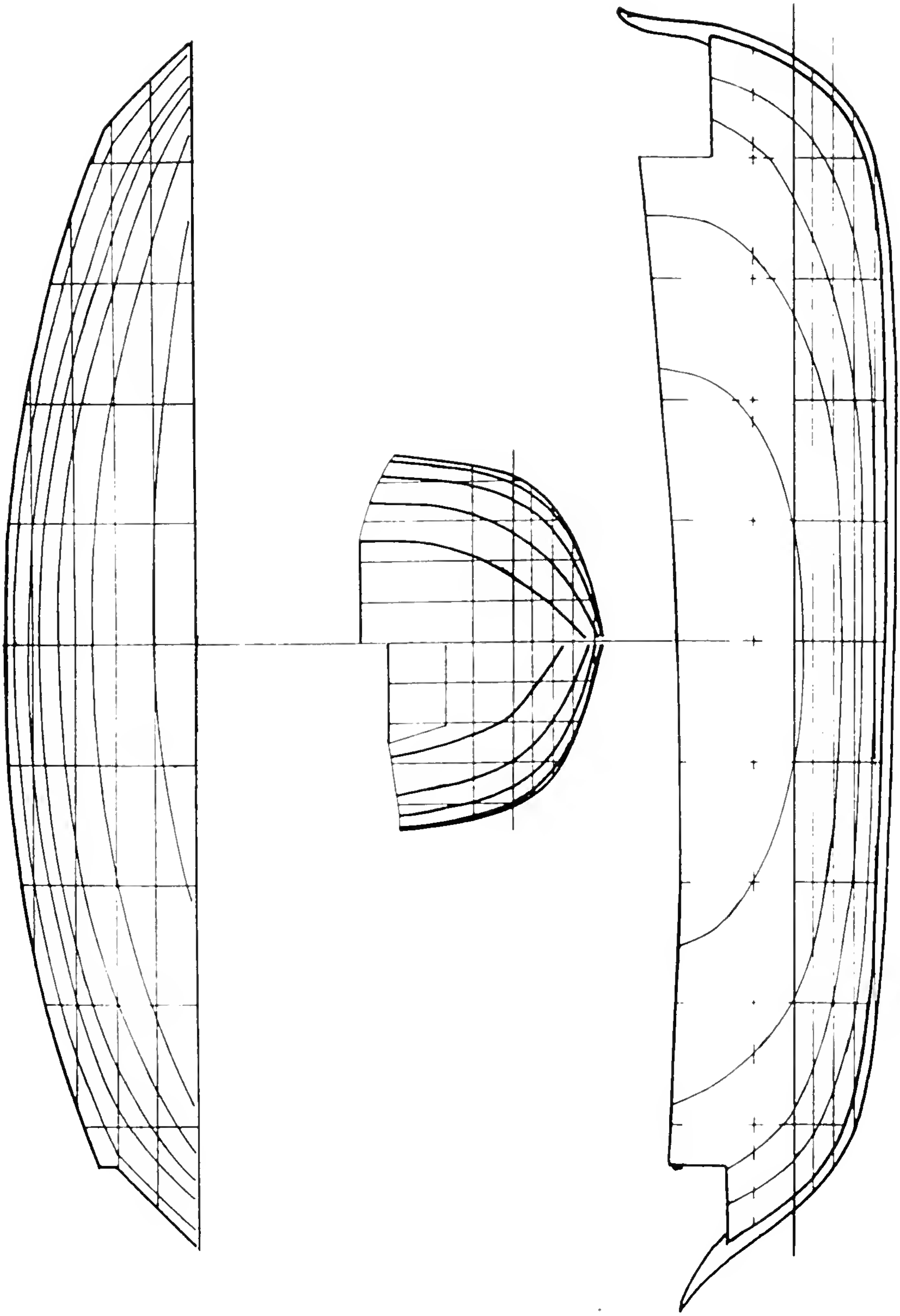

Fig. 17. Conjectural lines for a *perahu padewakang*.

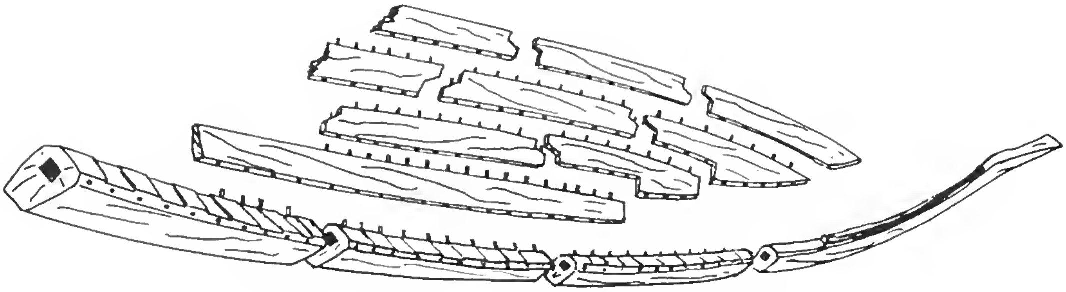

Fig. 18. Keel and planking assembly; the edge dowelled planks lock the keel assembly together.

Most *lopi* are employed for carrying salt from salt flats at the southern end of the harbour to anchorages around Bima where it is loaded on to larger inter-island *perahu*. *Lopi* are also sometimes engaged in short-haul inter-island trade. When carrying salt to the outer harbour they are obliged to beat back empty and with no ballast. They do not beat well but they are stable enough to beat in a 15-20 knot breeze with no ballast in sheltered water.

Four *lopi* were under construction at a village called Daru. The builders said that 3:1 was the correct ratio of length to beam but most *lopi* were given more beam out of regard for capacity and stability.

In Ujung Pandang, South Sulawesi, Rustam the boat builder agreed that a vessel of 15 meter length would normally have 5 meters or more beam. He pointed out that such a vessel would carry a very large sail. Following standard proportions for *tanja* rig the mainspar would be 17 metres long. He felt that such a sail was possible but it could be very difficult to handle, and no-one had seen or worked such a sail in living memory. In this century, vessels of 15 metre length are usually rigged as *pinisi* with a relatively manageable standing gaff ketch rig.

Rustam argued that a vessel given less beam could carry a smaller rig. Having inspected the various drawings and photographs of 19th century *perahu* used here, Rustam agreed that they did all carry large sails with very long spars, as described by Wallace:

> "The mainyard, an immense affair nearly a hundred feet long, was formed of many pieces of wood and bamboo bound together with rattan in an ingenious manner. Wallace, 1869: 311)

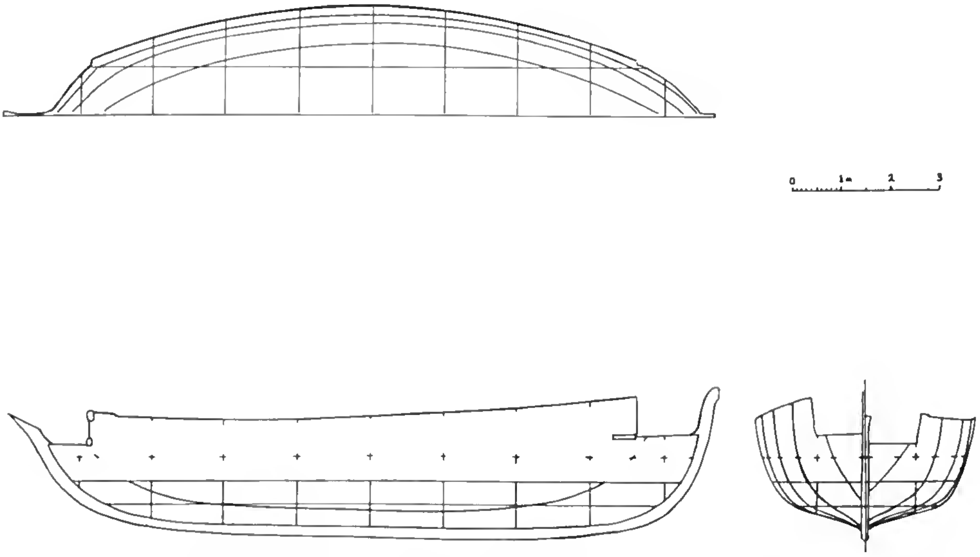

Fig. 19. Lines for a *perahu padewakang* as revised after discussion with South Sulawesi boat builders.

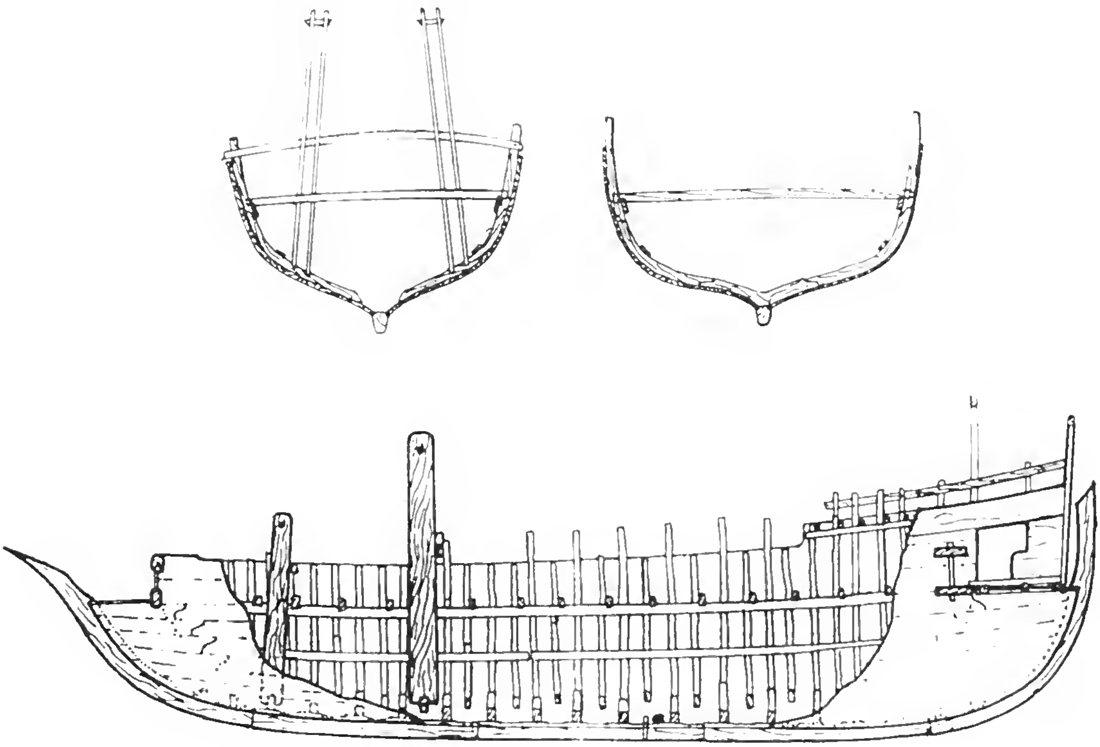

Fig. 20. Construction plans for a *perahu padewakang*.

In a further effort, photographs of the model *padewakang* were shown to *tukang Ara* building *perahu patorani* at Galesong. They quickly and confidently identified the model as built by *tukang Ara* and as representing a trading *perahu* from Sanro Bone, south of Galesong. They said it was a shallow draught design that could enter rivers to load cargo. Rustam and other builders suggested that the midships section was the midships section of a shallow draughted vessel, that it was not appropriate for a long distance trader; and was not very strong when taking ground. A more appropriate midsection would have some hollow in the deadrise *(lancap)* and perhaps a slightly harder turn to the bilge. Such a section would be structurally stronger, less prone to roll and would confer better sailing characteristics. It was also suggested that a slightly shorter vessel of 13 meters would be more easily managed.

With this information a new set of lines were drawn incorporating the modified midsection and the revised dimensions (Fig. 19).

It is not intended that the line drawings, models or sketches be used as precise plans for building a full sized reconstruction but that they should suggest the general proportions and arrangement. To this end a number of differing reconstructions were drawn and these are presented in Figures 21,22 and 23..

CONCLUSION

Definition of the 19th century *padewakang's* hull form and arrangement by using accurate planked models and comparison of the relative dimensions with those of local 20th century *perahu patorani* proved useful in that the information was sucessfully communicated to South Sulawesi boat builders and seamen. Discussion of the proposed reconstruction was conducted with great interest and attention to detail. In these discussions the boat builders and seamen gave confident and virtually unanimous statements on crucial questions including the midships section and the ratios of the dimensions. These opinions were based on long experience with their traditional sailing craft. Some of the 19th century illustrations were studied carefully by these men while other less plausible illustrations were dismissed as mistakes on the grounds that such a vessel could not be sailed.

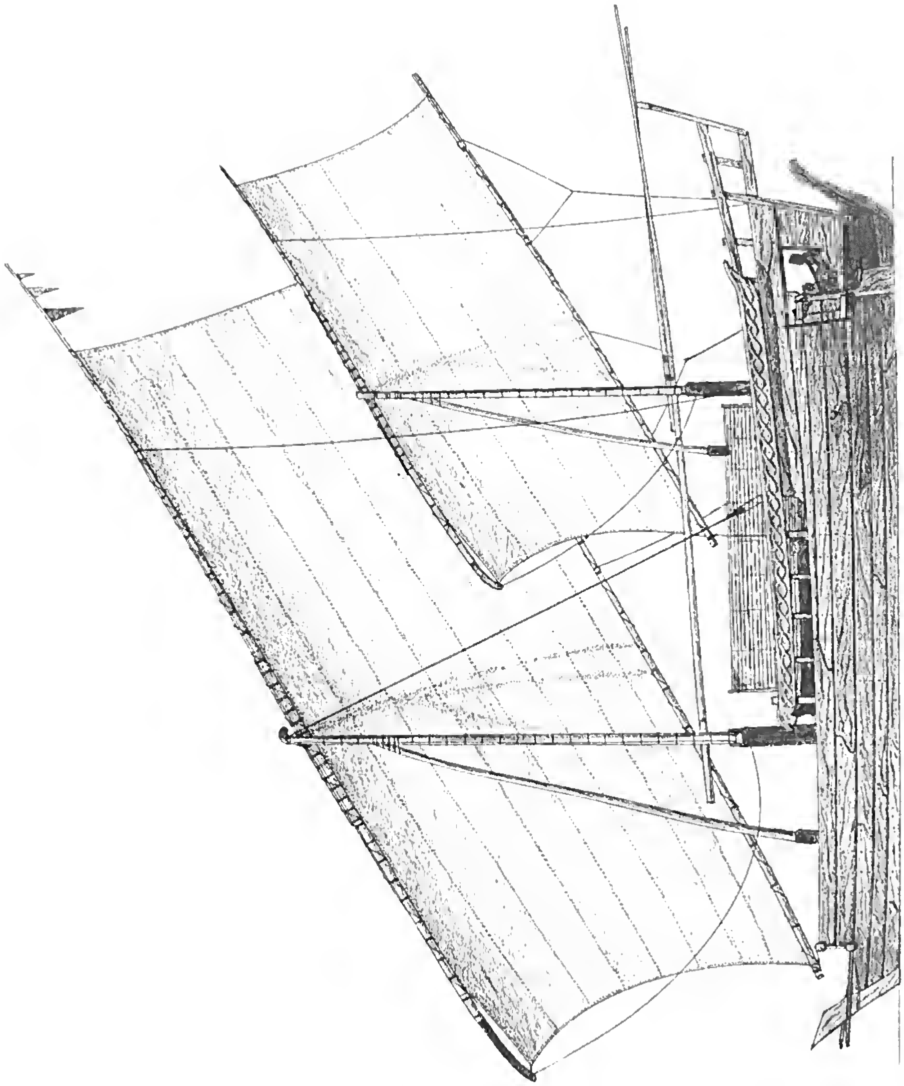

Fig. 21. Reconstructed appearance of a 19th century Makassan *perahu padewakang*.

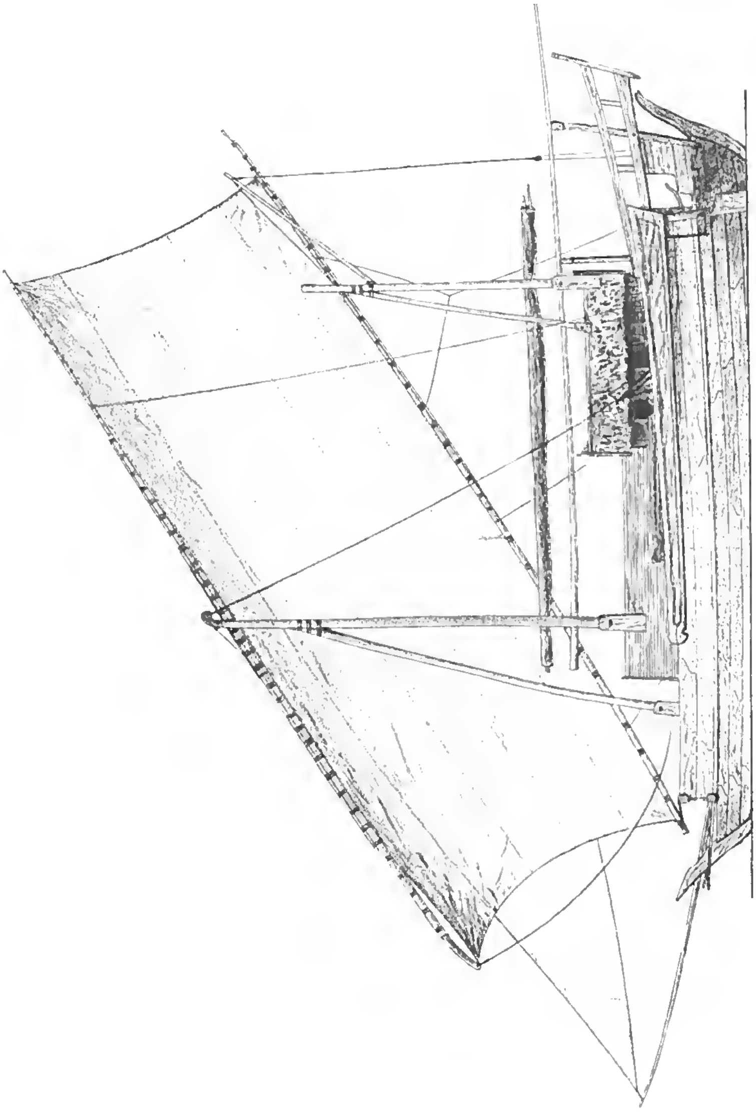

Fig. 22. Alternative reconstruction of a *perahu padewakang*. The hull form is the same but there are differences in the rig and superstructure arrangement.

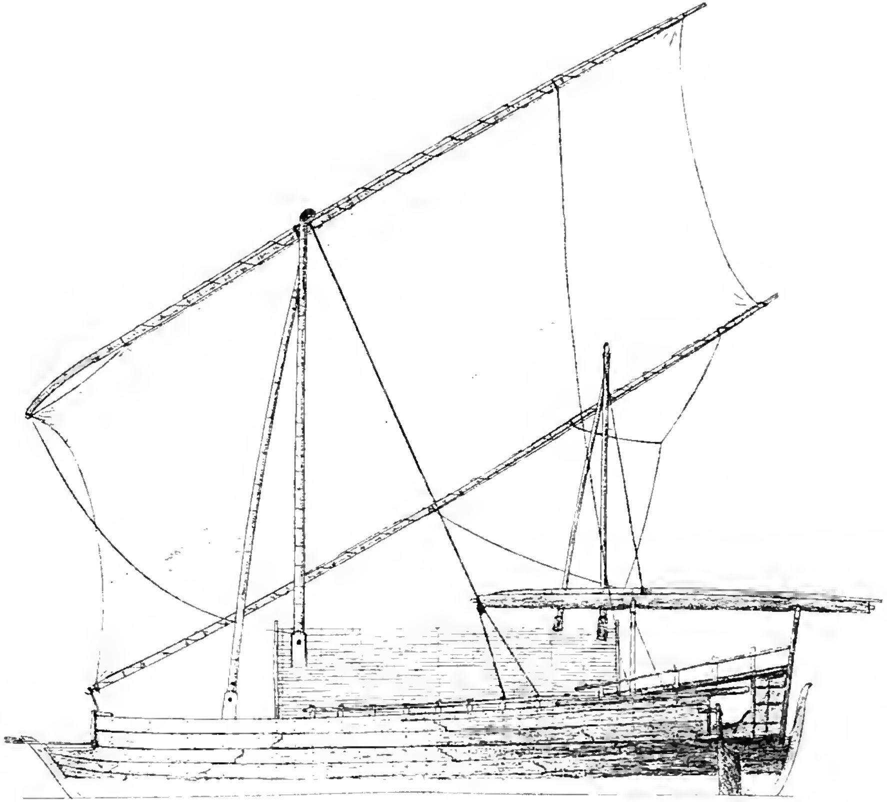

Fig. 23. Reconstruction of a *perahu padewakang* with another arrangement of rig and super structure.

The final reconstruction, as suggested in the line drawings, Figures 19 & 20 and the illustrations, Figures 21, 22 and 23, was agreed upon as being consistent with the historical evidence and consistent with the traditional knowledge of the design of successful seagoing, cargo carrying sailing vessels.

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DESCRIPTIVE NOTE ON AN OUTRIGGER CANOE FROM THE WAKDE ISLANDS, NORTH COAST IRIAN JAYA

MICHAEL GUNN
Northern Territory Museum of Art and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

A five-part single outrigger canoe from the Wakde or Arimoa Islands off the north coast of Irian Jaya and now held in the Oceanic collections of the Northern Territory Museum of Arts and Sciences, Darwin, Australia, is described, illustrated and compared with other documented examples.

KEYWORDS: Outrigger canoe, Wadke Islands, Sobei, Irian Jaya, Northern Territory Museum of Arts and Sciences.

This five-part single outrigger canoe (Fig. 1), capable of carrying one or two people, was collected from Wakde by Dr G.J.M. Gerrits in 1962 and is now in the Oceanic Collection of the Northern Territory Museum of Arts and Sciences in Darwin (Registration number NGE 1515).

Pulau Pulau Wakde is an island pair at 1°56′N 139°01′E and part of three groups of tiny islands, often termed the Arimoa Islands, off the north coast of Irian Jaya. Abel Tasman in 1643 referred to them as Moa, Gamna and neighbouring islands. Today some of the islands are also known as the Koemamba and Podena Islands. Wakde is the western-most of the central group of islands close to the coast. The people inhabiting these three groups of islands, as well as two tracts of mainland coast around the villages of Sarmi and Ahus, speak dialects of the Sobei language, one of a number of Austronesian languages that occur along the northern coasts of Irian Jaya and Papua New Guinea.

Including the outrigger and attachments, the canoe is 390 cm long and 218 cm wide. The height of the canoe measures 41 cm to the top of the washstrakes, where the beam is 16 cm. The canoe appears to have been constructed on the proportional ⅓ principle: measurements between bow and outrigger boom, between booms, and from boom to stern are equidistant.

Details, including local names for parts of small outrigger canoes, were collected by Dr Gerrits from Jamna Island, 25 km to the east

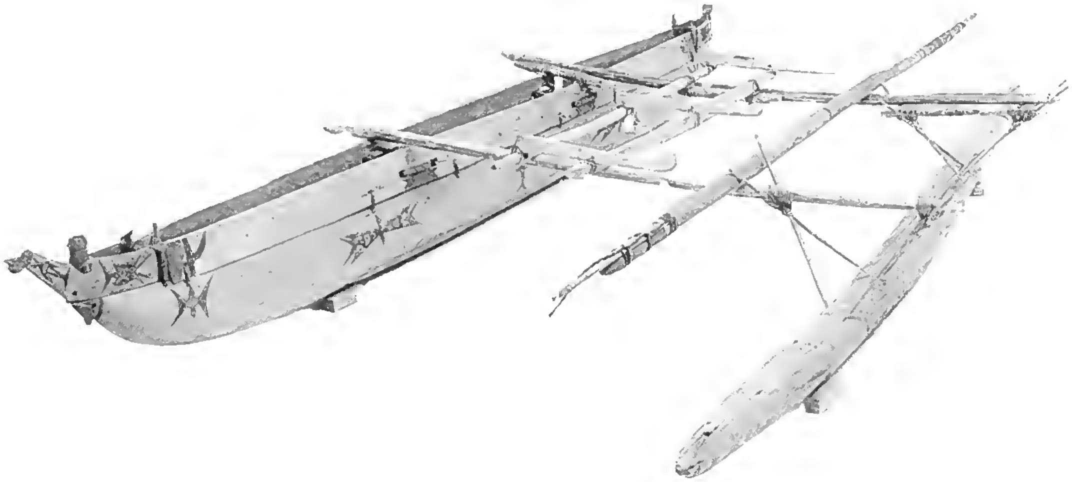

Fig. 1. Stern view of Wakde canoe, NGE 1515, in pre-reconstructed state. A fishing spear from the region is resting across the booms.

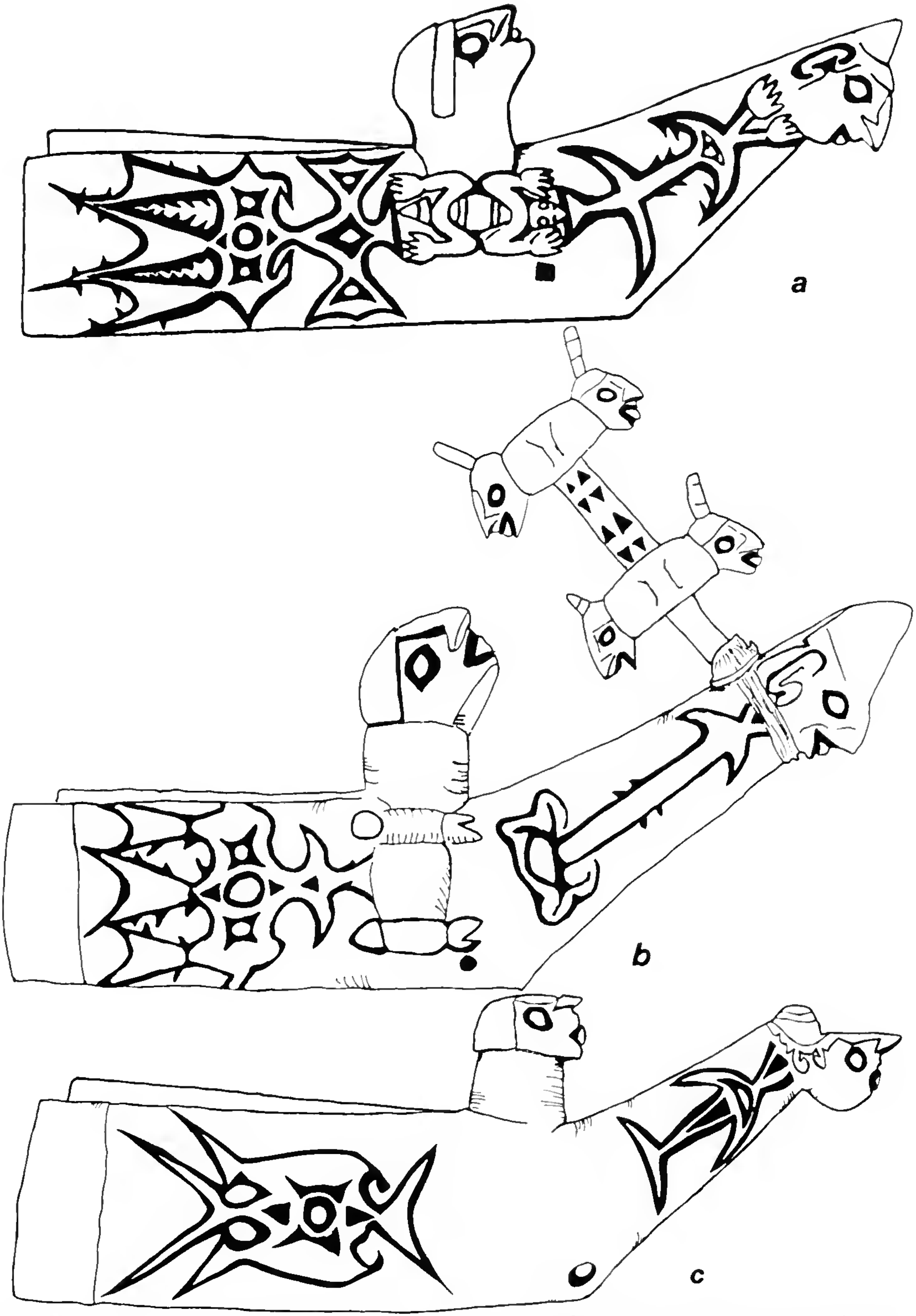

Fig. 2. a, aft end-piece in the Cambridge Museum attributed to Arimoa Islands (sketched slightly modified from that illustrated in Haddon and Hornell 1937 (II) :317); **b,** aft end-piece together with attached four-headed ornament, now in the Naturhistorisches Museum in Vienna (sketch derived from photograph in Führmann 1922: Pl.24); **c,** aft end-piece from NGE 1515.

