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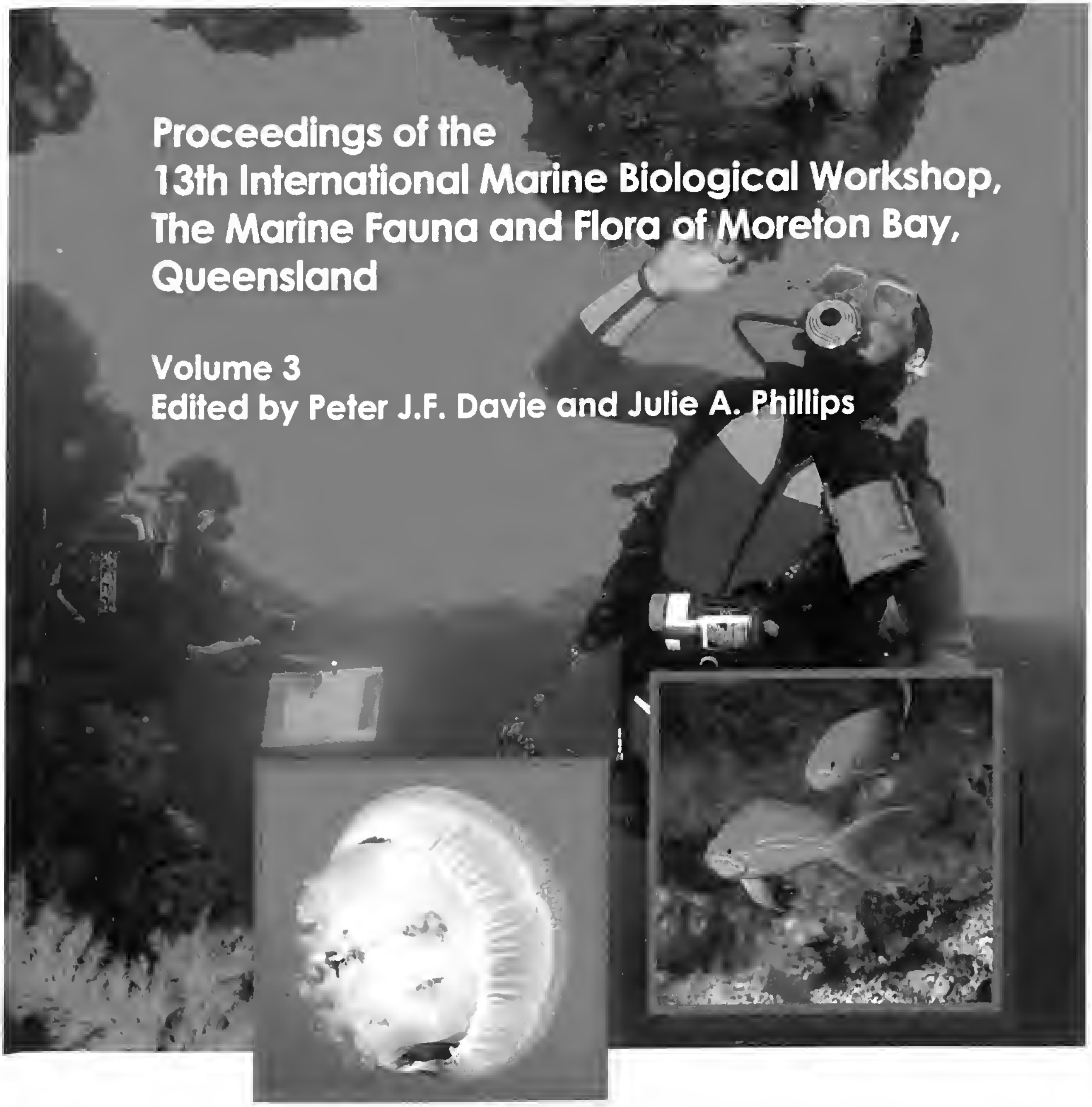
Proceedings of the 13th International Marine Biological Workshop, The Marine Fauna and Flora of Moreton Bay, Queensland

Volume 3

Edited by Peter J.F. Davie and Julie A. Phillips



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Peter J.F. Davie & Julie A. Phillips

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Cover Picture: Merrick Ekins and Jeff Johnson (in background with slate) photographing and visually recording fishes at the base of Hutchinson Shoal, at the north-eastern end of the Moreton Bay Marine Park. Insets: Redstripe Basslet, *Pseudanthias fasciata* (Kamohara, 1954); Giant Crinkled Jellyfish, *Versuriga anadyomene* (Maas, 1903). Photos courtesy Ian Banks (*Diving the Gold Coast*).

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Proceedings of the Thirteenth International Marine Biological Workshop
The Marine Fauna and Flora of Moreton Bay, Queensland

Volume 3

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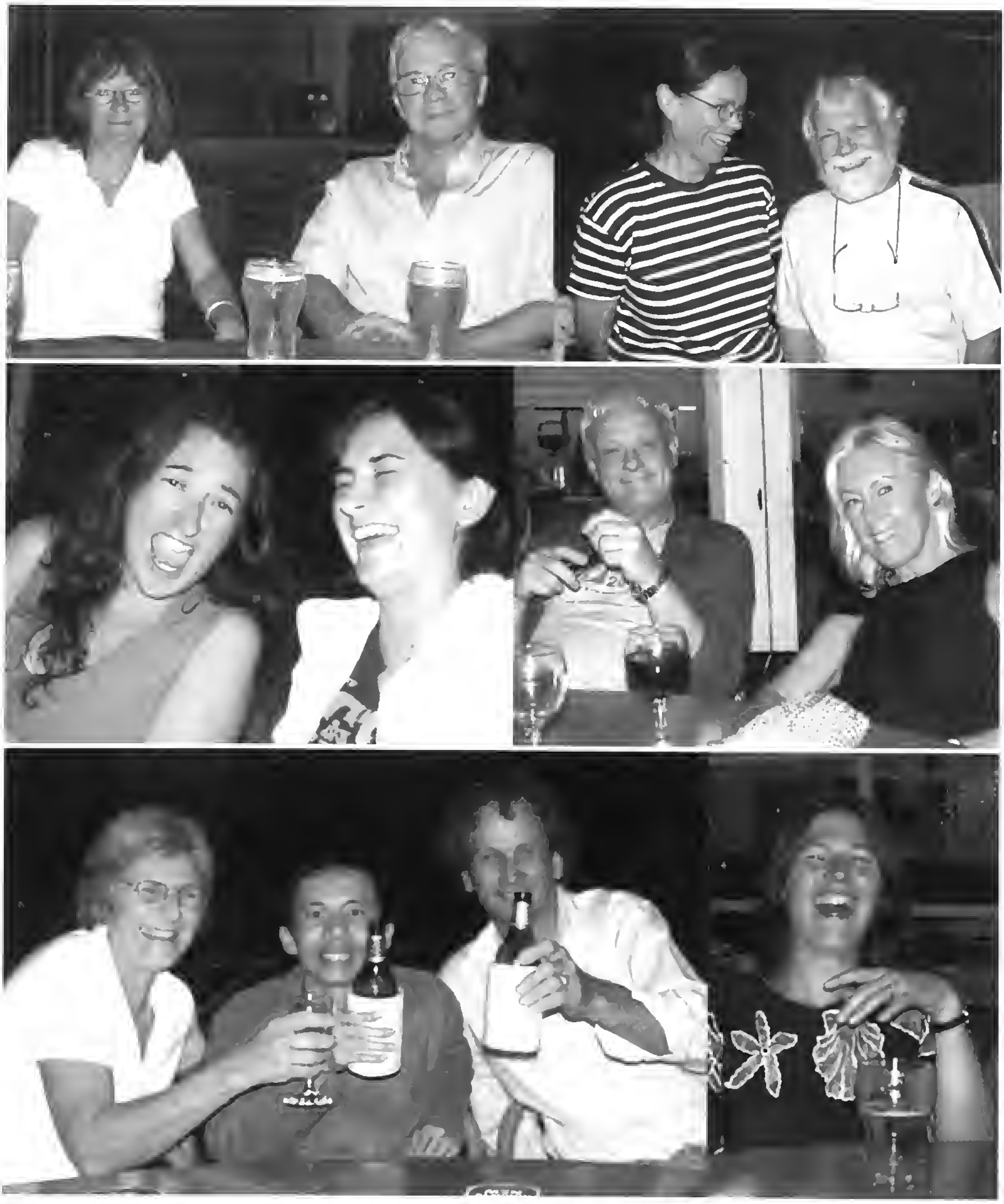
From left to right: QDPI&F Research Vessel, the *Tom Marshall*; Ian Brown; Ian Brown and Roger Bamber emptying the grab; Jo Carini, Lisa-ann Gershwin; a busy night in the laboratory.

From left to right: John Markham; Xinzheng Li; Justin Hsieh; Ida Fellegara; Paul Muir; Ana Glavinic, Chad Buxton and Anne-Nina Lörz with something interesting; ready for a day's diving.



Relaxation time at the Little Ship Club. From left to right: Emily Glover and John Taylor; Myriam Preker and Ian Lawn; Michela Mitchell and Andrea Crowther; Brian Morton and Diana Jones; Carden Wallace, Justin Hsieh and Paul Muir; Anne-Nina Lörz.

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A workshop of such size and duration demands a high degree of cooperation and good-will from a large number of people and organisations. We are very pleased to acnowledge and thank Margaret Iselin, President of the Minjerribah Moorgumpin, Elders-in-Council, Aboriginal Corporation, for representing the traditional owners of the land, and welcoming us to North Stradbroke Island, and also Darren Burns and other members of the Quandamooka Land and Sea Council for giving us their approval and support. The Directors of the Moreton Bay Research Station, Kevin and Kathy Townsend, and all their staff, were unstintingly helpful in the face of all our demands, and kept the wheels turning smoothly. The staff of the Moreton Bay Marine Park, and in particular Nicola Udy and Carly Bansemer, are thanked for their assistance with permitting and their overall support of the workshop. Similarly, the CEO and marine biodiversity staff of the Queensland Museum enthusiastically embraced the idea of the workshop and contributed greatly by providing Peter Davie's time and salary during the long months of organisation and editing, and through provision of preservatives, collecting equipment, and collection curation. In the field, the skipper and crew of the QDPI&F Research Vessel, the *Tom Marshall*, must be singled out for their cheerful and capable help with dredging and grab-sampling, despite large quantities of mud over the back deck. Mr Chad Buxton, of the University of Queensland, and Dr Jo Carini, Queensland Museum volunteered their time and energy during the Workshop as field assistants, and their efforts were greatly appreciated by the organisers and participants. Thanks also Ms Sarah Vershoore for her inspired cover designs.

We could not have undertaken the workshop, nor published the Proceedings, if not for the generous sponsorship of a number of organisations. We were enormously encouraged by the early interest and support of Damien McGreevy and Leonard Costantini of the Queensland Government's Department of the Premier and Cabinet. Similarly, Louise Morland of the Department of Primary Industries and Fisheries, and Chris Robson and Helen Sykes of the Department of Natural Resources and Water, facilitated the significant financial backing provided by those departments. The University of Queensland through the Faculty of Biological and Chemical Sciences, the Centre for Microscopy and Microanalysis, and the Centre for Marine Studies, was also a major sponsor and we are particularly grateful to Professors Mick McManus, John Drennan, and Ove Hoegh-Guldberg for their confidence in the success of the workshop. Dr Rick Morton and Ms Nikki Wood of the Port of Brisbane Corporation, also threw their weight behind the concept, and we are very pleased to acknowledge the generous financial help from the Port of Brisbane. We are also pleased to thank the Brisbane City Council and Consolidated Rutile Limited for also unquestioningly getting behind us financially. AMSA (National) gave early support through a donation to pay for the participation of two postgraduate students. We could not have succeeded without you all, and we sincerely hope that the result justifies your confidence in the project.

Finally we would like to thank sincerely all the participants in the Workshop. The time spent together was marked by not only everyones hard work, but also by a wonderful sense of camaraderie and the shared joy of discovery that makes being a biologist so exciting. Thank you one and all.

Ctenophora of Australia

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ABSTRACT

An overview of the Ctenophora of Australia is presented based on limited collecting efforts, together with the description of seven species new to science. *Euplokamis evansae* sp. nov. (Cydippida: Euplokamididae), has only been found in Tasmanian waters; it is distinguished from its congeners in the comb rows being about 4/5 of the body length, the tentacle bulbs being long and close to the stomach, and having extremely long polar plates. *Pukia falcata* gen. nov., sp. nov. (Cydippida: Pukiidae fam. nov.), is found across the tropical and subtropical north of Australia from Port Hedland, Western Australia, to the Moreton Bay region of southeastern Queensland; it has beehive-coiled tentilla, similar to those of the Euplokamididae, but differs from all other cydippids in having crescentic-shaped tentacle bulbs. *Bolinopsis ashleyi* sp. nov. (Lobata: Bolinopsidae), from Moreton Bay, differs from its large-lobed congeners in its striking pattern of broad red streaks along the ctene rows. *Leucothea filmersankeyi* sp. nov. (Lobata: Leucotheidae), from northwestern Tasmania, differs from other species in its genus in having narrow, blind tentacular pits; long slender papillae; and a pale orange tint to the body core. *Ocyropsis vance* sp. nov. (Lobata: Ocyropsidae), from southeastern Tasmania, is distinguished from other ocyropsids with a deeply-indented hourglass-shaped stomach in lacking tentacle bulbs and spots. Finally, three new forms of benthic ctenophores are reported from the Great Barrier Reef: *Coeloplana mellosa* sp. nov. (Platyctenida: Coeloplanidae) is found on the soft coral *Sarcophyton* sp., and differs from its congeners in a unique combination of pigmentation pattern, papillae number and distribution, and statocyst palp morphology; *Coeloplana reichelti* sp. nov., a larger form found on algae and seagrasses, differs from others in the number and form of papillae, colour pattern, and distribution; the last, a minute form found on the Crown-of-thorns starfish, *Acanthaster planci*, must await additional material for proper description. The distribution of *Neis cordigera* is broadened to include South Australia and Western Australia, and a redescription of the species is provided. The potential fisheries impacts by a form of *Bolinopsis* in Spencer Gulf, South Australia, are discussed. An annotated classification and a key for the ctenophores of Australia are given. ❑ *Ctenophora, Ctenophores, comb jellyfish, Cydippida, Platyctenida, Lobata, Cestida, Beroida, new family, new genus, new species, new records.*

Gelatinous zooplankton species are not typically well known, and this is especially true for members of the Ctenophora. Though well represented in nearly all marine pelagic zones, they are often difficult to capture and impossible (or nearly so) to preserve. Furthermore, their taxonomy is poorly resolved, making identification often difficult and inconclusive.

Australian ctenophores are no exception and are, in fact, even more poorly known than those of many other regions. Ironically, von Lendenfeld (1885a) stated that the Australian ctenophores 'really appear to be rare.' And while few species are reported, most are certainly not rare! In our experience, a small cydippid that is described as new herein and placed into a new family, is one of the commonest members of the Australian coastal gelatinous zooplankton community, and may be found throughout the year in just about any tropical and subtropical region. Furthermore, an unidentified species of *Bolinopsis* blooms in such plague proportions in the South Australian gulfs in the summertime that one must wonder what effect this might have on the larvae and food sources of other species in the gulfs.

The first mention of a ctenophore in Australian waters was by Quoy & Gaimard (1824: 575), who noted a *Beroe* from Port Jackson. Since that time, at least 24 additional species of ctenophores have been reported from Australian coastal waters, with another ten newly reported herein, including seven new to science.

During the course of the Thirteenth International Marine Biological Workshop, in Moreton Bay, Queensland, numerous collections were made of ctenophores. As we were identifying this material, we realised that it would be very useful to attempt to compile the first synopsis of Australian ctenophores, and thus provide a foundation for productive future work. To do this it was necessary to document not only the historical literature, but also specimens in museum collections, and our own samples gathered over the last ten years. This has resulted in numerous new distribution records, and the descriptions of the seven new species presented here. It is highly likely that many more species will prove to be present than so far recognised, and our knowledge of the distibutional ranges of many will no doubt increase significantly with further targeted collecting.

MATERIALS AND METHODS

The collections of ctenophores held in all Australian museums were examined; in most cases comparative type material was non-existent. Field-collected specimens were either captured individually in plastic bags or glass jars while snorkeling, dipped individually from jetties with a 500 µm mesh, 0.5 m-wide plankton net, or else 'trawled' with the net from a fixed location relying on existing current for flow.

Difficulties in preservation and inherent problems with shrinkage are a fundamental problem in ctenophore taxonomy. Thus, whenever possible, live specimens were observed, photographed, and morphological and behavioural characters noted prior to preservation attempts. Tissue samples were also collected for future study when tissues from congeners become available.

Extensive efforts were made to relax and fix live material, often without success. For cydippids and beroids, room temperature asphyxiation was the only effective method of relaxation, but was extremely labour intensive; preservation in about 2% formalin produced moderately good specimens. For lobates, no method of relaxation could be obtained, and efforts to preserve specimens universally resulted in total tissue disintegration, leaving only scattered ctenes; the only exception was *Ocyropsis vance* sp. nov., which preserved quite perfectly in 1-2% formalin.

Measurements were made on preserved material with Max-Cal digital calipers, to the nearest 0.01 mm. Every effort was made to obtain true dimensions across the widest points; however, some specimens were too brittle to be spread out, in which case absolute measurements were taken across the two farthest available points. Body length (BL) was measured from the aboral pole to the tip of the mouth for all specimens. In lobate ctenophores, lobe length (LL) was measured from the inner corner where the lobe attaches to the body to the distal tip; total length (TL) includes the lobes.

Morphological examinations were made under a variety of dissecting scopes, depending on what was available at the institution where the specimens were studied. Microscopic and macroscopic digital images were made of all observable structures with Fujifilm MX-700 and MX-2700 cameras, Nikon CoolPix 995, and Sony DVD-201e in JPG format. While it was not possible to publish all photographs made of each taxon, we have compiled a library of images of

Table 1. An annotated checklist of ctenophores recorded from Australian waters, including all previous records from Moreton Bay. Nomenclatural notes are given in parentheses, where appropriate. Abbreviations used: Queensland (QLD), New South Wales (NSW), Victoria (Vic), Tasmania (Tas), South Australia (SA), Western Australia (WA), Northern Territory (NT), Great Barrier Reef (GBR), Australia 'Unspecified' (AU), Southern Australia (SO), Northern Australia (NO); Species names highlighted in **bold** are dealt with in more detail in the present work.

Family	Species	Moreton Bay Records	Endemic/Australian Distribution
Phylum CTENOPHORA Eschscholtz, 1829 Class TENTACULATA Eschscholtz, 1825 Order CYDIPPIDA Lesson, 1843			
Euplokamididae Mills, 1987	***Euplokamis evansae* sp. nov.**		Endemic: TAS.
Pleurobrachiidae Chun, 1880	*Pleurobrachia pileus* (O. F. Müller, 1776)	Moreton Bay (Greenwood 1980; Gorman 1988); incorrect ID; referable to *Pukia falcata*, gen. nov., sp. nov.	
	Pleurobrachia spp.		NSW (Dakin & Colefax 1940); QLD (Hamond 1971; Greenwood 1980). [All previous records probably referable to *Pukia falcata* gen. nov., sp. nov.]. New records for SA, WA, and TAS.
	Pleurobrachiidae indet.		Southern Australia (Gowlet-Holmes 2008).
Pukiidae fam. nov.	'Sea Gooseberry'	Moreton Bay (Davie 1998).	
	***Pukia falcata* gen. nov., sp. nov.**	Moreton Bay [herein]	Endemic tropical Australia: QLD, NT, WA.
Order PLATYCTENIDA Bourne 1900			
Coeloplanidae Willey, 1896	*Coeloplana meteoris* Thiel, 1968		QLD (Arnold 1993).
	Coeloplana scaberiae Matsumoto & Gowlett-Holmes, 1996		Endemic: SA.
	Coeloplana thomsoni Matsumoto, 1999		Endemic: WA.
	Coeloplana willeyi Abbott, 1907		VIC (Smith & Plant 1976).
	Coeloplana spp.		QLD (Stephenson *et al.* 1931). Southern Australia (Edgar 1997, 2000).
	***Coeloplana mellosa* sp. nov.**		Endemic: Great Barrier Reef on *Sarcophyton* sp.
	***Coeloplana reichelti* sp. nov.**		Endemic: Great Barrier Reef on algae and seagrass.

continued ...

Table 1 (continued) ...

Family	**Species**	**Moreton Bay Records**	**Endemic/Australian Distribution**
	Coeloplana sp. A		Great Barrier Reef on *Acanthaster planci*.
Ctenoplanidae Willey, 1896	*Ctenoplana* sp.		Off Townsville, planktonic (Hamner, in Matsumoto 1999).
Order LOBATA Eschscholtz, 1825			
Bolinopsidae Bigelow, 1912	*Bolinopsis chuni* (von Lendenfeld, 1885a)		Endemic: NSW (Whitelegge 1889; Dakin & Colefax 1933).
	Bolinopsis spp.		NSW (Dakin & Colefax 1940; Dakin & Bennett 1987; Edgar 1997, 2000); SA (Gershwin & Zeidler 2003; Gowlett-Holmes 2008). New records for QLD, TAS, NT, and WA.
	***Bolinopsis ashleyi* sp. nov.**	Moreton Bay [herein]	So far only known from Moreton Bay.
	Bolinopsis sp.		SA (clear body with magenta canals).
	Mnemiopsis sp.	Moreton Bay (Greenwood, 1980)	Probably erroneous ID.
Leucotheidae Lesson, 1843	***Leucothea filmersankeyi* sp. nov.**		Endemic: TAS, SA.
	Leucothea spp.	Moreton Bay	QLD (Harbison & Miller 1986); VIC-TAS-NSW (Edgar 1997, 2000); QLD (Gershwin & Zeidler 2003)
Ocyropsidae Krumbach, 1925	*Ocyropsis crystallina crystallina* Harbison & Miller, 1986		QLD
	Ocyropsis maculata immaculata Harbison & Miller, 1986		QLD
	Ocyropsis maculata maculata Harbison & Miller, 1986		QLD
	***Ocyropsis vance* sp. nov.**		Endemic: TAS.
	Ocyropsis spp.		New records for QLD, NT, and WA.
Order CESTIDA Gegenbaur, 1856			
Cestidae Gegenbaur, 1856	*Velamen parallelum* (Fol, 1869)		Australia-wide (Gowlett-Holmes 2008). New records for TAS and QLD.

continued ...

Table 1 (continued) ...

Family	Species	Moreton Bay Records	Endemic/Australian Distribution
Class NUDA Chun 1879			
Order BEROIDA Eschscholtz, 1825			
Beroidae Eschscholtz, 1825	*Beroe cucumis* Fabricius, 1780		NSW (Stiasny 1931); southern Australia (Edgar 1997, 2000).
	Beroe macrostomus Péron, 1807		QLD (Lesson 1829).
	Beroe ovale Bosc, 1802		NSW (Quoy & Gaimard 1824).
	Beroe ovata Bruguière, 1792	Moreton Bay (Greenwood 1980)	WA (Goy 1990); QLD (Steene 1990).
	Beroe spp.	Moreton Bay (Hamond 1971)	WA (Péron 1807); NSW (Dakin & Colefax 1933, 1940); VIC (Zeidler & Gowlett-Holmes 1998); SA (Gowlett-Holmes 2008). New records for NT and TAS.
	Neis cordigera Lesson, 1829		Endemic: Australia. NSW (von Lendenfeld 1885b, 1885c; Whitelegge 1889; Stiasny 1931). New records for QLD, WA and SA.

Australian ctenophore specimens; images from this library are available upon request.

Abbreviations used: Australian states are abbreviated as follows: South Australia (SA), Western Australia (WA), Northern Territory (NT), Tasmania (Tas), Queensland (Qld), Victoria (VIC), and New South Wales (NSW). The Great Barrier Reef is abbreviated 'GBR'. Other institutional abbreviations used: the Australian Museum, Sydney, NSW (AM); the Museum and Art Gallery of the Northern Territory, Darwin, NT (NTM); the Museum of Tropical Queensland, Townsville, Qld (MTQ); the Museum of Victoria, Melbourne, VIC (MV); the Queensland Museum, Brisbane, Qld (QM); the Queen Victoria Museum and Art Gallery, Launceston, Tas. (QVMAG); the Tasmanian Museum and Art Gallery, Hobart, Tas. (TMAG); and the Western Australian Museum, Perth, WA (WAM). Copies of colour slides of specimens photographed by Karen Gowlett-Holmes are kept in the SAM photo-index collection (prefix 'PH'), with copyright retained by KGH; digital images of specimens photographed by LG are archived in the SAM collection. The prefix 'GZ', refers to field collection numbers that correspond to field notes and digital photos (archived in SAM); in some instances where material was unpreservable (e.g. species of *Pleurobrachia*, *Leucothea* and *Bolinopsis*) these notes and photos are the only remaining evidence of the material examined. Lots consist of single specimens, unless otherwise noted.

Latin and Greek names were derived using Brown (1956). German and French texts were translated with Globalink Power Translator v. 6.02 for Windows. Taxonomic classification is modified from Mills (2007).

SYSTEMATIC ACCOUNT

PHYLUM CTENOPHORA Eschscholtz, 1829
CLASS TENTACULATA Eschscholtz, 1825
ORDER CYDIPPIDA Gegenbaur, 1856

Family Euplokamididae Mills, 1987

Euplokamis Chun, 1880

Euplokamis evansae sp. nov.
(Fig. 1A, B)

Material examined. HOLOTYPE: SAM-H1557 (PH 0248), Shag Rock Bay, Tasman Peninsula, Tas., 0–2 m, K. Gowlett-Holmes, 24.05.1995; 13.32 mm BL, 5.07 mm tentacular width, 5.8 mm stomodael width.

Diagnosis. *Euplokamis* with a nearly spherical body; long ctene rows, nearly 4/5 the body length; long tentacle bulbs, parallel to one another and closer to the stomach than to the body wall; with extremely long polar plates; lacking pigment.

Description. Preserved body elongated, cylindrical with rounded ends (Fig. 1A; somewhat more spherical in life: Fig. 1B), of a very soft gelatinous consistency; with mouth protruding both in life and preserved.

Comb rows 8, equally spaced around body, extending from aboral end to about 4/5 body length toward oral end, leaving oral region free. Comb plates about 25–30 per comb row, spaced approximately 2–3 comb row-widths apart in the live animal, about 2/3 to 1 comb row-widths apart in the preserved animal.

Tentacles 2, with distantly-spaced, coiled, robust tentilla in life (Fig. 1B); could not be completely studied in preserved retracted state without damaging the delicate specimen. Tentacle bulbs elongate, arranged closer to stomodaeum than to outer body wall; sub-parallel to each other; about 1/4 total body length; located just forward of midline on oral-aboral axis. Tentacle sheaths long, slender, opening very close to aboral end; with very small ostia.

Infundibulum very narrow, straight, transparent, difficult to discern; short, less than 1/3 body length.

Stomodaeum broad, flat, about 2/3 body length; narrowed somewhat behind mouth at

Table 2. Comparison of diagnostic characters of the species of *Euplokamis* as considered valid by Mills (1987). Data derived from original descriptions, plus Chun (1880), and Mills (1987). Abbreviations: Body length (BL), Substomodeal (SS), Subtentacular (ST), Comb row (CR).

	Body	Comb rows	Tentacle bulbs	Other features
E. crinita (Moser, 1909)	4 mm BL; elongate, slightly compressed	Whole BL	Very small; between the stomach and body wall	Extraordinarily long ctenes covering most of the body; Seychelles
E. dunlapae Mills, 1987	20 mm BL; elongate, slightly compressed	2/3–3/4 BL	Parallel to stomodaeum; midway between stomodaeum and outer body surface	Red patches along comb rows, tentilla, and tentacle bases; Puget Sound
E. helicoides (Ralph & Kaberry, 1950)	11 mm BL; cylindrical	Nearly whole BL	Parallel to stomodaeum; midway between stomodaeum and outer body surface	Very broad paragastric canals; faint pink colour under comb rows; New Zealand
E. octoptera (Mertens, 1833)	'Pea-sized body'; pear-shaped	2/3–3/4 BL, along crest of raised wing-like structures	Leaf-shaped, parallel to stomodaeum; midway between stomodaeum and outer body surface	Canals faintly pink; tentilla red; central coast of Chile and Bay of St Lawrence in the Bering Strait
E. stationis Chun, 1879	25 mm BL; cylindrical	Full length of the body	Small, oblique; midway between stomach and body wall	Transparent and unpigmented; Gulf of Naples
E. evansae sp. nov.	13 mm BL; nearly spherical live, cylindrical preserved; not compressed	4/5 BL	Long, parallel; closer to stomach than body wall	Colourless; combs distantly spaced; polar plates extremely long; Tasmania

about the level of ctene termination; mouth with straight sides. Stomodaeum bears a sharp, aborally-orientated out-pocketing along one edge, believed to be an artifact.

Meridional canals round in cross section; smooth-edged; smaller diameter than ctene rows they underlie, and thus obscured by them. Internal canals could not be discerned in preserved specimen without dissection, or in photograph of live specimen.

Statocyst in shallow, broad, nipple-shaped indentation, less than body length deep. Polar plates extremely long.

Polar plates extremely long, extending orally up onto sides of body wall for a distance of about 7 comb rows.

Etymology. The specific name, *evansae*, is named after Jill Evans, librarian at the South Australian Museum, in recognition of the heroic service, often unsung, that librarians perform in the pursuit of scientific knowledge.

Remarks. The morphological characters of this species are inconsistent with known cydippid genera, but most similar to the genus *Euplokamis*. However, the specimen was unfortunately too delicate to be dissected in order to prove the existence of striated muscle in the tentilla, considered a defining character for the genus by Mills (1987). Nonetheless, we conservatively place this species in the genus *Euplokamis*, rather than destroying the type specimen or erecting a new genus, pending collection and examination of more material.