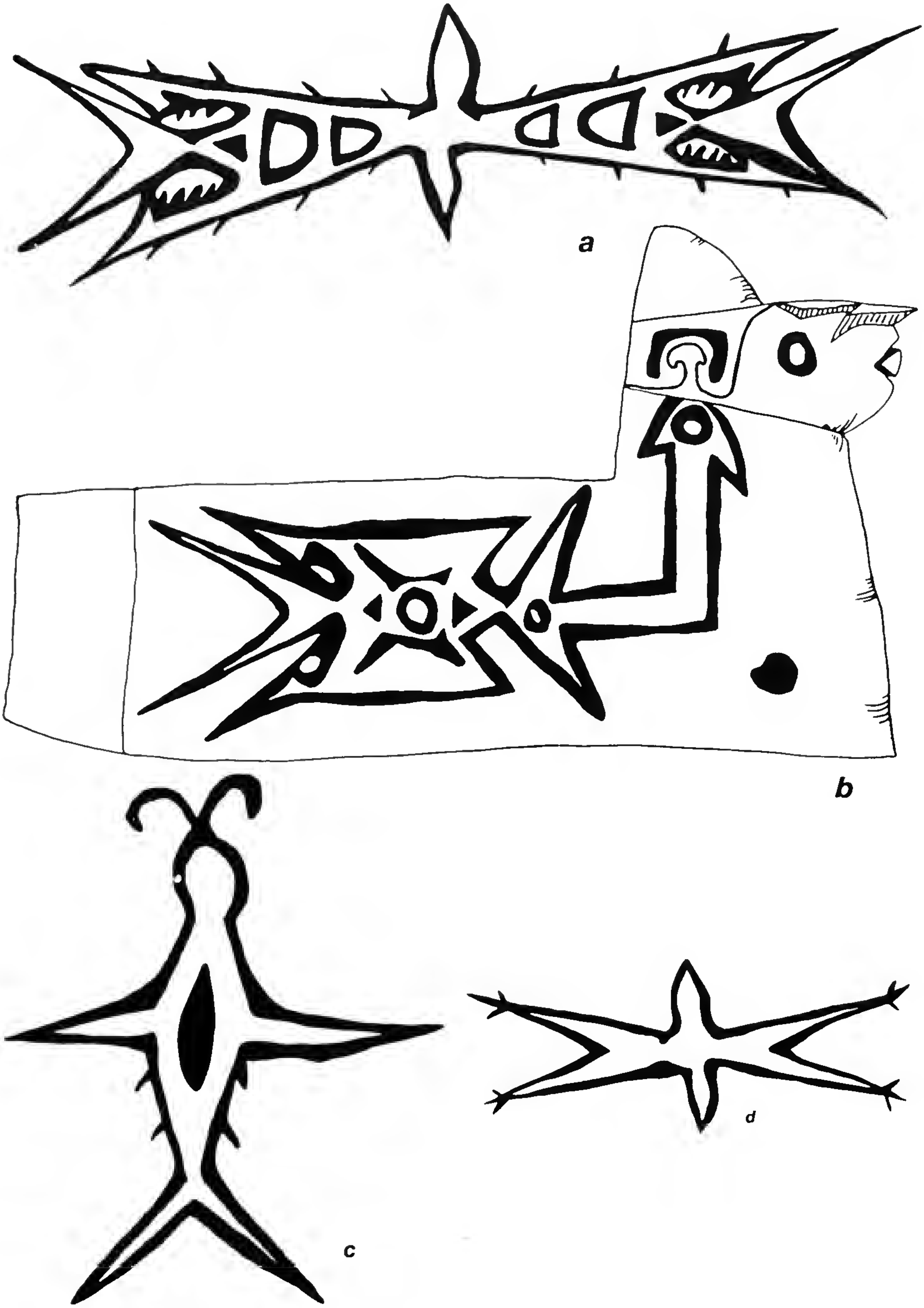

Fig. 3. a, double fish engraving with red and black colouring on NGE 1515, from near stern on outrigger side of hull; **b,** prow end-piece from NGE 1515, which has red and black colouring not shown on the sketch; **c,** flying fish design in centre offside hull of NGE 1515; **d,** engraved design on offside just aft of the prow of NGE 1515.

of Wakde. The people of Jamna speak a dialect of Sobei closely related to that of Wakde. From this record the hull is named *io*, the washstrakes *babo*, the outrigger float *samo*, the outrigger boom *keida*. The boom stringers *aftebir* together with the spear carriers *kajanja* form a railing to transport luggage, fish, paddle and fishing spear. Rope made of rattan is termed *wrairioe*.

By comparison with earlier illustrations of parts from other Wakde canoes, such as the unprovenanced elaborate aft end-piece in the Cambridge Museum attributed to the Arimoa Islands (Fig. 2a), and a further example complete with attached four-headed ornament now in the Naturhistorisches Museum in Vienna (Fig. 2b), we can clearly see that the canoe under discussion is from a conservative tradition. Conservatism amongst seafaring peoples is not unusual, particularly in Melanesia.

Hornell recorded the following with reference to the small canoes from Wakde:

> "the prow is carved into the form of a human head much conventionalized and quite small....." (1923:70)
>
> "The stern piece differs peculiarly from that at the fore end, for in addition to a terminal point carved into a very rude convention of a human head or at least into a projection showing a nose and eyes, there is immediately inwards an upwardly projecting parrot's head, stumpy and conventional .... Between these is tied a quadrangular arrangement of four human heads with the top of the nose extravagantly elongated......." (1923:71).

From the extant museum examples it would seem that rather than the projecting parrot's head described by Haddon on the aft end-piece, the more usual form is a protruding human head (Fig. 2a, b, c).

The most immediately noticeable difference between the aft end-piece of the canoe collected by Gerrits in 1962 and that of the earlier examples, is there is no provision for the attached four-headed ornament. Instead the neck terminates in a ridge.

From here, differences between the earlier and later end-pieces are matters of reduction rather than omission. The animal figure underneath the vertical head in the Cambridge aft end-piece forms an independant quadruped complete with head, one for each side of the end-piece. In the Vienna example the position of the quadruped changes to the vertical, utilizing the protruding head as its own. In the Northern Territory example the quadruped is reduced still further to one pair of barely recognizable leg stumps on each side of the base of the neck of the protruding head.

A further interesting variation in the Northern Territory example is the upturning and thrusting forward of the human head representation at the tip of the aft end-piece. The flying fish images engraved into the side of the aft end-piece and along the body of the canoe (Fig. 3), have undergone less simplification than has the quadruped. The images are less ornate, but the distinctive style of the region is still retained.

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A RE-INVESTIGATION OF THE FIND-SITE OF THE HUCKITTA METEORITE FROM CENTRAL AUSTRALIA

D. MEGIRIAN[1], M.J. FREEMAN[2] AND S. WYCHE[3]
[1]*Northern Territory Museum of Arts and Sciences,*
GPO Box 4646, Darwin, NT 5794, Australia.
[2]*Northern Territory Geological Survey*
GPO Box 2655, Alice Springs, NT 5750, Australia.
[3]*Northern Territory Geological Survey*
GPO Box 2901, Darwin, NT 5794, Australia.

ABSTRACT

The Huckitta meteorite from Central Australia is the largest known pallasite. Excavation of the find in 1937 showed that the 1415 kg unweathered main mass rested on a much larger sub-surface body of weathered remains known as "iron shale" in which the metal phase has completely oxidised but the pallasite structure is preserved. Madigan (1939) reported that all the meteoritic material had been removed. Further excavation in 1986 showed that the extent of the iron shale was greater than previously thought and approximately 1000 kg were collected and lodged with the Northern Territory Museum. The "crater" described by Madigan (1939) was not of impact origin but represented an aeolian feature known as a wrap-around dune. A terrestrial age greater than 18 000 years in suggested for the Huckitta meteorite.

KEYWORDS: Meteorite, Huckitta pallasite, field observations, Central Australia.

INTRODUCTION

The Huckitta meteorite is a large pallasite (stony-iron) which was found about 220 km north east of Alice Springs, Northern Territory of Australia at latitude 22°22'S, longitude 135°46'E. The main mass was reported to Dr C.T. Madigan, the noted geologist and explorer, during his 1937 expedition to the Tarlton Range in the northern Simpson Desert. Madigan visited the site on what was then Huckitta pastoral station and succeeded in acquiring the meteorite for the South Australian Museum. Brief mention of the find was made in Madigan (1937) and full details of the discovery and recovery, as well as chemical and petrological analyses, appeared in Madigan (1939). A small pallasite found in 1924 near Alice Springs (Spencer 1932) is considered to be a transported piece of the Huckitta meteorite (Madigan 1939; Corbett 1968). Additional chemical analyses of the meteorite were presented in Buseck and Goldstein (1969) and Scott (1977).

In 1985 the Northern Territory Museum acquired a 10 kg piece of the weathered remains (iron shale) of the meteorite reported to have been recovered from the site of the main mass earlier in the year. "Iron shale" usually refers to the laminated iron oxides produced by the weathering of an iron meteorite (Bates and Jackson 1980). Here we follow Madigan's (1939) precedent and use the term to describe all meteoritic material in which the metallic phase has weathered to iron and (minor) nickel oxides. Although some clearly laminated material was present (Fig. 1) the bulk of it appeared massive. When sectioned, many apparently massive hand specimens show a variously developed planar fabric, though the pallasite structure is perfectly preserved (Fig. 2). The recent recovery of a piece of iron shale aroused our interest as Madigan (1939:356) indicated all the meteorite material had been excavated and removed. A reconnaissance of the site in April 1986 showed evidence of recent excavation by fossickers but significant quantities of iron shale were still *in situ*. In July 1986 about 1000 kg were excavated and lodged with the Northern Territory Museum in Darwin (N.T. Museum registration numbers 861-1 to 861-25 inclusive). An additional 25 kg mass is held by the Northern Territory Geological Survey.

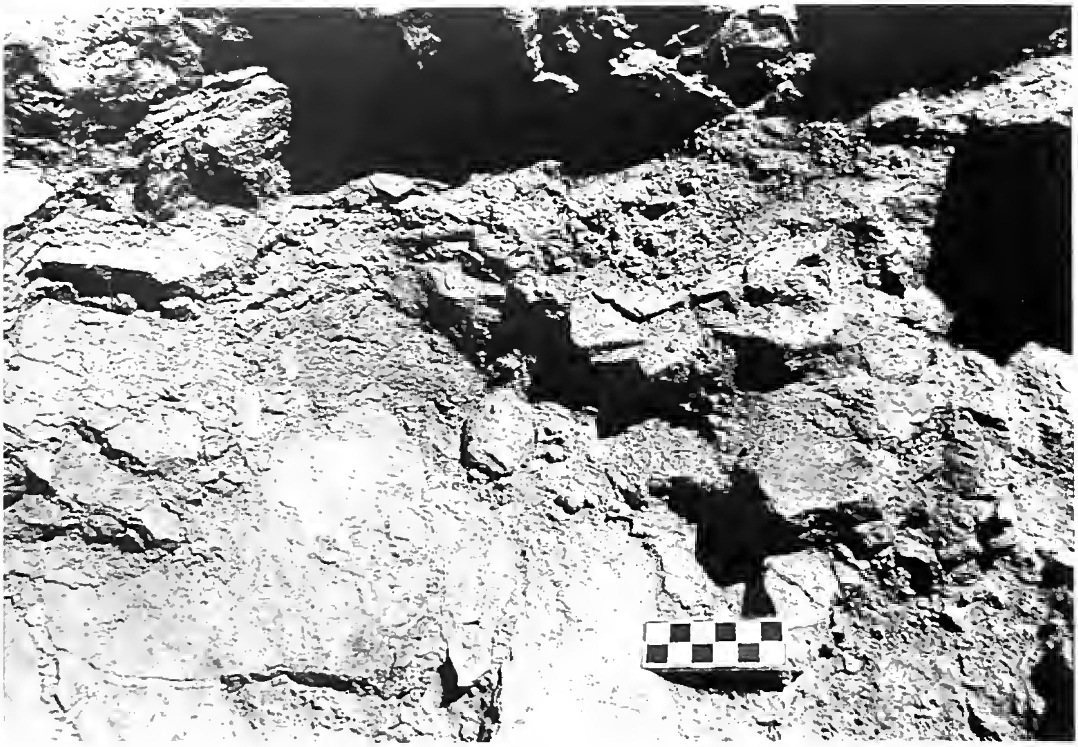

Fig. 1. Huckitta meteorite "iron shale" *in situ* showing the localised well-developed planar fabric. Most of the iron shale appeared massive. Each division of the scale bar is 1 cm.

An account of our observations and interpretations may be of some interest as a sequel to Madigan's (1939) paper.

THE MASS AND ORIENTATION OF THE METEORITE

The following account of the natural position of the Huckitta meteorite before recovery in 1937 is taken from Madigan (1939).

The unweathered main mass was found in a shallow depression on a devegetated plain of sandy gravel. Denudation of the vegetation in the vicinity was apparently the result of the area being used for cattle mustering. The depression and the low rim which bounded it resembled a very shallow crater. The position and orientation of the main mass within the depression, and the presence of a distinct break in the rim on the western side (Fig. 3), gave Madigan the impression the meteorite had arrived from 16° south of due west, travelling in an easterly direction. The unweathered portion of the meteorite rested on a much larger sub-surface mass of iron shale. From the geometry of the material *in situ* it was clear that the unweathered mass represented the core, or kernel, of the meteorite. Weathered material above the ground surface was dispersed by the agents of erosion but the subsurface iron shale remained unmoved. The original mass of the Huckitta meteorite before weathering and dispersal of the products was estimated at over ten imperial tons (approximately equal to 10 t). The unweathered main mass weighed 1415 kg and a total of 927 kg of iron shale were recovered. Madigan was not present during the final stages of the 1937 recovery operation but noted the inconsistency in the size of the excavation and the quantity of iron shale received at the South Australian Museum. He attributed the discrepancy to large amounts of iron shale breaking finely and being discarded.

In 1986 the meteorite site was marked by a hole in the ground, flanked by two old, low spoil heaps (Fig. 4). These were the only notable features on the plain which had in the intervening years been sparsely revegetated with stunted thorn bushes. The hole had recently been cleared and deepened at the western end by fossickers and freshly exposed iron shale was visible on the south-western face. No trace of the depression rim described by Madigan remained.

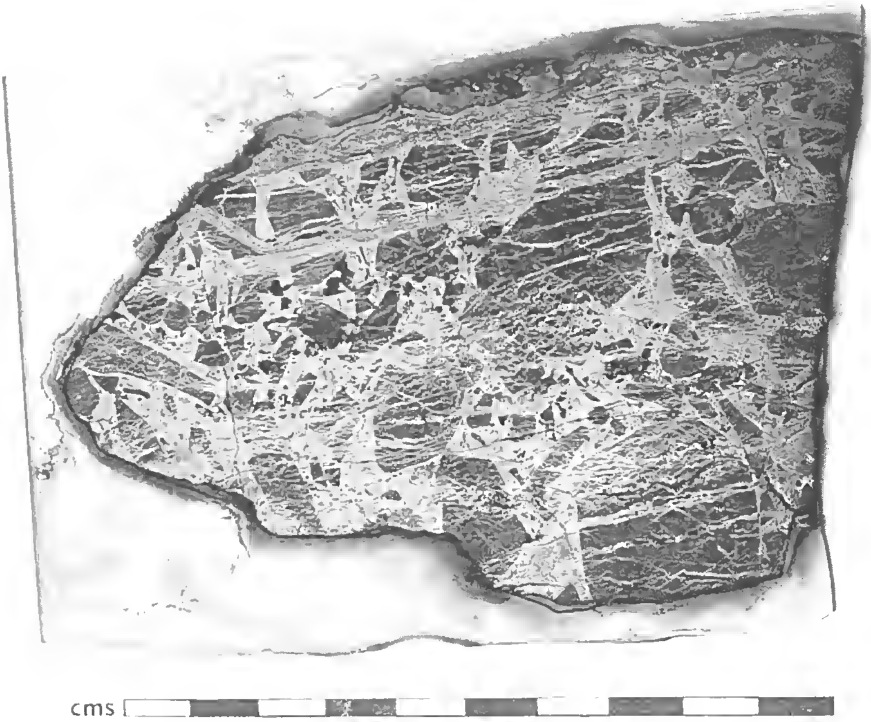

Fig. 2. Polished section of an apparently massive hand-specimen of iron shale (NTM 821-26). The pallasite structure is preserved though iron oxides have invaded fractures in the olivine crystals. The dominant crystal-fracture direction (left to right in the photograph) produces a planar fabric. Such specimens are not fissile along these planes.

The hole was initially cleared to reveal the extent of the iron shale remaining. In plan view the outline of the shallowest material showed a close correspondence to that recorded by Madigan (1939). Iron shale up to 10 cm maximum thickness extended across the bottom of the excavation and up the northern and southwestern faces, while a more substantial mass lay on the western side (Fig. 3). Further excavation showed that this mass penetrated both deeper and further westward than previously thought. Nevertheless the estimate of over ten tonnes for the original mass appears to be of the right order.

The thin (10 cm maximum thickness) lining of iron shale was first removed, though much of it was too friable to collect successfully. An attempt was made to dislodge the large block of iron shale by pulling it towards the centre of the excavation with a vehicle winch. The iron shale was not cohesive enough and broke up. The three largest pieces weighed 62, 85 and 100 kg respectively, with nine other specimens weighing between 10 and 36 kg. The remainder of the iron shale recovered consisted of smaller pieces. Total yield lodged with the Northern Territory Museum is estimated at about 1000 kg of iron shale. Some material found *in situ* was rejected on site because it was considered too finely fragmented to warrant collection, or too friable to withstand transportation over rough terrain.

TERRESTRIAL HISTORY

The crater described by Madigan is clearly too small to have been produced by the impact of such a large meteorite. Its geometry showed that it was related to the unweathered core of the meteorite rather than the original mass (Fig. 3). The "crater" was probably an aeolian structure similar to a wrap-around dune as described by Mabbutt (1977: 246). A wrap-around dune is a windward accumulation of sand which arcs around a narrow obstacle, with the convex side facing upwind. The upwind dune face slopes gently in contrast to the steeper downwind face and the leeward side of the obstacle is relatively clear of windborne

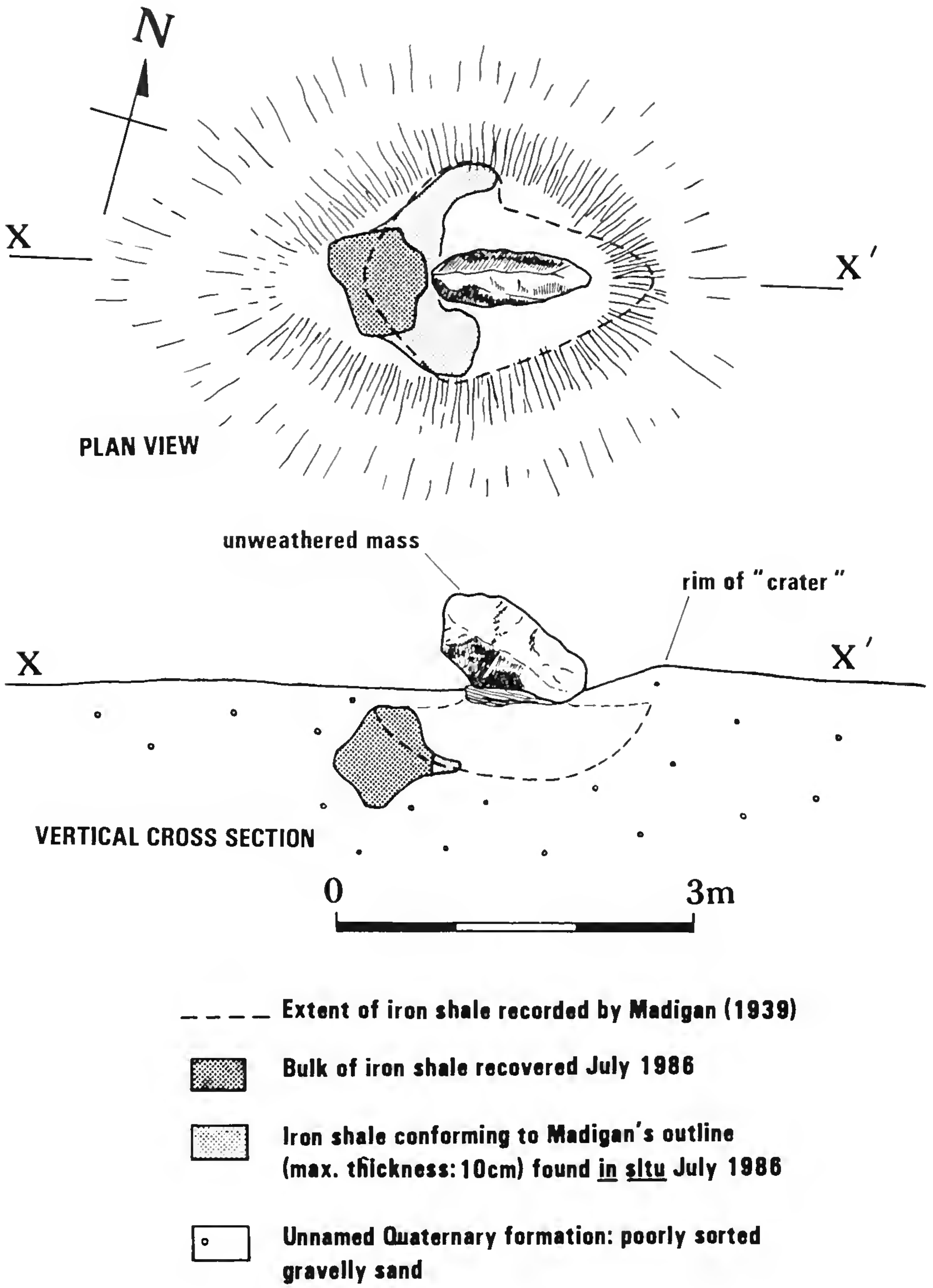

Fig. 3. Plan and cross section of the Huckitta meteorite based on the illustration in Madigan (1939). Madigan's vertical cross section was drawn through, or parallel to, the long axis of the unweathered mass and not on an E/W axis as he indicated. He also showed a distinct rim on the western edge of the depression in which the meteorite stood (not shown here). In plan view however, he showed a distinct break or reduction in elevation of the rim on that side; a feature which he also stressed in the text.

sand. These features are consistent with the structure described and illustrated by Madigan (1939). The orientation indicates the dune was formed under the influence of a WNW wind sweeping across the denuded cattle mustering area. It gives no indication of the direction of flight of the meteorite before impact.

The Huckitta pallasite was found in the piedmont of the Dulcie Range on an alluvial interstream area of the Turkey Creek drainage system. The elevated part of the range lies to the south but basement of predominently quartz arenite of the Cambro-Ordovician Tomahawk Beds crops out extensively in the vicinity of the find. Areas between outcrops may be relatively deeply alluviated by Quaternary reworkings of the older basement. Even in the arid landscape any structure on a piedmont, such as an impact crater, is particularly vulnerable to rapid erosion or burial. The Dulcie Range is capped by the remnant of a probably once extensive silcrete horizon which may be as old as Eocene or as young as Pliocene (Freeman 1986). If the younger age for the silcrete is correct, the average rate of erosion in the vicinity of the meteorite find has been relatively rapid since Pliocene times. No visible trace of an impact structure in the vicinity of the find remains.

The time of fall of the Huckitta meteorite cannot be determined by stratigraphic methods. Cosmic ray-produced radionuclides such as ^{10}Be, ^{14}C, ^{26}Al and ^{81}Kr have been measured and used to determine terrestrial ages (e.g. Boeckle 1972; Schultz and Freundel 1984; Nishiizumi *et al.* 1986). An analysis of cosmogenic radionuclides in the Huckitta meteorite will be undertaken and the results presented elsewhere (J.R. Arnold, pers. comm.). An attempt will also be made to determine a minimum age of weathering using palaeomagnetic methods on oriented samples collected druing the April 1986 visit (M.Idnurm, pers. comm.).

No data have been published on weathering rates of pallasites. In the Huckitta iron shale the olivine crystals do not appear to be significantly weathered, though crystal fractures have been invaded by iron oxides. Madigan (1939) found no evidence of alteration compared to olivine from the unweathered mass; A. Bevan (pers. comm.) noted incipient serpentinization. In contrast, the metallic phase has undergone nearly com-

Fig. 4. Panoramic view to the west taken in 1986 showing the site of the Huckitta meteorite find in the middle distance.

plete oxidization. Terrestrial alteration has not destroyed the pallasite structure.

Quaternary palaeoclimatalogical inferences for Australia based on palynological, faunal and geomorphic evidence suggest that the climate fluctuated during the last 120 000 years (Hope 1984), but reached an extreme at the peak of the last glacial period, 18 000 years B.P. At that time the climate was cool and dry. The present hot, dry climate of central Australia was established by 10 000 years B.P.

The approximately 75 cm thickness of iron shale found beneath the unweathered mass of the Huckitta meteorite, the preservation of the pallasite structure in the iron shale and the inferred arid climate in central Australia for at least the last 18 000 years suggest a long period of slow weathering. A terrestrial age greater than 18 000 years is indicated.

ACKNOWLEDGEMENTS

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Paul Fox, Andy Cappo, Roland Dyrting and Stefan Berger assisted in the field. Mr Lindsay Johannsen helped initially by locating the site. Alan Howard prepared the photographs and Jenny Griffiths and Lorna Watt typed the manuscript. Their contributions are appreciated.

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A NEW SPECIES OF BRYANINOPS (PISCES: GOBIIDAE) WITH NOTES ON NEW RECORDS OF THREE SPECIES OF THE GENUS

HELEN K. LARSON
Northern Territory Museum of Arts and Sciences,
GPO Box 4646, Darwin,
NT 5794, Australia.

ABSTRACT

A new species of commensal goby, *Bryaninops nexus,* is described from northern Australia and the Ryukyu Islands. This fish hovers, often upside down, among the branches of large staghorn corals (*Acropora*). It is unique in that the nostrils are absent, replaced by a low oval rim. Additional material of four species of *Bryaninops* Smith is reported on; three are new records for Japan.

KEYWORDS: taxonomy, Gobiidae, *Bryaninops,* new species, Australia, Japan, commensal.

INTRODUCTION

The commensal gobies of the genus *Bryaninops* Smith were recently reviewed by Larson (1985). As part of that study, several unusual specimens from Scott Reef, northwestern Australia, and Escape Reef, Queensland, were examined. They greatly resembled *B. erythrops* (Jordan and Seale) but differed in always having the nostrils absent, replaced by an oval low rim, and a very narrow interorbital. They were put aside in the hope that more material might be found so as to determine whether they were aberrant or truly a new species. Twenty-nine additional specimens (from the Great Barrier Reef, northwestern Australia, and the Ryukyu Islands) have been found. Examination of these confirmed that the fish is indeed a new species. It is the "upside-down-swimming goby" first observed among *Acropora* on the northern Great Barrier Reef by Doug Hoese and Bill Gladstone in 1981 (pers. comm.).

Methods of measurement follow Larson and Hoese (1980). An asterisk indicates counts of holotype. Type specimens are deposited in the Academy of Natural Sciences, Philadelphia (ANSP); the Australian Museum, Sydney (AMS); the Northern Territory Museum, Darwin (NTM); the University of the Ryukyus, Okinawa (URM); the Western Australian Museum, Perth (WAM); and the Yokosuka City Museum, Kanagawa (YCM).

SYSTEMATICS

Bryaninops nexus sp. nov.

(Figs 1-3)

Cottogobius sp. — Hayashi and Ito 1978: 31, Pl. 6, No. 95.

Tenacigobius sp. — Masuda *et al.* 1984: 284, Pl. 255, N.

Type Material. HOLOTYPE - AMS I. 22618 - 003, 17.5 mm SL ♂, Queensland, Escape Reef Lagoon, among *Acropora* thickets, 10 m depth, D.F. Hoese, November

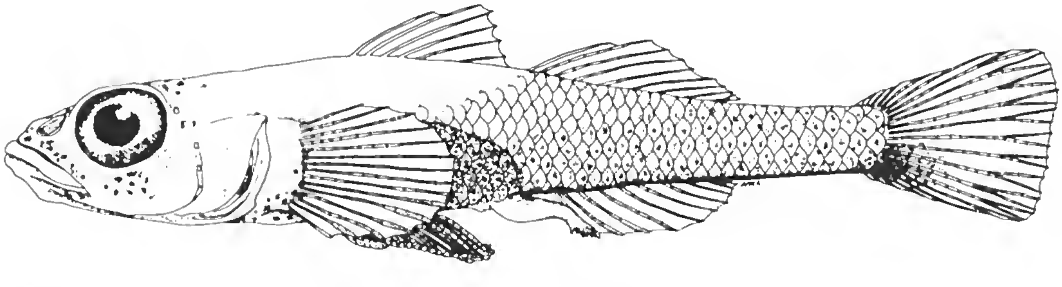

Fig. 1. *Bryaninops nexus* holotype (AMS I. 22618-003), Escape Reef, Queensland.

1981. PARATYPES - QUEENSLAND: AMS I. 22618 - 013 , 4 spec. 12.5-17.5 mm SL, same data as holotype; AMS I. 22585-016, 13.5 mm ♀, Escape Reef, 45m depth, G.R. Allen, W. Starck, 30 October 1981; ANSP 158272, 19mm ♂, Endeavour Reef, sand around isolated 3 m high coral knoll, 13 - 18 m depth, J. Tyler, C.L. Smith, 14 January 1969. WESTERN AUSTRALIA: AMS I. 21316 - 003, 8 spec. 11 - 18.5 mm SL, Scott Reef, South Reef lagoon, large staghorn beds on sand, 7 - 10 m, F. Talbot, 20 September 1979; NTM S.11384 - 033, 18 mm ♀, Scott Reef, North Reef, 10 m depth, B.C. Russell, 11 July 1984; WAM P. 28030 - 030, 5 spec. 10.5 - 18.5 mm SL, Rowley Shoals, Clerke Reef, central lagoon basin 2 km S. of Bedwell Reef, 3 - 5 m, G.R. Allen, R. Steene, 11 August 1983: JAPAN: YCM P.4611, 6 spec. 12 - 15.5 mm SL, Ryukyu Islands, Ishigaki-jima, Kabira Bay, M. Hayashi, T. Itoh, 31 July 1978; URM P. 2185, 15.5 mm ♀, Ryukyu Islands, Ishigaki-jima, Sukuji, K. Shimada, 26 July 1980; URM P. 4410, 15.5 mm ♀, Ryukyu Islands, Iriomote-jima, Amitori Bay, on *Acropora formosa*, Y. Yoshino, K. Shimada, 8 September 1982; URM P. 4689, 16.5 mm ♀, Ryukyu Islands, Iriomote-jima, Amitori Bay, on *Acropora formosa*, T. Yoshino, K. Shimada, 9 September 1982.

Diagnosis. A small (up to 18.5 mm SL) slender-bodied species, compressed posteriorly, with large, mostly lateral eyes. Interorbital very narrow (9% of HL). Second dorsal and anal rays usually I, 8. Pectoral rays 15-16, rays unbranched and usually not thickened distally. Body naked anteriorly, mean lateral scale count 37, transverse scale count backward 9. Gill opening reaches to a point below mideye or posterior half of eye. Anterior and posterior nostrils fused, leaving oval area with raised rim. Associated with staghorn corals *(Acropora)*.

Description. First dorsal VI (in 30)*. Second dorsal I, 7(in 1); I, 8 (in 28)*. Anal I,7(in 1); I,8(in 28).* Pectoral rays 15 (in 17)*, 16 (in 12). Longitudinal scale count 33 - 41, with a mean of 37 (34 in holotype). Transverse scale count backward 7-12, with a mean of 9*

Segmented caudal rays 17 (in 6), branched caudal rays 11 (in 5). Gillrakers on first arch short, with no spines. Gillrakers on second arch equally short, and with several forwardly-pointing fine spines. Membrane binding lower limb of first arch to opercular wall reduced. Rakers 2+1+8 (in 3), 1+1+9 (in 1).

Body slender, compressed, more rounded anteriorly. Body depth at anus averages 15% (13.5 - 17.0%) of SL (14.3% in holotype). Head rounded in cross-section, with large eyes occupying most of sides of head and extending into dorsal profile. Head depth about equal to or little less than head width. Eyes average 38% of head length (34.1 - 41.3%), always greater than snout length (which is 25% of head length). Snout narrow, rounded to slightly pointed in dorsal view. Nostrils absent, with low raised roughly oval rim (rim usually highest anteriorly) around area where nostrils should be, formed by remnants of nostril tubes and skin normally covering nasal sac (Figs. 1,2). Mouth terminal, oblique (about 25° to long axis of body), reaching to below anterior half of eye. Lower jaw protrudes a little beyond upper. Tongue usually distinctly trilobed (in 22), weakly trilobed or nearly blunt (in 5), and bilobed in a juvenile specimen. Gill opening wide, reaching to a point below mideye (in 13) or posterior half of eye (in 16)*. Interorbital usually narrow, 9% of head length (13% in holotype, range 7.3 - 13.3%).

Lateral line canals of head as in Fig. 2, with anterior interorbital pores elongate and very close together, pores fused together or with canals around pores open in four specimens. Postorbital canals detached in 15 specimens (connected in one or both sides in six); canal open on one or both sides in five specimens, canals absent in six (in the latter specimens, most head canals open). Sensory papillae reduced (as in other *Bryaninops*), with no scalloping of preorbital or lower preopercular edge (Fig.2).

Body scales reduced anteriorly, reaching no further forward than to below middle of first dorsal fin, usually reaching to below fifth dorsal spine or gap between dorsals, with one to three scales in isolated patch on lateral midline behind pectoral fin. Head and nape always naked.

First dorsal fin triangular, just reaches second dorsal fin origin when depressed. Second to fourth rays longest, subequal. Second dorsal fin short, high anteriorly, low posteriorly. Second dorsal fin rays usually unbranched (but for last), although tips of second to fifth may be branched. Anal fin rays all unbranched, tips may be covered with thick mucous coating. Pectoral fins short, central rays longest, reaching to above anus. All pectoral rays unbranched, with thickened mucous coating over lower four or five rays. Rays themselves not much thickened distally. Pelvic fins rounded to oval, forming a shallow cup, reaching to anus. Fifth pelvic ray branched once, base of ray not flattened and wide. Branching portions of pelvic rays and pelvic spine lobes thickened, usually finely papillose and folded (lobes especially). Caudal fin roughly truncate, upper lobe slightly longer than lower.

Teeth of males and females similar, but curved caniniform teeth much larger in males. In upper jaw, band of fine pointed teeth present in two or three rows, widest anteriorly, and abruptly narrowing at jaw symphysis. Outer row of eight or ten larger curved teeth across front of upper jaw, posteriormost tooth largest. Lower jaw with similar band of tiny pointed teeth, band about two rows wide at sides and three to five rows wide at front of jaw. Behind band of fine teeth, on either side of jaw symphysis, two canine teeth. At about mid-side of lower jaw, large curved tooth present outside band of fine teeth (lower lip expanded slightly beside tooth), in males. In females, this tooth small, lower lip straight. In some females, side canine not easily distinguished from other teeth at front of lower jaw.

Genital papilla of male conspicuous, slender, elongate, broad at base and rapidly narrowing to tip. Tip expanded, with several fimbriate lobes. Papilla equal to anal spine in height. Female genital papilla robust, cylindrical, short or equal to over half anal spine length in height. Four short lobes behind, and two to four shorter lobes in front of papilla opening, lobes occasionally fimbriate.

Colour in life. Colour slides of living fish at Escape Reef show head and body transparent, slightly dusky posteriorly. White internal pigment covers brain and along top of vertebral column. Pharynx and peritoneum bright silvery white. Brownish internal pigment fills area from behind eyes to pectoral base and dorsal surface of peritoneum. Streak of dense black pigment extends from posterior part of peritoneum to ventral surface of caudal fin base. Eyes silvery, with narrow red-gold rim. Some reddish pigment visible on snout. Fins clear, with dusky rays. First dorsal fin with faint red-brown pigment markings at base. Caudal slightly dusky.

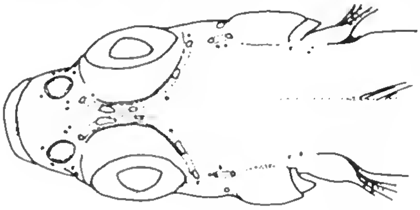

Fig. 2. *Bryaninops nexus* holotype, head, showing nostril area form.

Masuda *et al.* (1984) illustrate this species in colour (Pl. 255, N) identified as *Tenacigobius* sp.). Their photograph shows four red body bars and a red nape blotch (not visible in slides of living specimen), as well as red-brown pigment on snout and sides of head. Anal fin dusky red, with melanophores concentrated anteriorly. First dorsal dusky red at base. Peritoneum with some iridescent blue showing between the melanophores.

Colour in alcohol. Heavily-pigmented peritoneum shows through body wall as most conspicuous colour marking. Posterior lower half of body variably covered with fine melanophores (remainder of dense black stripe when live). Dense blackish wide streak along base of anal rays and ventral side of caudal peduncle, streak may be dense or diffuse, but always with distinct line of dense pigment along anal base. Breast and sides up to, but not including pectoral base, variably stippled with melanophores. Darkly-pigmented specimens with curved line of melanophores along lower pectoral ray bases. Head with some pigment always present across front of snout, upper lip, and sides of head below eye. Snout and lip markings form distinct broad line from eye to eye in some specimens. Chin and underside of head may or may not be evenly pigmented. Top of head with several irregular blotches behind eyes and over brain. Fins clear but for caudal, which generally shows fine speckling on lower half. No vertical bars visible. Some specimens (usually heavily-marked) with scattered melanophores across base of first dorsal fin membrane, and next to base of second dorsal fin.

Comparison with other species. In the key given by Larson (1985), *B. nexus* will key out as *B. erythrops*, a species it closely resembles in body form, colour and morphometrics.

The two are separated by a combination of characters, as indicated in Table 2. *B. erythrops* may occasionally lack nostrils as does *B. nexus*, and may have a very low rim or a partly formed one (5 out of 32). *B. erythrops* has very variable nostril form, as described by Larson (1985). *B. nexus* appears to be slightly more slender than *B. erythrops* (BDA 15% of SL versus 16%), especially posteriorly (caudal peduncle depth 7.5% of SL versus 8.8%). The eye of *B. nexus* tends to be larger than that of *B. erythrops* (38% of head length versus 32%). The postorbital canal is detached in 60% of *B. nexus* specimens, and detached in 22% of *B. erythrops*. *B. nexus* is always associated with large staghorn *Acropora* colonies, while *B. erythrops* occurs on *Millepora* and *Porites* (branching and knoll-forming) species. There is one lot of specimens examined from the Ryukyus in which both species were apparently obtained from *Acropora formosa*.

When observed underwater, the two species can be distinguished by behaviour and preferred host corals. *B. erythrops* does not hover among coral branches, and leaves them briefly only to select food items.

Ecology. *B. nexus* has been collected at depths ranging from 3-45m, usually from lagoon habitats, in or near staghorn *Acropora* thickets. The fish are unique in that when hovering among or near the coral branches, they are often upside-down (ventral surface upward), with head oriented diagonally downward. Bill Gladstone observed swimming and feeding behaviour of *B. nexus* at Escape Reef, Queensland (pers. comm.). He observed two kinds of feeding behaviour, which the fish appeared to spend equal amounts of time performing. For half the time, the fish picked plankton, in a similar manner to other goby plankton-pickers (except upside-down). The other half of their feeding time was spent clinging to the *Acropora* branches, darting out to grab a food item then darting back again to the coral branch (similar behaviour to other *Bryaninops*.)

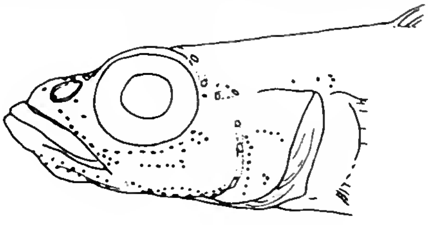

Fig. 3. *Bryaninops nexus*, composite lateral view of head indicating sensory papillae pattern.

Most collections of this species are probably incomplete, that is, they do not include all specimens associated with a particular colony of *Acropora*, as they are easily lost among the branches. Two lots from Scott Reef and Escape Reef include five males and three females, and four males and one female, respectively. One lot of six specimens from the Ryukyus comprises six females only. All other collections consist only of one or two specimens. Therefore, it is difficult to determine the normal sex ratio for this species (other *Bryaninops* species apparently sex-reverse).

Etymology. From the Latin "nectere", to tie or bind together, referring to the characteristic fused nostril rim.

Bryaninops dianneae Larson

Material. FIJI: NTM S.12003-001, 4 spec. 9-13 mm SL, Suva, Laucala Bay, off green sponge *Haliclona* sp., 14 July 1986, P. Ryan; NTM S.12007-001, 10 spec. 15-25 mm SL, Laucala Bay, off green finger-like sponge, 6-15m, 5-6 January 1987, P. Ryan.

Notes. Apart from the two type specimens, these are the only specimens known. The host sponge collected with the juvenile fish is a *Haliclona* sp. (Family Haliclonidae, Order Haplosclerida), and apparently all the fish seen or collected occur on the same species of sponge (P. Ryan, pers. comm.).

The pelvic fins of these specimens are large (reaching to first few anal rays), flat, not fleshy, without a forwardly-facing fold on the frenum, and with pelvic spine lobes rounded and flattened as described for the types. One 13 mm specimen has a narrow flat forwardly-facing fold on the frenum, two 13 mm and 10 mm fish show only a low indentation while the smallest fish's frenum is completely flat, thin and without rounded lobes around the pelvic spines. The frenum edge is somewhat pointed near each pelvic spine tip in juveniles.

Other counts and measurements are similar to the types (e.g. a wide interorbital, long flattened head, and high scale counts). Lateral scale counts of the 15-25mm long specimens are 40-49, with a mean of 47. In addition, these specimens have very deeply trilobed tongues. The gillrakers of two specimens were quite slender and numerous for this group of gobies (3+1+9). All pectoral rays in juvenile specimens 9-13mm SL are unbranched, with the lower 6 or so rays thickened somewhat distally. Juvenile *Bryaninops* of all species tend to have unbranched pectoral rays.

The formalin-fixed colour pattern of 10 specimens (NTM S.12007-001) was noted as soon as the fish were received. All fish were a translucent light pinkish-orange, with no internal body bars visible. The pectoral base and a stripe along the bases of both dorsals were speckled evenly with dusky pigment. The upper third to half of the body was unpigmented but for the above stripe. The lower half to two-thirds of the body was evenly pigmented with light brown. A very distinct brown stripe extended from eye to eye around snout, including the upper lip and continuing past the eye to over the opercle (where it became very diffuse and indistinct). Behind the eyes and over the brain were scattered brownish blotches. The iris was rose pink, with a margin of gold and black speckles. The caudal fin was clear with a bright orange broad streak on the lower half, and a small indistinct spot at the lower base. Other fins were transparent.

Bryaninops erythrops Jordan and Seale

Material. JAPAN: NTM S. 11784-002, 3 spec. 11-11 SL, Ryukyu Islands, Iriomote-jima, Amitori Bay, off branching *Millepora* sp., 11 August 1985, H.K. Larson; URM P.2125, 14.5 mm SL ♂, Okinawa, Sesoko-jima, off branching *Porites* sp., 7 June 1980, K. Shimada; out of URM P.4410, 11.5 mm SL ♀, Ryukyu Islands, Iriomote-jima, Amitori Bay, on *Acropora formosa,* 8 September 1982, T. Yoshino, K. Shimada.

Notes. These five specimens represent a new record for Japan. They all have "typical" goby anterior and posterior nostrils (anterior with short tube, posterior with low rim). Previously, only 15% of *B. erythrops* specimens examined had fully-formed nostrils; most specimens having no or only partly-developed nostrils. Specimens with fully-formed nostrils usually occur in ones and twos in a lot of many specimens with no nostrils. Locality, depth, etc. seem to have no correlation with the presence or absence of nostrils. More material from Japan and the Philippines needs to be examined before possession of nostrils can be correlated with this region.

The single specimen collected on *Acropora formosa* is the only record of this species living on any *Acropora* species. The specimen was collected with *B. nexus* by Yoshino and Shimada.

Bryaninops isis Larson

Material. JAPAN: NTM S.11785-001, 13mm SL ♂, Ryukyu Islands, Iriomote-jima, Amitori Bay, on gorgonian *Isis hippuris,* 11 August 1985, H.K. Larson.

Table 1. Measurements (in mm) of *Bryaninops nexus* holotype and some paratypes.

	Holotype *AMS* *I.22618-003*	*Paratypes* *AMS* *I. 22618-013*			*Paratypes* *WAM* *P.28030-030*				*Paratypes* *YCM* *P.4611*			
Standard length	17.5	17.0	16.0	12.5	18.5	17.0	15.5	15.0	15.5	15.0	13.5	13.0
Head length	5.4	5.5	4.9	4.6	5.9	5.5	5.1	5.0	4.9	4.6	4.4	4.4
Head depth	2.8	2.9	2.9	2.4	3.0	2.5	2.6	2.5	2.3	2.3	2.1	2.3
Head width	3.1	3.3	3.0	2.4	3.1	3.0	2.7	2.7	2.6	2.6	2.4	2.4
Body depth at anus	2.5	2.5	2.6	1.8	2.9	2.7	2.4	2.2	2.5	2.4	2.3	2.1
Caudal length	3.5	3.6	3.4	2.9	–	3.6	3.2	3.3	3.0	3.0	2.8	–
Pectoral length	3.6	3.3	3.2	2.6	3.8	3.0	3.2	2.0	2.8	2.7	2.8	2.6
Pelvic length	3.4	3.2	2.7	2.4	3.0	2.9	2.7	2.8	2.9	2.9	2.5	2.7
Caudal peduncle length	4.0	3.3	3.5	2.9	4.3	3.9	3.2	3.2	3.5	3.1	2.7	2.8
Caudal peduncle width	1.3	1.2	1.3	1.0	1.4	1.3	1.2	1.2	1.2	1.2	1.0	1.0
Snout length	1.8	1.5	1.3	0.9	1.4	1.3	1.3	1.0	1.2	1.0	1.0	0.9
Eye width	2.0	2.1	1.8	1.6	2.2	2.1	1.9	1.9	1.9	1.9	1.8	1.8
Jaw length	2.3	2.2	2.0	1.6	2.4	2.2	2.1	2.0	1.9	1.8	1.7	1.6
Interorbital width	0.7	0.4	0.4	0.4	0.6	0.3	0.4	0.3	0.4	0.4	0.3	0.3

This specimen represents a new record from Japan. The gorgonian *Isis hippuris* did not seem to be common in Amitori Bay, Iriomote Island.

Bryaninops loki Larson

Material. JAPAN: URM P.2195, 2 spec. 21.5 - 25 mm SL, Okinawa, Kerama Islands, Kuba-jima, 30 m, off *Junceella* sp., 16 July 1980, K. Shimada; URM P.3177, 23 mm SL ♂, Ryukyu Islands, Iriomote-jima, Barasuto, on unidentified gorgonian, 1 June 1982, T. Yoshino; URM P.8283, 21.5 mm SL ♂, Okinawa, Sesoko-jima, 20 m, off *Junceella* sp., 13 April 1977, T. Yoshino; NTM S.11787-001, 3 spec. 16-24 mm SL, Ryukyu Islands, Iriomote-jima, Amitori Bay, off Saba Saki Point, 67 m, on seafan, 18 August 1985, H. Kohno; NTM S.11788-001, 2 spec. 16-19.5 mm SL, Shikoku, Uwa Sea, Shirahama Bay, 35 m, on *Ellisella* sp., 10 July 1985, H.K. Larson.

Notes. Three of these additional Japanese specimens are similar in appearance to *B. amplus*, and could be confused with that species. The gill opening is relatively restricted, reaching to just forward of the posterior margin of the preoperculum, and the caudal fin blotch (noted as red to black when live) is absent in preservative. The other six specimens are more typical of *B. loki*. *B. amplus* had the gill opening reaching forward to below the posterior preopercular margin in only 19% of all specimens examined (150). Among the 19%, 5 out of 6 were Japanese specimens, with the other specimens mostly from the Great Barrier Reef (Lizard Island and Decapolis Reef).

B. loki and *B. amplus* can be distinguished in Japan by *B. loki's* possessing fewer pectoral rays (14-16, usually 14, versus 16-17), and by its gill opening reaching at least forward of the preopercular margin (usually at least halfway between preopercular margin and edge of eye), versus gill opening reaching up to, or slightly forward of the posterior preopercular margin. *B. amplus* usually has higher scale counts (50-60 lateral scales) than *B. loki* (40-50 scales). *B. amplus* is nearly always commensal on *Junceella fragilis*, and occasionally on *J. juncea* and *Ellisella* species (host not identified to species in some Japanese collections). *B. loki* has been collected from *J. fragilis* only once (in Western Australia), but occurs on *J. gemmacea*, and is often found on *Ellisella quadrilineata* and probably other species, as well as other coelenterates (Larson 1985).

Bryaninops rideus Smith

Material. JAPAN: URM P.2151, 4 spec. 11-13.5 mm SL, Okinawa, Kerama Islands, Agenashiki, 20m depth, off *Pachyseris* sp., 16 July 1980, K. Shimada; URM P.2121, 14.5 mm SL ♀, Okinawa, Sesoko-jima, 4 m depth, off *Millepora* sp., 4 July 1980, K. Shimada; NTM S.11783-001, 4 spec. 13-14 mm SL, Ryukyu Islands, Iriomote-jima, Amitori Bay, 4m depth, off branching *Millepora* sp., 11 August 1985, H.K. Larson; NTM S.11784-001, 3 spec. 11-13.5 mm SL, Ryukyu Islands, Iriomote-jima, Amitori Bay, 6 m depth, off branching *Millepora*, 11 August 1985, H.K. Larson.

Notes. These 12 specimens represent a new record from Japan. The lateral scale

Table 2. Characters separating *Bryaninops erythrops* and *B. nexus*.

	B. erythrops	*B. nexus*
Nostrils and nasal sac	Sometimes absent	Always absent
Remnant rim around absent nostril area	Sometimes present or incomplete	Always present
Nostrils completely developed	Sometimes incomplete	Always absent
Pectoral ray count	14-15 (usually 14)	15-16 (never 14)
Mean interorbital width	8.8% of head length	12.4% of head length
Gill opening extent	To posterior edge or posterior half of eye	Below mideye or posterior half of eye
Mean lateral scale count	41	37
Extent of scales	To above pectoral base, or to first few dorsal spines	To between dorsals, or up to mid first dorsal

counts are high for the species (average 33 scales, with the highest count previously known being 37). In these Japanese specimens, 3 have 37 lateral scales, 1 has 38, 1 has 39, 2 have 43 and 1 has 45. The specimens with high counts are not more fully sealed, but have smaller scales. The lateral scales in these specimens extend up to below the 5th or 6th dorsal spines (with a few scattered scales isolated far forward), as do those on fish from other localities. In the specimen with 45 lateral scales, the scales reach forward to below the fourth dorsal spine, with several scales scattered anteriorly near pectoral axil. Other counts and characters are similar to those in fish from other localities.

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TAXONOMIC STATUS OF SOME SPECIES FORMERLY REFERRED TO *MALMGRENIA* MACINTOSH 1874, WITH THE DESCRIPTION OF A NEW GENUS *LOBOPELMA* (POLYCHAETA:POLYNOIDAE)

J. RUSSELL HANLEY
Northern Territory Museum of Arts and Sciences,
GPO Box 4646, Darwin, NT 5794, Australia.

ABSTRACT

The genus *Malmgrenia* McIntosh, 1874, was recently synonymised with *Harmothoe* Kinberg, 1855 by Tebble and Chambers (1982). Eighteen species have been referred to *Malmgrenia* by previous authors. Examinations of type material (where possible), descriptions and additional material in this study indicate the species formerly referred to *Malmgrenia* are an artificial, polyphyletic group. Six of the species are referred to *Harmothoe,* two to *Halosydna* Kinberg 1855, one to *Hololepidella* Willey 1905, and a new genus *Lobopelma* is erected for *M. microscala* Kudenov, 1977. The status of the remaining species is discussed.

KEYWORDS: Polynoidae, *Malmgrenia,* taxonomic revision, *Lobopelma* new genus

INTRODUCTION

My interest in the genus *Malmgrenia* McIntosh, 1874 arose from a wider objective which was to examine the taxonomic, and eventually, phylogenetic status of the seven genera of polynoids characterised by a subterminal insertion of the lateral antennae upon the prostomium. The seven genera are *Malmgrenia, Paralepidonotus* Horst, 1915, *Alentia* Malmgren, 1865, *Gastrolepidia* Schmarda, 1861, *Arctonoe* Chamberlin, 1920, *Arctonoella* Buzhinskaya, 1967, and *Eulagisca* McIntosh, 1885.

Malmgrenia is the largest of the seven genera containing 14 species in Kudenov's (1977) treatment. These 14 species, with 4 additions are listed in Table 1. Before discussing the results of my examinations of material previously assigned to *Malmgrenia,* a brief outline of the historical background is presented.

The first publication of the name *Malmgrenia* was the description of *M. whiteavesii* by W.C. McIntosh in April 1874. Contrary to his usual thoroughness, the only clue given indicating that the name represented a new genus was a footnote underlying the description of *M. whiteavesii* (p. 263). The footnote briefly stated "The genus is a new one lately formed for certain British species". Just a few weeks later on May 19th 1874, McIntosh presented a paper to members of the Zoological Society of London in which he described in greater detail two more species, *M. castanea* and *M. andreapolis.* The paper describing these two species was not published until 1876, and it appears the publication of the 1874 paper describing *M. whiteavesii* before the descriptions of *M. castanea* and *M. andreapolis* were made public at the Society meeting, was accidental. In his monograph on British marine annelids McIntosh (1900) gave a generic diagnosis of *Malmgrenia* and incorrectly indicated 1876 as the first date of publication of the generic name.

The first author to question the status of *Malmgrenia* was Darboux (1899). He did not consider species of *Malmgrenia* should be separated from species of *Harmothoe* simply because they lacked cephalic peaks. Consequently, he referred all species of *Malmgrenia* to *Harmothoe.*

Willey (1902) disputed the synonymy, claiming the insertion of lateral antennae on the prostomium of species formerly placed in *Malmgrenia* was not similar to that of species of *Harmothoe* and warranted the retention of the genus *Malmgrenia* as defined by McIntosh 1900.

The validity of *Malmgrenia* was accepted by some authors, such as Fauvel 1923; Pettibone, (1953), and Day (1967) who refined the generic diagnosis to include important features such as the number of body segments, and which of those segments bear elytra. Hartmann-Schroeder (1971) suggested that *Malmgrenia* should be considered as a subgenus of *Harmothoe* and Lagardere (1970) also proposed a close relationship between these two genera. However, in spite of these doubts over the status of the genus, more species of *Malmgrenia* have since been newly described or referred from other genera by various authors (see Table 1). Kudenov (1975, 1977) described two new species of *Malmgrenia* and provided a key to the majority of the species. He did not discuss the status of the genus and does not indicate to which subfamily it might belong. The last species description was that of *M. furcosetosa* Loshamn, 1981.

Tebble and Chambers (1982) included a number of species from the North Atlantic formerly ascribed to *Malmgrenia* under *Harmothoe*, as they considered the absence of cephalic peaks, and subterminal insertion of the lateral antennae not sufficient grounds to warrant separation of *Malmgrenia* species from *Harmothoe*. They included *M. castanea, M. andreapolis, M. lunulata* and *M. furcosetosa*. The type species of *Malmgrenia, M. whiteavesii* (designated by Hartman, 1959 by monotypy) is also from the North Alantic. However the unique, fragmented type is lost. The original description of the species is poor and reference to Article 69 of the International Code of Zoological Nomenclature (1985) suggests the genus *Malmgrenia* is currently invalid as it lacks a valid type species.

Leaving aside the problem of the status of the genus under the terms of the "Code", it is obvious some of the species currently referred to this genus have presented difficulties to taxonomists and led to conjecture over their taxonomic position in the Polynoidae. The major problem appears to be interpretation of the arrangement of the lateral antennae upon the prostomium and the level of taxonomic importance attached to differences in this arrangement. Consequently, in my examination of the material of *Malmgrenia* species I have adopted a set of criteria which I hope others may also find useful in overcoming these problems of interpretation.

Methods. Where possible I have examined the type material and any other additional material available. Original descriptions of all species of *Malmgrenia* were also examined.

Subfamily classification. The distinction between the two main subfamilies of the Polynoidae is primarily dependent on the way in which the pair of lateral antennae are inserted upon the prostomium. In the Lepidonotinae the lateral antennae are considered to be inserted terminally, on the ends of the prostomium on either side of the median antennae. The ceratophores of the lateral antennae are anterior prolongations of each half of the prostomium and the ceratophores of all three antennae tend lie in the same plane. Examples of this type are illustrated in Fig. 1 B, D, F.

The other large subfamily, the Harmothoinae, is characterised by taxa on which the lateral antennae are inserted ventrally, lying under the anterior peaks of the prostomium, and consequently, lying at a lower level than the median antenna. Examples of this type of arrangement are also illustrated in Fig. 1 A, C, E.

There are 16 other subfamilies of Polynoidae, characterised in general by a reduction in the number of antennae on the prostomium and/or the possession of unusual features such as branchiae (Fauchald, 1977; Muir, 1982; Pettibone, 1985). The majority of polynoid species are however, still assigned to one or other of the two major subfamilies, and for the most part, determination of affiliation with either of these two subfamilies is straightforward. A small group of genera and species are exceptional (primarily the members of the seven genera referred to in the Introduction) as they possess lateral antennae which are inserted subterminally. Although the lateral antennae do appear to be attached to the anterior ends of the prostomium, they lie at a lower level than the median antenna (Fig. 1 G).

As a consequence of the difficulty associated with interpreting this subterminal type of lateral antennae attachment, the taxonomic status of many of these species has been uncertain, particularly when assignment to subfamily is considered. For example, Loshamn (1981) places *Malmgrenia* species within the Harmothoinae while Fauchald (1977) places them under Lepidonotinae.

Without reference to other characters, it is difficult to avoid making an arbitrary decision. There appear to be few characters which could be useful, but after examining some examples of *Lepidonotus* and *Harmothoe* species I have adopted the following approach which, while not entirely satisfactory, will I believe, prove to have some taxonomic utility.

In Fig. 2, I have illustrated ventral views of the prostomia of the specimens depicted in Fig. 1. Manipulation of specimens into a position enabling a good ventral view of the prostomium is sometimes difficult, particularly with small specimens, and may require the removal of one or both palps.

The specimens selected for illustration here as representatives of each genus were chosen because each shows a high level of agreement with recent descriptions of those genera. The three *Lepidonotus* species are all specimens collected in N.T. waters. The *Harmothoe* sp. is an as yet undescribed species from N.T. waters. *Harmothoe imbricata* is a specimen collected from Hong Kong and *H. praeclara* is a specimen donated by the South Australian Museum.

The three species of *Lepidonotus* (Fig. 2 B, D, F) all show a high level of similarity in the appearance of the underside of the prostomium. The lateral antennae are on anterior continuations of the prostomium without distinct ceratophores. Similar patterns are also found on representatives of the two other genera traditionally placed in the Lepidonotinae, *Parahalosydna* and *Halosydnopsis* (Fig. 3 A, B).

The three species of *Harmothoe* figured do not show quite the same level of similarity. All three differ from Lepidonotinae in that the lateral antennae have ceratophores inserterd ventrally and fused for at least part of their length, to the underside of the prostomium (Fig. 2 A, C, E). However, they differ from each other in the extent to which the posterior edges of the lateral ceratophores merge with each other in the midline. On *Harmothoe sp.* (Fig. 2 E) the bases of the ceratophores, while attached ventrally, are quite well separated. On *H. imbricata*, (Fig. 2 A) the bases almost meet, and on *H. praeclara* (Fig. 2 C) the bases of the ceratophores are fused for a part of their length. Members of the genus *Harmothoe* appear to form a transitional series from species with widely separated ceratophores to those exhibiting fusion of the ceratophores for some part of their length.

It may be that the present group of species currently referred to *Harmothoe* is polyphyletic (*sensu* Wiley, 1981: 86-87), containing several discrete groups of species. However, elucidation of this possibility is dependent on a revision of the species of *Harmothoe* (well over 100), which is beyond the scope of this work.

Therefore, in this revision of species formerly assigned to *Malmgrenia*, I shall place all species that exhibit the characteristic pattern shown in Figure 2 for the lepidonotine polynoids in the Lepidonotinae, and those which exhibit a pattern similar to the range of variation exhibited by the *Harmothoe* species shown in Figure 2 will be aligned with the Harmothoinae.

Characters. The terminology adopted here for description of taxonomic characters largely follows currently accepted criteria. Definitions of characters used here are those of Muir (1982) except for the manner of recording the pattern of elytron attachment and the use of the word setae (= chaetae in Muir 1982). Elytron attachment to segments is recorded after the method of Pettibone (see 1953:9, 1985, 1986 a,b for examples). The first body segment is considered to be the one bearing tentacular cirri, and the first pair of elytra are therefore attached to segment 2. The standard pattern of attachment in Polynoidae is then 2,4,5,7,9, . . . etc.

The numbers of pairs of elytra, *and* their pattern of attachment on a specimen is of paramount importance in determining generic status. Even in those genera for which the numbers of pairs of elytra on mature specimens is found to be variable, the pattern of elytron attachment is often discrete enough to be useful in distinguishing between genera (e.g. Pettibone, 1969,1977).

Descriptions. Comprehensive descriptions of species referred to other genera are not given here. The rationale behind referral to another genus is given under remarks. I suspect that in at least several cases, species I have referred to other genera will prove to be synonymous with existing species already described for those genera. In these cases, full description of species should be accompanied by a revision of the genus to which species have been assigned. The exception here, is the new genus *Lobopelma* for which a diagnosis and a description of the type species is given.

Material. Some of the species referred to *Malmgrenia* presented a problem as the type material was not available for examination. For some of these species, the original and subsequent descriptions are detailed enough to allow a decision on which genera each of the species should be placed in. The remainder are species with indequate descriptions, and I have accordingly placed the species as Incertae sedis, with some discussion of the possible taxonomic position.