Euplokamis was reviewed by Mills (1987) who regarded five species as valid (Table 2). Of those, *E. evansae* is most similar to *E. dunlapae* Mills (1987) and *E. helicoides* (Ralph & Kaberry, 1950) in general size of the body and shape of the tentacle bulbs, but differs from both in colouration and position of the tentacle bulbs, and the body is more spherical in the living specimens, and not compressed. It is also similar to *E. stationis* Chun (1879) in colouration, i.e., both are transparent and unpigmented; however, the two would be unlikely to be confused, with *E. stationis* having obliquely-orientated tentacular bulbs. *Euplokamis evansae* bears less resemblance to the other species in the genus, with *E. crinita* (Moser, 1909) having very long ctenes covering most of the body, and *E. octoptera* (Mertens, 1833) having red tentilla and the ctene rows set upon raised gelatinous wing-like structures.

Family Pleurobrachiidae Chun, 1880

Pleurobrachia Fleming, 1822

The following *Pleurobrachia* species have been previously reported from Australia:

Pleurobrachia pileus (O. F. Müller, 1776) — Greenwood, 1980: 91 (Moreton Bay, Qld); Gorman, 1988: 17 and throughout, pl. 12; (Moreton Bay, Qld) [incorrect identification = *Pukia falcata* sp. nov.].

Pleurobrachia spp. —Dakin & Colefax, 1940: 211 (NSW); Hamond, 1971: 27 (Moreton Bay); Greenwood, 1980: 88, 91 (Moreton Bay, Qld) [All probably erroneous identifications.]

Pleurobrachiidae indet. — Gowlett-Holmes, 2008: 54 (southern Australia).

Material examined (mostly unpreservable). SA: Kangaroo I., L. Gershwin, 5.05.1999, with short tentacle bulbs orientated parallel to stomodaeum in aboral half of body. Robe, W. Zeidler & L. Gershwin, 9.02.2002 (GZ0232); very spherical body with short parallel tentacle bulbs; found in large numbers; many specimens had either ?parasitic worms, or bright yellow eggs (believed to be from the worms), or both, in the infundibulum and tentacle bulbs (GZ0234). Robe, W. Zeidler & L. Gershwin, 21–22.01.2002 (GZ0103, GZ0108); with short parallel tentacle bulbs but with distinctively teardrop-shaped body; found in very large numbers; some infested with the hyperiid amphipod *Hyperoche mediterranea*. **WA**: Derby Jetty, W. Zeidler & L. Gershwin, 22.11.2000; several small specimens. Port of Broome, W. Zeidler & L. Gershwin, 25.11.2000; 5 mm juvenile. **TAS**: Triabunna, W. Zeidler & L. Gershwin, 26.01.2002 (GZ0146). Constitution Dock, Hobart, W. Zeidler & L. Gershwin, 29.01.2002 (GZ0170). CSIRO wharf, Hobart, W. Zeidler & L. Gershwin, 1–2.02.2002.

Field identification. Body spherical in life, cylindrical preserved; colourless and transparent, about 1 cm. Tentacle bulbs short, parallel, and closer to stomach than to body wall.

Remarks. No morphological comments or figures were given by most of the authors that have reported on Australian material, so it is impossible to determine which species they found. While it is clear to us from our own collections that *Pleurobrachia* does exist in Australia, it is uncommon relative to *Pukia falcata* gen. nov., sp. nov. Thus, it seems likely

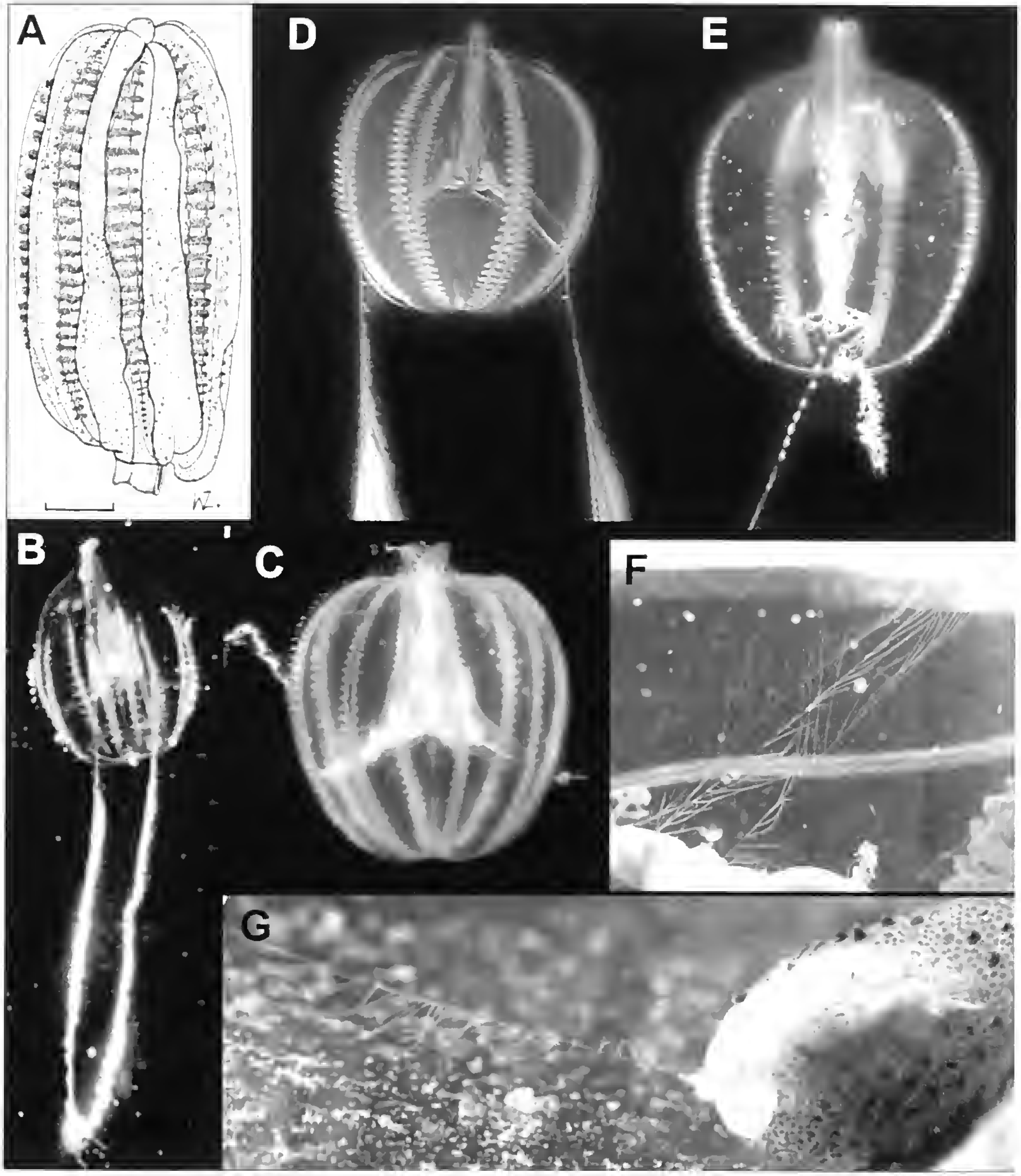


FIG. 1. **A–B**, *Euplokamis evansae* sp. nov., holotype (Tasmania). A. Preserved. B. Live, in situ; scale bar = 2 mm; photograph by Karen Gowlett-Holmes, used with permission. **C–E**, *Pukia falcata*, gen. et sp. nov. C. Holotype (Moreton Bay), in life. D. Sagittal view. E. Tentacular view. Note in C and D crescentic tentacle bulbs that wrap around base of stomodaeum rather than running parallel to it. Note in D and E coiled tentilla near proximal ends of tentacles. Note also permanently protruding mouth. Yellowish colouration under comb rows in C & D are due to recent consumption of brine shrimp nauplii in captivity. **F–G**, *Coeloplana mellosa* sp. nov., living specimens on *Sarcophyton* soft coral (Great Barrier Reef). Note tentacle branching pattern in F, and tentacle streaming off to left near mid-height of G. Photographs F & G by Bette Willis (James Cook University); used with permission.

Table 3. Comparison of diagnostic characters of ctenophore genera within the order Cydippida. Data derived from original literature, plus Bigelow (1912), Mayer (1912), Mills (1987), Harbison (1996), Wrobel & Mills (1998).

	Tentacle bulbs	Tentilla	Other features
Pleurobrachiidae			
Ceroctena Carré & Carré, 1991	Wide, subcylindrical, red, opening aborally	Filiform	Body pear-shaped with two large aboral digitiform papillae
Hormiphora L. Agassiz, 1860	Long, running parallel to stomodaeum	Two or more kinds of side branches	Body oval or egg-shaped
Minictena Carré and Carré, 1993b	Large, globular sheaths	Filiform with 5 types of colloblasts	Body small with two unequal pairs of aboral papillae; comb rows 2/3 body length
Moseria Ghigi, 1909	Very long, reaching the oral collar, parallel to stomodaeum	Not described	Body cylindrical; comb rows broad, full body length, ending before the mouth
Pleurobrachia Fleming, 1822	Short, parallel to stomodaeum	Numerous, filiform	Body more or less spherical; comb rows about 2/3 body length; mouth non-extensile
Sabaudia Ghigi, 1909	Long, voluminous, running parallel to stomodaeum	Numerous, simple, yellow	Cylindrical, boxy body
Tinerfe Chun, 1898	Long tentacle bases	Filamentous	Body elongate; two kidney-shaped gelatinous apical protuberances
Euplokamididae			
Euplokamis Chun, 1880 (*sensu* Mills, 1987)	Orientated midway between stomodaeum and outer body wall, opening aborally	Sparsely arranged, coiled, with smooth muscle	Body elongate; comb rows extend at least 2/3 of body length
Haeckeliidae			
Aulacoctena Mortensen, 1932	With lateral processes	Lacking; tentacles with large terminal knob	Body ovate, distinctly compressed in sagittal axis, with deep lateral furrow and apical prolongation
Haeckelia Carus, 1863	Long, narrow, opening toward oral pole	Lacking	Body ellipsoidal; tentacles with kleptocnidae; comb rows about 1/2 body length
Ctenellidae			
Ctenella Carré & Carré, 1993a	Teardrop-shaped, in oral third of body, opening medially	Tentacles lacking tentilla and colloblasts	Comb rows arranged in pairs; kleptocnidae in gastrovascular wall; suckers on lips
Bathyctenidae			
Bathyctena Mortensen, 1912	Crescentic at base of stomodaeum, opening close to mouth	Present	Body spherical, firm, darkly pigmented; canals with numerous blind side branches

Table 3 (continued) ...

	Tentacle bulbs	Tentilla	Other features
Lampeidae			
Lampea Stechow, 1921	Short, at midpoint of body, parallel to stomodaeum	Numerous, long, filamentous	Long, cylindrical body, with highly eversible pharynx
Cryptocodidae			
Cryptocoda Leloup, 1938	About half the body length, parallel to pharynx	Present	Fusiform body, with large combs running nearly full length
Mertensiidae			
Callianira Péron & Lesueur, 1810	Short, oblique, pointing oral-abaxially	Numerous, long, filamentous	Body strongly compressed, with two very long aboral processes
Charistephane Chun, 1880	Small and angled obliquely, at the midline of the body very near the outer body wall	Short, widely spaced	Strongly compressed body, lacking aboral 'keels'
Mertensia Lesson, 1836	Large, crescentic against pharynx; opening aborally	Filiform, long, red	Strongly compressed body, with two short aboral 'keels'
Dryodoridae			
Dryodora L. Agassiz, 1860	Small, globular, near the midline of the body very near the outer body wall	Tentacles fine, unbranched	Oral opening is actually margin of a large medusa-like chamber where food is captured; mouth is deep inside.
Pukiidae fam. nov.			
Pukia gen. nov.	Crescentic, curled around base of stomodaeum, opening aborally	Numerous, short, alternately filiform and coiled	Apple-shaped body; extensile mouth; no aboral papillae

that most or all earlier reports are probably *P. falcata* gen. nov., sp. nov., which is present in abundance throughout most of the year in the areas they studied. Gorman (1988) is the only author who provided figures, and the species she studied was unquestionably *Pukia falcata* gen. nov., sp. nov.

However, while the new form is common throughout the tropics and sub-tropics of Australia, we have found *Pleurobrachia* spp. occasionally in temperate waters of Tasmania and South Australia, as well as twice in tropical Western Australia. We identify those cydippid ctenophores with spherical or globular bodies; short, parallel tentacle bulbs; and with 'normal' cydippid tentilla (i.e., without the *Euplokamis* 'beehive' form), as *Pleurobrachia.* As suggested by Mortensen (1912) and Bigelow (1912), and echoed by Ralph (1950), 'great variability in shape, size, and the position of various body structures is found ... observations on a large number of living specimens are necessary in order to decide whether these differences occur in the living animal' (Ralph 1950: 79). We agree with these authors that *Pleurobrachia* is a problematic genus, and because we have not had sufficient comparative material available, we hesitate to identify any of these forms to species. The genus is in need of revision.

This is the first report of *Pleurobrachia* in the waters of Tasmania, South Australia, and Western Australia.

Pukiidae new family

Diagnosis. Cydippida with tentacle bases crescentic, curling around aboral end of stomodaeum; tentacles with numerous fine coiling tentilla; with very long polar plate; with apple-shaped body, with protruding mouth.

Type genus. *Pukia* gen. nov.

Remarks. *Pukia* shares some characters with various members of different families throughout the Cydippida (a comparison of generic characters of cydippids is given in Table 3). While we hesitate to erect another monotypic family, the conspicuous crescentic tentacle bulbs and the combination of other characters preclude it from existing families.

Pukia gen. nov.

Diagnosis. As for family.

Type species. *P. falcata* sp. nov.

Etymology. The generic name *Pukia* (pronounced 'pook-ee-uh') is to honor Puk Scivyer (nee Petersen), who while at Underwater World on the Sunshine Coast, Queensland, gathered these and other interesting gelatinous animals for public display and research, and generously allowed us to study and keep many specimens. Her name has Danish origins and is also the name of Shakespeare's merry trickster in *A Midsummer Night's Dream*.

Remarks. The crescentic tentacle bulbs are the most obvious and diagnostic character for *Pukia falcata* gen. nov., sp. nov. They are readily visible in all specimens with even casual examination; they are prominently curled around the aboral end of the pharynx. In most cydippids, the tentacle bulbs are more or less cylindrical and run parallel to the pharynx; generic distinctions are often based on relative length of the bulbs (e.g., *Pleurobrachia*, *Hormiphora*, see Wrobel & Mills (1998)). In a few other forms the bulbs are globular, as in *Minictena* (Carré & Carré, 1993b) and *Dryodora* (Agassiz, 1860), or teardrop-shaped, as in *Ctenella* (Carré & Carré, 1993a), while those of *Aulacoctena* have lateral processes (Mortensen 1932). Two other forms have crescentic tentacle bulbs like *Pukia*, but are wholly unlike *Pukia* in all other respects, namely *Bathyctena* and *Mertensia*. In *Bathyctena*, the tentacle bulbs open orally, whereas in *Mertensia* and *Pukia* they open aborally. It may then be said that, at least when it comes to the tentacle bulbs, *Pukia* is most similar to *Mertensia*; however *Mertensia* has a strongly compressed body with two short aboral 'keels'.

Pukia falcata sp. nov.
(Fig. 1C-E)

Pleurobrachia pileus — Gorman, 1988: 17, pl. 12, and throughout (Moreton Bay, Qld); ? Greenwood, 1980: 91 (Moreton Bay, Qld).

? *Pleurobrachia* sp. — Dakin & Colefax, 1940: 211 (NSW); Hamond, 1971: 27 (Moreton Bay, Qld); Greenwood, 1980: 88, 91 (Moreton Bay, Qld).

Sea Gooseberry — Davie, 1998: 240 (Moreton Bay, Qld).

Material examined. HOLOTYPE: QM-G315861, 200 m offshore of Bribie I., in Moreton Bay, Queensland, surface to 2 m, water temp 24°C, 0700 hours, Puk Petersen for display at Underwater World (Sunshine Coast), 25.11.1999. 16.2 mm total length, 14.37 mm widest diameter, measured live. PARATYPES: **Qld:** QM-G315862, same data as holotype, 34 spec.; 2 spec. also distributed from this series each to AM, SAM, NTM, MTQ, and WAM. QM-G322302, Dunwich fishing jetty, North Stradbroke I., L. Gershwin, 10.02.2005; 4 spec. QM-G322303, same loc. as G322302, 23.02.2005; 1 juv. spec. QM-G329015, same loc. as G322302, 18.02.2005; 2 spec. QM-G329019, same loc. as G322302, 10.02.2005; 1 spec. QM-G329029, same loc. as G322302, 12.02.2005; 2 spec. **NT:** NTM unreg., Stokes Hill Wharf, Darwin Harbour, Darwin, L. Gershwin, 17.08.1998; 2 spec., A) 16.92 mm BL, 10.92 mm BW; B) 11.5 mm BL, 7.86 mm BW. SAM unreg. (= GZ0005), Mandorah Jetty, 12.11.2000; numerous spec. in dilute formalin plus 3 in liquid nitrogen. **WA:** SAM-XH00427 (= GZ 0034 and 0041), Port Hedland main jetty, 20°18.679'S, 118°34.438'E, 27–28.11.2000, W. Zeidler and L. Gershwin; many spec. of various sizes; preserved in dilute formalin, EtOH, and frozen.

Non-type material. Qld: SAM-H1586, Palm Cove, Cairns, L. Gershwin, 16.12.1999; 4 juv. spec., c. 1 mm. Palm Cove, Dec 1999 to Feb 2000; hundreds of spec. captured during routine sampling and examined and kept to various stages. Breakwater Marina, Townsville, 24.09.2003; numerous, examined in field and released. Weipa, Evans Landing, 12°39'52.6"S, 141°50'51.4"E, 10.01.2004; numerous, examined in field and released. **NT:** SAM-H970 (= XH0174), Stokes Hill Wharf, Darwin Harbour, L. Gershwin, 17.08.1998; preserved in EtOH. **WA:** 19°13.021'S, 121°15.399'E, off Eighty Mile Beach, L. Gershwin, 16.04.2004; numerous small, pointy, with rows half body length.

Description. Body apple-shaped (Fig. 1C), with the oral end broader and flatter than the indented aboral end; octagonal to circular in cross-section;

of fairly rigid gelatinous consistency. Mouth typically protruding (Fig. 1C-E).

Comb rows 8, of equal length, nearly reaching mouth, extending aborally to halfway point of each wing of polar plate. Combs 30–35 per row.

Tentacles reaching over 175 mm when relaxed, with numerous tentilla, spaced approximately 1mm apart at equal intervals. Tentilla filamentous, all alike, held coiled much of the time in life (Fig. 1D–E). When tentacles are fully retracted into bulbs, portions of tentacle extend part way into sheath. Tentacle sheaths running obliquely from mid-line to body wall, opening closer to the midline than to the aboral pole; with short projection toward oral end, giving the overall appearance of a triangle with the shortest side braced along the stomodaeum, the longest being the oral side of the sheath to the body wall, and the middle length being the aboral side of the sheath. Tentacle bulbs crescentic, curled around aboral end of stomodaeum (Fig. 1C–D).

Stomodaeum broad, extending halfway to aboral pole. Infundibulum long, narrow, slightly conical, tapering toward statocyst.

Statocyst deeply embedded within the aboral indentation of the body.

Meridional canals broad, with bilateral diverticula beneath each comb plate. Interradial canals short, with adradial canals branched close to the infundibulum, as in Fig. 6.2b of Harbison (1985); perradial canals lacking.

Polar plate very elongated, with two opposing narrow, straight-sided wings, each extending approximately 5 mm in length beyond statocyst, nearly reaching the curvature of the body.

Body colourless and extremely transparent in life, though radial canals may retain pigment from food for many hours; in preservative, transparent with whitish or yellow-orange tentacles.

Etymology. The specific name is derived from the Latin adjective *falcatus* (= sickle-shaped, feminine *falcata*), in reference to the shape of the tentacular bulbs (Brown 1956: 314).

Behaviour in life. The tentilla are uncoiled in the relaxed state. The tentacles continuously pull in and out of the sheaths, with the tentilla along the proximal half coiling into beehive-like beads as they retract.

The mouth is generally held in the extended state. When disturbed, the animal might partially retract the mouth briefly, but will soon resume the extended state.

Captive specimens were maintained for months in pseudo-kreisels and modified box-kreisels, on a twice-daily feeding of newly-hatched *Artemia* nauplii enriched with Super Selco. As in the other forms with aborally-directed tentacle sheaths, *P. falcata* whirls to ingest its captured prey.

Bioluminescence. Numerous attempts to stimulate light responses under different conditions have been unsuccessful; it seems fairly convincing that this species is not bioluminescent. Haddock & Case (1995) noted that while most ctenophores are capable of producing light, 'several species from the family Pleurobrachiidae produced no evidence of bioluminescence capability'; thus, it is possible that as more species in the Pukiidae become known, this may also prove to contain other non-luminous forms.

Distribution. In Moreton Bay, Queensland, *Pukia falcata* was found in large numbers near the surface throughout September-December, 1999. Individuals ranged in size from about 5 to 15 mm, though smaller specimens were lost through the outflow mesh. This species is the most abundant ctenophore from at least Moreton Bay, Queensland, up around the coast to Darwin, Northern Territory. It was also found in large numbers through much of the summer (1999–2008) in the Cairns area, especially during northerly winds, in Darwin Harbour in August 1998, and along much of the coastline of Western Australia in spring 2000 and autumn 2004. Gorman (1988: 21) reported that this species (as *Pleurobrachia pileus*) was 'found in large numbers', and that it was among the three most common species in four of six sampling trips. It may also be the species reported as *Pleurobrachia* by Dakin & Colefax (1940: 211), and said to be 'so numerous as to block up not only plankton nets but even the dredge and fishing nets such as the seine used from the shore…', but this is not certain.

Field identification. Body apple-shaped in life, cylindrical preserved; colourless and transparent, about 1.5 cm. Ctene rows almost entire body length. Tentacle bulbs crescentic, curving around aboral end of stomach.

Remarks. The spherical apple shape of the body bears some discussion. Most cydippids have an oval or cylindrical body, while some are pear-shaped. However, the body of *Pukia* is distinctly apple-shaped, i.e., largest near the oral end, slightly smaller toward the aboral end. This is most similar to that of *Pleurobrachia*, which is more spherical.

The mouth is somewhat different, too. In *Pukia*, the mouth is typically held rigidly in the extended position, whereas in some cydippids it is highly extensile, while in others it is just a slit.

Pukia often coils its tentilla; the coiled tentilla are a key character of the Euplokamididae (Mills, 1987). While we were unable to determine the type of muscle present in the tentilla of *P. falcata*, the overall description does not match that given by Mills (1987) for *Euplokamis*. Specifically, she indicates that the side branches of euplokamids are widely spaced, and normally held coiled when relaxed and not in use, but stretching out at high velocity when triggered by contact with prey. She further refers to 'the natural tendency for all ctenophore tentilla to coil to some extent'. In *P. falcata*, the tentilla are sometimes coiled and sometimes filamentous, frequently switching between the two states, but are most often filamentous when at rest; furthermore, the tentilla are numerous and closely spaced.

ORDER PLATYCTENIDA Bourne 1900

Remarks. Benthic ctenophores were first identified in Australian waters by Stephenson *et al.* (1931), but he gave no morphological details to allow a species determination. Subsequent records have indicated fairly high rates of endemism, suggesting that the biodiversity of this peculiar group is potentially much greater in Australia than currently known.

The Australian benthic ctenophores have been well studied in comparison to their pelagic cousins. They appear to be relatively common in the temperate waters of southern Australia, with two endemic species described by Matsumoto & Gowlett-Holmes (1996) and Matsumoto (1999). However, Arnold (1993) and Hamner (in Matsumoto (1999)) reported tropical forms, as we do below.

Family Coeloplanidae Willey, 1896

Coeloplana Kowalevsky, 1880

The following *Coeloplana* species have been previously reported from Australia:

Coeloplana meteoris Thiel, 1968 — Arnold, 1993: 16 (Pioneer Bay, Orpheus I., Qld, free-living in muddy sand).

Coeloplana scaberiae Matsumoto & Gowlett-Holmes, 1996: 33–40, figs 1–4 (on both sides of the Yorke Peninsula, SA, on the brown alga *Scaberia agardhii*).

Coeloplana thomsoni Matsumoto, 1999: 385–393, figs. 2, 3 (Thomson Bay, Rottnest I., WA, on the coralline alga *Jania* sp.).

Coeloplana willeyi Abbott, 1902 — Smith & Plant, 1976: 43–46 (near Portsea, Port Philip Bay, VIC, on the green alga *Caulerpa* sp. and on red algae).

Coeloplana spp. — Stephenson *et al.*, 1931: 72 (Low Is., Qld, on an alcyonarian); Edgar, 1997: 149 (southern Australia); Edgar, 2000: 149 (southern Australia).

Remarks. We describe below two new tropical species of *Coeloplana*. One additional tropical form has been identified, but is presently awaiting additional material, and is thus beyond the scope of this paper. It is a minute form with a more or less transparent body, observed in abundance on the Crown-of-thorns starfish *Acanthaster plancii*, collected off Townsville 2003–2007.

Coeloplana mellosa sp. nov.
(Figs 1F–G, 2 A, B)

Material examined. HOLOTYPE: QM-G329570, off Townsville, Qld, Bette Willis, Jun 2005, commensal on *Sarcophyton* sp. (Octocorallia, Alcyoniidae); c. 2.5 cm long (live). PARATYPES: SAM-H1596, same coll. data as holotype; 1 spec., c. 2 cm long (live). SAM-XH00437, same data as holotype; 2 spec. in EtOH, c. 1-2 cm long (live).

Diagnosis. *Coeloplana* on *Sarcophyton* host; with brown translucent body with whitish ectodermal fine meshwork pattern, appearing to the unaided eye as a whitish body with hundreds of tiny brown dots; in live animals, papillae about 20, cylindrical, in longitudinal X-pattern through the statocyst; or in preserved specimens over 100, in 16 rows, in three sizes, of two types; with four-lobed statocyst palps.

Description of living specimens [primarily based on holotype]. Body extremely flattened, filmy, modified for creeping, resembling a platyhelminth flatworm; approx. 1.5 times as long as wide, more or less oval in shape with undulating margin, with outline constantly changing in amoeboid manner. Dorsal surface with deep groove down centre of body longitudinally, defined along both sides by ridges bearing ephemeral papillae; longitudinal ridges divided at statocyst by latitudinal groove.

About 20 papillae, extensile, with different ones appearing and disappearing with movement, and in response to stimuli; circular in outline, with straight sides and an evenly rounded top; mostly of same size, but occasionally one or two appearing about half again as broad. Arranged loosely in an X-pattern, converging at statocyst. When papillae are not extended, their position cannot be distinguished.

Tentacles 2, highly extensile and retractable into sheaths inside the body; emitting through two 'chimneys' (Fig. 1G), at opposite ends of the body. Main shaft cylindrical, bearing numerous filiform, pointed tentilla, more or less evenly and sparsely spaced along length of tentacle; the tentilla branch from main shaft dichotomously rather than laterally (Fig. 1F–G). Tentacle bulb shape was uninterpretable due to opacity of the body; placing the ctenophores over or near a light resulted in their balling up rapidly and tightly for over 30 minutes.

Statocyst placed dorsally near midpoint of body; appearing as tiny white granule, deeply embedded in niche between pair of permanently raised, opposing, crescentic, four-lobed, palmate palps, resembling fleshy, scalloped lips (compare with Dawydoff 1938: fig. II).

Gonads were not observed, but at least one specimen was brooding live cydippid embryos on ventral side of body, which began streaming out in mucus strands when disturbed.

Radial canals were not observed due to avoidance of light by ctenophores and partial opacity of their pigmentation.

Colouration: To unaided eye, uniformly whitish crowded with numerous tiny brown pin-point dots (Fig. 1F); under microscopic examination, body translucent brown, with cream-coloured ectodermal reticulations, giving an overall impression of honeycomb. Papillae resemble colourless bubbles, and are very difficult to observe at length due to their absolute transparency; when viewed dorsally, they act as windows through to the underside of the ctenophore's body. Tentacles are coloured with alternating whitish and clear bands. Crescentic statocyst-palp structures are opaque off-white.

Notes on preserved holotype. The specimen preserved extremely well, and a thorough study of its morphology could be made. Curiously, however, several features evident in the live specimen differed markedly in the preserved specimen. Most noticeably different were the number and arrangement of papillae, and the transparency of the animal.

The live colour pattern and opacity was such that the internal morphology, particularly the tentacle bulbs, gonads, and radial canals, could not be interpreted; however, while preservation typically makes most coelenterates more opaque, *C. mellosa* actually became considerably more transparent (Fig. 2A–B). The tentacle bulbs are large but without particular shape (e.g., anchor, cross-bar). The radial canals form an anastomosing network along the periphery of the animal. The gonads are arranged in eight distinct rows: four forming a double-turret-shaped figure-8 through the statocyst, orientated along the short axis of the animal; the other four, form loosely S-shaped structures along both sides of each of the two tentacle bulbs and sheaths. Sex or maturity of the gonads was not investigated; however, they appear from external examination to be well developed.

The papillae were difficult to study in the live specimens, due to their total transparency and ephemeral nature. Over about six hours of study of four specimens, it was concluded that they typically had about 20 papillae arranged in an X-pattern centred on the statocyst, running along the tentacular axis, i.e., opening toward the tentacles. However, a considerably more complex arrangement was revealed in the preserved holotype (Fig. 2A–B), where these papillae have taken on an opaque pointed form, protruding neatly from the body wall, and are readily visible. A total of well over 100 papillae are present, of two different types and three different sizes, in 16 distinct rows. The four primary papillae rows, i.e., crossing the statocyst, each contain about 20 small, cylindrical papillae, arranged in two opposing double-turret-shaped configurations along the short axis, arising along the abaxial edge of the gonad rows. Four rows of secondary papillae each contain about five papillae of the same size as in the primary rows; these papillae are arranged in a crescentic row, overlying the abaxial edge of the proximal portions of the lateral gonads, which run alongside the tentacle bases. Distal to this row of papillae and along the same gonad rows, lies the tertiary set of papillae, considerably smaller than the primaries and secondaries but of the same form; each of the four rows has about 15–20, crowded papillae, arranged along the adaxial side of the gonads. In addition, eight broad papillae, about ten times the size of the tertiary papillae, are arranged two on each side of each tentacle sheath near the opening, abaxial to, but not overlying, the corresponding gonad rows, and are of a different form, i.e., more like diverticula in the body wall rather than the more numerous opaque, pointy, cylindrical papillae.