The following abbreviations occur in the text to indicate the present location of the material examined or discussed: AHF Allan Hancock Foundation, University of South-

Table 1. A list of *Malmgrenia* species compiled from Pettibone 1953, Kudenov 1977, Loshamn 1981 and McIntosh 1900.

Name	Original name, author and date	Referred to *Malmgrenia* by	Type locality	Location of Type specimen
Malmgrenia whiteavesii	*Malmgrenia Whiteavesii* McIntosh, 1874	-	Gulf of St Lawrence	BMNH now lost
M. castanea	*M. castanea* McIntosh, 1876	-	North Unst, Shetland	BMNH
M. andreapolis	*M. andreapolis* McIntosh, 1876	-	St Andrews, Scotland	BMNH
M. crassicirrus	*M. crassicirrus* Willey, 1902	-	Cape Adare, Antarctica	BMNH
M. micropoides	*M. micropoides* Augener, 1918	-	Annobon, West Africa	ZMH
M. nigralba	*M. nigralba* E. Berkeley, 1923	-	Western Canada	USNM
M. curacaoensis	*Paralepidonotus boholensis curacaoensis* Horst, 1922	Augener 1927	Curacao, West Indies	ZMA
M. nesiotes	*Polynoe nesiotes* Chamberlin, 1919	Hartman 1938	Lower California	USNM
M. alba	*Laenilla alba* Malmgren, 1865	Hartman 1959	Finmark	NRS
M. ampulliferoides	*M. ampulliferoides* Uschakov & Wu, 1959	-	Yellow Sea, China	IOAS
M. purpura	*M. purpura* Day, 1960	-	False Bay, South Africa	USNM
M. marquesensis	*Allmaniella marquesensis* Monro, 1928	Day 1962	Marquesas Is. South Pacific	BMNH
M. monoechinata	*M. monoechinata* Rullier, 1965	-	Moreton Bay, Queensland	AM
M. phillipensis	*M. phillipensis* Knox & Cameron, 1971	-	Port Phillip Bay, Victoria	MV
M. hartmanae	*M. hartmanae* Kudenov, 1975	-	Gulf of California, Mexico	AHF
M. microscala	*M. microscala* Kudenov, 1977	-	Port Phillip Bay, Victoria	MV
M. furcosetosa	*M. furcosetosa* Loshamn, 1981	-	Bohuslan, Sweden	NRS
M. lunulata	*Polynoe lunulata* Delle Chiaje, 1841	Pettibone 1953	Mediterranean	?

Table 2. Taxonomic status of species formerly referred to *Malmgrenia*

Name of species	*Referred to*	*Referred by* *- indicates this paper*
Malmgrenia whiteavesii McIntosh, 1874	indeterminable	-
M. castanea McIntosh, 1876	*Harmothoe castanea*	Tebble and Chambers 1982
M. andreapolis McIntosh, 1876	*Harmothoe andreopolis*	Tebble and Chambers 1982
M. crassicirrus Willey, 1902	*Harmothoe crassicirrus*	-
M. micropoides Augener, 1918	*?Harmothoe* sp.	-
M. nigralba Berkeley, 1923	*Harmothoe nigralba*	-
M. curacaoensis (Horst, 1922)	*Harmothoe* sp.	M. Pettibone (pers. comm.)
M. nesiotes (Chamberlin, 1919)	*Halosydna nesiotes*	-
M. alba (Malmgren, 1865)	indeterminable	-
M. ampulliferoides Uschakov and Wu, 1959	*?Paralepidonotus ampulliferus*	-
M. purpura Day, 1962	*? Paralepidonotus* sp.	-
M. marquesensis (Monro, 1928)	*Hololepidella nigropunctata*	-
M. monoechinata Rullier, 1965	*? monoechinata*	-
M. phillipensis Knox and Cameron, 1971	*Harmothoe phillipensis*	-
M. hartmanae Kudenov, 1975	*Halosydna hartmanae*	-
M. microscala Kudenov, 1977	*Lobopelma microscala*	-
M. furcosetosa Loshamn, 1981	*Harmothoe furcosetosa*	Tebble and Chambers 1982

ern California, Los Angeles; AM Australian Museum, Sydney; BMNH British Museum of Natural History, London; IOAS Institute of Oceanology, Academy of Science, China; NRS Naturhistoriska Riksmuseet, Stockholm; NTM Northern Territory Museum, Darwin; MV Museum of Victoria, Melbourne; RSM Royal Scottish Museum, Edinburgh; USNM National Museum of Natural History, Smithsonian Institution, Washington; ZMA Zoologische Museum, Amsterdam.

SYSTEMATICS

Sub family Harmothoinae Horst, 1917

Genus *Harmothoe* Kinberg, 1855

Harmothoe andreapolis (McIntosh, 1876)

Malmgrenia andreapolis McIntosh 1874:195; 1876: 377-378, Pl. LXVII, Figs 20-23.

Harmothoe andreapolis Tebble and Chambers, 1982: 49-50, Figs 16 a-d, 46, 47.

Type material. SYNTYPES - BMNH. ZK 1921.5.1. 510-511. St Andrews, Fife, Coll. W.C. McIntosh.

Additional material. R.S.M. Irish Sea, off Clogher Head, 53° 46′N, 6° 08′ W, very fine sand coll. Det. Pres. M. Parker. Fisheries Research Centre, Dublin, Ireland.

Remarks. The type material available for examination was in poor condition and comprises two anterior ends and a large posterior fragment presumably from a third specimen. The ventral side of the prostomium (which lacks cephalic peaks) was examined on both the syntypes and the RSM material (Fig. 3 D). The ceratophores of the lateral antennae on the material examined are fused ventrally in the midline, although the suture where the outer edge of each ceratophore is fused to the underside of the prostomium is clearly visible (Fig. 3 D). This arrangement of lateral ceratophores on the ventral surface of the prostomium is similar to that found on specimens of *H. praeclara* (Fig. 2 C) although there is a greater degree of fusion of the ceratophores in the midline on specimens of *H. andreapolis*.

The syntypes examined were incomplete and therefore deduction of the numbers of pairs of elytra and their pattern of arrangement was not possible. However, in the original description of this species McIntosh states there are 15 pairs of elytra, and after comparison of the setae, elytra and parapodia of the type material and RSM specimen, I concur with Tebble and Chambers (1982) that all the material is conspecific. The RSM specimen is in excellent condition and the 15 pairs of elytra were attached on segments 2, 4, 5, 7, 9, ...21, 23, 26, 29, and 32. The notopodia have short acicular lobes and the neuropodia each have a supraacicular lobe. These features are found among species of *Harmothoe*, as are the similar thickness of the notosetae and neurosetae, and the shape and extent of the spinous patches on the distal ends of the neurosetae.

Harmothoe castanea (McIntosh, 1876)

Malmgrenia castanea McIntosh, 1876:376-377, Pl.LXVII, Figs 15-18.

Harmothoe castanea Tebble and Chambers, 1982:47-49, Figs 15, 44,45.

Type material. SYNTYPES - BMNH ZK 1921.5. 1. 507. 28 miles NNE of North Unst, Shetland, 85 fathoms on *Spatangus purpureus*, coll. W.C. McIntosh.

Additional material. RSM 59° 15.77′ coll. 8.v. 1983, MV "Whitethorn". 125m, fine, very shelly, sand, IGS code 59-02/284.

Remarks. I have examined the type material of this species. The specimens were not in good condition. Comparisons with the representative species of *Harmothoe* illustrated in Fig. 2 demonstrated the mode of insertion of the lateral antennae upon the underside of the prostomium in the types and the RSM material (Fig. 3 E) is very similar in appearance to that of *H. praeclara* (Fig. 2 C).

The material examined (where complete) has 15 pairs of elytra arranged on segments 2, 4, 5, 7, 9, . . . 21, 23, 26, 29, and 32. The body is short (36-38 segments) and the last pair of elytra effectively cover the posterior segments. The notopodia have relatively short acicular lobes and the neuropodia have a small supraacicular lobe. Notosetae and neurosetae are similar in thickness. The neurosetae have relatively short distal spinous patches. The neurosetae are mainly unidentate but there are a few weakly bidentate. All of these characteristics are consistant with species of *Harmothoe*.

Harmothoe furcosetosa Loshamn, 1981

Malmgrenia furcosetosa Loshamn, 1981: 5-7, Fig. 1, A-L.

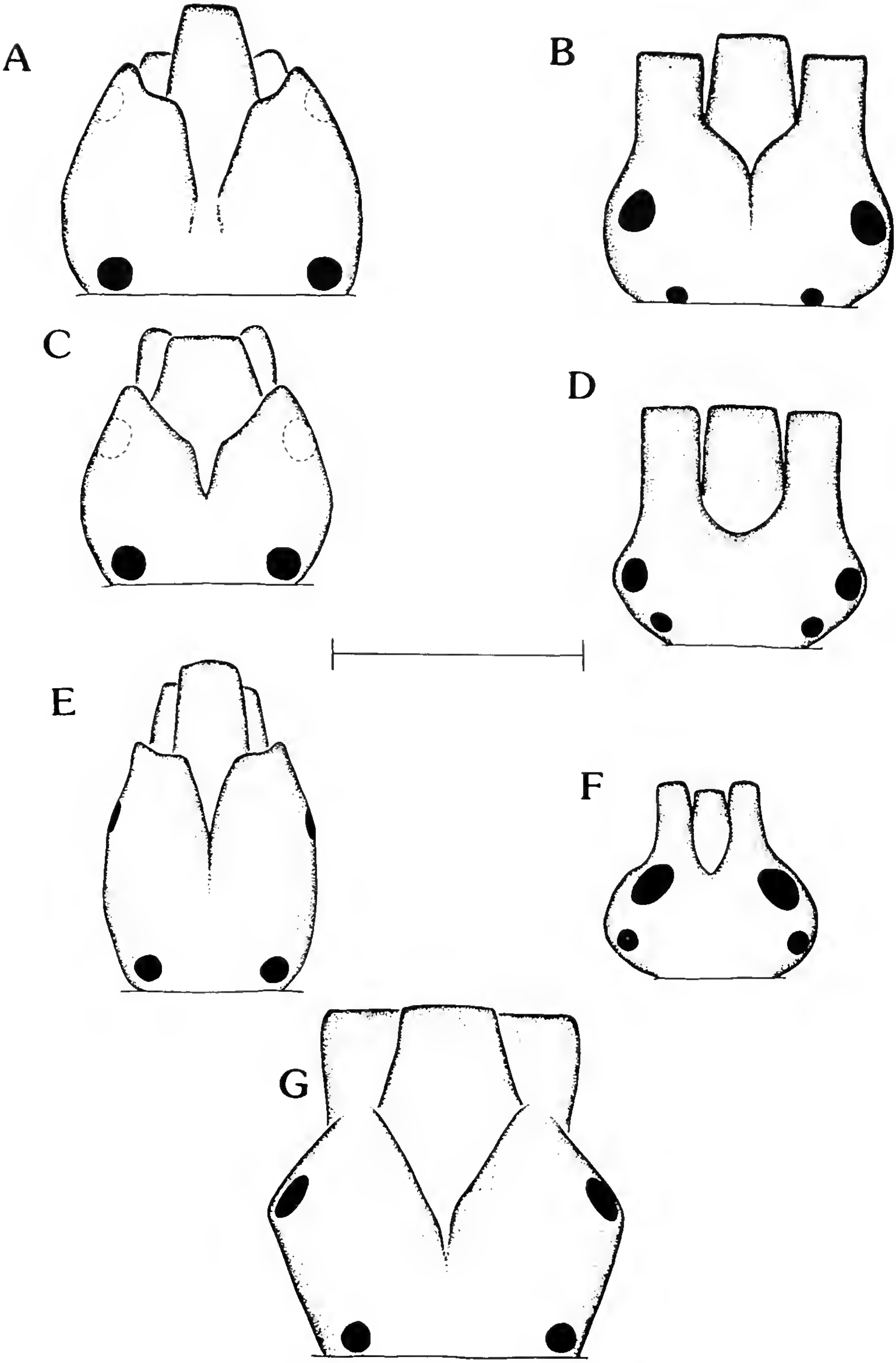

Fig. 1. Dorsal views of prostomia of representative polynoid species: **A**, *Harmothoe imbricata* NTM W3869; **B**, *Lepidonotus glaucus* NTM W190; **C**, *Harmothoe praeclara* NTM W 1566; **D**, *Lepidonotus cristatus* NTM W 253; **E**, *Harmothoe sp.* NTM W 201; **F**, *Lepidonotus kumari* NTM W2686; **G**, *Paralepidonotus ampulliferus* NTM W 2122. Scale line 0.5 mm.

Harmothoe furcosetosa Tebble and Chambers, 1982: 42-43, Figs 1e, 13a,b,e, 39.

Material. RSM. 1981. 109. Clyde Sea. coll. R.B. Clark 1949-50. det. S. Chambers, v 1980. RSM 1983.12.08. Helford. coll. R.B. Clark, 11 iv. 1964. RSM 1962.32.12. Clyde Sea, Etterick Bay. R.B. Clark coll. 1949-50.

Remarks. I have not examined the type material of this species. However, this species is one that was recently included in *Harmothoe* by Tebble and Chambers (1982). The RSM specimens sent to me for examination concur in every respect with the original type description of Loshamn and the species is easily recognised by the distinctive notosetae from which the species name is derived. Examination of the ventral side of the prostomium of the specimens indicates the type of attachment of lateral ceratophores is similar to that found on specimens of *H. praeclara* (Fig. 2 C), although the degree of fusion of the ceratophores in the midline is greater on specimens of *H. furcosetosa* (Fig. 3 G).

Features of the parapodia of *H. furcosetosa* are consistant with *Harmothoe* species, particularly the presence of a short, supraacicular extension of the presetal lobe of the neuropodium. Other characteristics which ally this species with *Harmothoe* are the numbers of pairs of elytra and their disposition on the body and the shape of the neurosetae.

Harmothoe nigralba (Berkeley) comb. nov.

Malmgrenia nigralba Berkeley, 1923 :213-214, Pl. 1, Figs 5-7.

Malmgrenia lunulata Pettibone, 1953:25

Type material SYNTYPES - USNM 32875, 32876 Pipers Lagoon, Vancouver Island, British Columbia. June 20th, 1920.

Additional material. AHF 7926. Departure Bay, British Columbia, July 3, 1940. coll. MacGinitie.

Remarks. There are other syntypes (BMNH) which have not been examined. The original description indicates the length of one specimen only, 18mm, with 40 segments, though apparently no holotype was designated. The USNM syntypes comprise three specimens, two of which were complete with 39 segments (14mm long) and 34 segments (11mm long) respectively. The third incomplete specimen has 25 segments and is 10mm long. The AHF specimen is 16 mm long and has 40 segments. There are 15 pairs of elytra attached on segments 2,4,5,7,9,.......21,23,26,29 & 32. The standard arrangement in *Harmothoe* species and those of many other genera. The prostomium is broader at the base than it is anteriorly and there are no cephalic peaks. The ceratophores of the lateral antennae are clearly fused in the midline on the ventral side of the prostomium on specimens of *H. nigralba* (Fig. 3 F,H). The degree of fusion is similar to that observed on *H. andreapolis*, *H. castenea* and *H. furcosetosa* (Fig. 3,D,E,G), and is slightly greater than that observed for specimens of *H. praeclara* (Fig. 2 C). The general shape of the prostomium and the position of the two pairs of eyes of this species resembles closely the prostomial features of a number of Harmothoe species including *H. andreapolis*, *H. marphsyae* and *H. ljungmani*. In addition the neuropodia, which have a small supraacicular prolongation on the presetal lobe are typical of *Harmothoe* species, as are the characteristics of the notosetae and neurosetae. The neurosetae bear a close resemblance to those seen on specimens of *H. andreapolis*, a fact referred to in the original description. However, the knob-like tips of the neurosetae on specimens of *H. nigralba* do not seem as well developed as those of *H. andreapolis*. The elytra of the two species are also similar but on specimens of *H. nigralba* the ring of dark pigment is well defined and often complete, whereas on specimens of *H. andreapolis* it is usually a poorly defined arc of pigment. The surface of the elytra of *H. nigralba* also have a prominent polygonal pattern of intersecting white lines not seen on elytra from specimens of *H. andreapolis*.

Pettibone (1953) referred this species to *M. lunulata* (Delle Chiaje) 1841 but has since (pers. comm.) changed her mind and now considers it to be a valid species although she does not agree that it is a species of *Harmothoe*.

Harmothoe phillipensis (Knox and Cameron) comb. nov.

Malmgrenia phillipensis Knox and Cameron, 1971:22-23, Figs 1-6; Kudenov 1977: 85-89, Pl. 1a-n.

Type material. HOLOTYPE - MV G1736, Prince George Buoy, Port Phillip Bay, Victoria. coll. Port Phillip survey 11.9.1960.

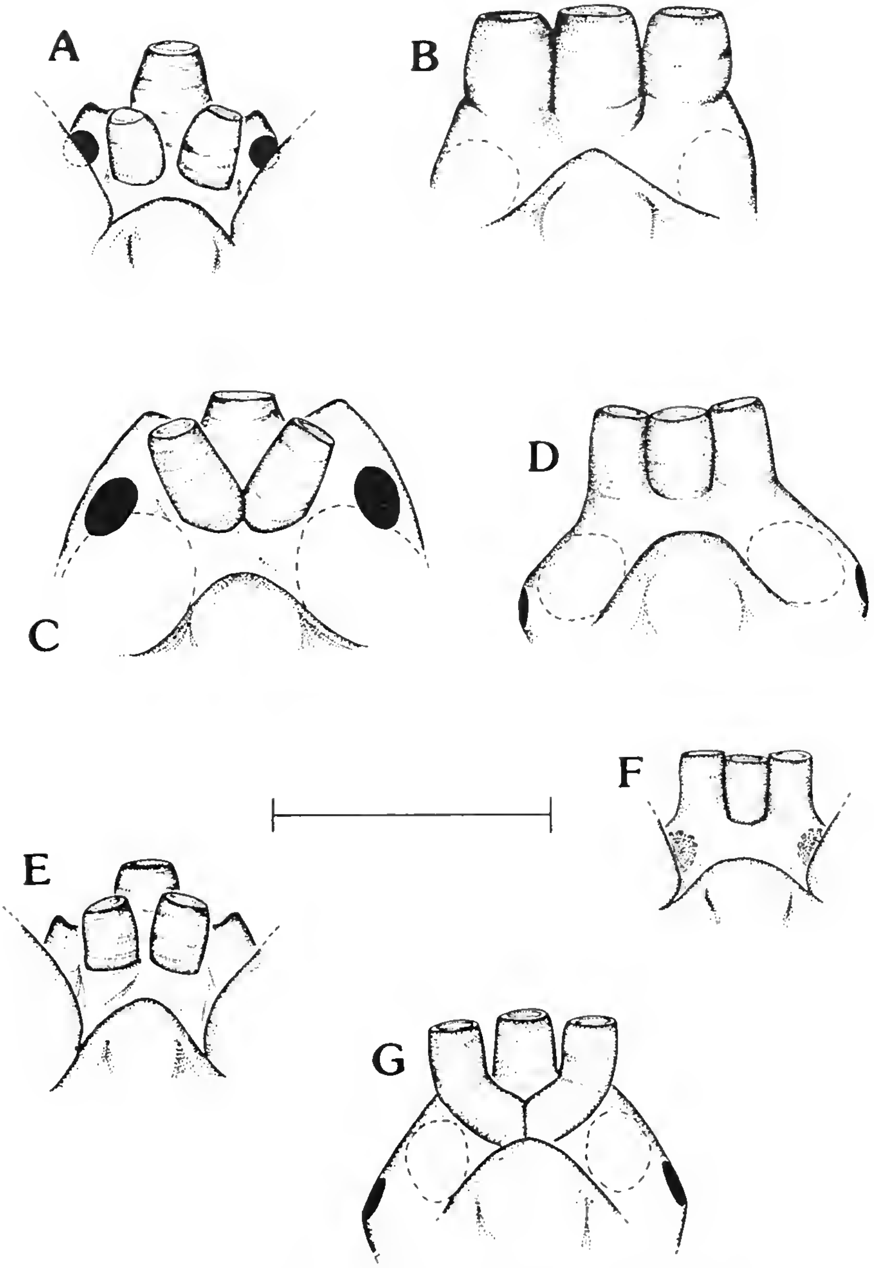

Fig. 2. Ventral views of anterior ends of prostomia of representative polynoid species (dashed lines indicate position of palps which have been removed): **A**, *Harmothoe imbricata* NTM W3869; **B**, *Lepidonotus glaucus* NTM W190; **C**, *Harmothoe praeclara* NTM W1566; **D**, *Lepidonotus cristatus* NTM W253; **E**, *Harmothoe sp.* NTM W201; **F**, *Lepidonotus kumari* NTM W2686; **G**, *Paralepidonotus ampulliferus* NTM W2122. Scale line 0.5 mm.

PARATYPES - MV G1737, Quiet corner, Port Phillip Bay, Victoria. coll Port Phillip survey.

Additional material. AM W7268 W7279, Station 958, Port Phillip Bay, coll. Port Phillip Survey; AHF 00103-01; Port Phillip Bay, Victoria.

Remarks. The bases of the lateral ceratophores meet in the midline on the underside of the prostomium of the holotype (Fig. 3 I). This arrangement closely resembles that seen on specimens of *H. praeclara* (Fig. 2 C). The material examined agrees well with the descriptions provided by Knox

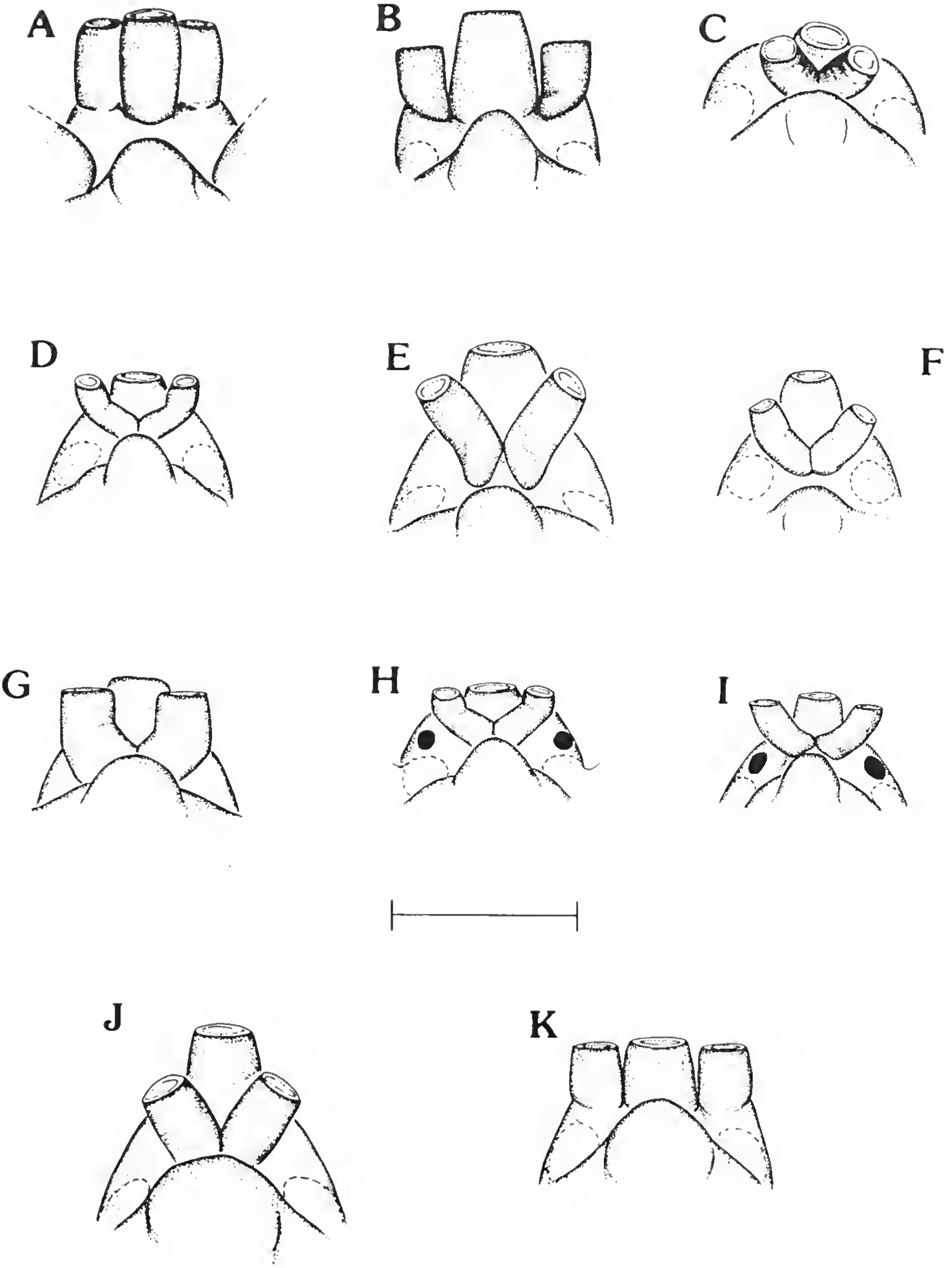

Fig. 3. Ventral views of anterior ends of prostomia of representative polynoid species and some species formerly referred to *Malmgrenia* (Dashed lines indicate position of palps): **A**, *Parahalosydna pleiolepis* NTM W3867; **B**, *Halosydnopsis pilosa* NTM W524; **C**, *Malmgrenia? monoechinata* AM W379; **D**, *Harmothoe andreapolis* RSM; **E**, *Harmothoe castanea* RSM IGS 59-02/284. **F**, *Harmothoe nigralba* USNM 32876; **G**, *Harmothoe furcosetosa* RSM 1983.12.08; **H**, *Harmothoe nigralba* AHF 7926; **I**, *Harmothoe phillipensis* AHF 000103-01; **J**, *Lobopelma microscala* MV G2544; **K**, *Halosydna hartmanae* AHF 1118. Scale line 0.5 mm.

& Cameron, and later Kudenov. I agree with Kudenov that the longitudinal ridges on the dorsal surface of some elytra are artifacts of preservation. Although both descriptions state there are 15 pairs of elytra present on specimens of *H. phillipensis*, there is no mention of their arrangement upon the body. The elytra are found on segments 2, 4, 5, 7, 9......21, 23, 26, 29 and 32, the standard pattern for many genera, including *Harmothoe*. The parapodia are like those of many *Harmothoe* species, and coupled with the characteristics of the setae, which are also typical of *Harmothoe* species, provides the basis for including *H. phillipensis* in the genus *Harmothoe*.

Harmothoe sp.

Paralepidonotus boholensis curacaoensis Horst,1922:198.

Malmgrenia curacaoensis Augener, 1927:45-47, Fig. 2A-D.

Type material. HOLOTYPE - ZMA V. Pol. 1039. Curacao, "Spaansche water", inside *Porites porites*, coll. van der Horst, 1920.

Remarks. I had cause to examine this specimen when revising the genus *Paralepidonotus*. At that time I decided it was not a species of *Paralepidontus*, primarily because it lacked ventral lamellae (contrary to the original description). Dr Marian Pettibone has advised me the species was, (pers. comm.) in her opinion, synonymous with one of the species of *Harmothoe* from the Caribbean described by Treadwell, and that both are to be referred to a new genus. However, after examination of the specimen I consider this species is sufficiently similar to *Harmothoe* species to warrant its inclusion in that genus. Perhaps the only criterion which would exclude it is the lack of cephalic peaks — and in this paper that is not considered sufficient grounds for separation from *Harmothoe*.

Genus *Hololepidella* Willey, 1905

Hololepidella nigropunctata Horst, 1915

Allmaniella marquesensis Monro, 1928:469-471, Figs 1-4.

Malmgrenia marquesensis Day, 1962:628, 629

Type material. SYNTYPES - BMNH ZK 1928 1.11. 1/3 Tai O Hae Pool, The Marquesas, coll C. Crossland, 1928.

Remarks. Of the five syntypes, only two specimens are complete, the larger (8.7mm) has 41 segments and 19 pairs of elytra, the smaller individual (6.3mm) has 37 segments and 17 pairs of elytra. All but a few of the elytra have become detached from the specimens.

The current diagnoses of the genera *Malmgrenia* and *Harmothoe* require members of these genera possess a maximum of 15 pairs of elytra (Fauchald 1977). As both complete specimens of *M. marquesensis* have more than 15 pairs of elytra, they were incorrectly referred to *Malmgrenia* by Day (1962) and cannot be referred to *Harmothoe*.

Monro originally placed the species in the genus *Allmaniella*, however, a comparison of the syntypes with the generic diagnosis given in Fauchald (1977) rejects their inclusion within *Allmaniella* as the specimens all lack the diagnostic feature of greatly enlarged and extended prostomial lobes.

On polynoid scaleworms with 15 or more pairs of elytra, the great majority of genera have the first 15 pairs of elytra attached to segments 2, 4, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 26, 29 and 32. Thereafter, if more pairs of elytra are present their attachment pattern varies between genera and is of diagnostic importance.

A few genera are unusual in that they exhibit a deviation from this common pattern of attachment for the first 15 pairs of elytra. One of these genera, *Hololepidella* has the elytra attached on segments 2, 4, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 26, 29, 31, 34, and subsequent pairs (with some irregularity) on alternate segments to the end of the body (Pettibone 1969). The two complete specimens of *M. marquesensis* both exhibit this pattern of elytron attachment which is characteristic of *Hololepidella* species. Reference to the key to *Hololepidella* species compiled by Hartmann-Schroeder (1984), and descriptions of *H. nigropunctata* (Horst 1915, 1917; Pettibone 1969) demonstrated the syntypes of *M. marquesensis* possess the characteristic features of prostomium, setae, parapodia and elytra which have been ascribed to specimens of *H. nigropunctata*.

Lobopelma gen. nov.

Type Species *Malmgrenia microscala* Kudenov, 1977.

Diagnosis. Body short, flattened, fusiform; segments up to 38. Elytra and prominent elytrophores. Sixteen to eighteen pairs of elytra on segments 2,4,5,7,9,11,13,15,17,19,21,23,26,29,32,35, last one to three pairs variable on segments 36,37, or 38 and sometimes asymmetrical. Elytra smooth, without papillae or tubercles. Prostomium bilobed, hexagonal, longer than broad. Cephalic peaks absent. Two pairs of eyes. Two palps. Three antennae, lateral antennae inserted ventrally, median ceratophore curved upwards. Lateral antennae with ceratophores fused in the midline for at least part of their length on the underside of the prostomium (Fig. 3 J). Two pairs of tentacular cirri. Segment 2 with elongate buccal cirri. Parapodia biramous, notopodia shorter than neuropodia. Notosetae stouter then neurosetae. Dorsal cirri present, ventral cirri shorter. Each parapodium with a pair of conspicuous fleshy lobes, the inner one often tripalmate. Pygidium, small rectangular, with pair of anal cirri.