Etymology. The specific name, *mellosa*, is from the Latin *mellosus* (= honey-coloured; feminine), in triple reference: A) to the honeycomb-colour pattern of this species, B) to the overall honey colour, and C) to the sticky viscosity of honey in a slow trickle, for this benthic, creeping form.

Type locality. Reefs off Townsville, North Queensland, on *Sarcophyton* sp. The exact locality is unknown, as the ctenophores were first observed in the laboratory on corals that had been collected from a variety of places for the zoology classes at James Cook University.

Behaviour. In addition to the morphological behaviour noted above in the description, *Coeloplana mellosa* displays a marked sensitivity to light, actively and rapidly moving away from lighted areas, or balling up tightly or sinking into crevices if light is shone directly on the animal. If left to its own will in darkness, it would be found anywhere on the coral or the sides of the study bowl; in dim light it would quickly seek branch-axil crevices or the underside of coral branches. Examined on a black-back petri dish, it readily spread out, but balled up again with direct light (e.g., for photography).

Preservation technique. Good formalin preserved specimens were obtained using the following technique. A specimen was placed into a small petri dish (55 mm diameter) nearly full of the seawater that the specimen had been living in. It was put in the dark and allowed to relax and adhere. If it hid in a corner, it would be gently prodded to get it moving, until it finally settled and relaxed on the flat bottom. It was then put into the refrigerator to immobilise it. After about one hour, the petri dish containing the relaxed ctenophore was very gently lowered with forceps into a 250 ml container of chilled seawater, so as to create as little water current as possible. Once settled on the bottom, a single drop of concentrated formalin was added along one side of the jar, and allowed to diffuse over 30 minutes, then another to a different side, and so on, until about 8–10 drops of formalin had been added and the specimen began to look dead (i.e., slightly crinkled and with muddled colour), at which time a little more formalin was added to bring the concentration to about 1–2%, and the jar was left at room temperature.

Field identification. Benthic ctenophores, with an extremely flattened body modified for creeping, often mistaken for flatworms, until the tentacles are observed. Tentacles of the typical ctenophore form (i.e., with tentilla), emitting from two ephemeral 'chimneys' near the farthest opposing ends upon the dorsal surface. Comb rows lacking in adults. Colour usually camouflaged with host, which may be algae, soft coral, echinoderm, or other. Characters specific to *Coeloplana mellosa* include its host, *Sarcophyton* sp. from the Great Barrier Reef, the brownish body with whitish reticulations, the 20 or so papillae in an X-arrangement in the live animal or over 100 in 16 rows in the preserved specimens, and the four-lobed form of the statocyst-palps.

Remarks. *Coeloplana mellosa* differs from all other species mainly in the number and

Table 4. Characters used to distinguish species of *Coeloplana*. Species are those considered valid by Matsumoto (1999). Data derived from original descriptions plus Dawydoff (1938) and Matsumoto (1999).

	Host	Colour	Papillae	Locality
C. agniae Dawydoff, 1930b	Cnidarian: Alcyonacean: *Sinularia*	Clear, milky white, or violet brown	4 distinct rows of 8–12 simple papillae each in an X-pattern through the statocyst, plus 3–4 each in 4 more rows, 2 flanking each tentacle bulb	Vietnam
C. astericola Mortensen, 1927	Echinoderm: Asteroid: *Echinaster luzonicus*	Deep red or claret with large, irregular spots of creamy-yellow, or the inverse	4 crescentic rows of 4 simple papillae, emanating from the statocyst in a figure-8 pattern	Amboina; Kei Is.
C. bannwarthi Krumbach, 1933	Echinoderm: Echinoid: *Diadema*	Dark purple	[Not described]	Red Sea
C. bocki Komai, 1920	Cnidarian: Alcyonacean: *Stereonephthya*	Dark vermillion, dark red, brick red, pink, orange, or grey stripes branching and anastomosing	[Not described]	Misaki, Japan
C. duboscqui Dawydoff, 1930c	Cnidarian: Pennatulid: *Pteroeides*	Intense orange or vermillion to orange; tentacles colourless	Papillae not observed	Vietnam, Hawaii
C. echinicola Tanaka, 1932	Echinoderm: Echinoid: *Toxopneustes pileolus*	Yellow brown with wide pale green margin	32 simple papillae: 8 larger, 24 smaller	Japan
C. gonoctena Krempf, 1920	Cnidarian: Alcyonacean: *Alcyonium*	Milky white or grey with brown spots	5 simple papillae in each of 4 rows forming an X-shape or figure-8, with the distal-most in each row larger	Vietnam
C. komai Utinomi, 1963	Cnidarian: Alcyonacean: *Alcyonium*	Uniformly milky white or seashell pink, with yellow tentacle bases	4–6 pairs of simple papillae	Sagami Bay, Japan
C. krusadiensis Devanesan & Varadarajan, 1942	Echinoderm: Asteroid: '*Pentaceros hedemanii*'	Red	6–20 simple papillae	India
C. lineolata Fricke, 1970	Cnidarian: Alcyonacean: *Sarcophyton*	Milky white or greenish with pale yellow or yellow-green spots	60–70 simple papillae	Madagascar
C. mesnili Dawydoff, 1938	Planktonic	Transparent pale green, with bright orange statocyst and papillae	32 simple orange papillae arranged in 8 short rows	Vietnam

Continued ...

Table 4 (continued) ...

	Host	Colour	Papillae	Locality
C. meteoris Thiel, 1968	Free-living on soft sediments	Clear with yellow-white reticulations covering body, and red pigmentation around canals, tentacle sheaths and papillae	4 rows of simple papillae, 3–4 per row	Somalia; North Queensland, Australia
C. metschnikowii Kowalevsky, 1880	Seagrass *Zostera*	Dorsal grey, ventral white	[Not described]	Red Sea
C. mitsukurii Abbott, 1902	Algae: red *Melobesia* sp., or brown *Sargassum* sp.	Pigmentless to chocolate brown, with yellow white cells around margin and two bands of yellow around statocyst	4 curved rows of 6–8 papillae per row with 2–5 digitate processes, radiating around the sense organ in a figure-8	Japan
C. perrieri Dawydoff, 1930a	Seagrass *Posidonia*	Deep olive green with sepia spots, with narrow yellow orange margin; tentacles yellow-brown	Lacking papillae (?, but see Dawydoff, 1938)	Vietnam
C. punctata Fricke, 1970	Cnidarian: Alcyonacean: *Sarcophyton*	Transparent with brown or grey lines parallel to the tentacle axis	70–100 simple papillae	Madagascar
C. scaberiae Matsumoto & Gowlett-Holmes, 1996	Algae: *Scaberia agardhii*	Solid dark orange or vivid red, without spots of any kind	Four rows of simple papillae in a figure-8 pattern, and also along the margin	Yorke Peninsula, South Australia
C. sophiae Dawydoff, 1938	Cnidarian: Gorgonian: *Solenocaulon*	Brick red with milky white spots	4 rows of 3–5 simple papillae	Vietnam
C. tattersalli Devanesan & Varadarajan, 1942	Planktonic	Transparent green	8 simple papillae; sometimes with secondary papillae, which may appear branched	India
C. thomsoni Matsumoto, 1999	Algae: *Jania*	Pale green or white with yellow white cells scattered over dorsal surface	Green morph has 16 papillae (8 rows of 2), four branched, others simple; white morph with 4 large permanent papillae and 12 small ephemeral papillae	Rottnest I., Western Australia
C. weilli Dawydoff, 1938	Echinoderm: Echinoid: *Heterocentrotus mammillatus*	Uniform brownish red	Lacking papillae	Gulf of Thailand

Continued ...

Table 4 (continued) ...

	Host	Colour	Papillae	Locality
C. willeyi Abbott, 1902	Not specific: seagrasses, all colours of algae, echinoderms	Deep purple, red or orange fading to pink, with white spots along margin and yellow blotches at base of papillae	20–30 cylindrical or club-shaped papillae	Japan; Hawaii
C. wuennenbergi Fricke, 1970	Cnidarian: Alcyonacean: *Sarcophyton*	Whitish to grey, with dark red/violet spots	40 simple papillae	Madagascar
C. mellosa sp. nov.	Cnidarian: Alcyonacean: *Sarcophyton*	Overall impression whitish with hundreds of tiny brown dots; close-up, body brownish with cream-coloured ectodermal reticulations	20 simple papillae arranged in a X-shape in life; preserved: over 100 papillae in 16 rows, 3 sizes, and two types	Great Barrier Reef off Townsville, Queensland
C. reichelti sp. nov.	Botanical: variety of red and green algae and seagrass	Transparent pale yellowish body with hundreds of ectodermal and endodermal green specks, with 'frosty' white cells on papillae and margin	8–20 large, branched, permanent papillae, plus 8 smaller, cylindrical, ephemeral papillae midway to margin	Great Barrier Reef off Townsville, Queensland

arrangement of papillae (Table 4), although this character becomes clearer upon preservation. In the preserved condition, it is the only species with 16 rows of papillae. Some species do have complex papillae patterns, e.g., *C. agniae* Dawydoff, 1930(c), and *C. mesnili* Dawydoff, 1938, with eight rows, *C. gonoctena* Krempf, 1920, with the distal-most in each of four rows larger than the others, *C. scaberiae* Matsumoto & Gowlett-Holmes, 1996, with papillae along the margin as well as in the primary figure-8, and *C. thomsoni* Matsumoto, 1999, with two different types of papillae in both colour morphs. Similarly, *C. lineolata* Fricke, 1970, and *C. punctata* Fricke, 1970, are both characterised by having a very large number of papillae, 60–70 in the former and 70–100 in the latter. However, in all these cases, the hosts and colour patterns serve to readily differentiate *C. mellosa* from each, and even though there are generalities such as 'a large number of papillae' or 'multiple rows or types of papillae', they are nonetheless dissimilar in actual number and arrangement. The colour of live specimens of *C. mellosa* is most similar to *C. gonoctena* with a milky white body with brown spots; however, in *C. gonoctena* the brown spots are quite large, whereas in *C. mellosa* they are minute.

Coeloplana reichelti sp. nov.
(Fig. 2C–F)

Material examined. HOLOTYPE: QM-G329571, off Townsville, Qld, 14.05.2008 from Reef HQ Aquarium, living on broad-leafy green algae; c. 1.0 cm body length (live). PARATYPES: QM-G329572, same coll. data as holotype; 1 spec., c. 0.4 cm BL (live); living on seagrass overgrown with dark red algae. QM-G329573, same coll. data as holotype; 1 spec., c. 0.5 cm BL when stretched out (live); living on green algae. SAM-H1629, same coll. data as holotype; 2 specs, c. 0.5 cm BL (live); living on green algae.

Diagnosis. *Coeloplana* on various green and red algal and seagrass hosts; with yellowish translucent body with numerous tiny ectodermal green specks, with whitish cells on branches of papillae and around margin, giving frosted appearance; in live animals, 20 permanent irregularly branched, primary papillae, arranged in figure-8 pattern, plus 8 ephemeral secondary papillae, 4 each in two rows, cylindrical, unbranched; with smoothly rounded statocyst palps.

Description. (Based on notes from laboratory examination of live specimens, primarily the holotype (Fig. 2C)).

Body extremely flattened, filmy, modified for creeping, resembling a platyhelminth flatworm; approximately 2–3 times as long as wide, more or less oval-shaped to lemon-shaped with an undulating margin, with outline constantly changing in an amoeboid manner. During study period, specimens changed shape several times from a primarily 'short, broad form' to a primarily 'long, narrow form' and back again, with respect to the direction of movement (perpendicular to the tentacular axis). Dorsal surface lacking a deep groove down centre; ventral surface with deep groove down centre of body in tentacular axis.

Papillae 28, of two types, arranged as follows in holoytype: permanent papillae 20, irregularly digitate, arranged in a figure-8 pattern through statocyst (Fig. 2C); two other rows of smaller, unbranched, ephemeral cylindrical secondary papillae, 4 in each row, arranged about midway between primary rows and margin. In paratypes, which are smaller in body size, permanent papillae are arranged in 2 rows of 4, close to, but either side of, midline (Fig. 2E).

Tentacles 2, highly extensile and retractable into sheaths inside body, at opposite ends of body; 'chimneys' not apparent; instead, tentacles emitted from an opening just proximal to 'edge' of body margin. Main shaft of tentacles cylindrical, bearing numerous filiform, pointed tentilla, more or less evenly and sparsely spaced along length of tentacle; tentilla branch from main shaft laterally rather than dichotomously. Tentacle bulbs in shape of angular 'C' or half a hexagon, with tentacle emitting from 'outside' or 'back' of central bar.

Statocyst dorsal, conspicuous, located at centre of body, midway between four central-most branched papillae; appearing as a tiny pale orange granule, deeply embedded in a niche between a pair of permanently raised, opposing, crescentic, simple, smoothly rounded, unscalloped palps, resembling fleshy lips.

Gonads were not observed.

Radial canals numerous, throughout body region peripheral to tentacle bulbs and papillae; not anastomosing; repeatedly branching toward margin into progressively finer canals (Fig. 2E–F). Gastrovascular origin of some canals not apparent.

Colouration: uniform transparent pale green to the unaided eye; under microscopic examination, the body is transparent and colourless, with hundreds of bright green ectodermal and endodermal specks, particularly over the vital region between tentacle bulbs and in a ring around just proximal to the periphery, and with frost-like whitish granules haphazardly arranged around the margin. Branched papillae transparent, with conspicuously 'frosted' appearance on some surfaces of tips and branches (Fig. 2C–D). Cylindrical papillae completely transparent and colourless, resembling bubbles, and remarkably difficult to see; microscopic examination through these windows into the inside of the animal revealed presence of numerous particles whirling around in a random motion, contained within papillae. Tentacles slightly translucent whitish. Crescentic statocyst-palp structures are opaque pale orange coloured, with granular appearance, resembling sand.

Etymology. The specific name, *reichelti*, is given to honour Dr Russell Reichelt, Chairman of the Great Barrier Reef Marine Park Authority which owns the Reef HQ Aquarium where this species was discovered; also because Dr. Reichelt has been extremely supportive of scientific projects relating to jellyfish and marine-stinger safety; and more personally because Russell has been an inspiring mentor to the senior author.

Type locality. Algal and seagrass beds off Townsville, north Queensland. The exact locality is unknown as they were first discovered at the Reef HQ Aquarium flourishing on algae and seagrasses that had been collected from a variety of locations nearby.

Behaviour. *Coeloplana reichelti* showed a marked propensity toward the air/water interface, and had to be repeatedly drawn off it during examination. Whether this is due to some feature of the study conditions, or is perhaps a natural dispersal mechanism, is unknown. In its undisturbed condition, *C. reichelti* spends

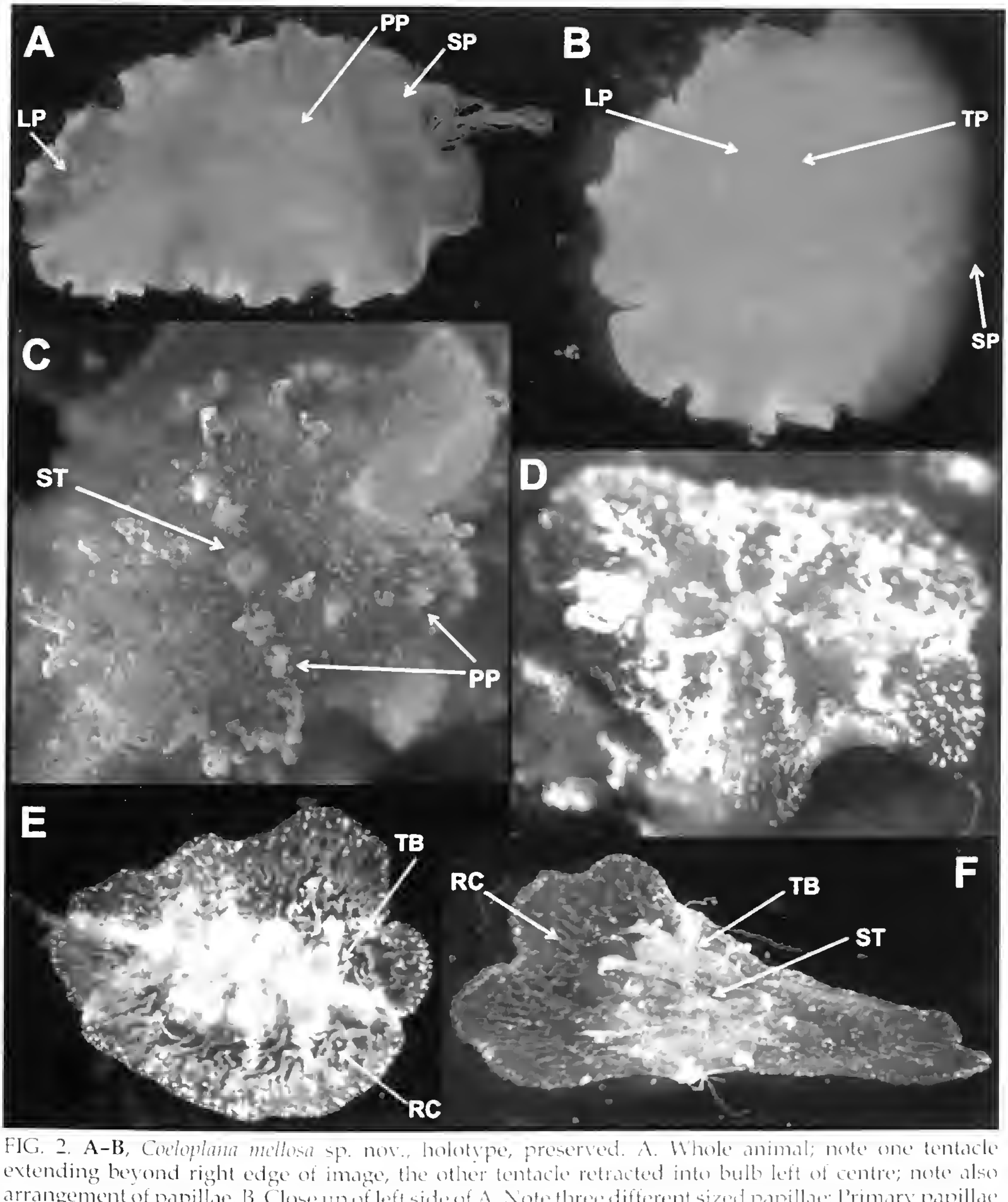


FIG. 2. **A–B**, *Coeloplana mellosa* sp. nov., holotype, preserved. A. Whole animal; note one tentacle extending beyond right edge of image, the other tentacle retracted into bulb left of centre; note also arrangement of papillae. B. Close up of left side of A. Note three different sized papillae: Primary papillae (PP) forming double-turret-shaped figure-8 in centre of A; secondary papillae (SP) along lateral gonads in A & B; tertiary papillae (TP) along adaxial side of lateral gonads in B; and large papillae (LP) along abaxial side of lateral gonads in A & B. **C–F**, *Coeloplana reichelti* sp. nov. C. Holotype, dorsal view, note figure-8 arrangement of permanent papillae. D. Paratype QM-G329572, in life, dorsal view, direction of movement is to lower right. E. Paratype QM-G329573, in life, ventral view. F. Dorsal view of E; note branching nature and arrangement of papillae in two rows. Abbreviations in C–F: radial canals (RC), tentacle bulb (TB), statocyst (ST), permanent papillae (PP).

most of its time near the tips of algae and seagrass, with the tentacles streamed out, up to about 20 cm, both day and night.

Field identification. *C. reichelti* is highly cryptic but appears to prefer tropical algal and plant hosts. Diagnostic characters are: yellowish body with green flecks and whitish frost-like cells on papillae and margin; conspicuous, irregularly branched permanent papillae, plus simple, ephemeral papillae; and the smoothly rounded form of the statocyst-palps.

Remarks. *Coeloplana reichelti* appears to be most similar in general form to *C. mitsukurii* from Japan. Both have branched papillae, and both have white cells around the margin and are found on various species of algae. However, *C. mitsukurii* has 24–32 branched papillae and no mention of secondary, simple papillae, whereas there are only 8–20 branched papillae in *C. reichelti*, plus eight simple, ephemeral papillae. Interestingly, Abbott (1902) described the papillae of *C. mitsukurii* as being 'entire or digitate and fringed'; this raises the possibility of further difference between the two in the actual form of the papillae, as one would not describe the papillae of *C. reichelti* as digitate and fringed, but possibly more as 'jaggedly branched, or haphazardly dendritic'. Without seeing fresh material of *C. mitsukurii*, it is difficult to compare the papillae branching forms between the two species. The two species further differ in colour, with *C. mitsukurii* being pigmentless to chocolate brown, but *C. reichelti* being whitish to yellowish with many bright green flecks. Furthermore, whereas *C. mitsukurii* is found in temperate northern hemisphere, *C. reichelti* is found in the tropical southern hemisphere. *C. reichelti* is also found on seagrass, but this does not appear to have been recorded for *C. mitsukurii*. Whilst the ephemeral papillae and seagrass host could have been overlooked, the number of primary papillae, the colour differences, and the great geographical separation, would seem to differentiate the two quite readily.

Two other species of *Coeloplana* also have branched papillae. In *C. tattersalli* Devanesan & Varadarajan, 1942, the secondary papillae are said to sometimes appear branched, but in *C. reichelti* the primary papillae are permanently and conspicuously branched, and greatly outnumber those in *C. tattersalli*. *C. tattersalli* is also planktonic, whereas *C. reichelti* is benthic.

C. thomsoni Matsumoto, 1999, has four large, branched, permanent papillae, plus 12 smaller, simple ephemeral papillae, whereas *C. reichelti* has 20 and 8, respectively; furthermore, *C. thomsoni* is found only on a single algal host, whereas *C. reichelti* is less discerning. As already described *C. reichelti* has a distinctive colour pattern within the genus. A comparison of primary diagnostic characters for species of *Coeloplana* is presented in Table 4.

Family Ctenoplanidae Willey, 1896

Ctenoplana Korotneff, 1886

Ctenoplana sp.

Only one unidentified *Ctenoplana* species has been previously reported from Australia:

Ctenoplana sp. — Hamner, in Matsumoto, 1999: 386 (off Townsville, Qld; planktonic).

Field identification. Essentially a planktonic version of a benthic ctenophore.

Remarks. The above report by Hamner noted only that the specimen was transparent and planktonic, and found off Townsville, but gave no further details. It will be interesting to see what species is/are present in Australian waters, when found again.

ORDER LOBATA Eschscholtz, 1825

Family Bolinopsidae Bigelow, 1912

Bolinopsis L. Agassiz, 1860 (*sensu* Mayer, 1912)

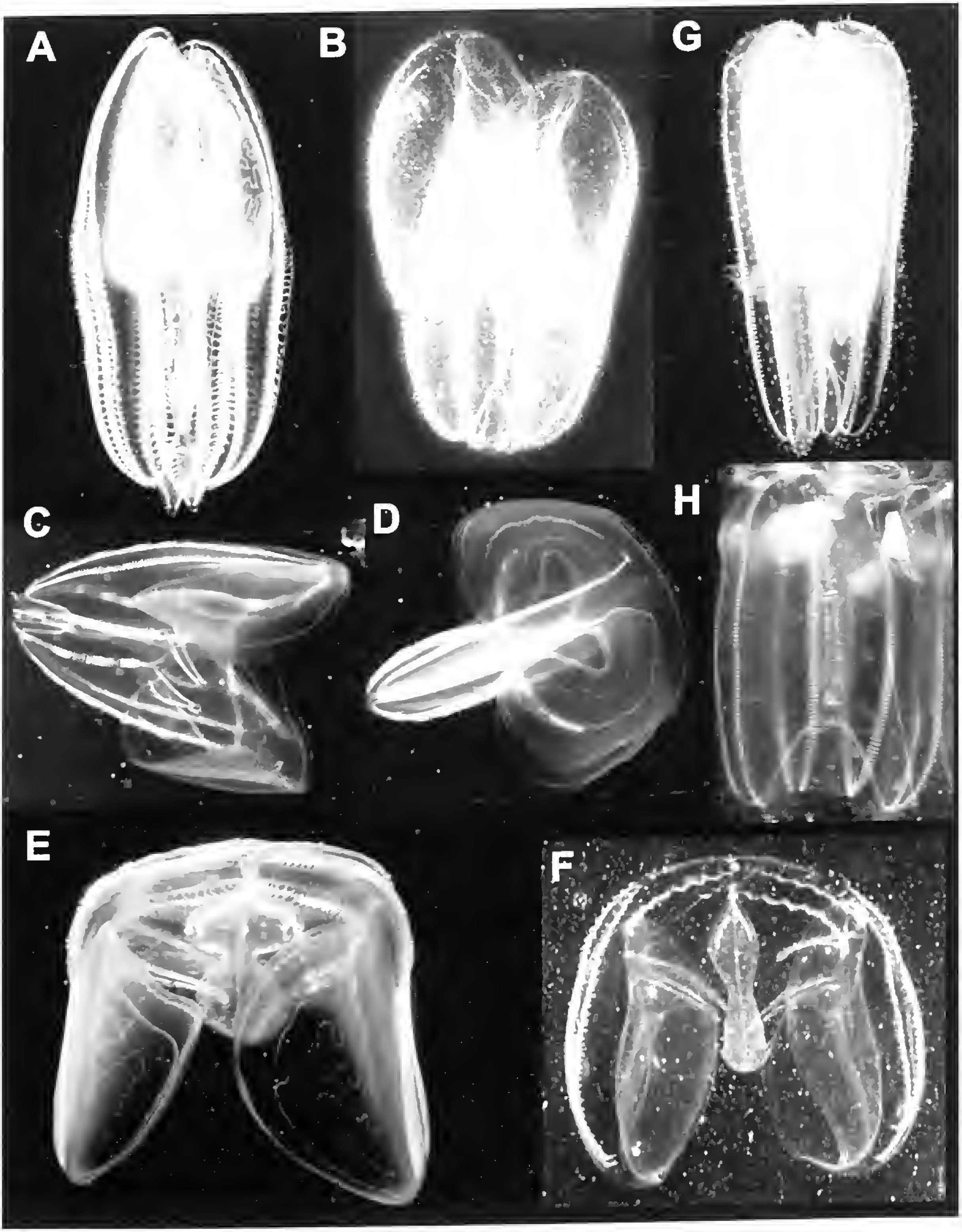
Bolinopsis species
(Fig. 3A–B)

The following *Bolinopsis* species have been previously reported from Australia:

Bolina chuni von Lendenfeld, 1885a: 929–931, pl. 44–45 (Port Jackson, NSW); Whitelegge, 1889: 197 (Port Jackson); Dakin & Colefax, 1933: 198 (NSW).

Bolina sp. — Dakin & Colefax, 1940: 211 (NSW).

Comb jellies – Dakin & Bennett, 1987: 179 (NSW).


A
B
G
C
D
H
E
F

Bolinopsis spp. — Edgar, 1997: 150 (NSW); Edgar, 2000: 150 (NSW); Gershwin & Zeidler, 2003: 237 (Great Australian Bight); Gowlett-Holmes, 2008: 54 (SA).

Material examined (mostly unpreservable). Wholly transparent forms: Qld: Palm Cove, Dec 1999 to Feb 2000; hundreds of specimens captured during routine sampling and examined to various stages; to about 7 cm long (Fig. 3B). SAM-XH436, Palm Cove, 10.12.1999; 1 spec. in EtOH. Palm Cove, 19.02.2000; transparent with 2 red dots on each side. Palm Cove, 22.02.2000; 1 spec. with 2 red dots on each side, 2 cm BL. Quarterdeck Marina, Townsville, 5.11.2003; 1 small, examined in the field and released. **NT**: Stokes Hill Wharf, Darwin Harbour, 6.08.1998; numerous specs. Mandorah Jetty, 12.11.2000; 2 specs in liquid nitrogen and EtOH. Dundee Beach, Fog Bay, 15.11.2000; numerous. **WA**: Cockburn Groin, Cockburn Sound, 7.03.1999; numerous specs examined. Derby Jetty, 22.11.2000; several small to medium, purplish clear. Port of Broome, 25.11.2000; 4 specs, 1–2 cm; 5 frozen (GZ0024). Port Hedland Jetty, 27–28 Nov 2000; numerous. Hearson Cove, near Dampier, 30.11.2000; 1 spec. 19°13.021S, 121°15.399E, off Eighty Mile Beach, 16.04.2004; numerous. 19°07′56.3S, 121°18′26.3E, off Eighty Mile Beach, 10.05.2004; numerous. 19°02′09.0S, 121°21′44.1E, off Eighty Mile Beach, 11.05.2004; numerous. **SA**: Whyalla Marina, 12.05.1999; in plague proportions up to about 4cm long, typically orientating in water column with aboral end up; highly bioluminescent. Murat Bay Jetty, Ceduna, 19–20.02.2002; large numbers; 6 frozen in liquid nitrogen (GZ0528). **NSW**: Bare Rock, Botany Bay, 20.12.1998; numerous examined. **Tas.**: Photograph by Karen Gowlett-Holmes, Waterfall Bay (Fig. 3A); specimen not preserved. **Transparent body with magenta canals: SA**: Whyalla Marina, 18.02.1999; thousands of specimens 3–8cm, casually examined in the field; numerous growth stages examined in detail. Kingscote Jetty, Kangaroo I., 1.05.1999; numerous, to 12 cm long; very highly bioluminescent; preyed upon in large numbers by *Cyanea* (Scyphozoa). Streaky Bay and Smoky Bay jetties, 19.02.2002; numerous. St Francis and Dog Is., Nuyts Arch., Great Australian Bight, 21–25.02.2002; numerous. **WA**: 19°07′56.3S, 121°18′26.3E, off Eighty Mile Beach, 10.05.2004; several with thick comb rows.

Field identification. Body similar in outline to a chicken egg in size and shape, i.e., with one end somewhat larger and more rounded than the other; more or less colourless and transparent; to about 8 cm long. Two lobes at larger end, capable of expanding out somewhat like scoops, or often held curled in, giving the animal the egg-like shape. The body is extremely soft and breaks apart easily. Ctene rows extend along on the body, four extending out along the lobes, and the other four ending in rabbit-ear-like auricles between the lobes.

Remarks. Unidentified, unpreservable forms of the genus *Bolinopsis* were found in great abundance along much of coastal Qld, SA (especially upper Spencer Gulf and Kangaroo I.), along the south-west coast of WA, and in Darwin Harbour, NT. *Bolinopsis* has not been previously reported in the waters of these states. No species identification was made, though medium to small lobes and a transparent/colourless body were noted. Another transparent and colourless form from Tasmania is characterised by short, triangular aboral extensions (Fig. 3A); these have not been observed in other Australian forms. It is possible that one or more of these forms can be referred to *B. chuni* (von Lendenfeld, 1885a), the only *Bolinopsis* previously described from Australian waters, but von Lendenfeld's description of this NSW species is insufficient for confident determination.

A common form throughout Queensland is completely colourless and transparent (Fig. 3B), whereas another small Queensland form lacks lobes and has two small red granular dots along each side, and a common form in South

FIG. 3. **A–B**, *Bolinopsis* spp. A. *Bolinopsis* sp. A (Tasmania). B. *Bolinopsis* sp. B (North Queensland). Note aboral extensions in A, lacking in B; complexly winding radial canals in the lobes of A compared to B; and comparatively heavier, longer lobes in B than in A. Both specimens photographed live and orientated with oral end toward upper right. **C–D**, *Bolinopsis ashleyi* sp. nov., holotype (Moreton Bay) in life. C. Sagittal view. D. Tentacular view. **E–F**, *Ocyropsis* spp. E. *Ocyropsis vance*, gen. et sp. nov., holotype (Tasmania) in life, orientated oral end toward lower right. Note deeply indented hourglass-shaped stomach, indicating affinity with the *O. maculata* species group. F. *Ocyropsis* sp., in life (Cairns Harbour, Far North Queensland). Note ctene rows longer but with comb plates more sparsely arranged than *O. vance*. **G-H**, *Leucothea* spp. G. *Leucothea* sp. (southeastern Tasmania). H. *Leucothea* sp. (Moreton Bay). Both G and H are orientated with oral end toward the left. Photographs A, E, and G by Karen Gowlett-Holmes; used with permission. Photographs C, D by Ross Easton (UnderWater World, Sunshine Coast, Australia); used with permission. Photograph H by Puk Petersen (UnderWater World, Sunshine Coast, Australia); used with permission.

Australian waters has a fine but conspicuous bright magenta colouration to the canals. Attempts to preserve this third form ended in the animals writhing to the point of exploding and disintegrating. Experiments to relax the specimens prior to fixation included magnesium chloride, menthol, extremely dilute formalin, dilute ethanol, cooling, freezing, warming, tea tree oil, eucalyptus oil, oxygen deprivation, and seawater diluted 50% with tap water. All relaxing efforts proved unsuccessful; however, the dilute ethanol and the tap water dilution both produced a temporary specimen. Specimens killed in dilute ethanol lasted a few days but exploded with further preservation attempts; specimens killed with tap water dilution died quickly in a good form, but disintegrated quickly if left untreated, and also exploded in response to other treatments.

Another unidentified form was found once in abundance off Palm Cove, Cairns, Queensland, in about 1–2 m water. It had peculiar double round marks midway inside the body. It was found along with *Pukia falcata* sp. nov. (this paper), during a time of low medusa diversity.

The *Bolinopsis* species found in the gulfs of South Australia warrants further study. It appears that it may pose a nuisance in the semi-enclosed waters of Spencer Gulf where blooms in plague proportions have been observed (unpublished data, and correspondence with fishermen and researchers). While the trophic dynamics of *Bolinopsis* in Spencer Gulf are unknown, the predatory impact of this species is of concern, and should receive priority in sustainability studies of commercially important species that depend on the Spencer Gulf, and Gulf St. Vincent, as a nursery or feeding ground.

Coelenterates, and ctenophores in particular, are very successful competitors, preying on eggs and larvae of other animals, and also competing with them for food resources (Purcell 1990; Purcell 1991; Purcell & Arai 2001). A well documented example is *Mnemiopsis*, which was accidentally introduced into the Black Sea in 1982, and by about 1990, was estimated to have a biomassover of a billion tons, and had led to the collapse of fisheries industries in the region (Shiganova 1998; Kideys 2002).

Bolinopsis and *Mnemiopsis*, although separated based on the length of the lobes relative to the body, have a similar functional biology and predation potential (Main 1928; Nagabhushanam 1959; Reeve *et al.* 1978; Kremer 1979; Schulze-Röbbecke 1984; Kasuya *et al.* 1994; Costello & Coverdale 1998). For example, *Bolinopsis vitrea* (Agassiz, 1860), which is similar to the Spencer Gulf *Bolinopsis* morphologically, was demonstrated by Kremer *et al.* (1986) to be a more efficient predator than *Mnemiopsis*. Similarly, according to Mills (2001: 65), 'Uye & Kasuya (1999) suggest that numbers of indigenous ctenophores, especially *Bolinopsis mikado* (Moser, 1907), may be rising in some Japanese coastal waters; this situation bears following in coming years.' We assert, therefore, that *Bolinopsis* in Spencer Gulf could pose a similar ecological threat to that of *Mnemiopsis* in the Black Sea.

Bolinopsis ashleyi sp. nov.
(Fig. 3C–D)

Material examined. HOLOTYPE: SAM-XH450, approx. 10 cm total live length, 1 km off Mooloolaba, Qld, coll. P. Petersen, M. Callaghan, and M. Rego, October, 1999. Preserved in 100% ethanol.

Non-type material. Video and photographs of several additional specimens (kept in the South Australian and Queensland Museums).

Diagnosis. *Bolinopsis* with large, hemispherical lobes; brilliant red pigmentation along most of the length of the ctene rows.

Description. Total length of specimens known to approximately 12 cm, slightly compressed in the tentacular plane. Aboral end of the body bluntly rounded, with mesogleal extensions slightly protruding past the aboral cleft. Lobes very broadly rounded, spanning approx. 4–5 times the body width in the sagittal plane.

Auricles narrow, ribbon-like, tapered distally, approximately 1/2 body length, reaching well beyond the mouth.

Ctene rows 8, wide, all with densely-packed comb plates. The four subtentacular comb rows, with about 60 comb plates, extend the entire distance from the apical pole to immediately short of the auricles; the four subsagittal rows, with well over 100 comb plates, almost touch where they begin slightly inward of the apical pole, and extend nearly to edges of the lobes, flaring a short distance along the path of the meridional canals before termination.

At approximately 4/5 of the distance to the outer edge of the lobe, the meridional canal continues from the distal end of each subsagittal ctene row, departs laterally, makes a broad wavy crescent following the contour of the lobe toward the central axis of the animal, then very near to the base of the lobe the canal loops back upon itself to the inside, once again following the contour of the lobe in a smaller, somewhat wavy crescent, back to the axis of the ctene row, then dips inward toward the mouth, then abruptly changes direction to unite with its mirror image in a finger-like, distal-pointing projection at the midline between the two ctene rows. The circumferential canal is not wavy, and closely mirrors the contour of the outer edge of the lobe along nearly its entire distance.

Statocyst situated within deep aboral cleft.

Stomodaeum reverse hourglass-shaped, widest immediately oral to the midpoint, tapered both aborally and orally, though wider in the oral half than the aboral half.

Body colourless and transparent, except for a brilliant red band of pigment beneath the distal 2/3 of the 4 subsagittal comb rows and out along most of the outer crescent of the lobe canals. This same colour-pattern and vibrancy has been observed in approximately 40 specimens of all sizes from 3 to 12 cm.

Type locality. About 1 km offshore, Mooloolaba, Sunshine Coast, Queensland.

Etymology. Named in honour of Ashley Scivyer, formerly of Underwater World on the Sunshine Coast. Ashley and his wife, Puk Petersen, have been extremely dedicated in discovering the medusa and ctenophore biodiversity of Queensland and other tropical regions of the world.

Distribution. Presently known from Mooloolaba, south to Moreton Bay. The material mentioned was all caught within 2 m of the surface, between October 1999 and about March 2000.

Bioluminescence. Could not be elicited with tapping on the tank, but direct stimulation was not attempted.

Ecological notes. Not observed during times of heavy salp blooms. Several specimens were captured with small (1–1.5 cm long) fish in the gut. In captivity they were fed a maintenance diet of small fish, adult and newly hatched *Artemia*, and unidentified mysid shrimp. They were also offered dead fish, but did not take them. They survived approximately three months in captivity. Puk Petersen observed, 'We saw a definite reaction to light; as soon as we took the covers off for feeding they would locomote towards the surface. When feeding, the flaps would open wide like a feeding whale shark, we would gently touch them on the inside of the oral lobe with the fish and they would instantly close and grab it, the fish was immobilised very quickly. At 18° it took a 10 cm animal about 2 hours to digest a 1 cm fish (approximately) .... I don't think they intently hunted for a particular item of food as much as hunting in general with the oral lobes wider open than when they weren't feeding.'

Field identification. Like other *Bolinopsis* (see earlier), but with massive lobes, and red pigmentation along the ctene rows.

Remarks. Although we have designated a holotype, as mandated by Article 72.3 of the I.C.Z.N. (1999), we must acknowledge that this specimen will of limited use for morphologically discriminating this new species. Unfortunately it is impossible to adequately preserve many types of ctenophore, including *Bolinopsis ashleyi*. Others have also attempted to deal with this problem including: Harbison & Miller (1986), who deposited specimens of which only gonads and comb row fragments remained; Robillard & Dayton (1972), who embedded their specimens in wax; and Matsumoto & Robison (1992), who preserved their specimens in 4% buffered gluteraldehyde. However, scattered ctenes and wax-embedded specimens are unsuitable for study, and gluteraldehyde is problematical and only a temporary solution; ultimately, these species are based on photographic evidence. While no method has so far been found to preserve these delicate taxa, in fact, Matsumoto & Robison (1992: 20), have stated that morphological information obtained from *in situ* observations, photographs and video, 'Often ... is far superior to that which can be inferred from preserved material.'

The necessity of having a deposited holotype specimen for a new species has also been recently questioned by Donegan (2008); and

Table 5. Comparison of diagnostic characters of species in the genus *Bolinopsis*. Data derived from original descriptions plus Bigelow (1912), Mayer (1912) and Wrobel & Mills (1998).

	Lobe size	Body size	Comb rows	Sense organ	Colour	Other chars	Locality
B. alata (L. Agassiz, 1850)	Large, round	Not stated	SV about twice as long as ST; SV to level of the mouth (i.e., barely extending onto lobes)	Moderately sunken	Colourless	Complex lobe canals; ctenes heavy	New England
B. chuni (von Lendenfeld, 1885a)	Very large, nearly circular	11cm	Ctene rows extending halfway onto lobes; comb plates numerous	Embedded 1 cm	Transparent with violet lobe vessels	Lobe vessels simple; stomach broad	Sydney, NSW
B. elegans (Mertens, 1833)	Huge	Not described	SS nearly to apex of canal on lobes	Shallow	Body uniformly rose-coloured	Body covered with tubercles	South Sea
B. hydatina (Chun, 1880)	Large, round	2.5–4 cm long	Barely extending onto lobes, to level of mouth	Deeply sunken	Not described	Lobe vessels not complex	Naples, Italy
B. indosinensis Dawydoff, 1946	Small, short, about 1/3 body length	15–22 mm	SS only to base of lobes; 16-18 plates on ST, 20-22 plates on SS	Moderately embedded	Colourless and transparent	Large, broad auricles	Indochina
B. infundibulum (O.F. Müller, 1776)	Medium sized	15 cm	Comb rows extending less than halfway onto lobes	Very deeply sunken	Row of dark spots on lobes	Short, flat auricles	Greenland
B. littoralis (McCrady, 1859b)	Small, not expanded	Up to 50 mm	Not described	Not described	Not described	Not described	Charleston, South Carolina
B. microptera (A. Agassiz, 1865)	Short	50 mm length	Not described or figured	Not described	Transparent and colourless	Complicated windings of canals	Eastern coast of North America
B. mikado (Moser, 1907)	Medium size	Not described	Subventral very long, nearly to margin of lobes	Deeply sunken (1/5 as deep as the whole body)	Body transparent; canals rosy in life	Commonest ctenophore in the region	Japan
B. norvegica (Sars, 1835)	Huge, round	–	Subventral not extending onto lobes	Very deeply sunken	–	–	Norway
B. ovalis (Bigelow, 1904)	Small	50 mm length; half as wide	Sparsely arranged comb plates (15–18 on short rows; 30–35 on long rows)	In deep cleft; with radiating muscle fibers	Colourless	Auricles similar in shape to *B. vitrea*; canals not complicated	Maldives

Table 5 (continued) ...

	Lobe size	Body size	Comb rows	Sense organ	Colour	Other chars	Locality
B. paragaster Ralph & Kaberry, 1950	Large (3/5 total length)	Up to 50 mm	Subventral slightly longer than subtentacular; subventral do not extend beyond mouth	Moderately sunken	Canals red; deep red-brown pigmented stomach	Branched paragastric canals join meridional canals; double tentacle bases	New Zealand
B. rubripuncta ta Tokioka, 1964	Moderate	50 mm	50–60 on short rows; 120 on long rows	In deep cleft	4–6 reddish-orange spots along periphery of each lobe; canals reddish	Auricles wide	Seto, Japan
B. septentrionalis (Mertens, 1833)	Very short	Not described	Ctene rows not extending onto lobes; comb plates distantly spaced	Shallow	Light blue-coloured	Lobe vessels straight	Bering Strait
B. vitrea (L. Agassiz, 1860)	Small, short	Narrow; length not stated	Subventral about 2x as long as subtentacular; more than halfway onto lobes	Deeply sunken	Remarkable in its transparency	Combs very small and fine, barely visible	Key West, Florida
B. ashleyi sp. nov.	Huge, round, about as broad as body is long	To 120 mm	Subventral extending nearly to edge of lobes, c. 2x subtentacular	Very deeply sunken	Crimson pigment marking the main canals	Thick comb rows	Southern Qld
B. sp. 1	Width equal to half body length or slightly less	To 70 mm	Subventral extending nearly to edge of lobes, c. 1.5x as long as subtentacular	Deeply sunken	Magenta canals	Elongate egg-shaped, extremely common	Southern Australia
B. sp. 2	Width narrow, but more than half total body length	To 70 mm	Subventral extending nearly to edge of lobes, c. 2x subtentacular	Deeply sunken	Completely colourless	Nearly perfectly egg-shaped; extremely common	Tropical Qld
B. sp. 3	Lacking	To 20 mm	(not noted)	Deeply sunken	Transparent and colourless body with two granular red dots along each side of body	Uncommon; generally found with dense gelatinous zooplankton bloom	Cairns region

while his argument against this process was primarily based on ethical and conservation issues, he also emphasised that superior information to assist identification can frequently be secured from non-corpse material. Our description of *Bolinopsis ashleyi* sp. nov. is thus primarily based on the excellent photographs that clearly illustrate the morphology of this species. If a suitable method of preservation is developed, designation of a neotype of *B. ashleyi* (as well as its congeners!) would probably be desirable.

The most striking feature of *Bolinopsis ashleyi* is its brilliant colouration. While colour is often regarded as of little taxonomic value because it cannot be studied in preserved specimens, many previous ctenophore workers have also used colouration (Mayer 1912; Bigelow 1912; Tokioka 1964; Harbison & Miller 1986; Mills 1987; Matsumoto 1988; Matsumoto & Gowlett-Holmes 1996; Matsumoto 1999). In the case of ctenophores, which often cannot be preserved at all, colour remains an invaluable tool to be used in combination with other characters.

Bolinopsis ashleyi differs from its congeners by the following (see also Table 5). Its broad, nearly hemispherical lobes, separate it from the narrow lobed species: *Bolinopsis microptera* (Agassiz, 1865), is more elongated, has very short lateral lobes, has complexly winding canals, and is transparent and colourless; *Bolinopsis indosinensis* Dawydoff, 1946, has small, short lobes and large, broad auricles; and *Bolinopsis ovalis* (Bigelow, 1904), has sparsely-arranged comb plates and is colourless.

Of the species with large lobes, *Bolinopsis ashleyi* can be distinguished by the following. *Bolinopsis rubripunctata* Tokioka, 1964, is about half the size, and has numerous conspicuous reddish orange spots along the periphery of the lobes. *Bolinopsis infundibulum* (Müller, 1776), has much shorter subsagittal comb rows, and rows of dark spots on the lobes, but lacks any trace of the brilliant red colouration of *B. ashleyi*. *Bolinopsis chuni* (von Lendenfeld, 1885a), has much shorter and less-dense subsagittal comb rows that are violet in the adult. *Bolinopsis elegans* (Mertens, 1833), is covered with tubercles. *Bolinopsis paragaster* Ralph & Kaberry, 1950, has bifurcated paragastric canals and double tentacle bases. Finally, *Bolinopsis alata* (Agassiz, 1850), has short comb rows that barely extend onto the lobes, and also a more complex form of lobe canals (see Agassiz, 1860: figs 88, 89).

Several other species are said to contain red pigment. First, Mayer (1912) stated that *Bolinopsis vitrea* sometimes displays intense pink colour in the peripheral parts of the chymiferous tubes, probably due to products of digestion or excretion. This is unlike *B. ashleyi*, in which the pigment granules are epithelial, not digestive. Second, like *B. ashleyi*, *B. paragaster* has red canals, but it also has a deep red-brown pigmented stomach, bifurcated paragastric canals, and double tentacle bases. Third, *B. mikado* (Moser, 1907) is said to be 'transparent and almost colourless; only the canals are rosy when living' (Komai, 1918: 455); however, there is another form of *Bolinopsis* in southern Australian waters which has rosy canals, but would not be easily mistaken for *B. ashleyi*, in which the red pigment might be more accurately likened to 'racing stripes'.

Family Leucotheidae Krumbach, 1925

Leucothea Mertens, 1833

Leucothea filmersankeyi sp. nov.

(Fig. 4A–D)

Leucothea sp. — Gershwin & Zeidler, 2003: 238 (Tas, SA).

Material examined. HOLOTYPE: QVM-20:4196, Stanley Jetty, Stanley, Tasmania [40 46'02.4"S, 145 18'19.1"E], 8.03.2009, at surface in 1 m of water, observed for 3 days in captivity then preserved in EtOH; 10 cm TL live. PARATYPE: QVM-20:4197, same coll. data as holotype; 13 cm TL live.

Non-type material. TAS: Same coll. data as holotype; 2 specs, 8–10 cm TL, observed in captivity for 2 days before spontaneous disintegration occurred. Same coll. data as holotype; 7 specs, 7–10 cm TL, observed in the field and released. Stanley Jetty, 3.09.2002 (GZ0210); one spec. torn beyond specific recognition, appeared to be approximately 15 cm TL; some tissue retained in 100% ethanol [SAM-XH445], some in liquid nitrogen [SAM-ABTC101331]. **SA (probably identical):** North Point, St Francis I. [32°29'33.9"S, 133°16'59.6"E], S. Murray-Jones, 23.02.2002 (GZ0549); fragmentary specimen in alcohol [SAM-XH449] and liquid nitrogen. Fenelon I., Nuyts Archipelago [32 34.474'S, 133 17.550'E], L. Gershwin, 25.02.2002 (GZ0559); 1 spec., about 15 cm TL, examined in the laboratory until disintegration. Several specs were observed at Masillon I. [32°33.581'S, 133°17.041'E], L. Gershwin, 25.02.2002.

Diagnosis. *Leucothea* with body to about 15 cm in length; with long, narrow, blind tentacular pits; with long, slender papillae; with ctene rows about 3/4 length of lobes, broad; with bimorphic diverticula beneath ctene rows; with pale orange tint to core of body, lacking other colouration.

Description from living specimens. Body highly compressed in the tentacular plane, flat along both broad sides; approximately 5 times as wide in the stomodael plane. Aboral end of body deeply cavernous, with statocyst further deeply embedded (Fig. 4A). Mouth small, inconspicuous, midway along narrow blade-like oral edge of body, concealed by lobes. Oral tentacles not observed. Tentacles 2, each located midway across each broad side, near mouth on oral edge of body, emitting from tentacular canals. Tentacular canals very long and narrow, about 1.5 mm wide, about 24 mm long, aboral-pointing portion about 3 times as long as oral-pointing portion, blind-ending in both directions; oral canal portion contains a linear internal structure of unknown function.

Lobes 2, relatively small compared to other species, comprising about half the total length (TL) of the ctenophore (Fig. 4A), attached to body such that approximately 1/2 of body and 3/4 of lobes overlap; with a broad figure-8 outline in normal posture, i.e., when lobes are curled in. When extended for feeding, lobes are broadly rounded in outline, about half as broad as the body is long, with a deeply incised midline notch along distal edge, appearing heart-shaped (Fig. 4B).

Auricles 4, attached to body somewhat oral to point of lobe attachment; long, slender, cylindrical, gradually tapered; held tightly coiled in a helical fashion most of the time (Fig. 4A), or, when relaxed and extended, movement by the animal causes ends of auricles to wave constantly, as if acting as lures.

Ctene rows 8, broad, arranged as follows: 4 substomodaeal ctene rows (SSCR) emanate from aboral end of body, extending to about 3/4 length of lobes, at point of divergence of meridional canals toward lobe margin; 4 subtentacular ctene rows (STCR) emanate from indented aboral end of body, extending somewhat beyond origin of auricles.

Tubercles prominent, numerous; most densely arranged and longest on aboral end and along long body corners, sparsely arranged and shorter on outer surfaces of lobes; slender, cylindrical, tapered, many reaching nearly 1 cm in length, about 1 mm diameter.

Canals: Infundibular canal short, elongated hourglass-shaped (Fig. 4D). Meridional canals straight, heavily diverticulated under comb rows, ovaries on opposite sides of adjacent canals. Diverticula bimorphic: those underlying subtentacular comb rows often alternate wide and narrow; those underlying substomodeal rows typically of equally broad width. Beyond oral termination of substomodael comb rows, canals diverge at approximately 45° angles, extending in straight line nearly to distal edge of lobes (Fig. 4B). Lobe canals winding circuitously, forming large loops and smaller complex patterns (Fig. 4C), with left and right not necessarily in mirror image.

Colouration: pale orange in long spindle-shaped region of body core; lobes and auricles transparent ghostly whitish; tubercles mostly transparent and colourless.

Etymology. Named to honour Mr Patrick Filmer-Sankey, then Director of the Queen Victoria Museum and Art Gallery in Launceston, Tasmania, where the types are lodged. Patrick's enthusiastic approach to science and gentlemanly approach to life have been of great inspiration to the senior author.

Field identification. Body covered in narrow, gelatinous, retractable, flexible tubercles. Body shape very compressed in the tentacular plane, considerably longer than wide, with small lobes always held curled; forward margin of lobes with deep indentation. Colouration: pale orange body core, with transparent and colourless tubercles; auricles and lobes whitish. Size range: 6–15 cm long, with most specimens observed about 8–9 cm long.

Distribution. *Leucothea filmersankeyi* has only been confirmed hitherto from Stanley, in the far north-west of Tasmania, along Bass Strait. Samples from Nuyts Archipelago, SA, are also probably of this species, but more material is needed for positive identification.

Behaviour. Very active in captivity, spending most of its time just under the surface of the water, hanging in a lobes-up orientation, frequently sinking to the bottom of the tank then bouncing back to the surface. On contact with the air-water interface, the lobes spread out somewhat, with no ripple whatsoever on the surface tension. Sometimes the animal begins to spin on its axis, which it may persist in doing for several minutes without ascending or descending from its position.

The animal is very responsive to mechanical stimulation. When touched gently on any side, it will recoil and immediately move away from the direction of stimulation. When a single tubercle is touched with a plastic probe, all neighbouring tubercles within about a 1.5 cm radius shoot out immediately in the direction of the probe, and stay extended for several seconds. The tubercles in a given area do not respond to continued stimulation, but will respond again if stimulated after another region.

Although no light-sensory apparatus was detected, it does respond to sudden illumination by immediately recoiling the body.

Bioluminescence was tested at night with a simple probe. Small flashes of blue light were emitted when stimulated along the canals; when stimulated near the base, all canals flashed simultaneously.

Remarks. *Leucothea filmersankeyi* differs from its congeners as summarised in Table 6. Structurally, *L. filmersankeyi* appears to be unique in having narrow, blind tentacular pits; the only other species for which the tentacular pits are well characterised is *L. pulchra*, in which they are broad. The gonadal regions of the meridional canals are bimorphic in *L. filmersankeyi*, whereas this pattern is undescribed for other species. Furthermore, the papillae are relatively narrower and longer than those figured for other species. For most species, the comb rows are described either as extending only halfway onto the lobes, or as 'very long'; in this respect, *L. filmersankeyi* seems most similar to *L. japonica*, in that the comb rows extend about 3/4 the distance toward the margin of the lobes. However, *L. filmersaukey* has no trace of red colouration, and does not squirt ink when poked, so it would be unlikely to be confused for *L. japonica*, which does.

In colouration, *L. filmersankeyi* is quite readily separated from all others, and its size separates it from many. Unfortunately, most structural features are not well described for the existing species of *Leucothea*, such that it is very difficult to compare across a range of features. However, logically, conspicuous differences in colouration may be indicative of other differences, which simply cannot be assessed at this time. For example, the striking colour pattern of *L. pulchra* has no counterpart in any other species; the spotted markings in *L. ochracea* and *L. tiedemanni*, while different from each other, are nonetheless not echoed in others; and finally, while most *Leucothea* species are yellowish, the presence of red pigment in *L. japonica* may be interpreted as a key difference.

We wonder about the relationship between *L. filmersankeyi* and a curious form from Little Waterfall Bay in southeastern Tasmania, further discussed in the next section. Both share the interesting characters of an elongate, narrow and largely colourless body, and tightly-held lobes. However, upon closer examination, the two have many differences. For example, the lobes of *L. filmersankeyi* comprise about half the total length of the ctenophore, whereas those of the southern form are nearly 2/3 the total length (compare this with the lobate family Bolinopsidae, in which a similar difference is used to separate the genera *Bolinopsis* and *Mnemiopsis*). In addition, the two Tasmanian forms of *Leucothea* have about the same density of tubercles, and they are quite slender in both forms, but the tubercles are

FIG. 4. **A–D**, *Leucothea filmersankeyi* sp. nov., holotype. A. Habitus, tentacular view. B. Stomodeal view; note broad heart-shape lobes. C. Detail of lobe canal pattern. D. Detail of sense organ and infundibular canal. **E**, *Velamen* sp. (Tasmania), in life. Oral end orientated toward right. F–H, Beroida, all specimens orientated with oral end 'up'. **F**, *Beroe* sp. A (North Queensland); completely transparent and colourless, in life. **G**, *Beroe* sp. B (North Queensland), with broad ctene rows and red pigmentation, in life. **H**, *Beroe* sp. C (Tasmania), with a pronounced neck lacking ctene rows, preserved. **I**, *Neis cordigera* (South Australia), in life. Photograph A by Karen Gowlett-Holmes; used with permission. Photograph E by Thierry Laperousaz (South Australian Museum); used with permission.


A
B
D
C
F
E
G
H
I

Table 6. Comparison of diagnostic characters of the species of *Leucothea*. Data derived from original descriptions, plus Chun (1880). Abbreviations: Substomodeal (SS), Subtentacular (ST), Comb row (CR).

	Body size	Comb rows	Body colour	Other colour	Other notes	Locality
L. multicornis (Quoy & Gaimard, 1824) (largely based on Chun 1880)	20 cm	Long	Dull brownish, with brown tint on the lobe edges	N/A	N/A	Mediterranean
L. grandiformis Agassiz & Mayer, 1899	13.5 cm length	Very long, SSCR's nearly to the edge of lobes. No described or illustrated diverticula	Hyaline	Comb plates, stomach, and canals are cinnamon- yellow	Canals far less complex than *L. multicornis*	Suva Harbour, Fiji
L. japonica Komai, 1918	To 12 cm body length	Said to be short. SSCR's to about 2/3 distance on lobes. In 80 mm spec, 75 SS combs, and 110 ST combs	Faintly brick red	Canals deeper red; lappets amber-yellow	Squirts ink when poked!	Misaki, Japan
L. ochracea Mayer, 1912	9.6 cm	SSCR's to about 1/2 distance on lobes	Transparent with 4 opaque yellow spots on edges of lobes	Not described	Lateral filaments on principal tentacles	Tortugas, Florida, USA
L. pulchra Matsumoto, 1988	To 26 cm	Said to be long; SSCR's end about 1/2 way out onto the lobes	Translucent white; distinctive orange papillae	Lacking gut colouration	Broad pits	California, USA
L. tiedemanni Eschscholtz, 1829	18 cm	Very densely packed; rows very long	Surface sallow, brown	A dark point at each ctene	N/A	Sea east of Japan
L. filmersankeyi sp. nov.	15 cm	Ctene rows 3/4 length of lobes; broad; diverticula bimorphic	Pale orange tinted	None	Narrow blind pits; long, slender papillae	NW Tas, SA
L. sp. 1	9 cm	Ctene rows wide, long	Transparent yellowish	Pale orange gut	Large papillae	SE Qld
L. sp. 2	30–45 cm	Prominent diverticula	Transparent, colourless	Yellow-green gut	Large papillae	SE Tas
L. sp. 3	12 cm	Ctene rows narrow, long	Transparent, colourless	None	Short, slender papillae; long lobes	SE Tas

quite short in the southern form, and much longer in the northern *L. filmersankeyi*. The exact relationship between the two forms remains unclear at this point, but it seems plausible that they represent different species. It also highlights the need for existing species to be re-examined across a range of structural characters, so that they can be properly compared.

Leucothea species
(Fig. 3G–H)

Other species of *Leucothea* that have been previously reported from Australia:

Leucothea spp. — Harbison & Miller, 1986: fig. 4 (Coral Sea); Edgar, 1997: 149 (Vic, NSW, Tas.); Edgar, 2000: 149 (Vic, NSW, Tas.).

Material examined [from photographs]. **Qld:** SAM-XH444, Pumicestone Passage, Moreton Bay, ethanol-preserved tissues from specimen in Fig. 3H, P. Petersen, Sept. 2000; about 9 cm TL. **TAS:** Little Waterfall Bay, Tasman Peninsula, K. Gowlett-Holmes, 2.03.1998; about 12 cm TL. Dog Leg Cave, Waterfall Bay, M. Baron, 18.11.1998; 30–45 cm TL.