Etymology. The genus is named for the distinctive lobes found on the ventral surface of the parapodia. Gender feminine.

Lobopelma microscala (Kudenov) comb. nov.

(Figs 3 J, 4)

Malmgrenia microscala Kudenov, 1977:90-95, Pl. 2 a-m.

Type material. All type material was collected from Port Phillip Bay, Victoria by the Port Phillip Bay Environmental Survey. HOLOTYPE - MV G2544, Station 953, Sand, 3m, 11. vi. 1971. PARATYPES - MV G2545, Station 930, Sandy, 10m, 11. ii. 1970; MV G2546, Station 940, silty clay, 8m, 12.ii.1970; AM W7280, Station 944, Sand, 2m, 10.VI.1971; AM W7281, Station 985, sand, 9m. 9.xii. 1971.

Description. *Holotype:* Body dorsally flattened, fusiform. Length 12 mm, width including parapodia 3.40 mm. 37 segments. Elytra overlapping medially and posteriorly. A pair of anal cirri (missing). Body colour light brown, tinged red by dye from label.

Prostomium bilobed, longer than broad, hexagonal, anterior half thinner than posterior half (Figs 3J,4A). Cephalic peaks absent. Two pairs of eyes. Anterior pair larger, circular, lying laterally, anterior to greatest width of prostomium. Posterior pair circular, dorsal, closer to midline. Two palps, gently tapering. Three antennae, sparsely papillated. Lateral antennae short, stout bases, filiform tips. Ceratophores well-defined, merge ventrally (Fig.3 J). Median antennae much longer, gently tapering to filiform tip, median ceratophore terminal, curved upwards.

Two pairs of tentacular cirri, sparsely papillated, resemble median antennae, dorsal pair longer than ventral pair. A single seta projects from each tentaculophore.

Parapodia biramous. Notopodium rounded, acicular lobe elongate. Notoaciculum protuding. Neuropodium elongate, presetal lobe extended, lanceolate, much longer than triangular, postsetal lobe. Neuraciculum protuding. Dorsal cirri long, cirriform, sparsely papillated, extending well beyond neurosetae. Ventral cirri much shorter than neuropodium, cirriform, smooth. Unusual, large, tripalmate lobe and smaller, cylindrical lobe lie ventrally on each parapodium between ventral cirrus and well-developed nephridial papilla (Fig. 4 C, D).

Notosetae curved, sabre-like, with many rows of fine serrations and blunt, smooth tips. Inferior notosetae longer than superior ones (Fig. 4 E). Neurosetae longer, thinner, with rows of serrations restricted to distal part below unidentate tip. Superior neurosetae with greatest number of serrated rows, inferior neurosetae with least number of rows (Fig. 4 F-H). Seventeen pairs of elytra attached on segments 2, 4, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 26, 29, 32, 35, 36, Elytra tinged reddish pink (with leached dye from specimen label). Elytra on segment 2 circular, subsequent pairs markedly reniform, gradually becoming oval towards posterior end of body. Elytra smooth, without fringe of papillae (Fig. 4 B).

Paratypes: None of the material has been affected by dye. The elytra are colourless and opaque. The prostomium is a slightly darker hue than the characteristic light brown of the rest of the body. Anal cirri are present on some specimens and are long, cirriform. There are some differences in the number of elytra and their distributions. These and other features are listed in Table 3.

Remarks. The original description of this species by Kudenov (1977) is incorrect in two important respects. The complete specimens all have more than 15 pairs of elytra (see

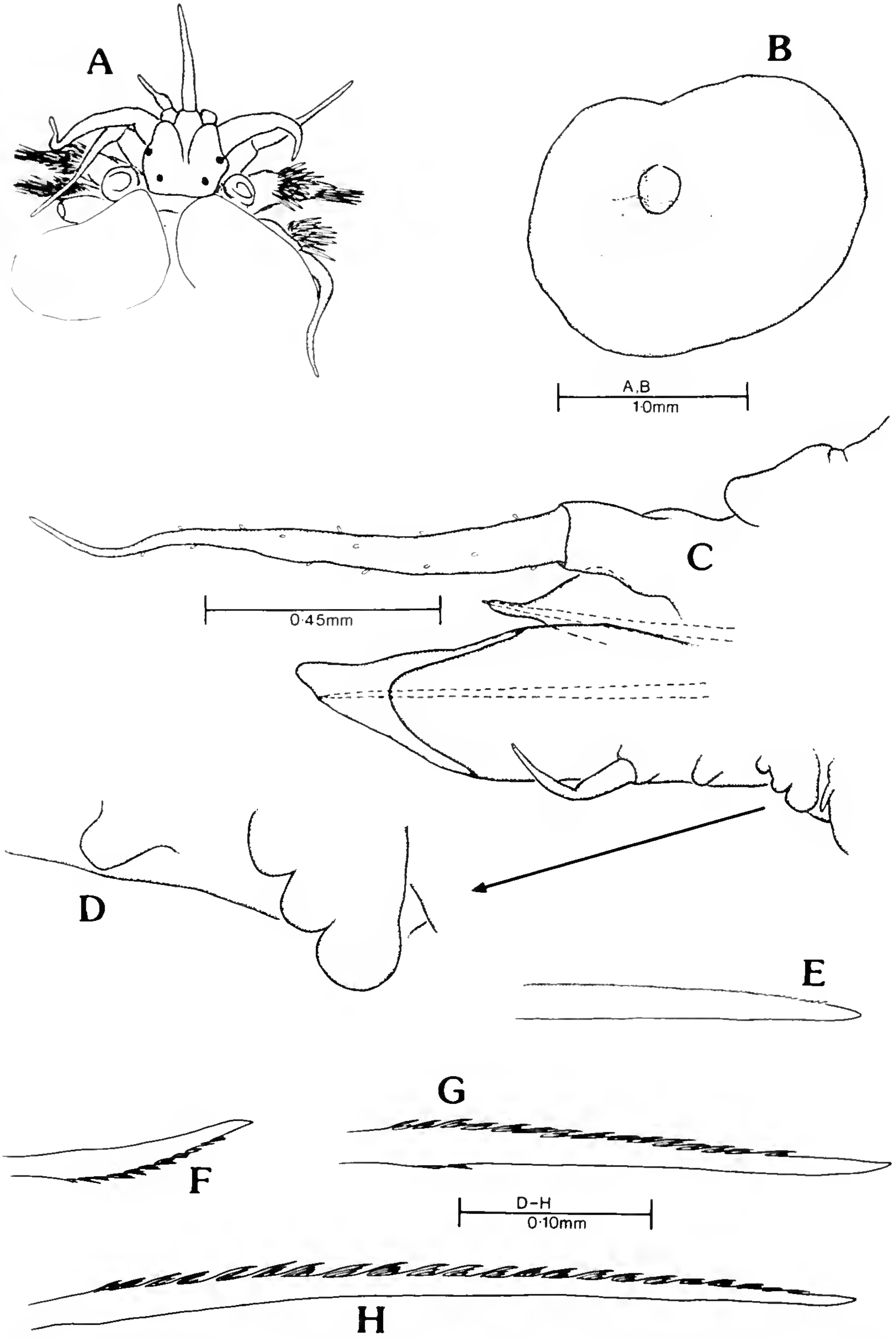

Fig. 4. *Lobopelma microscala* holotype: **A**, anterior end; **B**, elytron from middle of body; **C**, parapodium from left side of 18th segment; **D**, enlargement of ventral surface of parapodium showing distinctive tubercles; **E**, notoseta; **F**, inferior neuroseta; **G**, middle neuroseta; **H**, superior neuroseta.

Table 3. Variable features of paratypes of *Lobopelma microscala*

Paratype	Length (mm)	Width (mm)	No. segments	Pairs of elytra	Elytra attached on segments
MV G2545	7.80 (incomplete)	3.72	29-7 segments missing from middle of body	16	2,4,5,7,9,11,.....21,23,26,29,32,35
MV G2546	10.80	4.56	38	17	2,4,5,7,9,11,......21,23,26,29,32,35, (37 left side, 38 on right side.
AM W7281	11.88	3.48	38	18	2,4,5,7,9,11,.......21,23,26,29,32,35,36,37
AM W7280 (anterior end)	4.80 (incomplete)	2.80	20	10	2,4,5,7,9,11,13,15,17,19.

Table 3 and holotype description). In addition, Kudenov confused the unusual tripalmate lobe, found on the ventral surfaces of the parapodia of all the type material, with the nephridial papilla. The nephridial papillae are well developed and lie in their usual position at the junction of the ventral surfaces of parapodium and body (Fig. 4 C).

The maximum number of elytra found on the material examined was 18 pairs. It is possible that specimens with more body segments and/or pairs of elytra will be found, but I suggest that as some of the material examined contains oocytes (MV G2546) then it is unlikely individuals of this species attain a much greater body length than the range reported here.

There are a number of polynoid genera which have more than 15 pairs of elytra, however there are only three genera that have 16 to 18 pairs of elytra, are short-bodied i.e. a maximum of approxiamately 38 segments, and possess notosetae. These genera are *Acanthicolepis* McIntosh, 1900, *Halosydna* Kinberg, 1855 and *Alentia*.

Despite the similarities, Lobopelma differs significantly from them in the expression of several characters (Table 4), currently accepted as important in the diagnosis of polynoid genera (Pettibone, 1969).

The function of the lobes on the ventral surface of the parapodia of *Lobopelma microscala* is unknown. The flattened, tripalmate shape of the larger lobes suggests a respiratory function. Branchiae are not common among species of the Polynoidae, and those described so far are found only on the dorsal surface of the parapodia (eg. Pettibone, 1985).

If the respiratory water currents observed in *Halosydna brevisetosa* (Lwebuga-Mukasa, 1970) are assumed to be representative of the pattern in most polynoid worms, then the position of the branchiae upon the dorsal surface of the parapodia is advantageous as it places the respiratory organs in the middle of the incoming water. No such advantage would be enjoyed by an individual in which branchiae were located on the ventral surface and it seems unlikely that the ventral lobes of *Lobopelma microscala* act as respiratory organs.

Halosydnopsis and related genera (Pettibone 1977) all have papillae or tubercles on the parapodia. However, the tubercles are always filiform and restricted to the distal ends of the neuropodial lobes.

Phyllohartmania has paired foliose appendages on each segment (Pettibone 1961). However, these lie on the ventrum, not on

Table 4. Comparison of important generic characters

Genus	Elytra	Elytra attached to segment no.	Notosetae	Other
Lobopelma	16-18 pairs	2,4,5,7,9,11,.......21,23, 26,29,32,35 then variable 1 to 3 pairs on 36,37 or 38, often asymmetric	thicker than neurosetae, finely serrated	lateral antennae attached ventrally cephalic peaks absent, lobes on ventral surface of parapodia
Acanthicolepis	18 pairs	2,4,5,7,9,11,........21,23, 26,29,32,34,35,38	thicker than neurosetae, whorls of serrations	lateral antennae attached ventrally
Alentia	18 pairs	2,4,5,7,9,11,........21,23, 26,29,32,35,38,39.	capillary	lateral antennae attached terminally
Halosydna	18 pairs	2,4,5,7,9,11,.........21,23, 25,27,28,30,31,33.	slender, much thinner than neurosetae	lateral antennae attached terminally

the parapodia and the type-species of the genus P. taylori, has only 14 pairs of elytra.

Phyllosheila (Pettibone 1961) has papillae on the ventral surface of the parapodia but these are variable in number. In addition the ventral cirri are foliose and the type species *P. wigleyi* has only 15 pairs of elytra.

Distribution. Known only from Port Phillip Bay, Victoria, Australia.

Subfamily Lepidonotinae Willey, 1902

Genus *Halosydna* Kinberg, 1855

Halosydna hartmanae (Kudenov) comb. nov.

Malmgrenia hartmanae Kudenov, 1975: 77-79, Fig. 2 a-g.

Type material. HOLOTYPE - AHF 1118, Gulf of California, Mexico, 31°10′N. 113°50′W, in lateral setae of *Aphrodita mexicana*, found by K. Zimmerman.

Remarks. The elytra are attached on segments 2, 4, 5, 7, 9,.........21, 23, 25, 27 & 28. This does not agree with the distribution of elytron attachment on species of *Harmothoe*. The species could be referred to *Parahalosydna*, but the neurosetae are more like those of *Halosydna* sp. All the setae are typical of *Halosydna* species and the arrangement of elytra is also typical of *Halosydna* although the specimen lacks the last 3 pairs. In addition, insertion of the lateral ceratophores upon the prostomium agrees very well with the Lepidonotine type (Fig. 3 K). Given these similarities *and* the small size (6mm length) of this specimen, I conclude it is a juvenile *Halosydna* sp.

Halosydna nesiotes (Chamberlin) comb. nov.

Polynoe nesiotes Chamberlin, 1919: 72, P1.8 Fig. 8, P1.9 Figs 1-5.

Malmgrenia nesiotes Hartman, 1938: 122.

Type material. HOLOTYPE - USNM 19460, Lower California, Santa Margarita Island. coll 1891.

Remarks. The specimen is in poor condition, having at some time been dry, a fact mentioned in the original description. The way the lateral ceratophores are attached to the ends of the prostomium on either side of the median antennae indicates this specimen is a lepidonotine polynoid. Both Chamberlin and Hartman individually record 34 segments. However, my interpretation of the material suggests there are 36 segments, a fact not easily discerned because of the state of the specimen, and because the specimen is in two pieces. Some parts of the midsection are missing from each piece. The elytra are then found on segments 2, 4, 5, 7, 9,.......21, 23, 25, 27, 28, 30, 31 & 33. This pattern matches that found on species of *Halosydna*, several of which have been recorded from the Gulf of California. The setae of *H. nesiotes* are also typical of the genus and I have no hesitation in the conclusion this specimen is a member of the genus *Halosydna*.

Incertae sedis

1. *Malmgrenia whiteavesii* McIntosh, 1874. The type is missing and the original description is too vague to allow determination of the taxonomic status of this specimen.
2. *M. alba* (Malmgren) 1865. Originally described as *Laenilla alba* the species is questionably a species of *Harmothoe* (*Laenilla* is a synonym of *Harmothoe*). The type is in Stockholm (NRS).
3. *M. micropoides Augener, 1918.* I have not seen the type material of this species. However. Augeners excellent description of the type specimen indicates the species may well be a member of the genus *Harmothoe* as it possesses the following important diagnostic features.

   The specimen lacks cephalic peaks and the lateral ceratophores are attached ventrally on the prostomium. There are 15 pairs of elytra attached on segments 2, 4, 5, 7, 9,.......21, 23, 26, 29 and 32. There are 36 segments and the elytra cover the entire body. These characteristics are considered herein to be typical of *Harmothoe* species. The setae figured by Augener are not quite similar to those of *Harmothoe* species as there appear to be two distinct types of notosetae, a characteristic typical of species of *Gattyana*. However, the neurosetae are bidentate, and this is not consistant with species of *Gattyana*. Without examination of the type specimen, the species is tentatively referred to *Harmothoe*.
4. *M. purpura* Day, 1960. In the original description Day mentions the presence of rudimentary ventral lamellae. Several other characters, notably the setae and parapodia, suggest this specimen is close

to *Paralepidonotus*. However, examination of the type material is necessary to decide whether the species should be referred to *Paralepidonotus* or elswhere. Some of the type material is in the USNM.

5. *M. ampulliferoides* Uschakov and Wu, 1959. Dr Marian Pettibone first drew my attention to the similarity between the description of this species and the species *Paralepidonotus ampulliferus* (Grube) 1878. Indeed the authors themselves refer to *P. ampulliferus* and put forward a number of features which they believe distinguish their specimen from *P. ampulliferus*. Unfortunately, none of the features they use are reliable, eg. position of spherical ampullae on elytra, length of fringe on elytra, whether neurosetae are uni or bidentate. I agree with Dr Pettibone that this species is probably a specimen of *P. ampulliferus*, however, no mention is made in the original description of the presence or otherwise, of ventral lamellae. Without examination of the type of *M. ampulliferoides*, the referral of this specimen to *P. ampulliferus* is questionable, although Uschakov (1982:150) indicates he now considers this species to be a synonym of *P. ampulliferus*.
6. *M. crassicirrus* Willey, 1902. I have not been able to locate the type material of this species. Bergstrom (1916) referred the species to a new genus, *Gorekia* and deposited his specimens in Stockholm (NRS). The original description and the later one by Bergstrom suggest this species is close to *Harmothoe*. The only criterion Bergstrom uses to distinguish the species as a new genus is the presence of some tri- and quadridentate neurosetae. Given that only two specimens of the species are known it is possible the extra dentition on the neurosetae tips are an individual aberration. Indeed, in his description Bergstrom does state that some of the neurosetae have bidentate tips, a condition widespread in the Polynoidae. Assessment of the taxonomic status of this species is dependent on examination of the type. It is not clear whether Bergstrom examined Willey's type.
7. *M. monoechinata* Rullier, 1965. I have examined the holotype of this species (AM W3792), and I am presently uncertain of its status.

The pattern of attachment of lateral ceratophores on the underside of the prostomium in this specimen (Fig. 3 C) is similar to that of *Harmothoe praeclara* (Fig. 2 C), indicating the species should be placed in the Harmothoinae. The specimen has 15 pairs of elytra arranged on segments 2, 4, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 26, 29, and 32. There are only two elytra remaining with the specimen and these both have a central recurved boss. The notosetae are of two distinct types. Some are short, stout and coarsely serrated and the others are longer, fine tipped, thinner than the neurosetae and are finely serrated. These features of elytron arrangement and notosetae types are characterisitics of members of *Gattyana* McIntosh, 1900. Species of *Gattyana* also have neurosetae on which the distal ends are stoutly unidentate, a feature exhibited by the type of *M. monechinata*. However, Pettibone (1986) has recently revised several of the species formerly assigned to *Gattyana*. Her amended diagnosis based on the type species *G. cirrosa* (Pallas), 1766, suggests only species with distinct cephalic peaks should be assigned to *Gattyana*.

I have examined the holotype (AM W10570) of *Paralialosydna chrysostichus* Hutchings and Rainer, 1979 and consider the specimen to be synonymous with *M. monoechinata*.

Comparision of the type material of both species reveals no differences between the specimens in respect of: elytron number and arrangement upon the body; prostomial features such as shape, eye position, insertion of lateral ceratophores; elytron shape and ornamentation; shape of noto and neuropodia; characteristics of setae; distribution and habitat.

The material examined of these two species cannot be referred to *Paralialosydna*. The way in which the lateral ceratophores are attached to the underside of the prostomium is distinctly harmothoine on the type material of *M. monoechinata* (Fig. 3 C) and *P. chrysostichus*. In addition the arrangement of the 15 pairs of elytra on *P. sibogae* Horst, the type species of *Parahalosydna* is 2,4,5,7,9, ...21, 23, 26,28, 30 in contrast to the pattern found on these two specimens.

8. *M. lunulata* (Delle Chiaje) 1841. This species was placed in *Malmgrenia* by Pettibone (1983:25). There are no types of *Polynoe lunulata* Delle Chiaje available. The status of the species is uncertain.

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HERMIT CRABS (DECAPODA, ANOMURA: COENOBITIDAE, DIOGENIDAE, PAGURIDAE) OF DARWIN AND PORT ESSINGTON, NORTHERN AUSTRALIA

GARY J. MORGAN
Department of Carcinology, Western Australian Museum,
Francis Street, Perth, WA 6000, Australia.

ABSTRACT

Nineteen species of hermit crabs (families Coenobitidae, Diogenidae and Paguridae) are recorded from the terrestrial, littoral and shallow sublittoral habitats of Darwin and Port Essington, and an additional three species from other areas of the Northern Territory. Most of the species are widely distributed across the Indo-West Pacific region. Two new species, *Paguristes alegrias* and *Diogenes biramus*, are described. *Diogenes rectimanus* Miers, *D. gardineri* Alcock, *D. serenei* Forest, *Pagurus kulkarnii* Sankolli and possibly *Clibanarius longitarsus* (De Haan) are new records for mainland Australia. A key to Northern Territory hermit crabs is included.

KEYWORDS: Crustacea, Coenobitidae, Diogenidae, Paguridae, northern Australia.

INTRODUCTION

The hermit crab fauna of the Northern Territory inshore waters has not been scientifically documented. This paper concentrates on two areas of the Territory which have been relatively intensively collected: the waters adjacent to the city of Darwin, and those of Port Essington, a long (40 km), narrow (12 km) embayment 200 km northeast of Darwin. Both areas were sampled by the author in August 1986 and hermit crab specimens housed in the Northern Territory Museum also examined.

Some additional species, represented in the Museum collection by specimens from other Northern Territory localities, are briefly noted.

Northern Territory Museum registration numbers are prefixed by NTM, Western Australian Museum numbers by WAM. Unregistered material is lodged in the former institution. Specimen measurements refer to shield length and colour descriptions are based upon live material. Species of gastropod shell utilised by hermit crabs have been identified where possible and notes on habitat and recorded ranges are included.

Synonymies are not necessarily comprehensive but include reference to original descriptions, junior synonyms and some additional works which incorporate valuable descriptive material. Where listed, Alcock Fize and Serène (1955) and Gordan (1956) may be consulted for further references.

Key to Hermit Crabs of the Northern Terrritory.

1. Third maxillipeds contiguous at bases; chelae subequal or left usually larger than right 2
   Third maxillipeds widely separated at bases; right chela usually larger than left .... Paguridae 20
2. Antennules with flagella compressed and truncate, peduncles very long; maxillipeds 1-3 with flagella reduced or absent; terrestrial .... *Coenobita spinosus* (Coenobitidae)
   Antennules with well developed flagella; maxillipeds 1-3 with well developed flagella; marine .... Diogenidae 3
3. Males and females with 1 or 2 pairs of modified pleopods 4
   Paired pleopods absent 5
4. Males with two pairs of modified pleopods; gonopores on both sides in both sexes; shield black and white with medial orange stripe .... *Paguristes alegrias*
   Males with first pleopods paired but left pleopod much reduced (or absent), second pleopod and gonopore on right side only; females with single pair of

pleopods, gonopore on left side only; shield cream with brown mottling .... *Paguristes monoporus*

5. Cheliped fingers moving horizontally; chelipeds subequal .... *Clibanarius* 6
Cheliped fingers moving obliquely ... 9

6. Pereiopods 2 and 3 uniformly coloured green or brown except for dark annulus at distal edge of propodus, and dactyl cream (sometimes with darker patches mid-dorsally and mid-ventrally) .... *Clibanarius virescens*
Pereiopods 2 and 3 distinctly striped longitudinally 7

7. Ocular peduncles lacking distinct striping; antennal acicle not reaching base of terminal peduncular segment .... *Clibanarius longitarsus*
Ocular peduncles longitudinally striped; antennal acicle reaching or overreaching base of terminal peduncular segment . 8

8. Merus of chelipeds with large blunt proximoventral spine; ocular peduncles shorter than antennular peduncles; shield lacking distinct blue-green bands .... *Clibanarius infraspinatus*
Merus of chelipeds lacking large proximoventral spine; ocular peduncles as long as or longer than antennular peduncles; shield with 2 broad longitudinal submedial blue-green bands and narrower, darker lateral bands .... *Clibanarius taeniatus*

9. Moveable rostral scale or spine, sometimes very small or obsolete, between ocular peduncles; fingertips calcareous .... *Diogenes* 10
No moveable rostral scale; fingertips corneous .... *Dardanus* 16

10. Rostral scale as long as or longer than half length of ocular acicles 11
Rostral scale small, much shorter than half length of ocular acicles or obsolete 15

11. Ocular peduncles shorter than antennal peduncles 12
Ocular peduncles longer than antennal peduncles 13

12. Left chela with small tubercles but lacking large sharp spines along ventral margin and proximolaterally; left chela with incomplete lateral ridge of small spines and tubercles strongest proximally, and, on large males, cheliped very elongate with fixed finger strongly deflexed .... *Diogenes avarus*
Left chela with row of sharp spines projecting almost laterally from ventral margin, and several large spines proximolaterally; chela with dorsolateral ridge of distinct spines; on large specimens, left chela broad and laterally compressed with fixed finger only weakly deflexed .... *Diogenes rectimanus*

13. Ocular peduncles shorter than antennular peduncles; ocular peduncles with faint dorsolateral and dorsomesial longitudinal grey-green stripes .... *Diogenes gardineri*
Ocular peduncles longer than antennular peduncles; ocular peduncles lacking longitudinal stripes 14

14. Male pleopods uniramous; shield very spinose laterally; ocular peduncles cream with brown mottling and brown band proximal to cornea .... *Diogenes serenei*
Male pleopods biramous; shield almost smooth laterally; ocular peduncles cream, lacking mottling .... *Diogenes biramus*

15. Dactyl and propodus of left pereiopod 3 not laterally flattened, lacking dorsal and ventral fringes of setae .... *Diogenes jousseaumei*
Dactyl and propodus of left pereiopod 3 laterally flattened, with dorsal and ventral fringes of setae .... *Diogenes* sp. A

16. Cornea occupying less than one-third of ocular peduncles 17
Cornea occupying one-third of ocular peduncles 18

17. Lateral surface of dactyl and propodus of third left pereiopod with regular transverse squamiform markings; short setae on lateral surface of chelae .... *Dardanus setifer*
Lateral surface of third left pereiopod lacking distinct squamiform markings; long setae on lateral surface of chelae . ... *Dardanus lagopodes*

18. Chelipeds similarly sized, with numerous sharp corneous spines on dorsal and lateral surfaces .... _Dardanus hessii_*
Left cheliped much larger than right and not ornamented with long spines ... 19

19. Dorsolateral surface of left chela with rows of blunt spines or tubercles, ventrolateral surface rather smooth .... *Dardanus pedunculatus**
    Lateral surface of left chela with imbricating squamiform tubercles .... *Dardanus imbricatus**
20. Sexual tube absent in males, right cheliped much larger than left .... *Pagurus* 21
    Males with long spirally coiled sexual tube on coxa of left fifth pereiopod, chelipeds subequal .... *Spiropagurus spiriger**
21. Dorsolateral surface of chelae without medial ridge; ventromesial flange on carpus and merus of right cheliped of males smooth or only slightly uneven .... *Pagurus kulkarnii*
    Dorsolateral surface of chelae with low medial ridge; ventromesial flange of right cheliped with distinct spines .... *Pagurus sp.* A

* Not collected during this study.

SYSTEMATICS

Family Coenobitidae

Coenobita spinosus Milne Edwards

Cenobita spinosa Milne Edwards, 1837: 242.
Coenobita olivieri Owen, 1839: 84.
Cenobita brunnea Dana, 1852: 470; 1855: Pl. 29 Fig. 10a, b.
Birgus hirsutus Hess, 1865: 36, Pl. 7 Fig. 16.
Coenobita spinosus - Ortmann 1892: 318, Pl. 12 Fig. 24; Alcock 1905: 192; McCulloch 1909: 305, Pl. 88 Fig. 1, 1a.
Coenobita spinosus var. *variabilis* McCulloch, 1909: 305, Pl. 88 Fig 2, 2a.

Material. NORTHERN TERRITORY: ♀, 3.0 mm, Nightcliff, Darwin, littoral rock platform, 3 August 1986, WAM 121-87; 2 ♂, 10.4 mm, 5.1 mm, 4 ♀, 9.9 mm - 6.2 mm, Ludmilla Creek near mouth, Darwin, near mangroves, 3 August 1986, WAM 117-87, 118-87; ♀, 6.1 mm, Darwin, sand beach, 25 January 1983; 3 ♂, 11.0 mm, 4.8 mm, 3.6 mm, 2 ♀, 4.1 mm, 4.0 mm, Lee Point Beach, north of Darwin, 6 December 1976; 12 specs, 14.3 mm-6.8 mm, Fannie Bay, Darwin, 15 November 1965; 2 ♂, 5.0 mm, 4.4 mm, 3 ♀, 7.2 mm, 3.9 mm, 3.1 mm, Coral Bay island, Port Essington, upper littoral, sand near mangroves, 12 August 1986, WAM 126-87.

Coloration. Shield pale brown with darker areas especially laterally and anteriorly. Ocular peduncles pale to medium brown, corneas black. Antennular and antennal peduncles pale to medium brown, flagella pale brown. Chelipeds various shades of brown; dactyl and fixed finger paler near tip, tubercles pale; carpus with darker longitudinal lateral band; merus with darker areas distally. Pereiopods 2 and 3 brown with some pale areas, especially on dactyl and distally on propodus. Usually darker band longitudinally on carpus and distally on merus. Setae clear or pale yellow.

Remarks. The species was collected in shells of *Nerita lineata* Gmelin, *N. albicilla* Linnaeus, *Nerita* sp. cf. *N. polita* Linneaus, *Naquetia capucina* (Lamarck), *Littoraria scabra* (Linnaeus), *Turbo cinereus* Born, *Monodonta labio* (Linnaeus), *Planaxis sulcatus* (Born) and several other gastropods.

The taxonomic status of this species is very uncertain. *C. spinosus* displays considerable morphological variation as noted by McCulloch (1909). Specimens in the same population show marked variation in development of the stridulatory ridge on the left cheliped, a character usually employed in diagnosis of species of *Coenobita* (e.g. Alcock 1905; Yaldwyn and Wodzicki 1979). The ridge is usually best developed on small specimens of *C. spinosus*. Variation also occurs in the degree of flattening of the lateral face of the third left pereiopod and in the degree of spination and setation. McCulloch (1909) named a variety, 'variabilis', for those specimens with a stridulatory ridge and flattened third pereiopods. Sympatry of subspecies, however, is rarely tenable; the coexistence of variable forms indicates either intraspecific variation, without subspecific status, or two sympatric species. Further study of intermediate specimens between the extremes of form is necessary to resolve this conundrum.

Allowing for the above variation, most specimens of *Coenobita* from tropical Western Australia and Queensland appear conspecific with Northern Territory animals. It is possible that the nominal taxon *C. spinosus* is multispecific, but presently it seems best to assign this name to the Australian species.

Habitat. Terrestrial, usually within 100 m of the seashore, especially near mangroves.

Distribution. Eastern Africa east to Tahiti including northern Australia. As noted by

McCulloch (1909) the Sydney record of the species (as *Birgus hirsutus*) by Hess (1865) must be regarded as an error.

Family Diogenidae

Paguristes alegrias sp. nov.

(Fig. 1)

Type material. HOLOTYPE - ♂, 7.4 mm, Coral Bay, Port Essington, Northern Territory, 4-6 m, sand and coral, in *Drupella cornus* (Röding) shell, 11 August 1986, NTM Cr005256. PARATYPES - ♂, 5.9 mm, same locality as holotype, NTM Cr005257; 9 specs, 8.2 mm-4.2 mm (incl. 1 ovig. ♀), Coral Bay near headland, 3-4 m, sand and coral, 12-13 August 1986, WAM 165-87; ♂, 7.7 mm, 2 ♀, 6.1 mm (ovig.), 5.0 mm, Coral Bay Island, littoral sand and rocks, 12 August 1986, WAM 166-87.

Description. Shield (Fig. 1a) approximately one and one third times longer than broad. Anterior margin between rostrum and lateral projections concave; rostrum long and rather narrow, acute, deflexed ventrally, much exceeding lateral projections and reaching midlength of ocular acicles; lateral projections broadly triangular, with terminal spinule. Dorsal surface of shield smooth, deeply sculptured posterior to rostrum; some small spinules laterally. Setation sparse dorsally with some scattered clumps of long plumose setae; dense plumose setae laterally.

Ocular peduncles long, slender and cylindrical, length approximately equal to anterior margin of shield; peduncles distinctly inflated proximally and with long plumose setae proximodorsally. Ocular acicles simple (rarely a small mesial or midlateral spinule), mesial margins slightly convex, lateral margins concave; acicles approximate at tips, separated basally by almost basal width of one acicle.

Antennular peduncles three-quarters to five-sixths length of ocular peduncles; peduncular segments unarmed except for ventromesial spine and lateral spine on basal segment. Peduncles sparsely setose.

Antennal peduncles two-thirds to three-quarters length of ocular peduncles. Fifth (ultimate) segment unarmed; fourth segment with small distodorsal spine; third with strong distal spine; second with distolateral (often bifid) spine and distomesial spine; first segment unarmed. Antennal acicle reaching to or distal to half length of ultimate peduncular segment; acicle with terminal spine, 2 distolateral spines and 2 proximomesial spines. Scattered simple setae on segments 5 and 4, simple and plumose setae on segments 3 and 2, dense plumose setae on acicle. Antennal flagella overreaching chelipeds and longer than carapace; flagella with scattered short simple setae.

Chelipeds (Fig. 1b, c) similar though right slightly larger and stouter than left on both sexes. Dactyl half length or slightly more than half length of propodus; cutting edge with small teeth, often one larger tooth proximally, teeth corneous distally, distalmost enlarged; dorsal surface with medial row of small spines or tubercles and dorsomesial row of larger spines, decreasing in size distally; mesial surface with two irregular rows of small spines, one dorsomesially, one ventromesially, these rows poorly developed on small specimens; ventral surface smooth. Dactyl touching fixed finger for most of length, narrow gap proximally. Fixed finger of propodus broader than dactyl; with small cutting teeth, sometimes one or more enlarged proximally, distalmost two teeth corneous; row of spines parallel with cutting edge; remainder of finger with numerous conical spines, distributed proximally over palm; ventral surface of finger with scattered corneous spinules. Propodal palm slightly broader than long; dorsal and lateral surfaces with numerous conical spines and tubercles, smaller laterally, non-spined area of variable size proximodorsally; dorsomesial margin with 3-4 large spines, several smaller spines ventral to these; ventral surface of palm with scattered corneous tipped small spines. Carpus longer than broad, shorter than merus; dorsal surface with numerous small conical spines and tubercles and shallow sulcus; dorsomesial margin with 4-5 (rarely 6) large spines; lateral and mesial surfaces with scattered small spinules. Merus laterally compressed; distal, ventromesial and ventrolateral edges with irregularly sized spines; mesial and lateral faces almost smooth with some low tubercles. Long plumose setae dense on lateral surface of fixed finger and dorsal surface of propodus, dorsal surface of carpus, ventromesial and ventrolateral edges of merus; less dense on mesial surface of dactyl; scattered setae elsewhere.

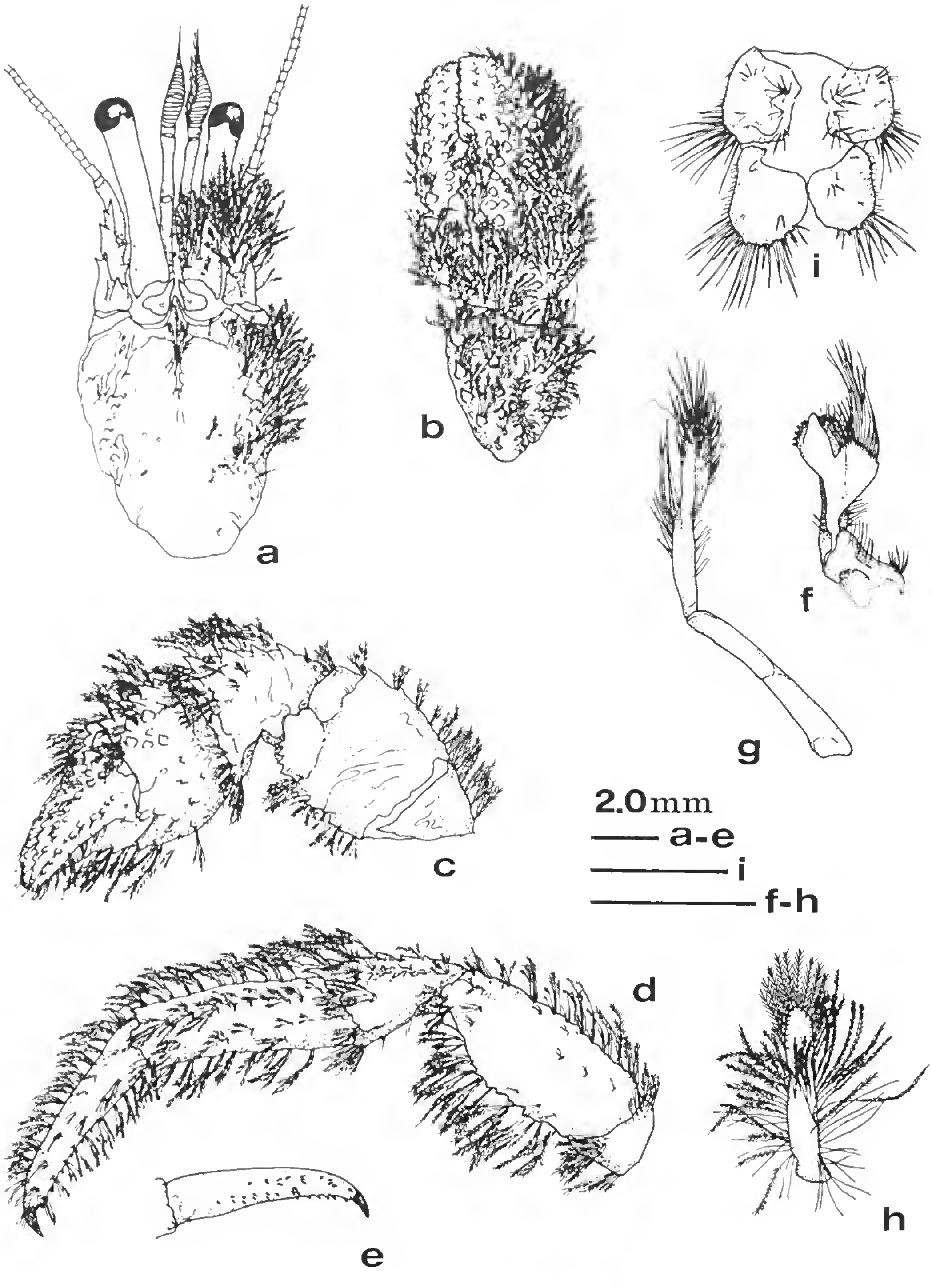

Fig. 1. *Paguristes alegrias* holotype ♂ except **h**: **a**, shield and cephalic appendages (dorsal view, setae omitted on left side); **b**, right cheliped (dorsal view, some setae omitted); **c**, right cheliped (mesial view); **d**, second left pereiopod (lateral view); **e**, dactyl of third left pereiopod (mesial view); **f**, left first pleopod of ♂ (lateral view); **g**, left second pleopod of ♂ (ventral view); **h**, left first pleopod of ♀ (ventral view, paratype); **i**, telson (dorsal view).

Second pereiopods (Fig. 1d) much longer than chelipeds. Dactyl similar length to propodus; row of corneous spines ventrally, decreasing in size proximally; no spines dorsally; strong terminal claw. Propodus unarmed except for 1 (rarely 2) distodorsal spine(s). Carpus with irregular dorsal row of spines, distalmost 1 or 2 large; lateral longitudinal sulcus. Merus very compressed laterally; dorsal margin unarmed or with slight tubercles at setal bases; ventral margin with small spines, largest distally; usually larger spine at distolateral angle. Dense long plumose setae along dorsal and ventral margins of all segments; less dense clumps of setae on lateral and mesial surface of dactyl and propodus (longitudinal row of setal clumps on lateral face of propodus) and lateral surface of carpus; mesial surfaces of carpus and merus and lateral merus with only short scattered setae.

Third pereiopods slightly longer than second, otherwise similar. Dactyl with ventral row of corneous spines, largest distally, and several longitudinal rows of small corneous spines on mesial surface (Fig. 1e). Propodus usually with several denticles or 1 spine at distodorsal angle, otherwise unarmed. Dorsal margin of carpus less spinose than on second pereiopod, merely irregular in outline except for large distal spine. Merus with 1 or 2 spines at distodorsal angle and spine at distolateral angle; ventral margin irregular or with small spines. Setation similar to that of pereiopod 2.

Sternite of third pereiopod with sharply concave anterior and lateral margins, lateral edges converging anteriorly; posterior margin shallowly concave.

First and second pleopods of male illustrated in Fig. 1f, g.

Female gonopores paired, first pleopods (Fig. 1h) paired. Brood pouch large and subquadrate.

Tailfan very asymmetrical, left uropods much larger than right. Telson (Fig. 1i) with left posterior lobe larger than right; lobes separated by deep median cleft; posterior margin of left lobe with 5 spines, of right lobe with 2 spines; lateral margins unarmed. Long simple setae on posterior margins of posterior lobes and posterolateral margins of anterior lobes; scattered long setae on dorsal surface of telson.

Coloration. Shield black with numerous irregularly sized and distributed cream or white spots and patches fusing laterally into irregular bands; bright orange medial stripe extending slightly onto thorax, some orange posterolaterally and on rostal and postorbital margins. Ocular peduncles black with white spots and white band at base of corneas; corneas black. Antennular peduncles black with white spots and patches; antennal peduncles white with irregular black patches and stripes; flagella orange. Dactyl of chelipeds black with white spines and tubercles, white areas fusing to form irregular bands. Propodus similar to dactyl, sometimes small orange patch proximoventrally. Carpus black and white, orange proximodorsally and proximomesially. Merus black and white, orange patch medially on lateral and mesial surfaces. Pereiopods 2 and 3 with irregular black and white longitudinal stripes and patches, white predominant on dactyl and propodus, black predominant on carpus and merus. Some orange tinge on propodus, distinct orange patches midlaterally and fainter mesially on carpus and merus. Pereiopods 4 and 5 black and white with some orange patches. Setae grey, obscuring some coloration on chelipeds.

Etymology. Named after the three-masted schooner, '*Alegrias*', from which sampling in Port Essington was undertaken.

Remarks. The species was collected from shells of *Drupella cornus* (Röding), *Turbo cinereus* Born, *Morula margariticola* (Broderip) and *Astraea rhodostoma* (Lamarck).

P. alegrias is similar to the Indo-West Pacific species *P. balanophilus* Alcock, *P. mundus* Alcock, *P. ciliatus* Heller, *P. seminudus* Stimpson, and *P. acanthomerus* Ortmann, in possessing antennal flagella longer than the carapace and antennular peduncles shorter than the ocular peduncles. *P. alegrias* possesses marginal spines on the posterior lobes of the telson and the right cheliped is slightly larger than the left. *P. seminudus*, *P. acanthomerus* and *P. balanophilus* lack posterior spines on the telson (Miyake, 1978) but the condition has not been recorded for *P. mundus* or *P. ciliatus*. The condition of the right cheliped being larger than the left is most unusual for the genus and also rare in the family Diogenidae. In the original figure of *P. mundus* (Alcock

1905: Pl. 3, Fig. 5), the right cheliped is shown as larger than the left, but the description cites the chelipeds as subequal.

Additionally, *P. balanophilus* has the carapace non-setose, chelipeds with a very short tomentum, chelae densely covered with squamiform tubercles and bifid or trifid ocular acicles. In *P. nundus*, the rostrum is broad and short, ocular acicles are illustrated (Alcock 1905: Pl. 3, Fig. 5) as multispinous, chelae are densely covered with small spines and setation is light. In *P. seminudus*, setation is also very light and ocular peduncles are only slightly longer than antennular peduncles. In *P. acanthomerus*, the merus of chelipeds bears a strong ventral spine.

Closest affinities of *P. alegrias* would appear to be with *P. ciliatus*. Heller's (1865) description is very brief and his figure inadequate to certainly identify his species. Alcock (1905) redefined *P. ciliatus* but expressed uncertainty as to whether or not he was in fact dealing with Heller's species. Heller (1865) noted *P. ciliatus* to have the carapace lightly setose laterally, pereiopods 2 and 3 with only short marginal setae, dactyl and propodus of pereiopods 2 and 3 with short spines on the upper edges and the left cheliped somewhat larger than the right. These characters indicate valid separation of the two species.

The colours of *P. alegrias* are vivid and eyecatching and distinctly different from those of *P. balanophilus* and *P. acanthomerus*, two of the above species for which live colours have been recorded (Miyake 1978).

Eggs carried by ovigerous females are relatively large (diameter 1.1-1.4 mm), suggesting abbreviated development as recorded for some other species of *Paguristes* (Dechancé 1963; Morgan 1987a).

Habitat. Littoral and shallow (to 6 m) waters with substrates of sand and coral.

Distribution. Presently known only from Port Essington, Northern Territory.

Paguristes monoporus Morgan

Paguristes monoporus Morgan, 1987b.

Type material - HOLOTYPE ♂, SL 4.1 mm, CL 7.1 mm, Orontes Reef, west end, (11°04'S, 132°04'E), Port Essington, 11-12 m, in *Cronia avellana* Reeve, 1846) shell, 10 August 1986, NTM Cr004345. PARATYPES - NORTHERN TERRITORY: ♂, SL 3.8 mm, 2 ♀, SL 3.1 mm and 2.9 mm, same locality as holotype, WAM 2240-86; 4 ♂, SL 3.4 mm - 2.9 mm, 2 ♀, SL 3.0 mm and 3.0 mm, Orontes Reef, west end, 14-17 m, in *Cronia avellana* shells, 9 August 1986, WAM 2241-86; 3 ♂, SL 3.8 mm, 3.1 mm, 2.9 mm, 3 ♀, SL 3.9 mm, 3.5 mm, 3.3 mm, Orontes Reef, west end, 12 m, in *Cronia avellana* and *Peristernia incarnata* (Deshayes, 1830) shells, 13 August 1986, WAM 2242-86; ♂, SL 3.5 mm, 2 ♀, SL 3.6 mm (ovig.) and 3.0 mm, Coral Bay, (11°11'S, 132°03'E), sand and coral, 4-6 m, in *Cronia avellana* shells, 11 August 1986, WAM 2243-86; 2 ♂, SL 3.4 mm and 3.3 mm, ♀, SL 3.4 mm, Coral Bay near headland, 4 m, in *Cerithium* sp. shells, 12-13 August 1986, NTM Cr004346; ♀, SL 3.7 mm, Coral Bay, on small island, sand and rocks, littoral, 12 August 1986, WAM 2244-86.

Remarks. Coloration and relationships of this aberrant species of *Paguristes* are discussed by Morgan (1987b). The species is characterised by the presence of the male gonopore and second pleopod on the right side only. This condition is remarkable both for the genus *Paguristes* and for the family Diogenidae.

Clibanarius virescens (Krauss)

Pagurus virescens Krauss, 1843: 56, Pl. 4 Fig. 3.

Clibanarius virescens Dana, 1852: 466; Dana 1855: Pl. 29 Fig. 6 a, b; Alcock 1905: 159; Grant and McCulloch 1906: 34; McCulloch, 1913: 346, Pl. 11 Fig. 2; Barnard 1950: 435, Fig. 80 b, c; Fize and Serène 1955: 138, Fig. 21; Gordan 1956: 310; Lewinsohn 1969: 26; Lee 1969: 43.

Material. NORTHERN TERRITORY: ♂, 6.7 mm, ♀, 3.4 mm, Nightcliff, Darwin, littoral, rock platform, 3 August 1986, WAM 129-87; 19 specs, 7.8 mm-2.3 mm, Table Head, Port Essington, littoral, rock platform, 8 August 1986, WAM 151-87.

Coloration. Shield green with darker brown-green anterolateral patches. Ocular peduncles orange and green with fine white band at base of corneas. Antennular peduncles green or green-blue, flagella orange. Antennal peduncles green, flagella blue. Dactyl of cheliped cream or pale yellow distally, some green or brown proximally;

spines cream. Propodus with fixed finger similar to dactyl, palm green-brown with some red-brown patches; spines cream. Carpus and merus green-brown with cream tubercles and spines. Pereiopods 2 and 3 with dactyl cream, sometimes with dark green, blue-green or brown patches dorsally or ventrally at midlength, patches sometimes fusing to form an irregular annulus. Propodus, carpus and merus green, green-blue or brown, propodus with darker patch at distal edge. Pereiopods 4 and 5 green and cream. Setae yellow.

Remarks. *C. virescens* was collected in shells of *Thais kieneri* (Deshayes), *Turbo cinereus* Born, *T. foliaceus* Philippi, *Trochus* sp. cf. *T. hanleyanus* Reeve, *Polinices tumidus* (Swainson), *Clypeomorus* sp. and others.

Colour variation in this species is quite marked. Background coloration can be olive green, green/blue or brown. The dactylar annulus on pereiopods 2 and 3 may be present, absent or incomplete.

Habitat. Collected from littoral rocky platforms.

Distribution. Eastern Africa, across Indian Ocean to northern Australia, east to Fiji Islands.

***Clibanarius longitarsus* (De Haan)**

Pagurus longitarsus De Haan, 1849: 211, Pl. 50 Fig. 3.
Clibanarius longitarsis - Dana 1852: 464; Alcock 1905: 158.
Pagurus (Clibanarius) longitarsis - Hilgendorf 1869: 96.
Clibanarius longitarsus - De Man 1902: 741; Barnard 1950: 434; Fize and Serène 1955: 83, Fig. 11, Pl. 3 Figs 1, 7, 10, 13; Gordan 1956: 309; Lee 1969: 44; Lewinsohn 1969: 18; Khan and Natarajan 1984: 8, Fig. 6.

Material. NORTHERN TERRITORY: ♂, 5.9 mm, 3 ♀, 8.1 mm, 5.3 mm, 4.4 mm, Rapid Creek near Trower Road, Darwin, mangroves, mud and rocks, 3 August 1986, WAM 132-87; 13 specs, 8.9 mm-1.7 mm, Ludmilla Creek near mouth, Darwin, in and near mangroves, 3 August 1986, WAM 131-87; 3 ♂, 6.6 mm, 4.2 mm, 3.8 mm, ♀, 4.4 mm, Ludmilla Creek, lower littoral, mangroves, mud, 1982, NTM Cr000382; ♀, 4.9 mm, Ludmilla Creek, 7 April 1976; ♀, 4.7 mm, Ludmilla Creek, low water spring, mangrove channel, 16 February 1987, NTM Cr004710; 2 ♂, 8.7 mm, 8.4 mm, Ludmilla Creek mouth littoral, 11 December 1974; ♂, 8.1 mm, 2 ♀, 8.9 mm, 8.5 mm, Caiman Creek, sandflat, 12 September 1985; ♂, 5.3 mm, ♀, 4.9 mm, Hope Inlet, Shoal Bay, littoral, trawl, 10 April 1975; 6 ♂, 5.9 mm-4.6 mm, 3 ♀, 7.5 mm, 7.4 mm, 5.5 mm, Hope Inlet, Shoal Bay, littoral, trawl, 14 April 1986; ♀, 5.7 mm, Hope Inlet, Shoal Bay, 17 December 1974; ♀, 9.3 mm, False Creek Point, Shoal Bay, littoral, 28 February 1975; ♂, 8.0 mm, Elizabeth Bay, 3 April 1975, NTM Cr002148; ♂, 9.2 mm, Casuarina Beach, Darwin, shore pool, 28 November 1981; ♂, 12.2 mm, Buffalo Creek, Darwin, 9 June 1972; 4 ♂, 6.6 mm-3.1 mm, 2 ♀, 4.5 mm, 4.0 mm, Coral Bay island, Port Essington, mangroves, sand, 12 August 1986, WAM 133-87.

Coloration. Shield green-brown with darker brown mottling and patches; thorax similar, with dark submedial lines. Ocular peduncles dorsally olive green, ventrally very pale green or cream (no distinct longitudinal stripes). Antennular penduncles green or blue-green, darker on lateral and mesial surfaces; flagella orange or pale brown. Antennal peduncles olive-brown, ultimate segment with dorsal and ventral cream stripes; flagella green-brown, darker laterally and mesially. Chelipeds olive or brown with irregular rows of paler, blue or blue-green tubercles and spines, many with corneous tips on dactyl and propodus. Pereiopods 2 and 3 with dactyl and propodus blue-green with two longitudinal olive or brown stripes on lateral and mesial surfaces, propodus also with fainter dorsal brown line; carpus similarly coloured to propodus except mesial lines diffuse; merus green dorsally and blue or blue-green ventrally, with broad dorsal, lateral and ventrolateral olive-brown stripes. Pereiopods 4 and 5 blue-green with dark brown or green mottling. Setae pale yellow.

Remarks. The species was collected from shells of *Telescopium telescopium* (Linnaeus), *Terebralia palustris* (Linnaeus), *Turritella terebra* (Linnaeus), Nerita lineata (Gmelin), *Nerita undata* Linnaeus and *Rhinoclavis vertagus* (Linnaeus).

C. longitarsus is the most abundant hermit crab in mangrove forests of the Northern Territory. The species is either somewhat variable in colour across its large range (see below) or is a member of a species complex as suggested by Fize and Serène (1955) and Ball and Haig (1972). Fize and Serène (1955) described two species, *Clibanarius* 1 and *Clibanarius* 2 as very similar to *C. longitarsus* but differing in coloration. The Northern Territory specimens agree well with Fize and Serène's description and illustration of *C. longitarsus*. Some specimens, particularly those from Darwin sites, display more distinct blue stripes on the carpus and merus of pereiopods, approaching the coloration of *Clibanarius* 1. The ocular peduncles of all specimens appear longer than those illustrated for *Clibanarius* 2. There is individual variation in the intensity of colours both at and between Northern Territory sites and I believe the specimens to be conspecific. Further work is required to warrant recognition of several species on the basis of small colour differences and at this time, the specimens are best regarded as *C. longitarsus*.

Habitat. Littoral, frequently associated with mangroves.

Distribution. East and south Africa, east to Japan, New Guinea and the Philippines, and now from northern Australia.

Clibanarius infraspinatus Hilgendorf

Pagurus (Clibanarius) infraspinatus Hilgendorf, 1869: 97 (footnote).

Clibanarius infraspinatus - Ortmann 1892: 290; Alcock 1905: 44; McCulloch 1913: 350, Fig. 52; Fize and Serène 1955: 77, Fig. 10; Gordan 1956: 309; Lee 1969: 41, Fig. 3; Lewinsohn 1969: 19; Khan and Natarajan 1984: 5, Fig. 3.

Material. NORTHERN TERRITORY: 2 ♀, 3.9 mm, 3.8 mm, Hope Inlet, Shoal Bay, littoral, trawl, 14 April 1976; ♀, 6.5 mm, King Creek mouth, Darwin, 11 December 1974; ♀ (ovig.), 6.2 mm, King Creek, Darwin, 9 October 1974; 1 spec., Camerons Beach, Darwin, 8 January 1976; ♂, 16.2 mm, Mickett Creek mouth, 25 November 1975, NTM Cr00263; ♂, 9.7 mm, ♀, 10.0 mm, Victoria Settlement, Port Essington, littoral, 8 August 1986, WAM 128-87.

Colouration. Shield and thorax cream or pale brown with green-grey patches and some tinges of blue-green. Ocular peduncles cream with dark green-brown dorsal, lateral and mesial longitudinal stripes. Antennular peduncles cream with green-blue stripes laterally and mesially; flagella orange. Antennal peduncles similar to antennular, flagella pale green. Dactyl of chelipeds green-blue or brown, with irregular dorsal, dorsolateral and ventral longitudinal cream or pale blue bands joining pale tubercles and spines. Propodus of cheliped similar, though bands less distinct; finger browner; paler ventrally. Carpus and merus similar to propodus. Pereiopods 2 and 3 with dactyl longitudinally banded, with 2 lateral and mesial blue-green bands bordered in brown or red; midlateral, dorsal and ventral bands of cream. Propodus similar but blue-green bands broader and ventral cream band less distinct. Carpus similar but ventral cream band obsolete. Merus of pereiopod 2 with dorsal cream band and diverging distolateral band; pereiopod 3 with merus bearing 2 diagonal cream bands. Pereiopods 4 and 5 green-brown with blue tinges.

Remarks. The species was collected from *Syrinx aruanus* (Linnaeus) and *Pugilina cochlidium* (Linnaeus).

The Northern Territory specimens agree well with the description and figure of Fize and Serène (1955), and the figure of McCulloch (1913) of an Australian specimen. The species is readily recognised by the strong proximomesial spine on the ventral edge of the merus of the chelipeds.

Habitat. Littoral, usually associated with sand.

Distribution. From the Red Sea and east Africa across the Indian Ocean to India, Japan, Taiwan, Singapore, Philippines, Vietnam, and northern Australia. As noted by McCulloch (1913), the record of *C. infraspinatus* from Sydney by Ortmann (1892) is probably inaccurate. The species is probably restricted in Australia to the tropics.

Clibanarius taeniatus (Milne Edwards)

Pagurus clibanarius - Quoy and Gaimard 1824: 529, Pl. 78 Fig. 1 (not *Clibanarius clibanarius* (Herbst, 1791)).

Pagurus taeniatus Milne Edwards, 1848: 63.

Clibanarius taeniatus - Stimpson 1858: 235; Miers 1884: 265; Alcock 1905: 158; Grant and McCulloch 1906:34; McCulloch 1913: 349, Pl. 11 Fig. 1; Gordan 1956: 310.

Material. NORTHERN TERRITORY: 12 specs, 8.4 mm-2.3 mm, Nightcliff, Darwin, littoral, rock platform, 3 August 1986, WAM 125-87; 13 specs, 7.2 mm-2.2 mm, Lee Point, north of Darwin, littoral, rock platform, 4 August 1986, WAM 124-87; ♂, 9.7

mm, Bullocky Point, Darwin, lower littoral, sand flat pool with stones, 2 October 1981, NTM X0071; ♀, 4.7 mm, Ludmilla Creek, Darwin, low water spring, mangrove channel, 16 February 1987, NTM Cr004709; 2 ♂, 7.2 mm, 6.5 mm, Minto Head, north of Victoria Settlement, Port Essington, littoral, rocks and sand, 8 August 1986, WAM 127-87; 32 specs, 8.2 mm-2.4 mm, Coral Bay island, Port Essington, littoral, sand and rocks, 12 August 1986, WAM 126-87.

Coloration. Shield with 2 broad submedial longitudinal blue-green bands and narrower, darker (often maroon tinged) lateral bands; bands edged in dark brown or red; shield cream between bands. Thorax blue-green, paler medially. Ocular peduncles pale yellow or orange dorsally, cream ventrally, with dorsal and mesial dark green, blue or brown longitudinal stripes. Antennular peduncles blue-green with dorsal band of cream edged with brown; flagella orange. Antennal peduncles blue-green with dorsal cream band on distalmost segment; flagella pale green or orange. Chelipeds deep blue-green with tinges of brown, cream patches on spines merging to form irregular longitudinal bands: mesially and ventrally on dactyl, dorsolaterally and dorsomesially on propodus, laterally and dorsomesially on carpus, dorsally, laterally and at distal margin on merus. Pereiopods 2 and 3 deep blue-green with longitudinal cream or yellow bands edged with dark brown: dorsal, lateral and ventral cream bands on dactyl and propodus; carpus with dorsal, ventral and 2 lateral bands; merus of pereiopod 2 with dorsolateral, lateral and ventral bands, merus of pereiopod 3 with dorsal, ventral and 2 laterals. Pereiopods 4 and 5 blue-green with cream longitudinal bands. Setae pale yellow. Blue coloration paler on small animals.

Remarks. *C. taeniatus* was collected from many species of gastropod shells, of varying shapes and sizes, including *Turbo cinereus* Born, *Morula margariticola* (Broderip), *Monodonta labio* (Linnaeus), *Cerithium novaehollandiae* A. Adams, *Clypeomorus* sp., *Rhinoclavis vertagus* (Linnaeus), *R. aspera* (Linnaeus), *Murex brevispinus* Lamarck, *Strombus urceus* Linnaeus and *Nerita albicilla* Linnaeus.

The Northern Territory specimens agree well with the figure of McCulloch (1913: Pl. 11 Fig. 1) of a specimen of *C. taeniatus* from Cooktown, Queensland. The species is very similar to *C. padavensis* de Man. Alcock (1905) described the antennal acicle of *C. padavensis* as rarely overlapping the base of the terminal joint of the antennal peduncle; it always does so on the Northern Territory specimens. Alcock's (1905) description and figure indicate C. padavensis to have very few spines on chelipeds, while the specimens in question display numerous large spines. In Alcock (1905) and Barnard (1950) the dactyl of pereiopod 3 of *C. padavensis* was described and illustrated as distinctly longer than the propodus while these specimens have the dactyl subequal to propodus. Alcock and Barnard also described the carapace as uniformly coloured while the present animals have distinct blue-green bands on the shield. Ball and Haig (1972) noted that *C. padavensis* can have brown stripes on the carapace but recorded only a single stripe on the ocular peduncle. *C. eurysternus* Hilgendorf is also a similar species but differs in its very flattened carapace and widely separated coxae of pereiopods 4 and 5.