Field identification. Body covered in gelatinous, retractable, movable tubercles; body usually longer than wide, with large or small lobes. Colourless and transparent, or yellowy, orangy, or greenish; medium-sized or massive.

Distribution. *Leucothea* was reported from Victoria to New South Wales, including Tasmania by Edgar (1997, 2000). We have also found *Leucothea* species of uncertain identity in South Australia (Gershwin & Zeidler 2003) and Queensland (unpublished data).

Remarks. *Leucothea* urgently needs revision. A good (though brief) summary of species was given by Matsumoto (1988), who recognised six species (Table 6). In Australian waters, it seems that several additional species may be present, based on our limited observations of specimens collected or photographed. However, any formal descriptions beyond those herein will require additional specimens with better photographs and/or preservation techniques.

Notes on the Australian forms are as follows. A specimen photographed by Karen Gowlett-Holmes on 2.03.1998 at Little Waterfall Bay on the Tasman Peninsula is about 12 cm long, and is characterised by having a very elongate, totally transparent and colourless body, with short, slender papillae; the lobes comprise much more that half the total length (Fig. 3G). No specimens were captured.

A second form, comparable to *L. multicornis* (Quoy & Gaimard, 1824), was caught by Puk Petersen in Moreton Bay in September 2000 (Fig. 3H). Unfortunately, specimens could not be preserved intact. From the photographs, and from first-hand accounts, it can be described as: body length c. 9 cm, with prominent gelatinous extensions at the aboral corners; extensively covered by large papillae (c. 5 mm tall); ctene rows wide, running the entire length of the animal; colouration transparent yellowish with pale orange gut. The auricles were thick, cylindrical, tapered and long, most often held coiled in a conical form, but occasionally unreeling into long, writhing, tentacle-like appendages. These characters are similar to *L. multicornis*, described from the Mediterranean by Quoy & Gaimard (1824) and Chun (1880). However, given the different biogeographic provinces it is unlikely that these two populations will be conspecific. In colouration, the Moreton Bay form is different from *L. grandiformis* (Agassiz & Mayer, 1899), which is cinnamon-yellow on the ctene rows, canals, and gastric cavity; from *L. ochracea* Mayer (1912), which has lateral filaments on the tentacles in the adult stage, and also has conspicuous opaque yellow areas on the sides of the oral lobes; from *L. japonica* Komai (1918), which has a faintly brick-red body, deeper red canals, and yellow-edged lobes; and from *L. pulchra* Matsumoto (1988), which has a very large body with large lobes, and the body is opaque whitish with prominent orange papillae.

A third large Australian form was videod by Mick Baron at Dog Leg Cave, Waterfall Bay, Tasmania on 18.11.1998. While no specimens were retained, they were 30–45 cm long, with large papillae, a yellow-green gut, and prominent diverticula beneath the ctene rows.

Family Ocyropsidae Harbison & Miller, 1986

Ocyropsis Mayer, 1912

Ocyropsis species
(Fig. 3E–F)

The following *Ocyropsis* species have been previously reported from Australia:

Ocyropsis maculata immaculata Harbison & Miller, 1986: 413–424 (Heron I., Qld).

Ocyropsis maculata maculata Harbison & Miller, 1986: 413–424 (Heron I., Qld).

Ocyropsis crystallina crystallina Harbison & Miller, 1986: 413–424 (Heron I., Qld).

Material examined (mostly unpreservable). Qld: Palm Cove, 29.12.1999, during rich bloom of gelatinous zooplankton; many specs, c. 5 mm across, lacking spots, with shallowly indented stomach, with ctene rows starting beyond polar plates. Palm Cove, 24.01.2000; 2 cm across. Palm Cove, 19.02.2000; in thick jelly bloom. Palm Cove, 22.02.2000; 3 small specs in rich zooplankton bloom. Cairns Harbour, 25.12.2005, during rich jelly bloom (Fig. 3F). **NT:** Stokes Hill Wharf, Darwin Harbour, 6.08.1998; 1 stout spec. 19°13.021S, 121°15.399E, off Eighty Mile Beach, 16.04.2004; numerous c. 1 cm, some with spots, some without. **WA:** SAM-XH428 (= GZ0055), Port of Dampier, NW side of King Bay, 30.11.2000; 2 specs with 2 black spots on top end of each lobe above gonad; 1 in EtOH, 1 in liquid nitrogen.

Field identification. Body resembling the general shape of two hands held together in prayer, i.e., two large lobes connected at the bottom. The lobes are massive, and used for clapping together for rapid escape. Generally transparent and colourless, may also have two large diffuse brown spots, or two small black spots on each lobe. Most specimens are small, but may reach up to about 8 cm across.

Distribution. In Australia, the species *O. maculata immaculata, O. maculata maculata*, and *O. crystallina crystallina* were reported at Heron I., Qld, by Harbison & Miller (1986).

Ocyropsis of uncertain affinity were also found at Palm Cove, Qld, in the summer of 1999–2000. Found in abundance, the largest specimen was never more than about 1 cm. They were active swimmers, and readily luminesced at night when gently stimulated. Despite great effort, specimens were impossible to preserve.

Remarks. Like most other ctenophores, *Ocyropsis* are difficult to preserve. The genus needs formal revision, but we tentatively recognise eight species (Table 7), including *O. vance* sp. nov.

In addition to the new species, there seems to be at least three other species/forms of *Ocyropsis* in Australian waters: 1) a small, transparent form with a shallowly indented stomach and no spots (? = *O. crystallina*; Fig. 3F); 2) *Ocyropsis maculata* with large diffuse brown spots and a deeply-indented stomach as reported by Harbison & Miller (1986) from Heron I., and 3) a small form from tropical North Queensland with a deeply-indented stomach and two small black spots near the margin of each lobe.

The last form is of interest, because it does not seem to match any known species. In colouration, it is most similar to *O. crystallina guttata*, described by Harbison & Miller (1986) with small brown to black spots closely associated with the substomodaeal meridional canals, located at the ends of the gonads where the substomodaeal meridional canals make a sharp bend to begin their windings on the oral lobes. However, in this last form, there are exactly two small black spots very near the margin. We have seen this form from time to time, but it is unpreservable and short-lived.

Ocyropsis vance sp. nov.
(Fig. 3E)

Material Examined. HOLOTYPE: SAM-H935 (PH0322), Waterfall Bay, Tasman Peninsula, Tasmania, drifting in 2–4 m, K.L. Gowlett-Holmes, 28.03.1999.

Diagnosis. Hermaphroditic *Ocyropsis* lacking tentacular bulbs or canals, pigment spots, and warts; with 26–27 ctenes per subtentacular row, 53–54 ctenes per substomodaeal row; with deeply indented hourglass-shaped stomodaeum; with long substomodaeal ctene rows, originating well before polar plates and extending to the level of the stomodael indentation; with gonads in diverticula on both sides of the meridional canals, ovaries facing one another, with testes projecting in opposite direction.

Description. Body 29.8 mm (aboral pole to mouth); 47.7 mm total length preserved (aboral pole to lobe tip), lacking warts or pigmentation. Tentacular canals and bulbs absent.

Lobes large, glove-like around mouth in preserved specimen; 41.3 mm long. Lobe musculature densely crowded, in distinct pattern of approx. every second longitudinal fibre heavier than those between; cross-fibres minute.

Auricles 15.0 mm long, nearly reaching level of mouth distally; long narrow triangles with straight edges.

Subtentacular ctene rows proximally joining at centerpoint of aboral 'edge' of body; distal terminus at level of lobe origination; with 26–27 ctenes, arched obliquely over raised row. Substomodaeal ctene rows parallel along aboral side; proximally well beyond polar plates but not adjoining; distal terminus approximately half again longer than subtentacular rows; with 53–54 ctenes, mostly perpendicular over raised rows.

Stomodaeum 26.3 mm long, deeply indented hourglass-shaped, 13.3 mm wide at mouth, 13.5 mm at widest part of base, 3.1 mm wide at constriction; mouth approx. 2/3 distance to tips of lobes.

Canals underlying ctene plates diverticulated, but appear to lack gonadal material. Lobe canals complexly looped. Paragastric canals fine, narrow, long.

Gonads in diverticula on both sides of the substomodaeal meridional canals, apparently confined to lobe regions distal to ctene terminus; diverticulations alternate and opposite, with ovaries in diverticula facing adjacent canals, testes facing away; pattern irregular, with those toward outer edge of lobe simple and short, approximately 1/3 to 1/2 as long as those toward center axis of lobe, which are somewhat branched.

Statocyst in shallow aboral cavity about half depth to level of subtentacular rows; polar plates each 9.6 mm long, very narrow.

Colour in life: transparent and colourless.

Etymology. The specific name '*vance*' is derived from a Category 5 cyclone that destroyed the town of Exmouth in Western Australia in the autumn of 1999 (while the senior author happened to be visiting). After wiping out Exmouth, the cyclone then went on to travel southward across Western Australia, emerging in the Southern Ocean, and never losing cyclone-rating the whole journey over nearly 1,000 km of land. Upon reaching the Southern Ocean, it regathered its strength and moved east towards South Australia and Victoria. Like Cyclone Vance, *Ocyropsis vance* seems nearly indestructible. Noun in apposition.

Remarks. *Ocyropsis vance* is most similar in overall appearance to *O. maculata immaculata* Harbison & Miller, 1986, in having a deeply indented, hourglass-shaped stomodaeum, gonads on both sides of the meridional canals and the comb rows originating well before the end of the polar plates, and in lacking spots; however, *O. vance* lacks tentacular canals and bulbs, as in *O. crystallina*. Primary characters of the species of *Ocyropsis* are summarised in Table 7.

Mayer (1900) described 'wart-like protuberances upon the surface of the ctenophore' for *O. crystallina* (legend, pl. 31), but in fig. 105 (pl. 31) these appear to be the internal gonads. Fewkes (1882) described *Ocyropsis* from the Tortugas two decades earlier, but did not note surface warts. Harbison & Miller (1986, fig. 1b, p. 415) also show what might be mistaken for protruding gonads in their *O. maculata immaculata*, but these appear to be encased within a nearly-invisible envelope. If Mayer's Tortugas form does indeed have surface warts, this would separate it readily from the Australian *O. vance*.

Despite *Ocyropsis* being notoriously difficult to preserve, the holotype is in excellent condition (preserved without special effort in 10% formalin/propylene glycol in seawater); whether there is any structural or physiological feature behind this should be investigated further. *Ocyropsis vance* is a cold-temperate species whereas all other ocyropsids inhabit warm, tropical waters.

ORDER CESTIDA Gegenbaur, 1856

Family Cestidae Gegenbaur, 1856

Velamen Krumbach, 1925

Velamen species
(Fig. 4E)

Only one *Velamen* species has been previously reported from Australia:

Velamen parallelum (Fol, 1869) — Gowlett-Holmes, 2008: 54 (Australia-wide).

Material examined. Qld: Palm Cove, Cairns District, L. Gershwin, summer of 1999–2000; several specs, c. 1 cm BL, caught during routine plankton tows, in cooler water believed to be of an oceanic current, with a rich diversity of other gelatinous zooplankton. **Tas:** SAM-XH448 (=GZ 0128), Bicheno [41 52'24.5"S, 148 18'39.2"E], W. Zeidler and L. Gershwin, 25.01.2002; 2 spec. approximately 3mm BL, tissues preserved in EtOH. Photograph K. Gowlett-Holmes, south of The Thumbs, Tasman Peninsula, 4.03.1998, c. 14 C; c. 9 cm, no spec. retained.

Table 7. Comparison of the characters of species of *Ocyropsis*. Information collated from original descriptions, newly collected material, and Rang (1828a, 1828b).

	Body size	Tentacle bulbs	Stomodaeum	Comb rows	Other characters	Locality
O. maculata maculata (Rang, 1828a)	70 mm stomodaeal axis length	Present	Deeply indented in hourglass shape	SS extend almost to statocyst; comb plates numerous	Large diffuse yellow brown to brownish black spots on inner surface of oral lobes	N Atlantic, Amazon, Heron I.
O. maculata immaculata Harbison & Miller, 1986	35 mm stomodaeal axis length	Present	Deeply indented in hourglass shape	SS extend almost to statocyst	Lacking spots	Southern Sargasso Sea, N Atlantic, Amazon, Heron I.
O. cristallina crystallina (Rang, 1828a)	75 mm length	Absent	Only slightly indented	SS only to ends of polar plates; comb plates sparse	Lacking spots	Equatorial; Southern Sargasso Sea, Heron I.
O. cristallina guttata Harbison & Miller, 1986	Not described	Absent	Only slightly indented	SS only to ends of polar plates	With small brown to black spots on oral lobes in association with meridional canals at oral ends of gonads	N Atlantic slope
O. pteroessa (Bigelow, 1904)	25 mm polar diameter	Not described	Large, variable in form; not normally lobed	Short, with only a few combs	Auricles short; spots absent; canals simpler than *O. crystallina*	Maldives
O. brune (Rang, 1828a)	150–200 mm length	Not described	Not described	SS to end of polar plates	Body uniformly brown in colour; lobes very big transversely but not thick	Cape Verde
O. tachee (Rang, 1828a)	250–350 mm length	Not described	Not described	SS to end of polar plates	Big, thick lobes with 2 big dark brown spots	Antilles
O. vance sp. nov.	30 mm stomodaeal axis length; ~50 mm total length	Absent	Deeply indented hourglass-shaped	SS twice as long as ST; nearly to statocyst	Transparent and colourless, lacking spots	Cold-temperate Tasmania

Diagnosis. Ribbon-like ctenophore, with the sides of the body drawn out to the extreme. In *Velamen*, the canals arise straight off the axial canal system toward the lobes, whereas in *Cestum*, the canals parallel the stomach for a short distance then curve sharply outward along the lobes.

Field identification. Body ribbon-like or belt-like, with the sides of the body drawn out to the extreme. In *Velamen*, the canals arise straight off the axial canal system toward the lobes, whereas in its close relative *Cestum*, which reaches about 1 m in length, the canals parallel the stomach for a short distance then curve sharply outward along the lobes.

Remarks. *Velamen parallelum* (Fol, 1869) was originally described from the Mediterranean and tropical Atlantic; it has subsequently been reported from the Indian Ocean (Harbison *et al.* 1978) and off California and the Sea of Cortez in the North Pacific (Stretch 1982). Ralph & Kaberry (1950) documented the closely related *Cestum* in cold New Zealand waters. It was recently reported in Australian waters for the first time by Gowlett-Holmes (2008).

The taxonomy of *Velamen* is in need of reassessment. Currently, most workers consider that there is only one species of *Velamen*, namely *V. parallelum*; the same has often been said for the closely related genus *Cestum*, although Harbison *et al.* (1978) thought differently. With the ctenophores of most of the world's regions poorly studied, not to mention the difficulty in their capture and preservation (Harbison *et al.* 1978), it is plausible that there may be additional species in either or both genera awaiting discovery. Specifically, we believe it is possible that there are species differences yet to be elucidated between our cold-water Tasmanian form and the warm-water Mediterranean *V. parallelum*; thus, we have not identified our form to species, in hope of stimulating further study. Thus, it seems unwise to assign these Australian forms to any particular species without closer examination and comparison with overseas material, especially since the Tasmanian specimen was much larger than those that we typically see in Australia, although still within the size-range reported for the species (see Harbison & Madin 1982).

CLASS NUDA Chun 1879

ORDER BEROIDA Eschscholtz, 1825

Family Beroidae Eschscholtz, 1825

Beroe Browne, 1756

Beroe species
(Fig. 4F–H)

The following *Beroe* species have been previously reported from Australia:

Beroe ovale Bosc, 1802 — Quoy & Gaimard, 1824: 575 (Sydney).

Beroe macrostomus Péron & Lesueur, 1808 — Lesson, 1829: 105–106 (south of New Guinea).

Beroe cucumis Fabricius, 1780 — Stiasny, 1931: 40 (Watson Bay, Port Jackson, NSW); Edgar, 1997: 150 (southern Australia WA to NSW, including Tas.); Edgar, 2000: 150 (southern Australia WA to NSW, including Tas.).

Beroe ovata Bruguière, 1789 — Greenwood, 1980: 93 (Moreton Bay); Goy, 1990: 110 (Shark Bay, WA); Steene, 1990: 86 (Lizard I., GBR).

Beroe spp. — Péron, 1807: 105; WA. - Dakin & Colefax, 1933: 198 (NSW); Dakin & Colefax, 1940: 211 (NSW); Hamond, 1971: 27 (Moreton Bay, Qld); Zeidler & Gowlett-Holmes, 1998: 117–118 (amphipod association in Port Phillip Bay, Vic.); Gowlett-Holmes, 2008: 53 (southern Australia).

Beroe "n. sp." — Dakin & Colefax, 1933: 198, pl. 7, fig. 1 (NSW).

Material examined. Qld: SAM-H1574, Palm Cove, L. Gershwin, 23.02.2000; 2 spec., 2–3 mm, with red dots on stomach and red lines. Gershwin coll., Palm Cove, L. Gershwin, 19.12.1999; 2 spec.: 6.88 mm BL with red granules under combs; 3.53 mm BL with yellowish comb rows. Gershwin coll., Palm Cove, L. Gershwin, 29.12.1999, during rich bloom of gelatinous zooplankton; several spec., incl. one pink c. 2 cm BL; not preserved. Gershwin coll., Palm Cove, L. Gershwin, 22.01.2000; 6 spec. in rich zooplankton bloom. Gershwin coll., Buchen's Cove, L. Gershwin, 10.02.2000; 3 spec. Gershwin coll., Palm Cove, L. Gershwin, 22.02.2000; 2 spec. c. 1 cm BL, plus several 2–3 mm juvs., in rich jelly bloom. **NT**: Cullen Bay Marina, Darwin Harbour, K. Gowlett-Holmes, 18.08.1998; 1 large purple spec., disintegrated prior to preservation. **SA**: SAM-GZ0537, Ceduna, W. Zeidler & L. Gershwin, 20.02.2002; 3 tiny spec. **WA**: SAM-H1284 (GZ0054), Port of Dampier, NW side of

King Bay, W. Zeidler & L. Gershwin, 30.11.2000; 1 spec. with wide flared mouth. **Tas:** TMAG K1726, Slopen main beach, Tasman Peninsula, L. Turner, May 1999, in very shallow water; 1 spec. TMAG K1727, same data as K1726; 6 spec. SAM-H1577, 'Sloping Main', Tasman Peninsula, J. Cossum, 29 Apr [no year stated]; 2 spec., 34.72 mm BL and 36.44 mm BL. TMAG 602/K32, Maria I. West. QVMAG, photograph by C. Reid, washed up on beach near Musselroe Bay, far NE, 8.05.2009; conspicuous red pigment under ctene rows, no specimen retained. **Vic:** SAM-PH0082, Portsea, Port Phillip Bay, 5.07.1993, with commensal amphipods.

Field identification. Body very soft and mucous, bag-like, typically flattened, with a very large open mouth at one end; usually colourless and transparent, but may be faintly coloured yellowish, purplish, or reddish, especially along the ctene rows. Body of some species may get quite large, but most specimens are about 1–6 cm long.

Remarks. *Beroe* is common in Australian waters. There are several easily distinguishable forms, although matching these up to existing species has proven difficult. One form from Darwin is large, about the size of a man's fist, faintly purple throughout with bright purple ctene rows, with comb rows almost to the mouth, with two oval rings of papillae near the apical organ; unfortunately, both specimens disintegrated prior to study. A second form, from tropical Queensland, always 1–2 cm or less in body length, is transparent throughout (Fig. 4F). A third, also from tropical Queensland, only about 2 cm long, has numerous bright red pigment granules around quite heavy comb rows and at the aboral end of the body, along with large, branched aboral papillae (Fig. 4G). A fourth, from Tasmania, has a long, narrow body with flared lips, and short, unbranched aboral papillae along both sides of a prominent conical cap over the statocyst (Fig. 4H). A fifth, also from Tasmania, has a fairly short, stout body, with conspicuous red pigment beneath the ctene rows. Two others have been identified as *B. cucumis* and *B. ovata* by Edgar (1997, 2000) and Steene (1990), respectively; the former has a more sloping aboral body contour, whereas this is more squared off in the latter. Without doubt, there are additional forms as well, yet to be elucidated, pending more field work and a formal review of the genus.

Neis Lesson, 1829

Neis cordigera Lesson, 1829
(Fig. 41)

Neis cordigera Lesson, 1829: 103-104, pl. 16, fig. 2 (Port Jackson); Lesson, 1843: 97-98 (summary); von Lendenfeld, 1885b: 968–976 (comprehensive redescription); von Lendenfeld, 1885c: 673–682, pl. 33 (detailed description); Whitelegge, 1889: 197 (Port Jackson); Stiasny, 1931: 40 (Gunnamatta Bay, Port Hacking, NSW; reg. no. AM-P12946).

Material examined. WA: WAM-Z4694, west side of groin, Cockburn Sound Power Boat Association Beach, Cockburn Sound, J. Fromont, 6.03.1999; 33.75 mm BL, 37.98 TL, mouth 25.4 mm wide. WAM-Z4695, South Mole, Fremantle, c. 1 m water depth, J. Fromont, 8.03.1999; 11 cm BL, 7 cm wide. Gershwin coll., 19°13.021S, 121°15.399E, off Eighty Mile Beach, WA, L. Gershwin, 16.04.2004; numerous at sunset only. **SA:** SAM-H1070, North Arm Marina, Commercial Fishing Harbour, Fisherman's Wharf, Port River, Adelaide, T. Laperousaz & K. Phillips, 24.05.2000; 6 spec.: 25.86 mm BL, 19.33 mm BW; 23.74 mm BL, 17.7 mm BW; 33.23 mm BL, 39.4 mm BW; 34.83 mm BL, 33.2 mm BW; 62 mm BL, 46.1 mm BW; 77.22 mm BL, 58.45 mm BW. SAM-XH233, same collection data as H1070; 3 spec.: 19.4 mm BL, 13.76 mm BW; 24.46 mm BL, 16.4 mm BW; 17.98 mm BL, 11.83 mm BW. SAM (GZ0523), Cowell, L. Gershwin & T. Laperousaz, 20.02.2002; 1 spec. **Qld:** Reefworld pontoon, Hardy Reef, Whitsundays, Great Barrier Reef Marine Park, 3.11.2008, photographs by Emily Smart / Fantasea Adventure Cruising; 1 specimen, 8 cm TL (note that this species is said to be sighted every year by Fantasea staff, and reaches up to 15 cm long).

Other material. SA: Streaky Bay, 5–7.03.08; approx. 30–40 individuals per 2 hours each day, varied from 10 cm to 20 cm; observed and videotaped by T. Laperousaz, SAM; no spec. retained.

Diagnosis. Beroida with pronounced aboral lobes; with canal network uninterrupted across the midline.

Redescription. Body dimensions of largest specimen (ex SAM-H1070): length along center axis 77.2 mm, total length including wings 96.5 mm; width between oral ridges 58.5, between mouth corners 52.0 mm; von Lendenfeld (1885b) reported specimens up to 250 mm, with general measurements being 2–2.5 times as long as broad, and 4–5 times as long as thick. The body is thickest in the centre region when viewed from the narrow sides. General shape square to slightly rectangular (excluding the wings), quite compressed, with distinct large, triangular aboral wings protruding to the posterior on either side of the statolith and center axis, edged by a prominent ridge, creating a hollowed-out appearance of the two narrow sides. Laterally, the oral edge flares into a ridge positioned along the midpoint of either narrow side, which ends about 2/3 back between the ridges of the wings.

Ctene rows along the entire length of the body; the four peripheral rows running from approx. 2 mm either side of the statocyst, along the aboral margin, around the edge of the wings, and up the side edge to the corner where the mouth opens. The four axial rows run from adjacent to the statocyst, flaring outward slightly, up toward the mouth, ending on the outer portion of the lip. Thus, the peripheral ctene rows are considerably longer than the axial ctene rows.

Mouth large, encompassing the entire leading edge of the animal, though not flared. Stomach vase shaped, largest at the oral end, spanning from corner to corner, tapering back to a point at statocyst; not extending into the aboral wings.

Gonads not observed.

Gastrovascular system forms a continuous network, i.e., it is not divided side to side. Canals of two types: some continuous between ctene rows, with anastomoses to adjacent canals, to the stomach, and possessing blind branches; others, singly or doubly between continuous canals, unbranched and ending blindly.

Aboral statocyst small, embedded shallowly in a cup-shaped pit in the 'saddle' between the two large aboral wings. Polar fields could not be found.

Aboral papillae of two types: lateral ones simple and short; axial ones biforked and approx. double the length of the lateral ones.

Colouration: The SA specimens were slightly cloudy with carmine red side edges (along nearly the entire length of the short sides). The bodies of the WA specimens were, in contrast, colourless with a slightly cloudy translucency, except for the ctene rows, under each of which runs a line of fine red points.

Bioluminescence. Bioluminescence was observed in the smaller of the two WA specimens. Several times throughout the first night following capture, tapping of the jar was found to produce a single response, approximately 1 x 1 mm. The exact point of light production could not be established prior to the death of the specimen.

Biology. At present, nothing is known about the reproductive or ecological biology of this species. In Western Australia, it was found at around midday, in about 0.5 m depth, where the water was about 3 m bottom-depth, over a sandy area beside a rocky groin, in windswept seas; in South Australia, large numbers were found in the harbour during the day; von Lendenfeld (1885b) repeatedly found single specimens accompanying swarms of *Bolinopsis* in Sydney Harbour. Its behaviour was not observed in situ in either case. In the laboratory, specimen number WAM-Z4694 vigorously avoided light, attempting to dive into the bottom of the observation dish and remaining curled until the water level was lowered. During observation, the aboral 1/3 of the sides of the stomach could be seen repeatedly undulating peristaltically within the body.

Distribution. Subsequent to Lesson's (1829) description from Port Jackson, *Neis* has been reported several times in the Sydney area: von Lendenfeld (1885b, 1885c) found it at Sydney Harbour, and Stiasny (1931) found it at Port Hacking. We here broaden the distribution to include Adelaide, the west coast of South Australia, Western Australia from the southern-most Indian Ocean sector to the tropics, and the Whitsunday region of the Great Barrier Reef. Because of its broad distribution as now known, it seems likely that *Neis* may be found in Northern Territory and Tasmanian waters. This is the first tropical report of *Neis*. It has not yet been found outside Australian waters.

Field identification. Body similar to *Beroe*, i.e., flattened, bag-like, with large mouth at one end, but with the aboral end extending past the statocyst on both sides into lobes. Characterised by brilliant red pigmentation, particularly along the two narrow sides.

Remarks. Although Lesson's (1829) description was relatively brief, the figure is a perfect rendition of the species, making it immediately recognisable. A good account of the morphology and behaviour of the species was given by von Lendenfeld (1885b). *Neis cordigera* remains today a relatively common ctenophore in temperate Australian waters, and may occasionally occur in large swarms.

There has been debate as to whether *Neis* is merely a *Beroe*. Chun (1880: 307) regarded *Neis* and *Beroe* to be identical. Von Lendenfeld (1885b) quite forcefully asserted that *Neis* is not identical with *Beroe*, and further remarked that *Neis* seems to represent a transition from *Beroe* to the Lobata. As elucidated by von Lendenfeld (p. 969), the vascular system of *Beroe* is divided in the two halves of the body, whereas no such separation is present in *Neis*.

KEY TO THE CTENOPHORES OF AUSTRALIA

1. Body globular or ribbon-like, gelatinous and planktonic. 2
— Body flatworm-like, creeping on algae, echinoderms, or other substrate. Benthic ctenophores. 18

2. Body more or less spherical or egg-shaped, with or without lobes. 3
— Body highly compressed, and sac-like or ribbon-like. 16

3. Body lacking conspicuous lobes; more or less spherical; with two conspicuous retractable tentacles issuing from cylindrical bulbs between stomach and body wall. 4
— Body with conspicuous lobes; more or less egg-shaped; lacking tentacles. 6

4. With two conspicuous tentacles issuing from crescentic-shaped bulbs. . . . . *Pukia falcata* gen. nov., sp. nov.
— With two conspicuous tentacles issuing from cylindrical-shaped bulbs. 5

5. Tentacles with distantly-spaced tentilla, usually held tightly coiled with a 'beehive' appearance, like droplets along the tentacle; mouth protruding. . . . . *Euplokamis evansae* sp. nov.
— Tentacles with closely-spaced tentilla, usually held relaxed out with a comb-like or feather-like appearance. . . . . *Pleurobrachia* species

6. Body surface smooth, lacking tubercles. 10
— Body covered in gelatinous tubercles. [*Leucothea* spp.] 7

7. Body (including lobes) to about 15cm in length, elongate. 8
— Body about 30-45cm long, with large papillae; gut yellow-green. . . . . *Leucothea* sp. A

8. Body overall yellowish, with large papillae (Qld). . . . . *Leucothea* sp. B
— Body overall transparent and colourless, with small papillae (Tas). 9

9. Body densely covered with long, slender tubercles; lobes 1/2 total length (north-western Tas, SA). . . . . *Leucothea filmersankeyi* sp. nov.
— Body sparsely covered with short, slender tubercles; lobes approximately 2/3 total length (south-eastern Tas). . . . . *Leucothea* sp. C

10. Lobes one-half total animal length or less. [*Bolinopsis* spp.] 11
— Lobes massively long, much greater than one half total animal length; animal moves with a hand-clapping motion when disturbed. [*Ocyropsis* spp.] 13

11. Lobes small, giving the whole animal a compact egg-shape appearance; pigment lacking or inconspicuous (e.g., fine canals coloured, but not body). 12
— Lobes broad and wing-like; with crimson pigment marking the ctene rows. . . . . *Bolinopsis ashleyi* sp. nov.

12. Body colourless; canals violet. . . . . *Bolinopsis chuni*
— Body colourless; canals finely magenta-coloured. . . . . *Bolinopsis* sp. A

13. Stomach deeply indented into a strongly pronounced hourglass shape; with or without spots. 14
— Stomach not deeply indented, more shallowly hourglass-shaped, lacking spots. . . . . *Ocyropsis crystallina*

14. Body small (c. 1 cm), found in the tropics. 15
— Body large (c. 5 cm long), transparent, lacking spots; found in temperate waters. . . . . *Ocyropsis vance* sp. nov.