Habitat. Littoral, associated with rock platforms and rocky and sandy tidal pools.

Distribution. Northern Australia, from Shark Bay in the west to Port Hacking in the east.

Diogenes avarus Heller

Diogenes avarus Heller, 1865: 83, Pl. 7 Fig. 2; Alcock 1905: 68, Pl. 6 Fig. 6; Grant and McCulloch 1906: 35; Gordan 1956: 316; Forest 1956: 524, Figs 1-4; Lewinsohn 1969: 37, Fig. 4; Khan and Natarajan 1984: 18, Fig. 15.

Material. NORTHERN TERRITORY: 14 specs, 2.6 mm-1.2 mm, Ludmilla Creek near mouth, Darwin, near mangroves, 3 August 1986, WAM 114-87; 12 specs, 3.0 mm-1.1 mm, Lee Point, north of Darwin, littoral sand flat, 4 August 1986, WAM 115-87; ♂, 1.9 mm, Woods Inlet, Darwin, 5 m, coarse sand, 10 May 1985, NTM Cr002945; ♂, 2.0 mm, ♀ (ovig.), 1.6 mm, Ludmilla Creek, Darwin, 7 April 1986; ♂, 1.9 mm, King Creek mouth, Darwin, 11 December 1974; ♂, 2.9 mm, Shoal Bay, near Darwin, 1 August 1973; ♂, 3.5 mm, Mickett Creek, Darwin, 28 May 1975; 1 spec. (in shell), King Creek, 18 September 1974; 4 ♂, 4.3 mm-3.2 mm, King Creek, 15 August 1972; ♂, 2.9

mm, Camerons Beach, Shoal Bay, 19 May 1976; 9 specs, 3.6 mm-1.0 mm, Hope Inlet, Shoal Bay, littoral, trawl, 25 August 1972; 13 specimens, 2.5 mm-1.2 mm, Hope Inlet, Shoal Bay, 17 December 1974; 2 ♂, 2.9 mm, 2.6 mm, Camerons Beach, Shoal Bay, 4 April 1975; 9 specs, 3.1 mm-1.7 mm, Coral Bay island, Port Essington, littoral, sand and rocks, 12 August 1986, WAM 116-87; 6 ♂, 2.4 mm-1.7 mm, Coral Bay, Port Essington, lower littoral, sand beach, 20 July 1981, NTM Cr003107.

Coloration. Shield pale grey and cream, sometimes with blue tinges. Ocular peduncles cream, sometimes with blue-green flecks basally; corneas black. Antennular peduncles cream, sometimes with green-blue spot on dorsal surface of penultimate segment near articulation with ultimate segment, and spots proximally and distally on ultimate segment; flagella cream. Antennal peduncles cream; flagella cream with narrow blue-green bands on ca. every 4th segment. Chelipeds cream with variable areas of brown especially ventrally on propodus. Pereiopods cream with some brown on propodus near midlength, and scattered brown areas on carpus and merus. Setae pale yellow.

Remarks. *D. avarus* inhabits a wide range of small gastropod shells including those of *Nassarius dorsatus* (Röding), *Nassarius* sp., *Turritella terebra* (Linnaeus), *Clypeomorus* sp., *Cerithium* sp. cf C. *tenuifilosum* Sowerby, *Monilea callifera* (Lamarck), and *Duplicaria* sp.

D. avarus has been diagnosed and keyed (e.g. Alcock 1905) by the characteristically elongate and very deflexed left cheliped of large adult males. As noted and illustrated by Forest (1956), however, this cheliped is shorter, stouter and only weakly deflexed on small males and all females. Small specimens are recognisable in northern Australia by the dense small tubercles and the incomplete lateral ridge on the left cheliped, the absence of sharp spines along the ventral margin of that chela, the paucity of setae on chelipeds and the coloration. It is the most common species of *Diogenes* in the Darwin area.

Habitat. Littoral and shallow sublittoral, usually associated with sand substrate.

Distribution. East Africa and Red Sea across Indian Ocean to Malaysia, Philippines and northern Australia.

Diogenes rectimanus Miers

Diogenes rectimanus Miers, 1884: 26, Pl. 27 Fig. c; Alcock 1905: 71, Pl. 6 Fig. 8; Gordan 1956: 318; Khan and Natarajan 1984: 20, Fig. 17.

Material. NORTHERN TERRITORY: 10 specs, 4.3 mm-1.0 mm, Port Essington north end, 14-16 m, trawl, mud, 8 August 1986, WAM 141-87.

Colouration. Shield grey-brown with some green flecks and mottling. Ocular peduncles, antennules and antennae pale orange-yellow. Chelipeds with dactyl and propodus cream or pale orange with darker green-grey tubercles; carpus and merus cream with green-grey or brown tinges. Pereiopods 2 and 3 cream with yellow tinges; propodus, carpus and merus with darker green or brown patches middorsally and midventrally. Pereiopods 4 and 5 pale yellow or cream with some darker flecks. Setae yellow.

Remarks. *D. rectimanus* was collected in shells of *Turritella terebra* (Linnaeus) (often only pieces of the shell spire), *Nassarius* sp. and a small fasciolariid.

Like *D. avarus*, *D. rectimanus* has ocular peduncles shorter than the antennal peduncles. The characteristic dorsolateral spinose ridge on the left cheliped is less strongly developed on small specimens. The cheliped is laterally compressed and the ventral margin bears a strong ridge of spines, projecting almost at right angles to the external face of the chela. The specimens agree closely with the description and figure of Alcock (1905).

Habitat. Sublittoral (14-16 m), mud substrate.

Distribution. Persian Gulf across Indian Ocean to India, Malaysia and Torres Strait, now recorded from mainland Australia.

Diogenes gardineri Alcock

Diogenes gardineri Alcock, 1905: 73, Pl. 7 Fig. 3; Forest 1956: 530, Fig. 16; Lewinsohn 1969: 45.

Material. NORTHERN TERRITORY: 14 specs, 2.6 mm-1.5 mm, Nightcliff, Darwin, littoral, rock platform, 3 August 1986, WAM 148-87; 25 specs, 2.9mm-1.1 mm, Lee Point, north of Darwin, littoral, sand flat, 4 August 1986, WAM 150-87; 18 specs, 2.6 mm-1.6 mm, Lameroo Beach, Darwin, littoral, rocks and sand, 2 August 1986, WAM

149-87; ♂, 2.7 mm, Ludmilla Creek, Darwin, low water spring, mangrove channel, 16 February 1987, NTM Cr004713; 3 ♂, 3.2 mm, 3.2 mm, 2.2 mm, 2 ♀, 2.6 mm, 2.3 mm, Minto Head, north of Victoria Settlement, Port Essington, littoral, rocks and sand, 8 August 1986, WAM 153-87; 3 ♂, 2.0 mm, 1.6 mm, 1.5 mm, ♀, 1.4 mm, Coral Bay island, Port Essington, littoral, sand and rocks, 12 August 1986, WAM 160-87.

Coloration. Shield pale grey with darker brown and green areas especially medially and laterally. Ocular peduncles cream with grey-green patch proximal to cornea and two faint grey-green dorsal longitudinal stripes; corneas black. Antennular and antennal peduncles pale green; antennular flagella orange, antennal flagella pale green-yellow. Chelipeds and pereiopods mottled brown and green-blue. Colours largely obscured by long pale yellow setae especially on legs.

Remarks. *D. gardineri* was collected in shells of *Clypeomorus batillariaeformis* Habe and Kosuge, *Clypeomorus* sp., *Morula margariticola* (Broderip), *Peristernia incarnata* (Deshayes), small *Turritella terebra* (Linnaeus) and *Cerithium* sp.

D. gardineri is a member of a small group of Indo-West Pacific species which possess antennal peduncles shorter than the ocular peduncles. The group includes *D. senex* Heller, *D. pallescens* Whitelegge, *D. serenei* Forest, *D. leptocerus* Forest and *D. capricorneus* Grant and McCulloch, together with *Diogenes biramus* described in this paper.

In particular, *D. gardineri* very closely resembles *D. senex*, as noted by Forest (1956) and Lewinsohn (1969). The similarities of this group of *Diogenes* are also discussed by Ball and Haig (1972). The specimens examined agree with Forest's (1956) description of *D. gardineri* in possessing ocular peduncles shorter than antennular peduncles, while in *D. senex* they are of similar length. The rostral spine of *D. gardineri* can display a ventral tooth (Forest 1956) which may be absent (Ball and Haig 1972), always absent on *D. senex*. Lewinsohn (1969) noted that cheliped features are almost useless in distinguishing these, and many other, *Diogenes* species. As observed by Forest (1956), the original descriptions and figures of *D. gardineri* and *D. senex* are not sufficiently detailed to definitely distinguish the species.

Habitat. Littoral, rock platforms and sand flats.

Distribution. Red Sea and east Africa, New Guinea, Tuamotu Archipelago; now recorded from northern Australia.

Diogenes serenei Forest

Diogenes serenei Forest, 1956: 530, Figs 12-15; Ball and Haig 1972: 91.

Material. NORTHERN TERRITORY: ♂, 2.8 mm, 2 ♀, 3.0 mm, 2.4 mm, Orontes Reef west end, Port Essington, 11 m, 10 August 1986, WAM 154-87; 3 ♂, 3.2 mm, 2.7 mm, 2.5 mm, ♀, 1.5 mm, Coral Bay near headland, Port Essington, 4 m, 12-13 August 1986, WAM 155-87.

Coloration. Shield cream, spotted and mottled with brown. Ocular peduncles cream or white with brown mottling and brown band one-third to one-quarter length of peduncle from distal end. Antennular and antennal peduncles cream with some brown mottling, both with dark brown band at distal edge of ultimate segments; antennular flagella cream, pale green or yellow; antennal flagella cream with faint brown band on each article. Chelipeds mottled cream and brown, spines and tubercles cream or white; merus and carpus darker than propodus, dactyl mostly cream. Pereiopods 2 and 3 mottled cream and brown; darker brown band often middorsally and dorsomesially on merus, carpus and propodus, and proximally on dactyl. Pereiopods 4 and 5 cream with some brown mottling.

Remarks. The species occurred in shells of *Thais echinata* (Blainville) and *Cerithium novaehollandiae* A. Adams.

D. serenei resembles *D. gardineri* in possessing antennal peduncles shorter than the ocular peduncles. The specimens examined here agreed well with the description of Forest (1956) and displayed the strong ventral tooth on the rostral spine. The species is very similar to *D. pallescens* (Forest 1956; Ball and Haig 1972) and on some animals the ocular acicles appeared as widely spaced as those illustrated for *D. pallescens* by Ball and Haig (1972).

Coloration of *D. serenei* was not recorded by Forest (1956) nor Ball and Haig (1972).

Habitat. Collected from sublittoral waters, associated with coral.

Distribution. West Indian Ocean, Vietnam, New Guinea and now northern Australia.

Diogenes biramus sp. nov.
(Fig. 2)

Type material. HOLOTYPE - ♂, 3.1 mm, Coral Bay near headland, Port Essington, Northern Territory, 4 m, in *Rhinoclavis bituberculatum* (Sowerby) shell, 12 August 1986, WAM 156-87. PARATYPE - ♂, 2.4 mm (damaged) Coral Bay, 4-6 m, 11 August 1986, WAM 157-87.

Description. Shield (Fig. 2a) slightly longer than broad. Lateral margins slightly convex with few, scattered spines; anterior margin between rostrum and lateral projections concave. Rostrum broad and short, just exceeding lateral projections, with rounded margin. Lateral projections broadly triangular, each with two terminal spinules. Long sparse setae laterally, some short setae dorsally.

Ocular peduncles slender and cylindrical, slightly inflated proximally, and much longer than anterior margin of shield. Ocular acicles with 2-3 distolateral spines; lateral margin almost rightangular; mesial margin with projection at midlength, concave distal and proximal to this; acicles separated basally by less than width of one acicle. Intercalary rostral process slightly shorter than ocular acicles, margins slightly convex tapering to long apical spine; ventral spine absent.

Antennular peduncles reaching approximately two-thirds length of ocular peduncles; segments unarmed except for small spine at distoventral angle of proximal segment; peduncles very sparsely setose.

Antennal peduncles very short, not reaching midlength of ocular peduncles. Fifth (ultimate) segment slender, unarmed; fourth segment unarmed; third with weak distal spinule; second with distal dorsolateral and dorsomesial spines and 2 larger ventrolateral spines; first segment unarmed. Antennal acicle laterally compressed, slightly exceeding distal margin of fourth peduncular segment; acicle terminating in strong spine with another dorsal to this and strong proximolateral and proximomesial spine. Scattered long simple setae on all peduncular segments and acicle. Antennal flagella short, comprising 15 articles; setae long, simple.

Third maxilliped (Fig. 2b) with 2 strong ventrolateral spines on merus; ischium lacking crista dentata but with ventromesial spine; basis with two strong ventromesial spines.

Left cheliped of male (Fig. 2c) much larger than right. Dactyl approximately half length of propodus, stout, strongly curved, slightly crossing fixed finger at tip. Cutting teeth small, strong terminal tooth. Dorsal margin with row of strong, broad spines, largest proximally; lateral surface with irregular row of tubercles near proximodorsal margin, remainder of lateral surface with few scattered tubercles; mesial surface smooth. Fixed finger slightly narrower than dactyl with large cutting tooth slightly distal to midlength; ventral margin with irregular row of spines extending back along palm; lateral surface with scattered small tubercles; mesial surface smooth. Palm of propodus approximately as long as broad; dorsal margin with strong, curved spines, largest proximally; lateral surface with scattered tubercles and small spines and very weak ridge with slightly larger spines proximomedially; large curved spines along ventral margin; mesial surface lacking spines. Carpus slightly longer than broad, just longer than merus; dorsal margin with row of 5 spines, distal 4 of which long and curved; row of spines along distolateral margin and several spines on lateral surface; mesial surface with large projection on distodorsal margin. Merus with spinules along dorsal margin and longer spines along ventrolateral margin; lateral surface with scattered tubercles. Long simple setae scattered over all segments, especially laterally, and some plumose setae particularly on propodus; mesial surfaces of palm and carpus almost naked.

Right cheliped (Fig. 2d) less robust than left. Dactylar length more than half that of propodus; cutting teeth very small; dorsal edge with row of corneous tipped spines; lateral surface roughened, mesial surface smooth. Propodus with smooth ventral margin; dorsal margin of palm with very irregular row of small spines; lateral surface of palm almost smooth, of fixed finger with some scattered tubercles. Carpus much shorter than merus, with 3 long curved spines distally on dorsal surface and 2 spines proximal to these. Merus with long spine at distodorsal angle; row of 5 spines along ventrolateral

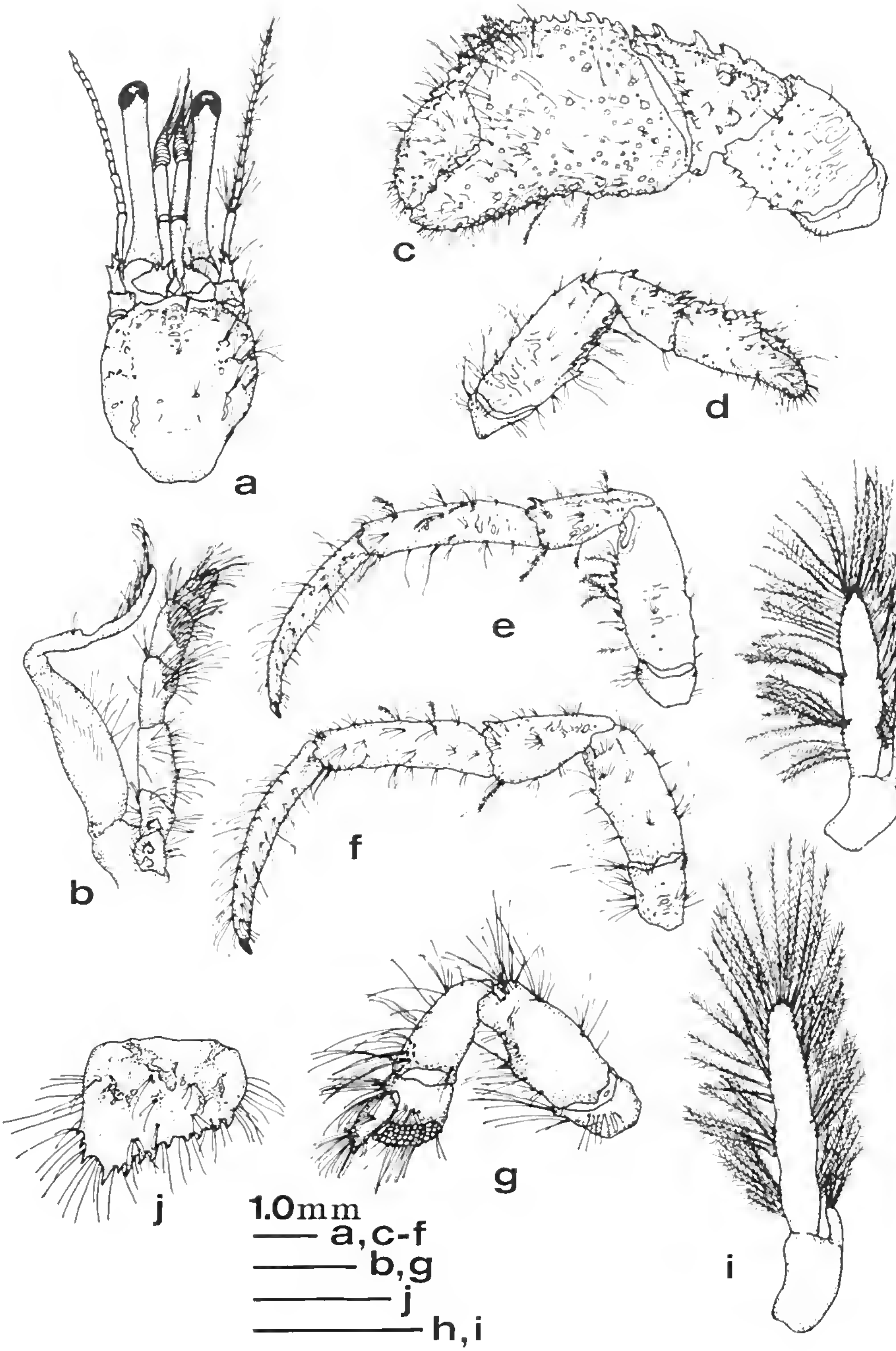

Fig. 2. *Diogenes biramus* holotype ♂: **a**, shield and cephalic appendages (dorsal view, setae omitted on left side); **b**, third maxilliped (mesial view, flagellum deflexed to avoid obscuration of endopod); **c**, left cheliped (lateral view); **d**, right cheliped (lateral view); **e**, second left pereiopod (lateral view); **f**, third left pereiopod (lateral view); **g**, fourth left pereiopod (lateral view); **h**, first pleopod (mesial view); **i**, fourth pleopod (mesial view); **j**, telson (dorsal view).

margin, 3 spines along ventromesial margin.

Second pereiopods (Fig. 2e) slightly longer than left cheliped. Dactyl slightly longer than propodus, terminating in strong claw; no spines along dorsal or ventral margins. Propodus one and a half times length of carpus; lateral surface unarmed; mesial surface with small spine distomedially and smaller spine distoventrally. Carpus two-thirds length of merus; strong spine at distodorsal angle and second spine two-thirds length of segment proximal to this. Merus laterally compressed; dorsal margin unarmed; ventral margin with row of 4-5 long curved spines. Scattered long and short simple, and some plumose, setae on all segments.

Third pereiopods (Fig. 2f) slightly longer than second; propodus relatively shorter and ischium relatively longer than in second pereiopods. Otherwise similar to second pereiopods, except proximal dorsal spine on carpus minute or absent and only 2 spines along ventral margin of merus.

Fourth pereiopods (Fig. 2g) with dactyl terminating in corneous claw. Rasp occupying less than half length of propodus. All segments lacking spines but with long simple setae.

Four unpaired biramous pleopods (Fig. 2h, i). Exopod incompletely divided into 3 lobes, and increasing slightly in size from pleopod 1 to 4. Endopod much shorter than exopod, with single lobe, decreasing in size from pleopod 1 to 4. Both rami with long, finely plumose setae. Clump of 5 long simple setae immediately proximal to base of endopod on pleopod 1; 1 seta on pleopod 2; these setae apparently absent on pleopods 3 and 4.

Tailfan very asymmetrical, left uropods much larger than right. Telson (Fig. 2j) broader than long; dorsal surface deeply sculptured; posterior margin with left side produced, lacking distinct medial cleft, armed with row of 12-13 spines; long simple setae along lateral and posterior margins and in small clumps on dorsal surface.

Coloration. Shield cream mottled with grey-green, deep green ventrolaterally. Ocular peduncles cream. Antennular peduncles cream with green tinges on penultimate segment and dark green proximal band on ultimate segment; flagella pale orange. Antennal peduncles cream, tinged with green, flagella translucent. Chelipeds cream with faint brown or brown-green stippling; right cheliped with green patches on carpus and merus. Pereiopods 2 and 3 cream with faint stippling of brown-green and darker green bands; dactyl and propodus with band at midlength and proximally; carpus with broader, fainter band at midlength; merus with diffuse green-brown patches. Pereiopods 4 and 5 cream with green stippling. Setae cream.

Etymology. Named for the biramous condition of the pleopods in males.

Remarks. *D. biramus* is a member of the group of Indo-West Pacific species with ocular peduncles longer than antennal peduncles, noted in this paper under *D. gardineri*. *D. biramus* is distinctive in the extreme length of the ocular peduncles, much longer than the antennular peduncles and approximately reaching the distalmost end of the antennular flagella. The lateral margins of the shield are less spinose than those of most members of this species group.

D. biramus is unusual in its genus for the possession of biramous pleopods in the male, a character shared with *D. mercatoris* Forest. No females of *D. biramus* have been examined and hence their condition is unknown. The uniramous nature of the male pleopods has been cited as a diagnostic character of *Diogenes* (e.g. Alcock 1905) but it is possible that biramous pleopods may have been overlooked in description of some species.

Habitat. Shallow (4-6 m) sublittoral waters associated with coral reef formations.

Distribution. Presently known only from Coral Bay, Port Essington.

Diogenes jousseaumei (Bouvier)

Troglopagurus jousseaumei Bouvier, 1897: 231, Fig. 6; Forest 1952: 7; Lewinsohn 1969: 51.

Troglopagurus jousseaumii - Alcock 1905: 75, Pl. 5 Fig. 6; Grant and McCulloch 1906: 36; Gordan 1956: 342.

Diogenes jousseaumei - Forest 1952: 9, Fig. 15.

Material. NORTHERN TERRITORY: ♂, 3.7 mm, Port Essington north end, 20 m, mud, trawl, 9-10 August 1986, WAM 145-87.

Coloration. Shield cream and pale brown with some darker brown patches. Ocular peduncles cream with thin brown line dorsally and ventrally; corneas black and irridescent yellow. Antennules and antennae cream. Chelipeds cream and dark brown, colours largely obscured by setae. Pereiopods 2 and 3 cream with grey-brown bands proximally on dactyl, and at approximate midlength of propodus, carpus and merus. Setae pale grey.

Remarks. The specimen was collected from a shell of *Murex brevispinus* Lamarck.

The single representative of this species collected from the Northern Territory displays both paired male and female gonopores. The animal was not dissected to determine whether or not it possessed both testes and ovaries.

The Port Essington specimen agrees well with the descriptions and figures of *Troglopagurus jousseaumii* in Alcock (1905) and *Diogenes jousseaumei* in Forest (1952). Of greater concern is the validity of the genus *Troglopagurus* Henderson. I have accepted the argument of Forest (1952) that *Troglopagurus* and *Diogenes* are synonymous, with the small interocular plate of the former homologous with the larger interocular process of the latter. Certainly the specimen examined here has a small cuticular plate between the ocular peduncles, though it is much less developed than the equivalent structure in most other species of *Diogenes*. In contrast, Lewinsohn (1969) considered that these structures might not be homologous and retained the name *Troglopagurus*. Only detailed comparison of the two genera can resolve the problem, but at this stage it seems preferable to regard the two as synonymous with variation in rostral process development.

Habitat. The species was trawled from mud at 20 m depth.

Distribution. Red Sea east to India and northeast Australia.

Diogenes sp. A.

Material. NORTHERN TERRITORY: ♀, 3.5 mm, Hope Inlet, Shoal Bay, littoral, trawl, 25 August 1972; ♂, 3.1 mm, Orontes Reef west end, Port Essington, 14-17 m, 9 August 1986, WAM 147-87; ♂, 3.5 mm, Orontes Reef west end, Port Essington, 11 m, 10 August 1986, WAM 146-87.

Coloration. Shield cream or pale brown with darker brown patches especially laterally. Ocular peduncles cream with some brown ventrally; corneas black. Antennular and antennal peduncles cream or pale blue; flagella pale orange. Chelipeds cream and red-brown, tubercles on dactyl and propodus cream or white, carpus and merus distinctly mottled; cheliped colours largely obscured by setae. Pereiopods 2 and 3 mottled red-brown and cream; pereiopods 4 and 5 mostly cream with some pale brown. Setae pale yellow or brown.

Remarks. The Orontes Reef specimens were collected from shells of *Favartia ?* sp.

Though similar to *D. jousseaumei* in most respects, this species differs in several characters. In particular, the antennal acicles are more spinose (with 7-8 spines while the specimen of *D. jousseaumei* has 4), the dactyl of pereiopods 2 and 3 is a similar length to the propodus (while the dactyl is longer on *D. jousseaumei*), the dactyl and propodus of the left pereiopod 3 are laterally flattened with very distinct dorsal and ventral fringes of setae and the lateral surface is naked, the ocular peduncles fail to reach the base of the terminal antennular segment (while those of *D. jousseaumei* slightly exceed the base), and the colours differ slightly as can be inferred from the respective colour notes. In addition, the interocular plate is obsolete on *Diogenes* sp. A and comprises only a minute piece of cuticle with a tuft of setae. This condition is more typical of that ascribed to *Troglopagurus*, further confusing the status of that genus.

Habitat. Collected from soft substrates, littoral to at least 17 m depth.

Dardanus setifer (Milne Edwards)

Pagurus setifer Milne Edwards, 1836: 274; Alcock 1905: 83, Pl. 8 Fig. 3; Barnard 1950: 426, Fig. 79d; Fize and Serène 1955: 182, Figs 27 A,B, 28, Pl. 5 Figs 4-8.
Pagurus sculptipes Stimpson, 1858: 246.
Pagurus pavimentatus Hilgendorf, 1878: 816, Pl. 3 Figs 1-5.
Dardanus setifer - Gordan 1956: 316; Ball and Haig 1972: 103; Khan and Natarajan 1984: 10, Fig. 7.

Material. NORTHERN TERRITORY: 2 ♂, 9.2 mm, 4.3 mm, ♀, 6.1 mm, Orontes Reef west end, Port Essington, 14-17 m, 9 August 1986, WAM 164-87; 2 ♂, 3.9 mm, 3.6 mm, 2 ♀, 5.9 mm, 1.9 mm, Orontes Reef west end, 11 m, 10 August 1986, WAM 143-87; ♂, 2.6 mm, Orontes Reef west end, 12 m, 13 August 1986, WAM 142-87.

Coloration. Shield pale brown with darker, redder patches and minute vibrant blue spots around setal pores; some small specimens with large blue-purple patches medially. Ocular peduncles pale-brown, corneas black with blue tinges. Antennules and antennae bright yellow, antennal acicles brown. Dactyl of left cheliped maroon with darker corneous spines dorsally, paler tubercles ventrally. Propodus with fixed finger maroon, palm paler maroon or red-brown; pale tubercles ventrally. Carpus brown and red-brown with large violet or blue-violet patch dorsomesially. Merus brown with paler tubercles. Right cheliped with dactyl and propodus red-brown with paler patches. Carpus and merus like left cheliped. Pereiopods 2 and 3 with dactyl red-brown with paler brown patches; pale orange or cream near tips. Propodus red-brown, paler proximally and distally. Carpus brown and red-brown, with violet patch on dorsomesial surface. Merus red-brown and brown with paler tubercles. Setae red and pale yellow or cream. Small specimens more speckled, larger areas of white or cream.

Remarks. *D. setifer* was collected from shells of *Mancinella mancinella* (Linnaeus), *Cerithium novaehollandiae* A. Adams and *Chicoreus microphyllus* (Lamarck).

Fize and Serène (1955) discussed at some length the differences between *D. crassimanus* (Milne Edwards) and *D. setifer*. The species are very similar and poorly distinguished by previous workers, including their author Milne Edwards (1836). Fize and Serène (1955) revised Alcock's (1905) description of *D. setifer* and distinguished that species from *D. crassimanus* by the presence on *D. setifer* of distinct fans of short setae around spines on the palm of the left chela and the short spines forming a 'palissade' along the lower margin of that chela. The Northern Territory specimens have the rosettes of short setae around the cheliped spines, but these spines are rather longer and more corneous than those illustrated by Fize and Serène (1955: Fig. 28 and Pl. 5 Fig. 6). The inner lower margin of the left chela of the Northern Territory animals is crenulate and resembles that of Fize and Serène's animals (Pl. 5 Fig. 7). The shapes of the chelae are similar. Alcock's illustration of *D. setifer* (1905: Pl. 8, Fig. 3) shows the left chela bearing longer spines than those of Fize and Serène's specimens, hence resembling the Northern Territory specimens, but the left chela is more elongate in Alcock's figure. The present specimens key to *D. crassimanus* in Miyake (1978).

The definitive separation of *D. setifer* and *D. crassimanus* requires further consideration and, if possible, comparison of type material. As noted by Fize and Serène (1955) it is likely that the two species have been confused often in the past.

Habitat. Found at depths between 11 and 17 m, on a silt and sand substrate with scattered corals.

Distribution. From east Africa to Hong Kong and Australia, but owing to confusion with *D. crassimanus*, its precise distribution is uncertain.

Dardanus lagopodes (Forskål)

Cancer lagopodes Forskål, 1775: 93.

Pagurus sanguinolentus Quoy and Gaimard, 1824: 532, Pl. 79 Fig. 2; Alcock 1905: 169; Forest 1953: 559, Figs 12-14; Fize and Serène 1955: 166, Fig. 25, Pl. 4 Figs 4, 5.

Pagurus affinis Milne Edwards, 1836: 274; Alcock 1905: 169.

Pagurus euopsis Dana, 1852: 7; Dana 1855: Pl. 28 fig 6; Alcock 1905: 86, Pl. 9 Fig. 2; Grant and McCulloch 1906: 37; Barnard 1950: 427.

Pagurus depressus Heller, 1861: 22.

Dardanus hellerii Paul'son, 1875: 90, Pl. 12 Fig. 4 a-c.

Dardanus euopsis - Buitendijk 1937: 275; Gordan 1956: 314.

Dardanus affinis - Gordan 1956: 312.

Dardanus sanguinolentus - Gordan 1956: 315.

Dardanus lagopodes - Lewinsohn 1969: 32, Pl. 2 Figs 1, 2; Lee 1969: 50; Ball and Haig 1972: 92.

Material. NORTHERN TERRITORY: 2 ♂, 14.6 mm, 13.5 mm, 2 ♀, 10.1 mm (ovig.), 9.6 mm, Coral Bay, Port Essington, 4-6 m, coral and sand, 11 August 1986, WAM 169-87; ♂, 13.3 mm, Oxley Island, 80 km east of Port Essington, lower littoral, 19 October 1982.

Coloration. Shield grey-brown with dark red-brown patches especially anterolaterally. Ocular peduncles dorsally grey with yellow band at base of corneas; ventrally white. Corneas black. Antennular and antennal peduncles yellow with thin dorsal and ventral olive green lines; antennular flagella yellow or orange, antennal flagella yellow or pale green. Chelipeds with dactyl mottled red, brown, orange and grey; propodus red-orange on finger and most of palm, dorsally brown-grey; carpus red-brown with large grey-violet patch dorsally; merus red-brown and grey. Cheliped spines tipped with pale brown or cream. Pereiopods 2 and 3 red-brown mottled with flecks of pale violet; carpus mostly dark brown-maroon dorsally and similar patch on dorsal surface of merus. Setae red with cream tips.

Remarks. *D. lagopodes* was collected from shells of *Syrinx aruanus* (Linnaeus) and *Tectus pyramis* Born.

The Port Essington specimens, for which live coloration was recorded, can be assigned to the dark colour variety or form of Fize and Serène (1955) and Ball and Haig (1972).

Habitat. Lower littoral and shallow sublittoral waters of the Northern Territory.

Distribution. Red Sea and eastern Africa, to Australia, New Guinea, Japan and east to the Tuamotu Archipelago.

Family Paguridae

Spiropagurus spiriger (De Haan)

Pagurus spiriger De Haan, 1849: 206, Pl. 49 Fig. 2.

Spiropagurus spiriger - Stimpson 1858: 248; Henderson 1888: 72; Alcock 1905: 118, Pl. 13 Fig. 1; Gordan 1956: 341; Ball and Haig 1972: 104.

Material. NORTHERN TERRITORY: 2 ♂, 5.7 mm, 4.9 mm, 4 ♀, 5.6 mm-5.1 mm (2 ovig.), Darwin, 25-38 m, September 1965.

Coloration. No live material was collected.

Remarks. Alcock (1905) diagnosed, keyed and illustrated three varieties of *S. spiriger*, (*S. spiriger var. profundorum*, *S. s.* var. *spinosicarpis* and *S. s.* var. *lophomeris*) in addition to the nominotypical variety (for which he did not employ a subspecific name).

The present specimens key best to Alcock's *S. spiriger* but display long, regularly distributed setae on the antennal acicle which is not characteristic of the nominotypical variety. There are only two rows of spines on the carpus of chelipeds and the merus of pereiopods 2 and 3 is not distinctly carinate, hence, keying to neither *S. s. spinosicarpis* nor *S. s. lophomeris*. The Northern Territory specimens are somewhat intermediate between *S. spiriger* and *S. s. profundorum*, but the presence of rows of setae on the ocular peduncles best characterises *S. spiriger*. Lewinsohn (1982) noted that these varieties may warrant specific recognition.

Lewinsohn (1982) also erected a new Indo-West Pacific species, *S. fimbriatus* contrasting this with *S. spiriger*. The Darwin material agrees well with Lewinsohn's description and figure of *S. spiriger*, with the exception that the specimens display larger spines on the carpus of the chelipeds, and as noted above, regularly distributed setae on the antennal acicles. The setation and spination of pereiopod 3 and telson shape concur with *S. spiriger* and are very distinct from *S. fimbriatus*.

The Darwin specimens are therefore here designated *S. spiriger*, though several characters may warrant specific segregation from that taxon.

Habitat. Specimens in Northern Territory Museum collected from 25-38 m depth.

Distribution. Indian Ocean east to northern Australia, Japan and Admiralty Islands.

Pagurus kulkarnii Sankolli

Pagurus kulkarnii Sankolli, 1962: 136, Figs 1, 2.

Material. NORTHERN TERRITORY: ♂, 3.9 mm, East Point, Darwin, lower littoral, 8 January 1985, NTM Cr002745; 2 ♂, 2.8 mm, 2.2 mm, Dudley Point Reef, Darwin, lower littoral, silty reef flat pool, 18 October 1985, NTM Cr003373; ♂, 4.0 mm, Nightcliff, Darwin, 0.5 m, shore reef, 9 September 1975; 1 spec. (in shell), Hope Inlet, Shoal Bay, 25 August 1972; 2 ♂, 3.6 mm, 3.4 mm, ♀, 2.7 mm, Orontes Reef west end, Port Essington, 14-17 m, 9 August 1986, WAM 136-87; 9 specs, 3.9 mm-3.4 mm, Orontes Reef west end, 11 m, 10 August 1986, WAM 134-87; 18 specs, 4.4 mm-2.5 mm, Coral Bay, Port Essington, 4-6 m, sand and coral, 11 August 1986, WAM 135-87, 137-87; ♀, 2.1 mm, Coral Bay island, littoral, sand and rocks, 12 August 1986, WAM 140-87; ♂, 3.5 mm, 3 ♀, 3.9 mm, 3.6 mm, 3.4 mm (ovig.), Coral Bay near headland, 4 m, 12 August 1986, WAM 138-87.

Coloration. Shield cream with grey-brown patches, darker laterally often with blue tinge. Ocular peduncles with thin cream band proximally, then broad orange band, blue band, and orange band distally; corneas black with white spots. Ocular acicles cream and blue-grey. Antennular peduncles with penultimate segment pale blue proximally and orange distally, ultimate segment blue; flagella orange. Antennal peduncles cream with darker bands dorsally and ventrally; flagella faintly banded. Chelipeds predominantly cream; dactyl sometimes with faint pink tinge and some pale brown proximally; merus, carpus and propodus with several incomplete longitudinal stripes of brown. Pereiopods mostly cream or very pale brown; dactyl with stripes subproximally and often faint grey subdistal band; propodus with brown stripes at midlength and sometimes pale pink subdistal band; carpus with short brown stripes approximately at midlength; merus with several short brown stripes at midlength and sometimes faint pink band subdistally. Setae sparse, pale.

Remarks. The species was collected primarily from *Cronia avellana* (Reeve) shells. Other shells utilised include *Mancinella mancinella* (Linnaeus), *Morula margariticola* (Broderip), *Cerithium* spp, *Mitra variabilis* Reeve and unidentified fasciolariids.

P. kulkarnii is very similar to *P. hedleyi* (Grant and McCulloch). Miers' (1884) description and figure of that species (as *Eupagurus kirkii*, not *E. kirkii* Filhol) do not permit definite distinguishing of the two species, and further comparison of these species is required to clarify specific differences. The Northern Territory material agrees in morphology and colour with Sankolli's description of *P. kulkarnii*, though Sankolli does not note the coloration of ocular and antennular peduncles.

The species has a prominent ventromesial flange or keel on the merus and carpus of the right cheliped of adult males. The flange is rather smaller in females and juveniles. The edge of the flange is either smooth or only slightly irregular in outline, in contrast to that of *Pagurus* sp. A. *Pagurus kulkarnii* can also be distinguished from other Northern Territory hermit crabs by the distinct blue and orange coloration of the ocular and antennular peduncles.

Habitat. Littoral and sublittoral habitats to depths of at least 17 m; associated with soft silt sediments, sand, rock and sometimes coral reefs.

Distribution. This is the first record of the species outside of Indian waters.

Pagurus sp. A

Material. NORTHERN TERRITORY: ♂, 3.1 mm, Orontes Reef west end, Port Essington, 14-17 m, 9 August 1986, WAM 163-87; ♂, 4.4 mm, ♀, 3.7 mm, 1 very damaged specimen, Orontes Reef west end, Port Essington, 11 m, 10 August 1986, WAM 162-87.

Coloration. Shield cream with some green-brown patches. Ocular peduncles cream with short, green-brown stripes distally and subproximally; corneas black. Antennular peduncles cream with green-brown patch distally on penultimate segment; flagella orange. Antennal peduncles cream with slightly darker patches and darker lines along dorsal and ventral edges of ultimate segment; flagella faintly banded cream and green-brown. Chelipeds cream with incomplete longitudinal brown or green-brown stripes on merus, carpus and propodus. Pereiopods cream with short longitudinal stripes similar to *P. kulkarnii*. Setae pale grey or cream.

Remarks. This species was collected from shells of *Cronia avellana* (Reeve).

The Northern Territory material, comprising only three usable specimens, could not be identified with certainty. The species closely resembles *P. kulkarnii* but differs slightly in coloration, especially of ocular and antennular peduncles, and in several morphological characters. Although both possess a distinct ventromesial ridge or flange on the carpus and merus of the right cheliped of males, that of *P. kulkarnii* is almost smooth while the flange of these specimens is ornamented with distinct spines. The ventrolateral edge of the carpus is also more spinose than that of *P. kulkarnii*. The dorsomedial surface of the propodus of chelipeds of *P. kulkarnii* lacks any distinct spination or ridge while these specimens display a low medial ridge, with some blunt spines, on right and left chelipeds. The setae of *P. kulkarnii* are sparsely distributed and simple while this species possesses plumose setae, which are densely distributed along the medial cheliped ridge and along lateral and mesial margins.

The species keys to *P. conformis* de Haan in Miyake (1978). The description of that species in Ortmann (1892: 305) agrees quite well with the Northern Territory specimens except that he described the dactyl of perciopods as long and thin, while the dactyl of these specimens, and those of *P. kulkarnii*. is slightly shorter than the propodus and quite stout. Like *P. conformis*, *P. triserratus* (Ortmann) has a row of medial spines on the right cheliped but also has the dactyl of pereiopods longer than the propodus and the right cheliped is almost devoid of setae.

I believe that further specimens are required for an accurate description of this probably new species.

Habitat. Sublittoral silt and sand habitats, with some coral, at depths between 11 m and 17 m.

Additional Northern Territory Species

Three species of *Dardanus* are represented in the NTM collection from localities other than Darwin and Port Essington:

1. One specimen of *D. hessii* (Miers) (NTM CR003529) has been collected from Cape Wessel, 650 km eastnortheast of Darwin, and three specimens were collected from the Arafura Sea (12°58′S, 132°10′E). The Cape Wessel specimen appears to have a regenerate right cheliped, but otherwise it is identical to the Arafura specimens with typical subequal chelipeds.
2. *D. pedunculatus* (Herbst) is represented by a specimen (NTM Cr002977) from north of the Wessel Islands, in the Arafura Sea.
3. A specimen (CP/76) very similar to *D. imbricatus* (Milne Edwards) lacks locality data. It closely resembles the specimen of *D. imbricatus* illustrated by Fize and Serène (1955: Fig. 35) however the ocular peduncles are longer than those figured and the imbricating tubercles on the left cheliped have prominent blunt medial spines, possibly indicating specific differences from that species.

DISCUSSION

The majority of the hermit crab species recorded here have extensive ranges over much of the Indo-West Pacific region. The dominance of *Diogenes* and *Clibanarius* species is to be expected in tropical shallow waters, espcially when associated with mud and sand flats, mangroves and soft bottomed sublittoral habitats. *Diogenes avarus* and *D. gardineri* are the commonest littoral hermit crabs, especially on open sand and mud flats. *Clibanarius longitarsus* is very common in mangrove forests and *C. taeniatus* on rocky platforms. Suspended sediment loads and consequently water turbidity are high in most waters and coral reef development is only patchy in Port Essington. These conditions may explain the apparent absence of *Calcinus* species, usually common inhabitants of shallow coral and rocky reefs.

Dardanus species are the largest marine hermits in Northern Territory waters. Several species (*D. imbricatus, D. hessii* and *D. pedunculatus*) appear to prefer deeper offshore areas.

Of the pagurids, *Pagurus kulkarnii* is the most common, occurring in a range of habitats and depths from the littoral to at least 17 m.

Coenobita spinosus is the only member of the Coenobitidae known to occur on the mainland of the Northern Territory and is also the most common coenobitid in Australia.

The diversity of hermit crabs collected from the Northern Territory is comparable to that noted for some other tropical areas of the West Pacific e.g. Lee (1969) recorded 22 species from Taiwan, and Ball and Haig (1972) recorded 19 species from eastern New Guinea (with an additional 11 species noted for New Guinea from historical reports). Fize and Serène (1955) recorded 29 species (and a further three possible species) from Vietnam.

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BOOK REVIEW

The Flowering of the Pacific: Being an Account of Joseph Banks' Travels in the South Seas and the Story of his Florilegium.

By Brian Adams

British Museum (Natural History): London 1986 ISBN 000 217472 3

Pp. 194; 18 B. & W. and 48 Col. Pls; R.R.P.: $39.95 (cloth)

Brian Adams has written a superbly readable account of the collection of the raw botanical material that is cumulated in Banks' *Florilegium*. In addition to intensive research on the journals of Joseph Banks, James Cook, Sydney Parkinson and an anonymous manuscript believed to have been written by Able Seaman James Mario Matra, the author drew upon his own personal experience by visiting most of the *Endeavour's* landfalls; Madeira, Brazil, Tahiti, New Zealand, Australia, and Java. The result is another of Adams' masterpieces.

Banks' *Florilegium* is the most highly acclaimed collection of botanical prints ever to be published. *Florilegium* in Latin means "a binding of flowers".

Work on the *Florilegium* began when Joseph Banks returned to England in 1771 with the results of three years of sea voyage and collection on the *Endeavour*. The 738 exquisitely engraved plates were completed in 1784 but were not published as the *Florilegium* until Joe Studholme, the director of Editions Alecto, had his attention drawn in the 1960's to the existence of Banks' engraved plates by Dr Chris Humphries, Curator of Botany at the British Museum (Natural History). One hundred sets of these plates are currently being printed by Edward Egerton-Williams.

The voyage of the *Endeavour* between 1768-1771 took place during that period of British history which saw the expansion of the British Empire to the "New World". The expedition was commissioned by the Admiralty to observe the transit of Venus in the South Seas and the noted astronomer Charles Green was chosen to carry out this scientific observation. Underneath this scientific facade, the *Endeavour's* voyage had a strong political motive: to beat the French and other European navigators to the discovery of the mythical "Terra Australis". Lieutenant James Cook was appointed as captain of the *Endeavour* instead of the more experienced Alexander Dalrymple, who was equally knowledgeable of the Pacific. The reason for this lay in the *Endeavour's* status as a warship and the Admiralty ruled that a naval officer should be in command.

Joseph Banks was only 25 years old when he joined the *Endeavour* as one of the paying gentlemen passengers. He was a wealthy landowner from East Anglia who from a very tender age possessed a passion for both botany and young maidens. He had become a Fellow of the Royal Society as a result of his successful expedition to Labrador and New Foundland two years previously.

For his scientific team, Banks gathered two artists Sydney Parkinson and Alexander Buchan. In addition he took his personal secretary and the keen naturalist Herman Sporing, together with four servants. He had his cabin well stocked with nets, bottles for preserving animals and fish in spirit, chemicals to treat plants and seeds, drawing materials, paper and paint.

Sydney Parkinson, an extremely talented draughtsman from Edinburgh, was responsible for drawing most of the botanical specimens. After the death of landscape artist Alexander Buchan early in the voyage, Sydney Parkinson took on the role of ethnographer as well. Parkinson completed 1000 illustrations during the voyage, but sadly died of malaria, contracted in Java, on the last leg of the expedition to London. After the *Endeavour's* return to England a legal battle was fought between Sydney Parkinson's elder brother Stanfield and Banks over ownership of certain illustrations that Sydney Parkinson had made outside his working time.

Banks' companion, Dr Daniel Solander, a 33 year old Swedish bachelor, was a graduate of Uppsala University and former student of the renowned botanist Linnaeus. His intellectual and personal association with Banks brought the pair of them into the limelight following the *Endeavour's* return to England. Both were highly sought after at social gatherings and were invited to give lectures about their voyage to numerous scientific bodies in Europe.

On one occasion, Banks delivered a lecture entitled "The Manners of the Women of Otaheite (Tahiti)" to the Batavian Society of Rotterdam. In his humorous account he extolled the virtues of the freedom of love in the societies of the South Seas and described the women as "wonderful goddess-like creatures from the Pacific".

Since Europe was at the time enamoured with the virtues of chastity and modesty in women, Banks and Solander as a consequence became the subjects of caricature and criticism by a group of London satirists. Banks was dubbed "The Fly-Catching Macaroni": macaroni had just been introduced from Italy and was becoming a very fashionable analogy for a fop.

After Dr Hawkesworth's publication of the account of *Endeavour's* voyage to the South Seas, Banks and Solander were once again subjected to the ire of satirists who let forth a deluge of verse scrutinizing the morality of the *Endeavour's* crew, especially that of Banks. Banks had written a very vivid diary account of his meeting with Queen Oberea of Tahiti and her sexual prowess. Similarly, Mario Matra had noted in his diary that the women of Otaheite were readily available to the crew for "three nails and a knife", a situation that led Cook to express his concern that the *Endeavour* was losing her seaworthiness. In fact half the sailors paid for these pleasures with their lives, after contracting venereal disease from the local women who had indulged in liasons with the crew of the Spanish ship *Dolphin* a year earlier.

Even during these "moral lapses" of the expedition, the scientific collection of botanical specimens was faithfully carried out by Dr Solander and Sydney Parkinson. On their return to England, Solander and Banks carefully classified the plant specimens according to the Linnaean method and they named about 110 new genera and 1300 new species. One of the new genera first collected in Australia was named Banksia after Banks.

The *Endeavour* spent four very interesting but perilous months along the uncharted eastern coastline of Australia. First landfall on this continent was at Botany Bay, so called because Banks and Solander collected hundreds of new plant species here. The largest section of the *Florilegium* consists of 340 sheets of botanical prints of Australian flora, developed from the finished watercolours by Sydney Parkinson. The Pacific did indeed blossom forth for Banks and his team, as well as Captain Cook, who raised the British flag for the first time at Botany Bay and discovered Port Jackson, the future site for Sydney.

Europe's scientific world waited with bated breath for the publication of the *Florilegium*. Linnaeus wrote constantly to John Ellis, his counterpart in England, asking him to remind Banks and Solander of the vast impact their findings would make in the learned world. Seventeen years after the *Endeavour's* return to England, Dr Daniel Solander, co-author of the *Florilegium* died of a stroke. Banks' enthusiasm began to wane after Solander's death; and since he was always the gentleman amateur, not a scientist, he never felt the pressure to publish. Banks died aged 77 years in 1820, without completing the *Florilegium*.

As an account of the history of the origin and production of the *Florilegium*, Adams' book has much to commend it. His easy narrative style is very captivating and the reader cannot help but become a 'stowaway' on the expedition. The 'armchair stowaway' bounces back to reality only to consult an atlas for geographic bearings, as the book is a little short on maps. The only map in this publication is of New Zealand, taken from a reproduetion of Captain James Cook's map in Sydney Parkinson's journal. Separating the book into its two natural sections - the voyage with the collecting of the raw material, and the saga of the realization of Banks' *Florilegium* — was a logical step. *The Flowering of the Pacific* is well documented and carries a bibliographic list of the material the author used for his research, additional information concerning Bank's *Florilegium* and an extensive index. Overall this is a fine account, and comes highly recommended.

BEE FONG GUNN
76 Wulagi Crescent,
SANDERSON NT 5793 Australia.

Frogs of the Northern Territory

by Michael J. Tyler and Margaret Davies

Government Printer of the Northern Territory: Darwin 1986 ISBN 0 7245 0820 1

Pp. vi+77; 39 Figs; 49 Col. Pls; R.R.P.: $7.00

For someone trying to come to grips with the frog fauna of the Northern Territory, this slim volume is unsurpassed in its content and accuracy. The reason is that Mike Tyler and Margaret Davies remain the most active amphibian systematists operating in Australia generally, and in the Northern Territory specifically. Indeed, of the 45 species identified in the Territory, 20 were originally described by the present authors, either individually or jointly with other colleagues.

The chief advantage of this volume is its presentation: it has soft covers, measures 165 x 240mm and is easily carried as a field guide. The first part of the book comprises a general introduction, followed by sections on: names of frogs; their external features; the frog fauna of the N.T.; sexual differences; enemies; reproduction; habitats; collecting and legislation. These brief introductory sections provide the reader with the very basic information necessary for capturing and identifying species. My only criticism of the presentation of this information is essentially an editorial one. Each of the sections starts on a separate page regardless of its size. The result is that large areas of blank paper necessarily appear when sections are small. This is also inconsistent with latter parts of the book which are in a continuous format.

The second part of the book consists of species descriptions. Each species is individually listed in alphabetic sequence. The species name is provided, although unfortunately the authors have not followed systematic practice and included the names of the workers who described the beast. A plate citation is then noted, so that the reader can refer to the photographic section in the centre of the book to see what the animal looks like. A brief description, remarks on biology, distribution, the origin of the species name, and general comments then follow. A detailed map showing known point locations is included for each species, or in some cases several species. This is easily the best approach to plotting distributions, for one may be able to find new extensions of a species range, without the vagaries of a shaded overlay.

The photographic section has been included in the middle of the book. Six clear colour plates are grouped on each page, and while it is usually preferable to have a photograph of the animal accompanying its description text, this means of presentation is cheaper and it also permits comparisons between other closely related species which is a definite advantage for a volume of this type. Only three of the 45 species do not have colour photographs. This is hardly surprising when one considers the beasts involved: *Ranidella remota*, which is very similar to *R. bilingua* and can only be separated with great difficulty; *Uporelia micromeles*, which is known from one locality in the Tanami desert; and *U. orientalis*, which is known only from preserved specimens originating from one station on the Barkly tableland.

Subsequent to the species descriptions is a section on identification methods, and then a series of four comprehensive keys, distinguishing frogs found in the north west, north east, south west and south east Northern Territory. This form of geographic subdivision is an unusual approach, but is quite a good idea in this ecologically most diverse territory. A series of checklists of frogs found at major centres follows (Jabiru, Darwin, Katherine, Tennant Creek and Alice Springs), and this is also of considerable value, particularly to the tourist or traveller who happens on a chorus of marauding frogs on some rainy night.

To sum up then, Mike Tyler and Margaret Davies have produced an excellent publication which should be a must for any frogologist, and a welcome addition to the library of all those just generally interested in understanding what goes on around them.

MAX KING

Northern Territory Museum of Arts and Sciences
GPO Box 4646
DARWIN NT 5794 Australia

Resources for Aboriginal Family History

Edited by Rodney Lucas

Australian Institute for Aboriginal Studies: Canberra 1986

Pp. 123; R.R.P.: $6.00

This is a resource book of interest to researchers, in particular Aboriginal people seeking to trace family members or compile histories of their family or community. The book contains two main sections, an annotated bibliography of written Aboriginal genealogies and registers, and a preliminary listing of oral history tapes held by the Australian Institute of Aboriginal Studies library in Canberra.

The first section lists 221 published and unpublished works held at the Institute library, which contains information on family trees, geneological charts registers of births, deaths, marriages, census returns of named individuals and lists of traditional owners compiled for land claim purposes. The data includes historical material from the 18th and 19th centuries as well as more recent material.

The second section is an audiography which lists holdings of tapes containing predominantly oral history data such as anecdotes, personal experiences, stories or memories of particular people, places, institutions and events as well as genealogical material.

All listings are indexed under author, language or tribal affilliation and community or place.

MARGIE WEST

Northern Territory Museum of Art and Sciences,
GPO Box 4646,
DARWIN NT 5794 Australia.

University of Tribal Art.

Universalite de l'art tribal.

by Werner Muensterberger

Musee Barbier-Muller:Geneve 1979

Pp. 105; 47 B. & W. and 5 Col. Pls.

Werner Muensterberger is emeritus professor of psychiatry (ethno-psychiatry) at the State University of New York and has a distinguished career behind him, including ethnopsychoanalytic fieldwork in Indonesia. He has written several books and a number of papers dealing with ethnographic art, an interest he has held since the ninetheen twenties. This current work, designed for an innocent audience, presents photographs of 34 artefacts from the collections held at the Barbier Müller Museum in Geneva, together with an accompanying essay.

In this book Muensterberger endeavours to bring the inexperienced audience into more than just a passing contact with ethnographic art. The photographs by Perre-Alain Ferrazzini and the explanatory paragraphs are both clear and concise, and achieve this aim. The New Ireland *kulap* limestone figure (p-. 93), for example, is accompanied by a brief text together with a print of one of the few extant sketches of kulap figures in an internal display house. A similar treatment is given to all the artefacts presented, and they range from a prehistoric Mississippian mask through to a number of ethnographic pieces from West Africa, insular Southeast Asia and Oceania.

Muensterberger's essay is less successful. Here he grapples with the problem of wresting "meaning" from ethnographic art objects. He uses this approach as part of a technique designed to introduce ethnographic art at a more comprehensive level.

Getting beyond the initial reactions of bemusement or intrigue is always difficult for the Westerner when confronting ethnographic art, and the quest for "meaning" is never far from mind. Often, a few comfortable ideas are digested and the artefact is neatly labelled as a native god, or an ancestor figure, a fetish, sorcerer's charm, or a heathen idol. These ideas originated in the early days of mission contact and have been perpetuated by an endless series of art auction catalogues.

In an attempt to "get behind the various forms and styles and focus on fundamental currents" (p. 5), Muensterberger follows Panofsky's (1939) identification of a class of primary or natural meanings comprising both factual and expressional content. He then gives a brief exegesis of a myth relating to the invention of masking from the Bakongo in Zaire. Rather than the deep structural analysis we have come to expect from myth analysts since Levi-Strauss made his mark, Muensterberger reinterpretes the surface elements in a psychoanalytic vein, elaborating on supposed expressional meaning. He tries to emphasize the experiental facets of masking traditions, yet assumes the masks out of context in an oddly naive way, and dismisses emic traditions as "a rigid determinism as spelled out by the tribal lore" (p. 9). It appears that Muensterberger in recent years has not strayed far from the security of the psychoanalytic couch.

After several curious errors of fact, such as: "We [Europeans] have no history of tribal art" (p. 7), Muensterberger comes to the core of his argument when he notes that the early modern artists in the Western tradition were strongly influenced by ethnographic and prehistoric artists. "If these people [modern European artists] had found the key with which to unlock access to a new pictorial grammar they gave primary evidence of the universal connotations of the arts of the "savages" ....[these art objects] now became allegorical expressions for the unity of mankind." (p. 16, p.30 in the French). Muensterberger preceded Rubin *et al.* (1984) in this recognition, but does not succeed in giving a convincing argument for "universality of primary meanings".

From his essay, it would appear that questions relating to meaning, universality, and ethnographic art seem to coil up and die the moment they are put to the floor. Possibly the reason for this sudden death lies with the framework Muensterberger has used to view ethnographic art. Concepts developed from within a European cultural milieux generally assume a self-contained standard system of symbol referents in an art tradition. This approach does not travel well. For anthropological field work Victor Turner distinguished three levels or fields of meaning of a symbol:

1. the level of indigenous interpretation (exegetical meaning), including semantic referents as well as myth.
2. the operational meaning derived from observing a symbolic element in a series of interactions.
3. the positional meaning derived from analysis of relationships between symbols.

(derived from Turner 1967, 1969)

Turner's fields of categorization offer far more potential than those Panofsky offered. Primarily, Turner's levels establish the crucial emic/etic opposition necessary to cope with the interrelations between symbols without having to step into very illusive territory. This then led to a more coherent approach to the intercultural interpretation of symbol systems.

To get beyond Western belief systems entails shifting the point of reference from the author and placing it with traditional artists. These artists continue to work in an unbroken line of descent from their precontact traditions.

In many traditional societies, art objects are primarily vehicles for the tenents of traditional law, land ownership, social organization and other basic principles of social structure. These societies almost invariably have a non-literate background. In order to transfer crucial aspects of their social structure, ritual action is embodied around the production or curation of sculpture.

Art can act either as focus for ritualized behaviour by assembling a transitional framework of communication. In other cases it can act as a legal charter, validating change. These art works are directly equivalent to signs of authority in our societies. Here lies the universality that Muensterberger was seeking.

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MICHAEL GUNN

Northern Territory Museum of Arts and Sciences,
GPO Box 4646,
DARWIN NT 5794 Australia.

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Authors are advised to follow the layout and style in the most recent issue of *The Beagle*.

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The Title should be concise and informative. An abridged title (not exceeding 50 letter spaces) should be included for use as a running head.

The Abstract should not exceed 150 words, and should state concisely the scope of the work and give the principle findings.

Keywords, to facilitate information retrieval, of up to 10 in number should be chosen to outline the main subjects covered.

The Introduction, including a review of literature, should not exceed what is necessary to indicate the reason for the work and the essential background. Abbreviations used throughout the text may be explained at the end of the introductory material.

Footnotes are to be avoided, wherever possible, except in papers dealing with historical subjects.

The International System of units should be used.

In the descriptive text numbers from one to nine should be spelt out and figures used for numbers over 9. For associated groups, figures should be used consistently, e.g. 5 to 10, not five to 10.

Systematic papers must conform with the International Codes of Botanical and Zoological Nomenclature and, as far as possible, with their recommendations.

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Tables should be numbered with arabic numerals and accompanied by a title. Horizontal rules are inserted only above and below column headings and at the foot of the table. Footnotes on tables should be kept to a minimum and be reserved for specific items in columns. All other explanatory material should be incorporated with the title.

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Line drawings, maps, graphs and photographs are generally regarded as "figures" and are to be numbered consecutively for interspersion through the text. Under special circumstances colour illustrations may be accepted. Drawings must be on drafting film or good quality board with appropriate lettering inserted. Black and white photographs must be sharp, of high contrast on glossy paper, and mounted on board. The author's name, title of paper and figure number must be indicated on the reverse side of all illustrations. Captions or legends should be typed together on pages at the end of the text.

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