15. Transparent, with large diffuse brownish or blackish spots on inner surfaces of lobes. . . . . *Ocyropsis maculata*
— Transparent, with two small black spots near edge of lobes. . . . . . . *Ocyropsis* sp.

16. Body compressed, sac-like, with large mouth at one end. 17

– Body highly compressed, ribbon-like or belt-like. . . . . *Velamen* sp.

17. Body with rounded lobe extensions on 'corners' of aboral end; oral end broad and square; conspicuous crimson pigment on lobes. . . . . *Neis cordigera*

– Body with smoothly rounded aboral end; oral end broad or pursed; colourless or sometimes purplish or pinkish. . *Beroe* spp.

18. Benthic ctenophores found on algal or seagrass host. 19

– Benthic ctenophores found on animal host or free-living in tropical waters. 22

19. Benthic ctenophores found on algal host in temperate waters. 20

– Benthic ctenophores found on algal or seagrass host in tropical waters; body transparent with numerous green specks, with branched papillae, about 20 mm long. . . . . *Coeloplana reichelti* sp. nov.

20. Body colour red, pink, or orange. 21

– Body colour green or white, found on *Jania* sp. (coralline alga) at Rottnest I.; about 10mm long. . . . . *Coeloplana thomsoni*

21. Found on *Scaberia agardhii* (brown alga) in South Australia; body bright red or orange, 25 mm long. . . . . . . *Coeloplana scaberiae*

– Found on red and green algal hosts in Port Philip Bay; body dark pink to orange-red with transparent or whitish areas, 10–50 mm long. . . . . *Coeloplana willeyi*

22. Found on animal host, e.g., starfish or soft coral. 23

– Free-living on muddy sand on the Great Barrier Reef; body with yellowish-white reticulate pattern and red pigment, about 36 mm long. . . . . *Coeloplana meteoris*

23. On *Sarcophyton* sp. (soft coral) on Great Barrier Reef; body colourless, mottled with ectodermal pale reddish-brown blotches, about 25 mm long. . . . . *Coeloplana mellosa* sp. nov.

– Found on *Acanthaster plancii* (Crown-of-thorns starfish) on Great Barrier Reef; body transparent and colourless, about 5 mm long. . . . . *Coeloplana* sp. A

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Medusae (Cnidaria) of Moreton Bay, Queensland, Australia

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ABSTRACT

The medusae (Scyphozoa, Cubozoa, Hydrozoa, including Siphonophora) of Moreton Bay are reviewed based on recent collections and literature records. Seven new species are described. *Euphysora juliephillipsi* sp. nov. differs from its congeners in having a long narrow apical projection with complete apical canal, moniliform main tentacle with a terminal knob, opposite tentacle longer than the other two, and lacking aboral papillae. *Euphysa scintillans* sp. nov. is distinct in having a pear-shaped body distinctly thickened aborally, one long main tentacle with 20–30 abaxial nematocyst clusters and an enormous globular bulb, and three rudimentary tentacles. *Aequorea kurangai* sp. nov. differs from its northern counterpart *A. australis* in having a fixed number of radial canals (16) but multiple tentacles per canal. *Cirrholovenia violacea* sp. nov. is closest to *C. polynema* but differs in having more statocysts with more concretions, fewer tentacles and cirri, and a gelatinous peduncle. *Orchistoma mauropoda* sp. nov. is most similar to *O. collapsa* but differs in maturing at half the size, having a more rounded body, and ungrouped radial canals. *Cyanea barkeri* sp. nov. is most similar to *C. nozakii* but differs in having T-shaped muscle septa, with resultant different sizes of muscle bands, the tentacle groups are considerably longer than wide and have well over 300 tentacles per group, and it lacks gastro-vascular intrusions into the muscles. *Cassiopea maremetens* sp. nov. is most similar to *C. ndrosia* but differs in having four square lappets per paramere, few to no vesicles between the mouths, lack of conspicuous exumbrellar colouration, and the oral arms terminate in a bifurcation. Numerous new distribution records are presented for Moreton Bay, as well as for other states and regions. The following species are revalidated and redescribed based on examination of new material: *Turritopsis lata* von Lendenfeld, 1884; *Proboscidactyla tropica* Browne, 1905; *Eutima australis* Mayer, 1915; *Physalia utriculus* (Gmelin, 1791); and *Crambione cookii* Mayer, 1910. The nomenclature of *Physalia physalis sensus lato* is discussed; a simulteous neotype is erected for *Physalia utriculus*, and *Physalia meglista* Péron & Lesueur, 1807. ❑ *Cnidaria, Scyphozoa, Hydrozoa, Cubozoa, Siphonophora, jellyfish, marine stingers, new species, new records.*

In Australia, the jellyfishes of tropical North Queensland have attracted the most attention, primarily because of the alarming health effects associated with box jellies and Irukandjis (Williamson *et al.* 1996). However, outside the tropics, the medusae have been poorly studied, particularly so the smaller, inconspicuous and non-harmful species. Moreton Bay has attracted a surprising number of medusan studies, given that the medusae are not generally associated with economic impacts (Pennycuik 1959; Payne 1960; Stephenson 1962; Hamond 1971; Greenwood 1980; Gorman 1988; Davie 1998). Even so, some of the larger and more conspicuous species have been erroneously identified, shedding some doubt on the accuracy of identification of some of the smaller, harder-to-identify species.

This work focuses on the medusae of Moreton Bay, i.e., the hydrozoans (including the siphonophores), scyphozoans, and cubozoans; the ctenophores are treated in a companion paper elsewhere in this volume. The well-known 'Morbakka', or 'Moreton Bay Carybdeid' was earlier formally described as a new genus and species, *Morbakka fenneri* by Gershwin (2008); this species has been associated with symptoms similar to Irukandji syndrome that may be life-threatening.

The present paper brings together the results of previous work on Moreton Bay medusae in light of new knowledge, and describes several new species that were collected during the Thirteenth International Marine Biological Workshop, in Moreton Bay, in February 2005. We have attempted to gather as much comparative information as possible on other Australian records for each taxon treated herein, in order to convey some measure of the spatial distribution and relative commonness of each species. We had originally intended this paper as a review of the medusae of Australia or the medusae of Queensland; however, it became clear that both of those projects are massive undertakings, and thus the present study has been restricted to the Moreton Bay fauna only. However, as part of our long-term commitment to monographing the group, we would appreciate receiving any specimens or information that others may have relating to Australian medusae.

MEDUSAE OF MORETON BAY

Table 1 gives an outline classification of medusae known from Moreton Bay, annotated with state records. For those species known from Moreton Bay and also from elsewhere in Australia, other records are noted in order to convey a measure of relative distribution and commonality.

MATERIALS AND METHODS

The collections of preserved medusae held in the Queensland Museum were examined. New material was collected by hand-trawl from jetties and anchored boats using a 0.5 m wide plankton net with a 500 mm mesh.

Live material was relaxed in MgCl (added dropwise) prior to examination and photography, then fixed in 5–10% formalin. Measurements of larger specimens were made to the nearest mm; on specimens under 15 cm, Max-Cal digital calipers were used to measure to the nearest 0.01 mm. Every effort was made to obtain true dimensions across the widest points; however, some specimens were too brittle to be spread out, in which case absolute measurements were taken across the two farthest available points, and indicated by a '+' following dimensions. In hydromedusae and scyphomedusae, bell diameter (BD) and stomach diameter (SD) were measured with the specimen lying exumbrella-down, and bell height (BH) was measured with the specimen lying on its side. In cubomedusae laying on their side, BH was measured from the apex to the velarial turnover; diagonal bell width (DBW) was measured between opposite pedalia at the upper point of insertion; inter-rhopalial width (IRW) was measured between adjacent rhopalia; tentacle base width (TBW) was measured across the widest points of the tentacle at the point of pedalial insertion. It must be borne in mind that DBW represents approximately twice the width.

Morphological examinations were made under a variety of dissecting microscopes, depending on what was available at the institution where the specimens were studied. Microscopic and macroscopic digital images were made of all observable structures with Fujifilm MX-700 and MX-2700 cameras, Nikon CoolPix 995, and Sony DVD-201e in JPG format. While it was not possible to publish all photographs made of each taxon, we have compiled a large image library of Australian specimens; images from this library are available upon request.

Abbreviations. Australian states: South Australia (SA), Western Australia (WA), Northern Territory (NT), Tasmania (TAS), Queensland (QLD), Victoria (VIC), New South Wales (NSW). Great Barrier Reef = GBR. Specimen numbers prefixed

Table 1. List of all species so far recorded from Moreton Bay, with an indication of earlier records and wider Australian distributions. Nomenclatural notes are given in parentheses, where appropriate. Abbreviations used: Queensland (QLD), New South Wales (NSW), Victoria (Vic), Tasmania (Tas), South Australia (SA), Western Australia (WA), Northern Territory (NT), Great Barrier Reef (GBR), Australia 'Unspecified' (AU), Southern Australia (SO), Northern Australia (NO); Taxa highlighted in **bold** are dealt with in more detail in the present work.

Family	Species	Moreton Bay References	Endemic/Australian Distribution
Class HYDROZOA Owen, 1843 Subclass ANTHOMEDUSAE Haeckel, 1879 Order FILIFERA Kühn, 1913			
Bougainvilliidae	*Bougainvillia muscus* (Allman, 1863).	Gorman (1988) [as *B. ramosa*].	VIC (Southcott 1971)
	***Bougainvillia* spp.** [Widespread and speciose in Australia; see text for discussion].	Greenwood (1980).	Endemic: NSW, WA; also found in QLD, VIC, SA, and TAS.
Oceanidae	***Turritopsis lata*** von Lendenfeld, 1884d	Present work.	Endemic: NSW, TAS, QLD, NT, WA and SA; New records for QLD, NT, WA and SA
Pandeidae	*Leuckartiara octona* (Fleming, 1823).	Pennycuik (1959).	GBR (Kramp 1953).
Proboscidactyl-idae	***Proboscidactyla tropica*** Browne, 1905a	Present work; new record.	New family record for WA.
Order CAPITATA Kühn, 1913 Suborder TUBULARIIDA Fleming, 1828			
Corymorphidae	***Euphysora juliephillipsi* sp. nov.**	Present work; new record.	Only known from QLD.
Euphysidae	***Euphysa scintillans* sp. nov.**	Present work; new record.	New family records for QLD, Tas, and SA.
Suborder ZANCLEIDA Russell, 1953			
Porpitidae	***Porpita porpita*** (Linnaeus, 1758).	Hamond (1971); Davie (1998).	NSW (Bennett 1860, as *P. chrysocoma*; Dakin & Colefax 1933; Whitelegge 1889; Pope 1953a). WA (Hamond 1974). Australia-wide (Bennett 1966, as *Porpita pacifica*). New state record for NT.
	Velella velella (Linnaeus, 1758)	Davie (1998); Present work.	NSW (Bennett 1860, as *V. limbosa* and *V. scaphidea*; Dakin & Colefax 1933, as *V. spirans*; Whitelegge 1889, as *V. cyanea* and *V. pacifica*; Pope 1953a). WA (Hamond 1974). Australia-wide (Bennett 1966, as *V. lata*; Coleman 1981; Edgar 1997, 2000, 2008). New state record for NT.
Subclass LEPTOMEDUSAE Haeckel, 1879 Order CONICA Broch, 1910			
Aequoreidae	*Aequorea australis* Uchida, 1947	Greenwood (1980); Gorman (1988).	Endemic: NT, QLD (Kramp 1953, 1961a, 1965b), WA (Goy 1990).

Family	Species	Moreton Bay References	Endemic/Australian Distribution
Aequoreidae (cont.)	*Aequorea macrodactyla* (Brandt, 1838)	Hamond (1971)	QLD (Mayer 1915; Kramp 1953, 1961a, 1965b). TAS (Hamond 1974). SO (Kramp 1965b; Southcott 1982).
	Aequorea pensilis (Eschscholtz, 1829)	Gorman (1988)	Endemic: WA (Hamond 1974). QLD (Kramp 1953, 1965b).
	***Aequorea kurangai* sp. nov.**	Present work	Endemic: NSW, QLD.
	Aldersladia magnificus Gershwin, 2006c	Gershwin, 2006c	Endemic: NT, QLD, WA. Reported by Kramp (1961a) as *Aequorea pensilis*
Cirrholoveniidae	***Cirrholovenia violacea* sp. nov.**	Present work	Endemic: new family record for QLD.
Dipleurosomatidae	*Dipleurosoma* sp.	Gorman (1988)	Not reported elsewhere in Australia.
Eirenidae	***Eirene ceylonensis*** Browne, 1905b	Kramp (1965); Hamond (1971); Gorman (1988).	Not reported elsewhere in Australia.
	Eirene hexanemalis Goette, 1886	Hamond (1971)	QLD (Kramp 1953, 1961a, 1965).
	Eirene menoni Kramp, 1953	First record for Moreton Bay	QLD (Kramp, 1953). NSW (Kramp, 1965b). SA (Kramp, 1965a; Southcott, 1982). New record for NT and WA.
	Eirene palkensis Browne, 1905b	Hamond (1971)	QLD (Kramp 1953).
	Eutima australis Mayer, 1915	New record; present work	Endemic: QLD. New records for sub-tropical Queensland and Tasmania.
	Eutima curva Browne, 1905b	Greenwood (1980)	QLD (Kramp 1953; Kramp 1961a).
	Helgicirrha malayensis (Stiasny, 1928)	Hamond (1971)	QLD (Kramp 1953).
Malagazziidae	*Octophialucium medium* Kramp, 1955	Gorman (1988)	Not reported elsewhere in Australia.
	Octophialucium sp.	Greenwood (1980)	Not reported elsewhere in Australia.
Orchistomatidae	***Orchistoma mauropoda* sp. nov.**	Present work	Endemic: new family record for Australia.
Phialellidae	***Phialella* sp.**	Present work	New family record for QLD.
Order PROBOSCOIDA Broch, 1910			
Campanulariidae	*Obelia australis* von Lendenfeld, 1884d	Pennycuik (1959); Gorman (1988)	NSW (von Lendenfeld 1887). VIC (Blackburn 1937). TAS (Hodgson, 1950). Considered unrecognizable by Kramp (1953).
	Obelia spp.	Greenwood (1980)	NSW (Whitelegge, 1889; Dakin & Colefax 1933).
	Clytia lomae (Torrey, 1909)	Hamond (1971) [as *Phialidium*]	Not reported elsewhere in Australia.
	Clytia rangiroae (A. Agassiz & Mayer, 1902)	Hamond (1971) [as *Phialidium*]	QLD (Kramp 1953).

Family	Species	Moreton Bay	Endemic/Australian Distribution
Campanulariidae (cont.)	*Clytia simplex* Browne, 1902	Hamond (1971) [as *Phialidium*]	QLD (Kramp 1953). WA (Hamond 1974). VIC (Watson & Chaloupka, 1982).
Malagazziidae	*Malagazzia carolinae* (Mayer, 1900a)	Hamond (1971) [as *Phialidium*].	QLD (Kramp 1953, 1961a, 1965b).
Subclass SIPHONOPHORA Eschscholtz, 1829 Order CYSTONECTAE Haeckel, 1888			
Physaliidae	***Physalia utriculus*** (Gmelin, 1791) [Widely misidentified as *Physalia physalis* (Linnaeus 1758), see text for discussion].	Gorman (1988); Davie (1998) [as *Physalia physalis*]; present work	Australia-wide [see text for extensive references].
	Physalia **sp.** (multi-tentacled form). [Previously misidentified as *Physalia physalis* (Linnaeus, 1758), see text for discussion].	Exton (1988); present work	Central QLD [see text for references].
Order CALYCOPHORAE Leuckart, 1854			
Diphyidae	*Muggiaea* sp.	Gorman (1988)	Not reported elsewhere in Australia.
	Diphyes chamissonis Huxley, 1859	Greenwood (1980)	Endemic: QLD (Huxley 1859; Totton 1932).
Subclass TRACHYLINA Haeckel, 1879 Order TRACHYMEDUSAE Haeckel, 1866			
Geryoniidae	***Liriope tetraphylla*** (Chamisso & Eysenhardt, 1821)	Hamond (1971); Greenwood (1980); Gorman (1988); present work	Reported from QLD, WA, TAS [see text for references]. New records for SA and NT from present study.
Rhopalonematidae	*Aglaura hemistoma* Péron & Lesueur, 1810	Hamond (1971)	QLD (Mayer 1915; Kramp 1953). SE Aus (Blackburn 1955; Kramp 1965b; Watson & Chaloupka, 1982). WA (Hamond 1974; Goy 1990; Gaughan and Fletcher, 1997).
	Rhopalonema velatum Gegenbaur, 1856	Hamond (1971)	QLD (Mayer 1915; Kramp 1953). WA (Hamond 1974). SE Australia (Blackburn, 1955; Kramp, 1965b, 1968c; Hamond, 1974; Southcott, 1982; Watson & Chaloupka, 1982).
Order NARCOMEDUSAE Haeckel, 1879			
Solmarisidae	*Solmaris* sp.	Hamond (1971)	*Solmaris flavescens* (Kölliker, 1853): WA (Hamond, 1974). *Solmaris lenticula* Haeckel, 1879: QLD (Kramp, 1965b). WA (Hamond, 1974; Goy, 1990). *Solmaris rhodoloma* (Brandt, 1835): QLD (Kramp, 1953). NSW, TAS (Blackburn, 1955; Southcott, 1982). WA (Hamond, 1974). (Continued ...)

Family	Species	Moreton Bay	Endemic/Australian Distribution
			Solmaris spp.: SA (Gershwin & Zeidler, 2003).
Class SCYPHOZOA Goette, 1887 Order SEMAEOSTOMEAE L. Agassiz, 1862			
Pelagiidae	***Chrysaora*** **sp.**	Kramp, 1968b; present work.	QLD (Payne 1960; Dawson 2004).
	Pelagia noctiluca (Forsskål, 1775)	Greenwood (1980); Davie (1998); present work	Widespread around Australia; see text for discussion.
Cyaneidae	***Cyanea capillata*** (Linnaeus, 1758) Probably erroneous ID (see text for discussion)	Greenwood (1980); Gorman (1988)	Widely reported around Australia (see references in text).
	Cyanea nozakii Kishinouye, 1891 Probably erroneous ID (see text for discussion)	Davie (1998)	Australia-wide (White *et al.* 1998).
	Cyanea **cf.** ***rosea*** Quoy & Gaimard, 1824a, b, sensu Dawson, 2005c. New record for Moreton Bay	New record; present work	Endemic: NSW.
	Cyanea barkeri **sp. nov.**	Present work	Endemic: QLD-wide.
Ulmaridae	*Aurelia aurita* (Linnaeus, 1758). Probably erroneous ID: recent studies elsewhere on this genus have revealed a far more diverse group than has been inferred throughout most of the 20th century (Gershwin 2001; Dawson & Jacobs 2001; Schroth *et al.* 2002)	Payne (1960); Davie (1998)	AU (Bennett 1966; Edmonds 1975; Coleman 1979; Marsh & Slack-Smith 1986; Williamson *et al.* 1996; White *et al.* 1998). QLD (Kramp 1965a). NSW (Cleland & Southcott 1965). VIC (Fancett 1986). SA (Kramp 1965a). WA (Kramp 1965a). SE (Gillett & Yaldwyn 1969). SO (Southcott 1982; Edgar 1997, 2000).
	Aurelia coerulea von Lendenfeld, 1884b	Gorman (1988)	Endemic: NSW (Stiasny 1924, 1931a; Whitelegge 1889; Dakin & Colefax 1933, 1940, as *A. caerulea*). AU (Kramp 1968b; Dakin & Bennett 1987).
	Aurelia labiata Chamisso & Eysenhardt, 1821. Probably erroneous ID: Native to coast of California (Gershwin 2001); all other records considered doubtful.	Payne (1960); Greenwood (1980)	QLD (Mayer 1915).
	Aurelia spp.		NSW (Pope 1947; Pacy 1957; Dawson 2004). WA (Backhouse 1843; Dawson 2004). QLD (Barnes notes, unpublished; Dawson 2004).

Family	Species	Moreton Bay Records	Endemic/Australian Distribution
Order RHIZOSTOMEAE Cuvier, 1817 Suborder KOLPOPHORAE Stiasny, 1921a			
Cassiopeidae	*Cassiopea andromeda* (Forsskål, 1775)	Stephenson (1962)	QLD (Stephenson *et al.* 1931; Stiasny 1931a).
	***Cassiopea maremetens* sp. nov.**	Present work	
Cepheidae	***Cephea octostyla*** (Forsskål, 1775)	Payne (1960)	
	***Cephea* spp.**	Present work (including Gold Coast)	
Thysanostomatidae	*Thysanostoma thysanura* Haeckel, 1880	Payne (1960)	Endemic: AU (Stiasny 1922a; examined Haeckel's original specimen).
Versurigidae	***Versuriga anadyomene*** (Maas, 1903)	Present work; new record	QLD.
Suborder DAKTYLIOPHORAE Stiasny, 1921a			
Catostylidae	***Catostylus mosaicus*** (Quoy & Gaimard, 1824a)	Agassiz & Mayer (1898); Mayer (1915); Payne (1960); Greenwood (1980); Gorman (1988); Davie (1998); Coleman (1999); Dawson (2004)	Endemic: NSW, southern QLD.
	Crambione cookii Mayer, 1910	Present work; new record	Endemic: QLD (Kramp 1970). First report since original description, range extension to non-tropical Australia.
Class CUBOZOA Werner, 1973 Order CARYBDEIDA Gegenbaur, 1856 (sensu Werner, 1984)			
Carybdeidae	*Carybdea rastonii* Haacke, 1886	Payne (1960); Greenwood (1980)	Endemic: SA; WA (Marsh & Slack-Smith 1986). Southern Australia, NSW to WA (Southcott 1958, 1982; Gillett 1968; Coleman 1977; Edgar 1997, 2000; Gershwin 2005a). Reports N. of Cape Leeuwin are erroneous (= *C. xaymacana* Conant, 1897).
Tamoyidae	*Morbakka fenneri* Gershwin, 2008 [mis-identified in previous works *Tamoya virulenta* Kishinouye, 1910, or *Tamoya gargantua* Lesson, 1829]	Fenner *et al.* (1985); Southcott (1985); Fenner (1987, 1997) [as 'Morbakka']. Payne (1960) [as *T. gargantua*]. Davie (1998) [as *T. virulenta*]	Endemic: QLD.

with SAM-H = spirit collection of South Australian Museum, Adelaide, SAM-PH = the photo index collection at SAM, and those prefixed with an 'X' indicate analytical-grade EtOH-preserved tissues for DNA analysis. Those prefixed with an 'A' are from the collection of the late Ronald V. Southcott (RVS), now housed at the SAM; those prefixed with a 'J' are from the collection of the late Jack Barnes (JHB), now housed at the Museum of Tropical Queensland, Townsville (MTQ); both collections correspond to valuable notes made by those authors. In cases where specimens are referable to more than one number, the institution number is given first, with the other numbers in parentheses. Other institutional abbreviations used: Australian Museum, Sydney (AM); Museum and Art Gallery of the Northern Territory, Darwin (NTM); Museum of Victoria, Melbourne (MV); Queensland Museum, Brisbane (QM); Tasmanian Museum and Art Gallery, Hobart (TMAG); and Western Australian Museum, Perth (WAM). Lots consist of single specimens, unless otherwise noted.

Latin and Greek names were derived using Brown (1956). German and French text was translated with the help of Globalink Power Translator v. 6.02 for Windows.

Taxonomic classification of the Hydrozoa is modified from Bouillon *et al.* (2004); Scyphozoa follows Calder (2009), and the Cubozoa follows Gershwin (2005a). Classification of the Siphonophora follows that of Daniel (1974). Genera and species within families are alphabetised.

SYSTEMATIC ACCOUNT

Phylum CNIDARIA Verrill, 1865, sensu Hatschek 1888
Subphylum MEDUSOZOA Petersen, 1979
Class HYDROZOA Owen, 1843
Subclass ANTHOMEDUSAE Haeckel, 1879
Order FILIFERA Kühn, 1913
BOUGAINVILLIIDAE Lütken, 1850

Bougainvillia Lesson, 1829

Bougainvillia Lesson, 1829: 102.

Remarks. Only a single identified species of *Bougainvillia*, *B. muscus* (Allman, 1863), has been previously reported from Moreton Bay by Gorman (1988) [as *B. ramosa*]. Otherwise Greenwood (1980) has mentioned *Bougainvillia* spp. as being present. In general, numerous species of *Bougainvillia* are common in Australian waters (Table 2); however, most have wider distributions. The taxonomy of this genus needs revision, and until such time as a thorough study is undertaken we maintain some reserve regarding the veracity of many of the records. Table 2 also summarises available information on characters so far being used to separate the Australian species.

The record of '*Bougainvillia ramosa*' from Port Philip Bay, Victoria by Southcott (1971: 5) was based on an incorrect identification and these specimens correctly belong to *Rathkea octopunctata* (M. Sars, 1835).

Bougainvillia sp.
(Fig. 1A)

Material examined. QM-G329002, 3 specs, c. 2–3 mm BD, Amity Jetty, Stradbroke I., 23.02.2005, L. Gershwin. Gershwin private collection, 1 specimen, Amity Jetty, Stradbroke I., 16.02.2005, L. Gershwin.

Description. (Moreton Bay material). Bell spherical, to about 3 mm diameter. Manubrium slender, tapering, with four oral tentacles twice bifurcated. Gonads arranged in a distinct cross at the base of the manubrium where it connects to the bell, extending along edges of manubriums a short distance, not along subumbrellar surface. Tentacle bulbs 4, globular, with up to five tentacles each; with ocelli. Tentacles very fine, with fine rings of nematocysts, with ends conspicuously thickened.

Remarks. We were unable to confidently identify these specimens to species, without comparison to overseas material. They do not seem to be identical to any of the species previously reported in Australian waters.

It is intriguing to us that we found *Bougainvillia* only on the outer, exposed side of Stradbroke I., rather than on the more protected, Moreton Bay side. Our experience in collecting *Bougainvillia* medusae at other locations around Australia (e.g., Port Lincoln (South Australia), Palm Cove (Queensland), numerous locations around Tasmania, and Broome, Port Hedland and Esperence (Western Australia)), has led us to infer that they are most abundant in protected waters.

OCEANIDAE Eschscholtz, 1829

Turritopsis McCrady, 1857

Turritopsis lata von Lendenfeld, 1884
(Fig. 1B)

Turritopsis lata von Lendenfeld, 1884d: 588, pl. 22, fig. 36; Kramp, 1953: 310 (discussion of type specimens).

Material examined. QLD: QM-G322308, 9 specs, Dunwich fishing jetty, North Stradbroke I., 10.02.2005. QM-G322309, 29 specs, Dunwich fishing jetty, North Stradbroke I., 21.02.2005. SAM-XH00434, numerous specs in EtOH, same data as QM-G322309. SAM-H1029, 2 specs (? female, 2.38 mm BH, 38 tentacle bulbs; ? female, 1.81 mm BH, 46 tentacle bulbs), Pumicestone Passage, Moreton Bay, A. Scivyer and P. Petersen, 13-20.12.1999. SAM-H1030, 2 specs (1 immature, 1.20 mm BH, 23 tentacles; 1 immature, 1.09 mm BH, c. 20 tentacles), same locality as SAM--H1029, 6.01.2000. SAM-H1594, 2 young specs, Pumicestone Passage, Moreton Bay, P. Petersen, Underwater World, 6.01.2000. SAM-H1611, 6 specs, Palm Cove, Cairns region, L. Gershwin, 20.12.1999. Numerous unregistered lots, c. 100 specs, Palm Cove, Cairns region, summers of 2003–2008. **NT**: NTM-C014620, numerous specs, Cullen Bay Marina, Darwin, L. Gershwin, 28.03.2004; (Fig. 1B). SAM-H1250 (= GZ0011), 1 spec., Mandorah, 12°26.577'S, 130°456.098'E, off jetty, 0–3 m, L. Gershwin & W. Zeidler, 12.11.2000. **SA**: SAM-XH00430 (=GZ 0075), 10 in EtOH, 1 on slide, numerous specs in formalin, max. 3 mm BH, Ceduna, 15.12.2000. **TAS**: GZ0112, 2 specs, St. Helens Waterfront, NE Tasmania, 41°19' 36.0'S, 148°14'56.3'E, W. Zeidler & L. Gershwin, 24.01.2002. **WA**: Broome, Western Australia, numerous specs collected by lifeguards during routine water monitoring 2004–2008; examined and returned to Surf Life Saving collection.

Diagnosis. Tentacles 30–50, in single row. Peduncle gelatinous, with vacuolated cells on proximal portions of radial canals. Oral nematocyst knobs stalked or sessile.

Revised description. Body minute, to about 3 mm tall, bell-shaped, with rounded sides and flat to domed top, mesoglea thin though fairly rigid. Peduncle gelatinous, c. one-quarter length of subumbrellar cavity. Tentacles in single crowded row, with short, tapered bulbs; with conspicuous terminal dilation; typically held 'up' in life. Abaxial side of tentacle bulb with a pigment spot of dark red cells, which could be mistaken for ocellus without high magnification. Velum broad, thin but stiff. Ocelli red, adaxial, singular on clear portion of base of tentacle rather than on translucent portion of tentacle bulb. Statocysts lacking. Stomach quadrate to nearly cruciform in cross section, with the main radii drawn outward somewhat; longitudinally flask-shaped, narrower at mouth than at base of peduncle. Gonads upon interradial sides of stomach walls. Radial canals with vacuolated cells in the proximal portions, extending along entire length of peduncle from canal arch to base of stomach. Manubrium about half as long as stomach. Mouth drawn out into four short rounded lips; with many nematocyst knobs in single row along entire outline of mouth, most appearing sessile. Colour: Mostly transparent, with red ocelli and tentacular pigment spots, and orange gonads.

Remarks. Kramp (1928) thought that *Turritopsis lata* might be identical with *T. pacifica*, stating 'the description and figures are, however, so bad that nothing can ever be stated with certainty as the identity of *T. lata*, which ought, therefore, to be altogether cancelled from the system as an apocryphal species.' However, 25 years later, Kramp (1953) re-examined von Lendenfeld's original specimens in the British Museum, and concluded that the species is valid, and that the original description is correct. Comparative genetics of species in the genus *Turritopsis* were recently studied by Miglietta *et al*. (2007); however, *T. lata* was not included in the analysis.

In some regions, we have found both *T. lata* and a larger *Turritopsis* sp. (previously reported as *T. nutricula*, and again most recently as *T. rubra* by Miglietta *et al*. (2007)). Therefore it is possible that some of our small specimens are young *Turritopsis* sp. rather than *T. lata*. However, their morphology matches *T. lata* perfectly, rather than what might be expected for a young *Turritopsis* sp. Nevertheless it is possible that the two species may occur sympatrically in some locations. However, we also found *T. lata* repeatedly at numerous locations where *Turritopsis* sp. has never been reported despite extensive

Table 2. Comparison of diagnostic characters of species of *Bougainvillia* medusae reported from Australian waters. The description of *Bougainvillia balei* Stechow (1924) was based on an immature specimen, and therefore useful morphological comparisons can not be made at this time.

Species	Bell height, shape	No. of tentacles per bulb	No. of oral tentacle branches	Gonads	Manubrium shape	Type locality	Australian Records
B. balei Stechow, 1924	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Insufficient data	Shark Bay, WA (Stechow, 1924: 58-59)	Watson, 1996: 78 (Shark Bay to Exmouth, WA); only known from hydroid).
B. brittanica (Forbes, 1841)	12 mm, walls thick	30, with red ocelli in a fine transverse line; bulbs half as broad as intervals	With long basal trunk, divided 4–6 times with terminal knob	Cruciform, on sides of manubrium	No peduncle; cruciform	Cornwall, southern England	Goy, 1990: 110 (Shark Bay, WA).
B. fulva Agassiz & Mayer, 1899	14 mm, cylindrical with flatly rounded top; bell walls thick	15–20 tentacles; ocelli black; bulbs epaulette shaped	Divided 8 times	8, adradial	Wide, half as long as bell cavity, no peduncle	Fiji	Kramp, 1953: 264–265 (Great Barrier Reef, QLD); Kramp, 1965b: 14–18 (QLD, NSW, including Brisbane and Sydney); Kramp, 1968a: 153 (SE Australia); Hamond, 1974: 551 (WA); Southcott, 1982: 131–132, fig. 4.19b (SE Australia); Goy, 1990: 110 (Shark Bay, WA).
B. platygaster (Haeckel, 1879)	12 mm BH & BD, with flat apex and vertical sides	10–12, with triangular bulbs; with crescentic ocelli	Divided 5–6 times immediately from base; short	Interradial	Quadrangular, very flat, without a peduncle; with medusa buds	Cape Verde; Canary Is.; Trinidad	Hamond, 1974: 551 (WA).
B. prolifera (von Lendenfeld, 1884d)	3 mm BH, 2.5 mm BD, semispherical or ovate higher than broad	5, on broad bulbs, with ocelli	Not branched	Medusa buds produced on gonads at every stage of development	Stomach nearly cubic, small	Port Jackson, NSW (von Lendenfeld, 1884d): 589–590, pl. 23, figs 38, 39)	Goy, 1990: 110; (Shark Bay, WA).

Table 2 continued ...

Species	Bell height, shape	No. of tentacles per bulb	No. of oral tentacle branches	Gonads	Manubrium shape	Type locality	Australian Records
B. muscus Allman, 1863 [earlier records refer to this species (van Beneden, 1844), an invalid name replaced by *B.muscus* by Calder (1988)]	Up to 3 mm, thicker apically	Variable, 4–9 (usually 3–5) per group, with round black ocelli	1–2, or up to 4, branches; with medium to long basal trunk	Interradial, but reaching perradius; bulging	Bulbous, half subumbrellar height; sometimes with slight peduncle	Monaco	Gorman, 1988: 16, pl. 9 (Moreton Bay) [as *B. ramosa*].
B. trinema (von Lendenfeld, 1885a)	2–3 mm BD, semi-spherical, higher than broad	3, curving upward terminally	Each oral tentacle with 3 equal branches	Four pair of oblique folds, ascending toward primary radii	Short, cylindrical, half as long as umbrella	Port Jackson, NSW (von Lendenfeld, 1885a: 918, pl. 41 fig. 13)	von Lendenfeld, 1887: 33 (summary).

collecting, particularly in the Great Barrier Reef and Moreton Bay regions, as well as Broome, WA, and Darwin, NT.

This is the first time that new material has been examined and reported since the original specimens of von Lendenfeld. Our material provides new information regarding their smaller size at maturity, and smaller number of tentacles. Many individuals also lack an apical projection, being flat across the top or evenly rounded. Most of the oral nematocyst knobs appear sessile, but some are unmistakably stalked. The vacuolated cells are transparent and exclusive to the proximal portions of the radial canals, with the gelatinous peduncle being clearly visible between the main radii. Finally, von Lendenfeld illustrated his medusae without terminal tentacular swellings, but such swellings are quite conspicuous in many of the individuals we studied. These specimens also broaden the range of *Turritopsis lata* to include Queensland, South Australia, Western Australia, and the Northern Territory.

PROBOSCIDACTYLIDAE Hand & Hendrickson, 1950

Proboscidactyla Brandt, 1835

Proboscidactyla tropica Browne, 1905 (Fig. 1C, D)

Proboscidactyla sp. — Huxley, 1877: 132–133, fig. 17.
Proboscidactyla tropica Browne, 1905a: 727–728.

Material examined. QM-G329003, 1 spec. (1.63 mm BD), Harald Walker Jetty, Dunwich, North Stradbroke I., Qld, 11.02.2005. QM-G329004, same data as QM-G329003; 2 specs (1.43 & 1.16 mm BD). Unreg. Gershwin personal collection, 1 spec. (slide mount), same data as QM-G329003.

Diagnosis. (Based on Moreton Bay material). *Proboscidactyla* with a hemispherical to shallowly conical umbrella, with a slight apical projection; with a well developed gelatinous peduncle, bearing a short, cruciform stomach. Radial canals 4, trifurcated, with each branch leading to a tentacle bulb; a small, globular gonad just proximal to each trifurcation, each bearing about 3 medusa buds on well defined stolons. Tentacles 12, filiform, in correspondence with radial canals.

Description. (Moreton Bay material). Bell dome-shaped to shallowly conical, somewhat wider than high; with a well-developed, gelatinous peduncle extending about halfway through the bell cavity, quadrilobate in cross section, incised by radial canals. Exumbrella with sparsely scattered, tiny clusters of nematocysts.

Radial canals 4, trifurcated at the gonads, each branch leading to a tentacle bulb. Canals fine, barely visible. Stomach cruciform, extending out along radial canals to gonads. Gonads 4, small, globular, located midway on radial canals just proximal to branch-point. Numerous (1–4, typically 3) medusa buds arise from each gonad, in different stages of development.

Tentacles 12, all alike, filiform, held coiled in life, about 1x BD when relaxed. Tentacle bulbs small, globular, without excretory pores. Tentacles arise from the apical-most abaxial point of the bulbs, somewhat adherent to the exumbrellar wall. Velum narrow, delicate. Statocysts and ocelli lacking. Cnidothylacies appearing as a small cluster of nematocysts located on exumbrellar surface, above margin between adjacent tentacles, connected to margin by a fine line.

Manubrium short, tapered, with a cruciform mouth. Lips crenulated, with a thickened margin.

Colour in life: body transparent and colourless, gonads and stomach pale yellowish, mouth green, medusa buds and tentacle bulbs brown.

Remarks. The present form seems most closely similar in overall morphology to *Proboscidactyla tropica* Browne, 1905. This species was first figured by Huxley (1877) from material from the Louisiade Archipelago, off the southeastern tip of Papua New Guinea, but only later formally described by Browne (1905a) based on Huxley's description. However, the Moreton Bay material bears one major structural difference from *P. tropica* as described, namely, the branching pattern of the radial canals. In *P. tropica*, the canals bifurcate, then each branch bifurcates again; thus, each of the four branches leads to the margin and a tentacle, but the primary stem branch does not. In contrast, the radial canals of the present specimens branch only once into a trifurcation, with the primary stem branch continuing on to meet the margin and a tentacle. Another similar species, *Proboscidactyla ornata* McCrady, 1859, with which *P. tropica* has been considered synonymous, typically has 4–5 branches per primary canal, and the stem canal does not lead to a tentacle.

Three other *Proboscidactyla* species have been described with medusa buds: *P. gemmifera* (Fewkes, 1882), *P. stolonifera* (Maas, 1905), and *P. varians* Browne, 1905a, all of which were synonymised with *P. ornata* by Hartlaub (1917). Fewkes (1882b) described *P. gemmifera* as an equivocal juvenile of *P. ornata;* each radial canal has a trifurcation, and a single stolon arises from each corner of the stomach, bearing several medusa buds; this is unlike the present material, with trifurcated canals, and *P. tropica*, in which the medusa buds arise from very near the branchpoint. Maas (1905) described *P. stolonifera* as a variety of *P. ornata;* each canal is twice bifurcated, and the medusa buds arise from the second and third branch-points rather than from the first, as in the present collection and *P. tropica*. Browne (1905a) described *P. varians* from a single badly contracted specimen; there are six primary canals, each with 1–3 branches, and the medusa buds arise close to the stomach; this is unlike the characters of the Moreton Bay specimens and *P. tropica*.

It appears that the true *P. ornata* does not possess medusa buds, and mistakes have probably been made in synonymising other species with it that do possess medusa buds. Fewkes (1882b) suggested that the younger stages of *P. ornata* have medusa buds (e.g., the *P. gemmifera* stage), and they are later outgrown. Bigelow (1909: 218) noted gonadal, tentacular, and budding differences between Pacific and Atlantic forms, but still regarded *P. gemmifera*, *P. stolonifera*, and *P. tropica* as identical to *P. ornata* from both oceans. Mayer (1910: 192) commented that the common *P. ornata* does not have medusa buds, and the budding variety is not known north of Beaufort, North Carolina. Kramp (1961b) considered all those bearing medusa buds as junior synonyms of *P. ornata*. The life cycle of *Proboscidactyla ornata* from Naples was described by Brinckmann & Vannucci (1965); the life cycle of *P. ornata* from Virginia was described by Calder (1970); neither involved medusa buds at any stage.

We have studied approximately 25 specimens of *Proboscidactyla* from Dampier and Port

Hedland (Western Australia) that perfectly match the descriptions given for *P. ornata*; the Moreton Bay material is unlike the Western Australian material in overall morphology.

Huxley (1877) illustrated *P. tropica* with two sets of visible radial canals: one, with the primary stem canal bifurcating, then each of the branches bifurcating again; the other, with the primary stem canal giving rise to two lateral branches, but the stem canal continuing, then subsequently bifurcating. Curiously, *P. varians* Browne (1905a) has this same pattern. Hand (1954) used the branching patterns as key characters in separating eastern North Pacific species. The significance of two types of branching in the type specimens of *P. tropica* and *P. varians* is not well understood at this time, but is not exhibited by specimens in the present collection.

Hand (1954) commented that the description of *P. occidentalis* by Fewkes (1882b) with three equally branching parts from each primary canal was 'nearly an impossibility' (Hand 1954: 60). Hand went on to describe the primary canal of each quadrant as bifurcating 'rather symmetrically'. However, the pattern that Fewkes illustrated is exactly the pattern we see in the Moreton Bay specimens. It is possible that the specimens on which Hand based his redescription do not belong to the same species that Fewkes originally described. Further evidence suggesting this possibility is in comparison of the illustrated bell shapes: Fewkes drew a medusa with a bell-shaped body and absolutely no indication of a peduncle, whereas Hand drew a medusa with a rather rounded body and a pronounced peduncle.

It seems unlikely that the Japanese form of *P. ornata* described in detail by Uchida & Sugiura (1975) could be considered identical to the present form, if one were to wish to persist in keeping *P. ornata* and *P. tropica* united. Uchida & Sugiura (1975) described and figured medusae in which the primary radial canals bifurcated; this is unlike the Australian specimens, in which the primary canals trifurcate, such that the extension of the primary canal reaches the margin. Furthermore, it is interesting that Uchida & Sugiura described medusa buds arising from the stomach in smaller medusae, but medusa buds arising from the radial canals in larger medusae; whether this represents different local sub-species, or some unidentified ontogenetic feature is unknown. However, the size range of the smaller Japanese specimens with stomach-buds is similar to the Australian size range of specimens with canal-buds. Finally, Uchida & Sugiura (1975) make a point that in their largest specimens, the medusa buds arise directly from the radial canals and 'not from the blastostyle'; in the present collection, the medusae arise from a well defined stolon.

Whichever way one wishes to consider the medusa buds of the Japanese *Proboscidactyla ornata* or the radial canals of the Californian *P. occidentalis*, the Moreton Bay form is nonetheless unlike the Western Australian *P. ornata*, and is quite similar to published descriptions of *P. tropica*. Rather than propose a new species for the Moreton Bay form simply because of the branching pattern of the canals, we have decided to be conservative at this time and refer them to *P. tropica* Browne, 1905, and consider this species to be distinct from *P. ornata*.

Proboscidactyla ornata was previously reported by Kramp (1953) from the Great Barrier Reef; however, this is the first record of the family in Moreton Bay, as well as the first record of the family in Western Australia.

Order CAPITATA Kühn, 1913
Suborder TUBULARIIDA Fleming, 1828

CORYMORPHIDAE Allman, 1872

Euphysora Maas, 1905

Euphysora juliephillipsi sp. nov.
(Fig. 1E, F)

Material examined. HOLOTYPE. QM-G322313, male (2.97 mm total BH), Amity Jetty, North Stradbroke I., Qld, 23.02.2005. PARATYPES. QM-G322314, 1 male (3.09 mm total BH [1.87 mm not including apical projection], 1.49 mm BD), Dunwich fishing jetty, North Stradbroke I., Qld, 10.02.2005. QM-G322301, 1 specimen (1.61 mm BH, missing apical projection), Dunwich fishing jetty, North Stradbroke I., Qld, 12.02.2005.

Diagnosis. *Euphysora* with a very long, narrow apical projection, with an off-centre long, narrow apical canal emitting up into the

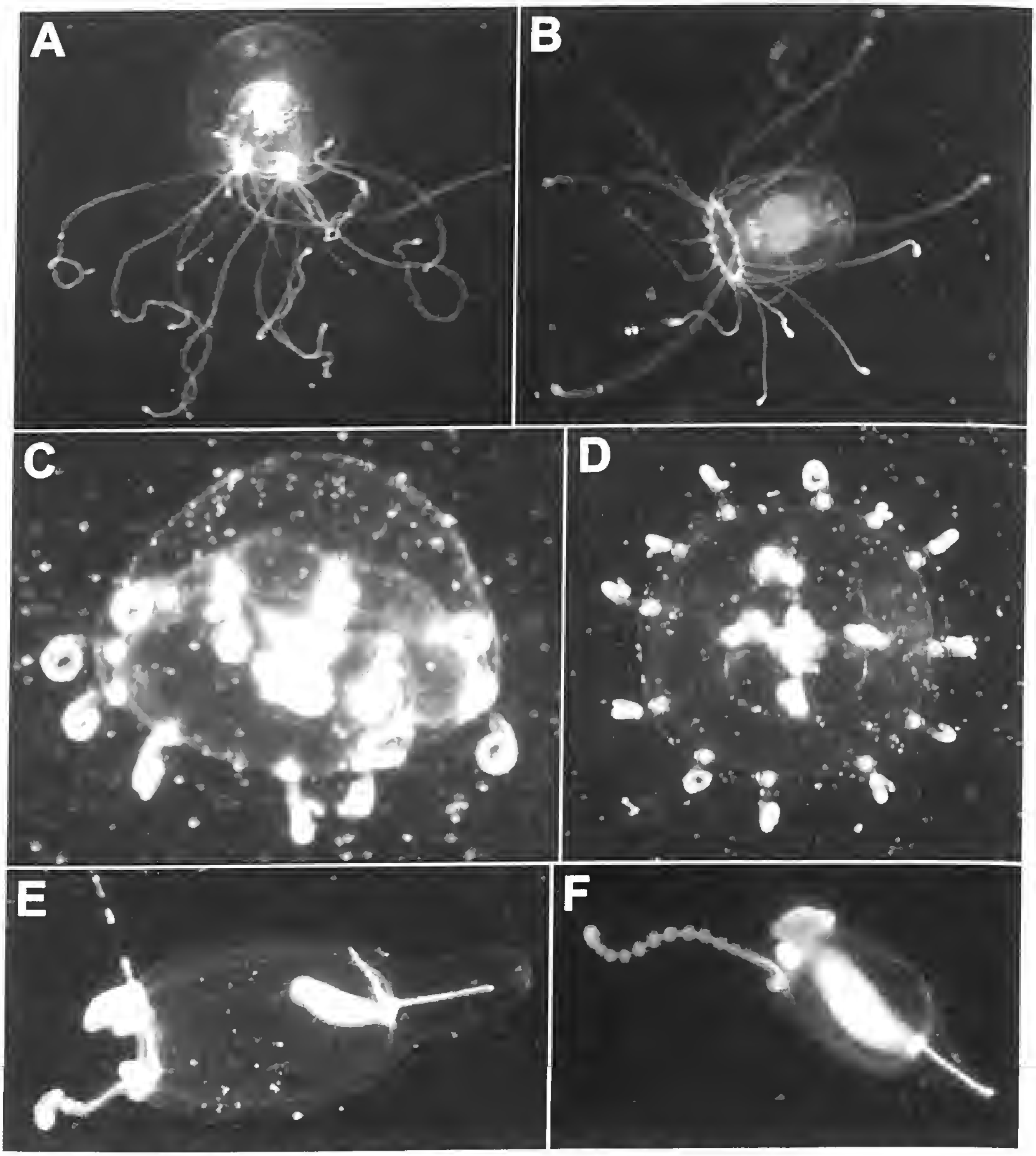


FIG. 1. **A**. *Bougainvillia* sp., live, from Moreton Bay (unregistered) (note 5 marginal tentacles per bulb, oral tentacles twice bifurcated). **B**. *Turritopsis lata* von Lendenfeld, live, from Cullen Bay, Darwin, NT, 28.03.2004. **C, D**, *Proboscidactyla tropica* Browne, from Moreton Bay (QM-G329003); both images taken while specimen was alive. C, Semi-lateral view. D, Aboral view. Note medusa-buds on radial canals. **E, F**, *Euphysora juliephillipsi* sp. nov., from Moreton Bay, both images taken while specimens were alive. E, Holotype, QM-G322313. F, Paratype QM-G322314.

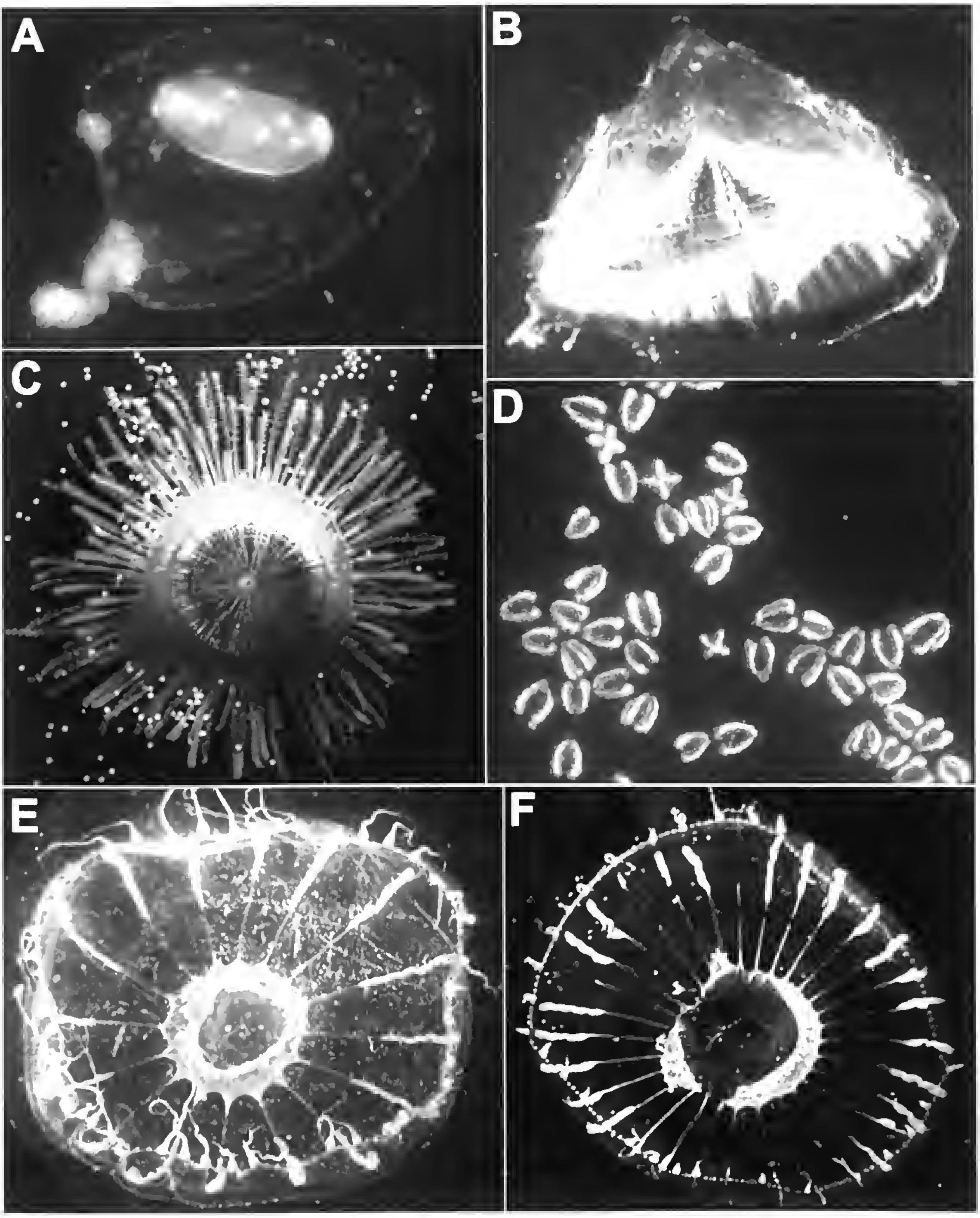


FIG. 2. A. *Luphysa scintillans* sp. nov., holotype, live, from Moreton Bay (QM-G329005). B. *Velella velella* (Linnaeus), live, from Moreton Bay (QM-G329010). C, D, *Porpita porpita* (Linnaeus), from Moreton Bay; both images taken while specimens were alive. C. Colony, from dorsal surface. D. Medusae. Note medusae being released by colony in Fig. C, resembling sand grains. E, F, *Aequorea* spp. E. *Aequorea kurangai* sp. nov., holotype, preserved. F. *Aequorea australis* Uchida, preserved, WAM-Z2921, Fremantle, Western Australia. Note 16 radial canals with numerous tentacles in *A. kurangai*, compared to numerous radial canals with only one tentacle per canal in *A. australis*.

projection; main tentacle moniliform, with up to 12 rings plus a teardrop-shaped terminal knob; opposite tentacle about twice as long as other two; exumbrella lacking nematocyst clusters or tracks.

Description of holotype. Body taller than wide, barrel-shaped in life, hourglass-shaped when preserved, with a long, narrow apical projection approximately 2/3 BH. Exumbrella without nematocyst clusters or radial sculpturing. Subumbrellar musculature not conspicuous. Tentacles 4, of two different forms; three cylindrical simple tentacles, with one opposite main tentacle about twice as long as other two; main tentacle longer, with 10 distinct swellings and a terminal teardrop-shaped knob. Three simple tentacles and swellings of main tentacle frosted with nematocysts. Tentacle bulbs lacking. Peduncle lacking. Manubrium cylindrical, reaching to about 0.5 BH, with a simple pore-like mouth. Apical canal long, narrow, extending about ¾ the height of the apical projection, off-centre, arising closest to largest unadorned tentacle. Radial canals 4, straight, simple, extremely narrow. Velum narrow. Marginal bulbs lacking. Ocelli lacking. Statocysts lacking. Colour in life: body transparent and colourless; radial canals nearly invisible; manubrium, apical canal, and tentacles with ochre yellow core; mouth and main tentacle tipped with magenta.

Variation. Specimen QM-G322301 is missing the apical projection due to damage, but the apical canal is still intact and held coiled above the apex of the bell; the main tentacle is contracted, and possesses about 12 rings. Specimen QM-G322314 has only about 5 swellings on the main tentacle, but appears otherwise mature.

Etymology. Named to honour Dr Julie Phillips, A co-organiser of the Thirteenth International Marine Biological Workshop, and a dedicated scientist who has contributed much to our knowledge of the biota of Moreton Bay.

Remarks. *Euphysora juliephillipsi* most closely resembles *E. annulata* and *E. bigelowi* in having a long, narrow apical projection, and by having a terminal knob on the main tentacle. *E. juliephillipsi* is also similar to *E. annulata* in having the tentacle opposite the main tentacle longer than the other two, but differs in having the manubrium mounted upon a short cone, and by the apical canal extending to the top of the apical projection. Compared to *E. bigelowi*, *E. juliephillipsi* lacks the aboral patch of papillae, and in *E. bigelowi* the tentacle opposite the main tentacle is reduced compared to the other two, versus longer in *E. juliephillipsi*. A comparison of primary diagnostic characters of medusae in the genus *Euphysora* is given in Table 3.

EUPHYSIDAE Haeckel, 1879

Euphysa Forbes, 1848

Euphysa Forbes, 1848: 71.

Remarks. In addition to the above, another form was found at Moreton Bay, as described below. At least five additional new species of *Euphysa* have also been identified in Tasmania, the eastern and western coasts of South Australia, and southern Western Australia, all of which are beyond the scope of this paper. It thus appears that there is a *Euphysa* cluster in temperate Australian waters, and it is possible that additional species will be found with further collecting.

The following *Euphysa* species have been previously reported from Australia:

Euphysa australis von Lendenfeld, 1884d: 586, pl. 21, fig. 33 [Port Jackson, NSW]; von Lendenfeld, 1887: 32 [summary].

Euphysa aurata Forbes, 1848 — Goy, 1990: 110 [oceanic and metahaline waters, Shark Bay, WA].

Euphysa scintillans sp. nov.
(Fig. 2A)

Material examined. HOLOTYPE. QM-G329005, 1 male (1.30 mm BD), Dunwich fishing jetty, North Stradbroke I., Qld, 12.02.2005. PARATYPE. QM-G329006, male, Dunwich fishing jetty, North Stradbroke I., Qld, 10.02.2005.

Diagnosis. *Euphysa* with a small, dome-shaped bell, 1.5–2 mm in height, taller than wide; with one main tentacle on an enormous globular bulb, and three rudimentary bulbs; main tentacle not moniliform, with 20–30 abaxial nematocyst clusters; manubrium reaching bell margin, without peduncle; gonad encircling whole length of stomach.

Description of holotype. Bell dome-shaped, slightly higher than wide, with smoothly

Table 3. Comparative characters of medusae in the genus *Euphysora*. Literature used: all original descriptions, plus Kramp (1961b). Abbreviations: bell height (BH), bell cavity (BC).

Species	Apical projection	Apical canal	Principal tentacle form	Manubrium	Exumbrella	Other three tentacles	Locality
E. abaxialis Kramp, 1962	Slightly conical, with patch of papillae	Low apical chamber in young specimens	Mounted on large bulb, with many abaxial nematocyst clusters	Globular, voluminous, almost filling bell cavity	Lacking nematocyst clusters	Bulbs only, with the one opposite main tentacle a bit larger than other two	Vietnam
E. annulata Kramp, 1928	Distinct apical projection, pointed at top	Narrow, extends to top of apex	17 distinct rings and a terminal knob	Globular, voluminous, mounted on short cone	No nematocysts visible	Short, stout, cone-shaped; tentacle opposite main is ½ BH, other two are ¼ BH	Sunda Strait
E. apiciloculifera Xu & Huang, 2003	Well defined conical-rounded	Spherical-oval apical chamber	Bulb swollen on inner side, nearly spherical	Stomach very large, almost entirely filling bell cavity	Smooth	Bulbs only; the one opposite the main tentacle larger than other two	China
E. bigelowi Maas, 1905	Conical, about 0.25–0.33 BH; sometimes w/apical patch of papillae	Narrow, extending about ½ height of projection	Moniliform, with c. 30 nematocyst rings	Cylindrical to barrel-shaped, about ¾ BC	Lacking nematocyst clusters	Short, pointed; the one opposite the main tentacle smaller than other two	Malay Archipelago
E. brunnescentis Huang, 1999	Very slight, bell almost spherical	Rounded apical chamber; canal lacking	Long, with 50–60 large abaxial nematocyst knobs and a bulb-like terminal knob	Cylindrical, large, about 2/3 as long as bell cavity, with irregular processes	Smooth, lacking nematocyst clusters	Bulbs only; with sickle-shaped 'pedalia' and 6–8 brown pigment spots	Datan Bay, Hong Kong, and Taiwan Strait, China
E. crassocanalis Xu & Huang, 2003	Evenly rounded, short	Slightly protruding apical chamber, with vacuolated cells as in radial canals	Bulb similar to others; tentacle with 5 adaxial knobs and a large terminal knob	Long, tapered, nearly as long as bell cavity	Smooth	All alike, with short conical bulbs, without tentacle	China
E. furcata Kramp, 1948	Shallowly conical	Shallowly conical	Terminally bifurcate, each branch with two capitate knobs	Globular barrel-shaped, voluminous, with narrow protruding mouth; 2/3 BC	Lacking nematocysts	Opposite tentacle slender, filiform; other two short, thicker, conical	Newfoundland

Table 3 continued ...

Species	Apical projection	Apical canal	Principal tentacle form	Manubrium	Exumbrella	Other three tentacles	Locality
E. gemmifera Bouillon, 1978	Absent	Absent	With a dozen or more abaxial clusters	Cylindrical, tapered, protruding from bell cavity	Lacking nematocyst clusters	Reduced to bulbs, with medusa buds on bell margin	Papua New Guinea
E. gigantea Kramp, 1957	Absent; body globular	Absent	Long, thin, several bifurc-ated lateral branches	Cylindrical to barrel-shaped; 05–0.66 BC	Nematocysts unknown	Completely absent	Antarctic
E. gracilis (Brooks, 1882)	Long, pointed, sharply conical	Long, undulating	Ringed, with spherical enlargement	Tapered on both ends; ¾ to >1 x BC	Not described	Opposite 3x longer than two rudimentary	North Carolina
E. interogona Xu & Huang, 2003	Absent; smoothly rounded	Very short dome-shape d apical chamber	Very long, with over 60 abaxial knobs	Quadrate, large bulbous gonads along sides	Smooth	All alike, very small, without tentacles	China
E. knides Huang, 1999	Thick, bluntly conical	Lacking canal or apical chamber	Very long, nearly spher-ical bulb, over 30 abaxial knobs; without enlarged terminal knob	Spindle-shaped, about 2/3 length of bell cavity	With scattered nematocyst clusters	All alike, rudimentary bulbs	Hong Kong and Taiwan, China
E. macrobulbus Xu & Huang, 2003	Lacking, or barely perceptible nipple	Lacking	With large, oval bulb and 3–6 very small spherical lateral abaxial knobs, and large oval terminal knob	Cylindrical, longer than bell cavity	Smooth	Opposite main tentacle with very small bulb only; other two with longer cone-shaped bulbs and filiform tentacles	China
E. normani (Browne, 1916)	Conical, pronounced	Endedermal cellular prolongation	Long, hollow sac-like basal bulb, ending in large armed globular ball and 3 other globular clusters	Massive, cylindrical, protruding from bell cavity	12 longitud-inal streaks of nemato-cysts; lateral branches; anastomosed in lower part of bell	Reduced to bulbs	N. of Chagos, Indian Ocean

Table 3 continued ...

Species	Apical projection	Apical canal	Principal tentacle form	Manubrium	Exumbrella	Other three tentacles	Locality
E. pseudo-abaxialis Bouillon, 1978	Absent	Slightly bulged	With a dozen abaxial spherical capitations	Slim barrel- to teardrop-shaped, about ¾ BC	Lacking nematocyst clusters	All 3 greatly reduced to bulb-like swellings	Papua New Guinea
E. russelli Hamond, 1974	Spherical knob	Absent	Moniliform, with 9 globular rings plus a terminal knob	Barrel-shaped, voluminous, 2/3 as long as BC	Lacking nematocysts	Tentacle opposite main reduced to a protuberance, other two filiform, as long as BH	Indian Ocean between Australia and Indonesia
E. solidonema Huang, 1999	Lacking; bell smoothly rounded	Lacking canal or apical chamber	Short and stiff, with over 10 rings of nematocysts and a large terminal knob	Flask-shaped, longer than half the bell cavity	Smooth, lacking nematocyst clusters	Lateral two short and pointed; opposite main cone-shaped, smaller than other two	Taiwan Strait, China
E. taiwan-ensis Xu & Huang, 2003	Broad, short, bluntly conical	Lacking	Moniliform, with over 16 nearly elliptic nematocyst knobs	Conical, tapered, about 2/3 length of bell cavity	Lacking nematocyst clusters	All alike, rudimentary bulbs	China
E. valdiviae Vanhöffen, 1911	Bluntly conical	Low conical, well developed	Twice bifurcated, lacking nematocyst clusters	Globular, nearly spherical; massive	With anasto-mosing tracks	Tapered conical, relatively short, all alike	Siberut I., Indian Ocean
E. verrucosa Bouillon, 1978	Absent	Absent	Semi-monilifor m, with c. 30 bands plus a terminal knob	Truncate barrel-shaped, about ½ BC	With nematocyst clusters	All reduced to sessile knobs	Papua New Guinea
E. julie-phillipsi sp. nov.	Long, narrow conical, 2/3 BH	¾ apical height, narrow, off-centre	Up to 12 rings, plus tear-drop-shaped terminus	Cylindrical	Lacking nematocyst clusters	Tentacle opposite main about 2x as long as other two	Moreton Bay, QLD

Table 4. Comparison of primary diagnostic characters of medusae of the genus *Euphysa*. *Euphysa ruthae* Norenburg & Morse (1983) is not included due to lack of information of the mature medusa. Literature used: all original descriptions listed below, plus Mayer (1910), Kramp (1928, 1961b), and Russell (1953). Abbreviations used: radial canals (RC), bell height (BH), tentacle (T).

Species	Bell height & shape	Tentacle No.	Tentacle nematocyst arrangement	Manubrium length	Gonad development	Colour	Type locality
E. aurata Forbes, 1848	4–6 mm, bell-shaped, fairly thick, apically rounded	1 long and 3 short & cirrus-like (? or 3 small bulbs); with ocelli	Moniliform	Shorter than bell cavity	Encircling almost whole length of stomach	Ocellus bright golden yellow in the upper half, vivid scarlet in the lower; tentacles golden; stomach yellow, mouth red	Shetland Is.
E. australis von Lendenfeld, 1884d	2.5 mm, half-egg-sha ped	1, with large basal bulb; 3 rudimentary with nematocyst knob; with ocelli	Moniliform	Cylindrical, half bell cavity	(Not described)	Mouth deep violet, gonad and manubrium with brown patches, ocellar bulbs and tentacle brown with violet spots	Port Jackson, NSW; regarded as unrecognis-able by Kramp (1953).
E. brevia (Uchida, 1947)	0.7 mm, glob-oid, with thick jelly	4, alike, with abaxial pig-ment fleck	Not monili-form, 4 abaxial clusters	Bulged and voluminous	Completely surrounding stomach	Unknown	Iwayama Bay, Palau
E. flammea (Linko, 1905)	15 mm, thin walls; height slightly grea-ter than wid-th; apical mass thick	4, added successively	Scattered groups of nematocysts	2/3 bell cavity, very thick	4 interradial, long & pointed in upper part of manubrium (or whole length of stomach, as per Kramp, 1961)	Bell transparent, manubrium and tentacle bases orange-red, tentacles orange-yellow, RC whitish; ocelli lacking.	Barents Sea
E. japonica (Maas, 1909)	12–15 mm, cylindrical with thick walls	4, equally developed; bulbs large, triangular, with abaxial spurs	Moniliform	Broad, barrel–shaped or cylindrical, as long as bell cavity	Entire length	RC narrow, smooth to jagged; ocelli lacking	Japan
E. monotentaculata Zamponi, 1983	3 mm, roun-ded, slightly higher than wide	1, with large basal bulb; 2 rudimentary bulbs	?Filiform	Half bell cavity; broad	Completely surrounding stomach	(Not described)	Argentina; regarded as unrecognizable by Brinckmann-Voss & Arai

Table 4 continued ...

Species	Bell height & shape	Tentacle No.	Tentacle nematocyst arrangement	Manubrium length	Gonad development	Colour	Type locality
E. problematica Schuchert, 1996	1 mm, almost spherical	4, all alike, rather short, with broad perradial bulbs	About 10 nematocyst clusters plus larger terminal cluster	Cylindrical, bell cavity, with small apical chamber	Completely surrounding stomach, restricted to distal 1/3 of manubrium	(Not described)	New Zealand
E. tentaculata Linko, 1905	6 mm, rounded, slightly higher than wide; widest in upper 1/2	1 long, 2 half as long, and 1 small bulb opposite the long one	Moniliform	Slightly < than bell cavity, on a small peduncle	Almost whole length, sometimes free on oral & aboral ends	Manubrium light orange	Barents Sea
E. tetrabrachia Bigelow, 1904	4 mm, pear--shaped, with blunt apical projection, with thin side walls	1 long (4x BH) with warts of nematocysts; 3 short (1/3 BH) all alike; with ocelli	Moniliform, 6–8 rings in long T, and 3 rings in short T's; [Brinckmann-Voss & Arai say not moniliform]	Spindle-shaped, as long as bell cavity	8 distinct rows of half-spherical masses, on upper half of stomach; not extending to mouth	Gonads brownish-yellow, manubrium pinkish, ocellar bulbs and nematocyst rings rose-pink	Indian Ocean
E. vervoorti Brinckmann-Voss & Arai, 1998	6 mm, dome-shaped, delicate	4 of different sizes, with the longest always on the largest bulb	Moniliform, with thick nematocyst pads and endodermal swellings on the basal bulbs	Slightly shorter than bell cavity	Entire length of stomach, leaving only mouth free	Manubrium and endoderm of marginal bulbs deep red; bell colourless	Juan de Fuca Strait, Eastern north Pacific
E. scintillans sp. nov.	1.5–2 mm, dome-shaped, higher than wide	1 long main tentacle on enormous globular bulb, plus 3 rudimentary bulbs	Not moniliform, 20–30 abaxial clusters	Reaching bell margin, without peduncle	Encircling whole length of stomach	Bell transparent and colourless; manubrium whitish with ochre nuclei, mouth black, tentacles with white, orange, yellow, black and red	Moreton Bay, QLD

rounded apex, lacking any indentations or protrusions. Exumbrellar nematocysts scattered but a pattern cannot be discerned due to wear of bell surface. Radial canals 4, unbranched, fine. Main tentacle held coiled in life, with about 20–30 abaxial nematocyst clusters; with enormous globular basal bulb protruding into substance of bell. Other three tentacles reduced to mere rudimentary bulbs, with pigmented core. Stomach cylindrical, enormous sausage-shaped, almost entirely filling subumbrellar cavity, with a constricted, simple mouth protruding through velum. Peduncle lacking, stomach attached directly to subumbrellar surface of bell wall. Gonad compeletely encircling entire length of stomach, leaving only mouth free, with 12 solid, pigmented granulations scattered inside. Velum relatively broad, but quite flimsy. Excretory and sensory structures lacking. Colour in life: Bell transparent and colourless; manubrium translucent whitish with yellow ochre nucleii; mouth black; main tentacle with a ring of whitish granules at base, orangish abaxially, whitish-yellowish adaxially, with mustard yellow nematocyst clusters ringed with black below; other three tentacle bulbs with bright red centre mass. Ocelli lacking.

Etymology. The specific name, *scintillans*, is from the finely dusted appearance of the exumbrellar surface; here used as a noun in apposition.

Remarks. *Euphysa scintillans* is most similar to *E. brevia* (Uchida, 1947) and *E. problematica* Schuchert, 1996, in having abaxial clusters of nematocysts on the main tentacle, but differs from both in having more numerous abaxial clusters, and in the tentacle number, being only one in the Moreton Bay form, but four in the two others (Table 4).

Two species of *Euphysa* have been previously reported in Australian waters, but are morphologically dissimilar to *E. scintillans*: *E. australis* von Lendenfeld, 1885, described from Port Jackson, differs from *E. scintillans* in having a moniliform main tentacle and conspicuous ocelli on all four bulbs; and *E. aurata* Forbes, 1848, reported by Goy (1990) from Shark Bay, differs from *E. scintillans* in being about twice the size and having a moniliform main tentacle and three short cirrus-like tentacles with ocelli.

Suborder ZANCLEIDA Russell, 1953

PORPITIDAE Goldfuss, 1818

Porpita Lamarck, 1801

Porpita porpita (Linnaeus, 1758) (Fig. 2C, D)

Medusa porpita Linnaeus, 1758: 659.

Porpita chrysocoma — Bennett, 1860: 49–54, text figs 4, 5 (NSW).

Porpita pacifica — Bennett, 1966: 38–41, pl. 22 (Sydney); Gillett & Yaldwyn, 1969: 36 (NSW, QLD).

Porpita porpita — Dakin & Colefax, 1933: 198 (NSW); Hamond, 1971: 27 (Brisbane); Hamond, 1974: 551 (110°E between Perth, WA, and Java); Dakin & Bennett, 1987: 167–168 (NSW); Davie, 1998: 12 (Moreton Bay).

Porpita sp. — Whitelegge, 1889: 196 (Coogee Bay, NSW); Dakin & Colefax, 1940: 210 (NSW); Pope, 1953a: 18 (NSW); Barnes, 1964a: 5, 8 (QLD); Southcott, 1982: 129–130, fig. 4.19a (southern Australia).

[Synonymy restricted to Australian records]

Material examined. QLD: QM-G322307, 1 spec. (c. 6 mm disk diameter); numerous additional specimens examined in the field and released, Main Beach, North Stradbroke I., B. Morton, 24.02.2005. SAM-H1032, numerous intact specs, Trinity Beach, Cairns, 29.01.2000, washing up at high tide. SAM-H1033, numerous fragmented specs with other pleuston, same data as H1032. SAM-XH435, numerous specs in EtOH, same data as SAM-H1032. JHB-J674, 1 spec. c. 2 cm BD, Mourilyan Harbour, A. Healey, 16.03.1961. SAM-H1593, medusae and tentacles from *Porpita* colonies, Palm Cove, L. Gershwin, 29.01.2000. **NT**: NTM-C10000, 9 specs (3–4 cm BD), Mindil Beach, Darwin, Oct. 1989. NTM-C10001, 7 specs (2–3 cm), same data as NTM-C10000. NTM-C10002, 3 specs (2–4 cm BD), same data as NTM-C10000. NTM-C12107, 10 specs (2–3 cm), Casuarina Beach, Darwin, R.C. Willan, 8.11.1993. **WA**: WAM-Z1364, 5 specs on display, Houtman Abrolhos, J. Fromont. SAM-H1591 (=GZ-0020), many specimens, formalin, EtOH, and liquid nitrogen, Cable Beach, Broome, 23.11.2000, 17 55.228'S, 122 12.558'E, W. Zeidler and L. Gershwin. SAM-H1592, 2 specs perfectly preserved with tentacles intact, same data as SAM-H1591. **NSW**: AM-G15928, 6 specs, Dee Why Beach, G. Carter, 22.01.1999, at surface over 0–1 m depth.

Remarks. *Porpita* is commonly blown ashore in Queensland waters. This is the first report of *Porpita* in the waters of Western Australia, where it is apparently quite common (Surf Life Saving WA, pers. com.), and the Northern Territory, where it is said to be rare (P. Alderslade, NTM, pers. com.). Outside Australia, it is commonly blown ashore in tropical regions. A fossil relative of *Porpita*, namely *Eoporpita*, was originally described from the Ediacaran formation of the Flinders Range, South Australia (Wade 1972).

Porpita appears to have an imperceptable sting for humans — when tested by the senior author, no sensation could be felt even when applied to the inner lip and tongue.

Preservation of intact specimens is problematical, for in formalin (added dropwise or all at once) they typically drop their appendages quickly from the disk. Relaxation in $MgCl_2$ was incomplete, and did not stop disarticulation. However, with great patience we were able to duplicate the procedure of Jane Fromont (WAM) with beautiful results: relax whole specimens floating in Petri dishes by adding 1–2 drops $MgCl_2$ every 30 minutes for about 1½ to 2 hours; after letting them sit undisturbed an additional hour or so, add 1 drop of concentrated formalin every 30–45 minutes for about 4 hours. Then let them sit undisturbed overnight; in the morning add several more drops of formalin to make a 5–10% solution. Do not attempt to move them for at least a week. After that time, they are able to withstand a surprising amount of jostling.

Velella Lamarck, 1801

Velella velella (Linnaeus, 1758) (Fig. 2B)

Medusa velella Linnaeus, 1758: 660.
Velella limbosa — Bennett, 1860: 54 (NSW).
Velella scaphidea — Bennett, 1860: 54 (NSW).
Velella cyanea — Whitelegge, 1889: 196 (Coogee Bay, NSW).
Velella ? pacifica — Whitelegge, 1889: 196 (Coogee Bay, NSW).
Velella spirans — Dakin & Colefax, 1933: 198 (NSW).
Velella velella — Bennett, 1966: pl. 7.2; Coleman, 1979: 64; Coleman, 1981: 20, 65–66 (all states except NT); Southcott, 1982: 128, pl. 13.6 (southern Australia); Dakin & Bennett, 1987: 167–168 (NSW); Edgar, 1997: 123 (circum-Australian); Edgar, 2000: 123 (circum-Australian).
Velella lata — Bennett, 1966: 38–41, pl. 21 (Sydney); Gillett & Yaldwyn, 1969: 36, fig. 20, pl. 17 (NSW and QLD).
Velella sp. — Dakin & Colefax, 1940: 210 (NSW); Pope, 1953a: 18 (NSW); Barnes, 1964a: 5–8, fig. 1, 2 (QLD); Southcott, 1958: 54–56 (SA, WA); Davie, 1998: 13 (Moreton Bay).
[Synonymy restricted to Australian records]

Material examined. QLD: QM-G329010, 1 specimen (11.37 mm diameter of long axis), plus numerous small specimens examined in the field and released, Main Beach, North Stradbroke I., L. Gershwin, 16.02.2005. **TAS**: TMAG-K29, Shoal Bay, Maria I., A. Powell, Jan. 1936. 976, Spring Beach, near Orford, J. Steane, 2.12.1985, beached. TMAG, numerous specs, Eaglehawk Neck, Tasman Peninsula, L. Gershwin and L. Turner, Nov. 1999. **WA**: WAM-Z1373, numerous display specimens.

Southcott material. The following collections were catalogued by Ron Southcott, and are held in the South Australian Museum: **QLD**: RVS A448, Bell's Beach, near Daintree River, Cairns, 7.07.1960; sky overcast but bright, tide rising, wind strong SE for three days, still blowing 20+ knots; accompanied by *Physalia* varying from ¼ to 1 ½ inches float length. **SA**: RVS A375, Ocean Beach, Beachport, 26.12.1958; 'washed up on beach. Profuse numbers.' RVS A449, same data as A448. RVS A860, numerous specs, Beach near 'Graham's Castle', Goolwa; 14.03.1965; 'discussed with Scorsby Shepherd 15-3-65 who says that *Velella* is seen in Jan–Feb along coast between Goolwa and Port Elliott each year.' RVS A1105, 3 specs, Middleton Beach, 4.01.1969 - stranded [Note added 7.09.1987: Decomposed and of no value, discarded]. RVS A1374, 10 specs, Aldinga Beach SA, 27.12.1972. RVS A2260, St. Vincent's Gulf, no date. RVS A2262, 3 specs, Encounter Bay, Jan. 1973.

Distribution. Collection records exist for *Velella* in all states except NT. Despite this, its presence in Australian waters has rarely been mentioned in the scientific literature. Outside Australia, *Velella* is found worldwide in tropical and temperate regions.

Remarks. The *Velella* that washed up on North Stradbroke I. beaches during the Workshop was peculiar from most other forms, in having a primarily silvery colour with blue only around the margin of the disk and on four 'tentacles'. The taxonomic significance of these differences, if any, is not currently known, and is beyond the scope of this paper.

Subclass LEPTOMEDUSAE Haeckel, 1879
Order CONICA Broch, 1910

AEQUOREIDAE Eschscholtz, 1829

Perhaps more than any other family within the Hydrozoa, the Aequoreidae is in serious need of revision. Within Australian waters, numerous distinct forms can be discerned by casual inspection alone. Péron & Lesueur (1810) also noted a large number of *Aequorea* species, but many of their descriptions were insufficient for proper identification today.

Species recognition criteria have differed amongst authors, but have generally focused on or included the radial canal-to-tentacle ratio, or the tentacle bulbs. Browne (1905a) stated that all species differed in the shape of their tentacle bulbs, and that the shape was constant at all stages of development. Some authors have used the tentacle-to-canal ratio as a primary means of species recognition (Vanhöffen 1911; Bigelow 1909; Russell 1953; Pagès *et al.* 1992), while others found that these characters were insufficient (Bigelow 1919; Arai & Brinckmann-Voss 1980), and still others thought they were of no use whatsoever (Claus 1880, cited in Bigelow 1909). Mayer (1910) used overall morphology, as did Haeckel (1879) and Kramp (1961b). Curiously, however, Kramp (1961a) ignored other obvious characters, such as the conspicuous subumbrellar papillae that separate the Australian *Alderslадia magnificus* Gershwin (2006c), from all other aequoreids.

Aequorea Péron & Lesueur, 1810

Aequorea kurangai sp. nov. (Fig. 2E, 3A)

Material examined. HOLOTYPE: AM-G16011, Hawksbury River, NSW, 4.01.1972; male, 26.97 mm BD, 7.53 mm SD, 16 canals, 52 tentacles. PARATYPES: **QLD**: QM-G329001, Harold Walker Jetty, Dunwich, N. Stradbroke I., Moreton Bay, L. Gershwin, 15.02.2005; 1 spec., 16.88 mm BD, 5.20 mm SD, 16 canals, 39 tentacles. SAM-H1537, Bribie I., 200 m offshore in Moreton Bay, P. Petersen, c. 21.12.1999; 19.54 mm BD, 6.18 mm SD, 16 canals, 51 tentacles. **NSW**: AM-G16010, data as for holotype; 2 specs: 1) male, 25.94 mm BD, 8.39 mm SD, 16 canals, 51 tentacles; 2) female, 23.52 mm BD, 7.83 mm SD, 16 canals, 43 tentacles. AM-G16023, data as for holotype, 9 specs, sex undetermined: 1) 17.70 mm BD, 4.39 mm SD, 16 canals,? tentacles; 2) 18.84 mm BD, 6.85 mm SD, 16 canals, 51 tentacles; 3) 18.22 mm BD, 6.22 mm SD, 16 canals, 49 tentacles; 4) 16.91 mm BD, 5.46 mm SD, 16 canals, 45 tentacles; 5) 17.95 mm BD, 5.15 mm SD, 16 canals, 43+ tentacles (damaged); 6) 17.81 mm BD, 6.23 mm SD, 16 canals, 40 tentacles; 7) 10.62 mm BD, 3.63 mm SD, 17 canals, 50 tentacles; 8) 13.23 mm BD, 5.56 mm SD, 16 canals, 40 tentacles; 9) 13.36 mm BD, 4.43 mm SD, 16 canals, 37 tentacles. SAM-H1542 same data as holotype; 4 specs. SA: SAM-H1231, Smoky Bay jetty, 32°22′44.3′S, 133°55′59.7′E, T. Laperousaz & L. Gershwin, 19.02.2002; 1 spec. SAM-H1538, Ceduna town jetty, 32°07′35.9′S, 133° 40′19.5′E, T. Laperousaz & L. Gershwin, 19.02.2002; numerous specs. SAM-H1539, Ceduna town jetty, T. Laperousaz & L. Gershwin, 19.02.2002; numerous specs. SAM-H1540, Ceduna town jetty, T. Laperousaz & L. Gershwin, 19.02.2002; numerous specs. SAM-H1541, Port Augusta, main wharf, 32° 29′19.9′S, 137° 45′41.9′E, T. Laperousaz & L. Gershwin, 27.02.2002; 1 specimen. SAM-H1588, Whyalla Marina, L. Gershwin, 14.05.1999; 25.04 mm BD, 5.90 mm SD, 16 canals, c. 36 tentacles. SAM-H970, Adelaide outer harbor jetty pilons, S.J. Edmonds & J. Window, 27.10.1977. **WA**: SAM-H1589 (= GZ0036), Port Hedland, town jetty, L. Gershwin & W. Zeidler, 27.11.2000; 7 specs, 1–3 cm BD. OTHER MATERIAL. **QLD**: SAM-XH00433, Harold Walker Jetty, Dunwich, N. Stradbroke I., Moreton Bay, L. Gershwin, 18.02.2005; 1 specimen in EtOH. Bribie I., 200 m offshore in Moreton Bay, P. Petersen, 25.11.1999; tissues retained in EtOH for DNA analysis. Harold Walker Jetty, Dunwich, N. Stradbroke I., Moreton Bay, L. Gershwin, 18.02.2005; numerous specimens examined then released or discarded. **SA**: SAM-XH0120, Whyalla Marina, L. Gershwin, 14.05.1999; 1 specimen in EtOH.

Diagnosis. Bell mostly flat, thin, with small stomach, lacking peduncle. Radial canals typically 16, with linear gonads on distal ½ to 2/3 of all canals. Tentacles 2–3 times as numerous as canals, with narrow, elongate bulbs. Rudimentary tentacle bulbs 1–3 times as numerous as tentacles. Excretory papillae prominent. Statocysts as numerous as tentacles plus bulbs, with one concretion.

Description. Bell to about 30 mm, flat to shallowly conical, with thin jelly, somewhat evenly thickened at center. Radial canals almost invariably 16, typically straight, slightly wavy in some specimens. Gonads linear, not noticeably compressed; on distal ½ to 2/3 of all radial canals, stopping short of margin. Tentacles outnumbering radial canals by more than 2:1; fine, coiled, with those nearest to radial canals not necessarily in radial correspondence; length approximately 1x BD in life. Tentacle bulbs narrow, elongate. Rudimentary tentacle bulbs small, 1–3 between adjacent tentacles. Excretory papillae prominent behind all tentacles and tentacle bulbs. Statocysts typically one between adjacent tentacles and bulbs, with two concretions; apparently easily lost. Stomach small, approximately 1/3 BD, mounted upon a very shallow gelatinous peduncle; with cobweb-like extensions leading to radial canals; circular musculature lacking; radial musculature poorly developed. Mouth with crenulated margin, slightly projecting on radii of canals; lips short, blunt, corresponding radially and numerically to canals. Colour in life: Body transparent and colourless; radial canals, stomach, and tentacles translucent whitish; mouth emerald green.

Etymology. The specific name is from Kurangai, the name of the aboriginal tribe that inhabited the coastal region of New South Wales, including the Hawksbury River (Reed 1977). We first became aware of *Aequorea kurangai* from this location, where it is common.

Behaviour and appearance in life. *Aequorea kurangai* is quite active in life, most often pulsing upward at the surface of the water, and occasionally coming to rest on the bottom, subumbrella up. When at rest, the medusa constantly twitches the muscles at the base of the radial canals, causing the mouth to pull in the direction of the twitch. The muscles tug in succession, such that the mouth is pulled progressively around the stomach region.

This species is extremely transparent, except for the mouth, which is brilliant emerald green. The gonads upon the radial canals appear glassy, and the tentacles are somewhat whitish, though their fine texture makes them nearly impossible to see without the aid of a good side light. When disturbed at night, it exhibits dull blue flashes of bioluminescence; though the exact points of light origin could not be determined, it was noted at the time that light was not coming exclusively from the margin.

Type locality. Hawksbury River, Sydney area, New South Wales, Australia.

Distribution. This species was collected abundantly from Moreton Bay, Qld, and the Hawksbury River, NSW, as well as throughout South Australia. Whether its distribution extends around to Western Australia is not currently known. It does not appear to reach as far north as Cairns, as it is not present in extensive collections made from 1958–1985 (J.H. Barnes, collection and unpublished notes) and was not found in daily netting at Palm Cove, Cairns throughout the summer 1999–2000, or during summer Irukandji monitoring since.

Remarks. *Aequorea kurangai* bears a strong overall resemblance to *A. australis* and *A. conica* Browne, 1905, in the small number of radial canals, the elongate tentacle bulbs, and the small stomach. However, in *A. australis*, the tentacles match the number of radial canals and are on the same radii (Fig. 2F), whereas in *A. kurangai* the canals are outnumbered by tentacles more than 2:1, and they are not necessarily on the corresponding radii (Fig. 2E). It is also interesting to note that in *A. kurangai* the radial canals almost invariably number exactly 16, regardless of BD (type collection 10.62 mm to 26.97 mm preserved), whereas in *A. australis* the radial canal number increases with BD (type collection 11 mm to 31 mm preserved). *Aequorea australis* is apparently common in the warmer waters of northern Australia, whereas *A. kurangai* appears to replace *A. australis* in the cooler southern and transition waters.

Aequorea conica, while nearly always having exactly 16 radial canals, is immediately distinguishable from *A. kurangai* in the shape and size of the bell, which is small and very tall in *A. conica* but larger and considerably flatter in *A. kurangai*. In addition, the two are easily distinguished in the gonads of *A. conica* being upon the proximal portion of the canals and very much laterally compressed, whereas in *A. kurangai* they are distal and not compressed. Furthermore, the tentacles of *A. conica* are typically less than twice the number of the radial canals; thus, *A. kurangai* has the higher number of tentacles at all sizes. *A. conica* was reported in Queensland waters by Kramp (1953, 1965b), and was also found in abundance during the summer of 1999–2000 at Palm Cove north of Cairns.

CIRRHOLOVENIIDAE Bouillon, 1984

Cirrholovenia Kramp, 1959

Cirrholovenia Kramp, 1959 : 250.

Remarks. When Kramp (1959) proposed *Cirrholovenia*, he placed it in the Lovenellidae. Bouillon (1984b) moved the genus to its own family, the Cirrholovenidae, which is defined, in part, as lacking a peduncle (Bouillon & Boero 2000b). Indeed, the other species in the genus lack such a structure, but *C. violacea* sp. nov., described below, possesses one that is short and broad, but unmistakable.

Only two species have been previously recorded from Australia.

Cirrholovenia polynema Kramp, 1959, was reported off Qld and NSW by Kramp (1965b: 68). Southcott (1982: 135) appears to have reported it in error from southern Australia, based on Kramp (1965b), and it has not subsequently been reported from there.

Cirrholovenia tetranema Kramp 1959, by Goy (1990: 110) from oceanic and metahaline waters, Shark Bay, WA.

Cirrholovenia violacea sp. nov.
(Fig. 3C)

Material examined. HOLOTYPE. QM-G329000, Harold Walker Jetty, Dunwich, N. Stradbroke I., 16.02.2005; 1.34 mm BD.

Diagnosis. *Cirrholovenia* with 12 long, coiled tentacles, with fig-shaped, globular, tapered bulbs; with 2–5 statocysts between adjacent tentacles, each with two concretions; with cirri same number as, and in alternation with, statocysts, very short, coiled; with stomach on a short, broad peduncle; with gonads on radial canals midway between stomach and margin; with tentacle bulbs deep purple.

Description of holotype specimen. Bell sub-hemispherical, with a short, broad gelatinous peduncle. Exumbrellar nematocysts not observed. Radial canals 4, relatively broad, with gonads starting to develop about midway between stomach and margin. Ring canal difficult to discern. Tentacles 12, asymmetrically arranged; one each on main radii, with 1 to 3 others between main radii; extremely fine; coiled in life. Tentacle bulbs small, fig-shaped, with a globular base, tapered into tentacle. Ocelli and excretory pores lacking. Lateral cirri absent. Stomach broad, cruciform, with short, narrow manubrium; mouth simple, with a thickened ridge marking the lip, without defined cross-sectional shape. Statocysts numerous, 2–5 between adjacent tentacles, each with 2 concretions. Marginal cirri present, approximately 1 between adjacent statocysts; short, curled. Velum very broad, about ½ bell radius. Colour in life: Gelatinous substance of body transparent and colourless, subumbrellar epidermis translucent whitish; tentacle bulbs deep purple, with a faint green dot to either side; manubrium with a faintly purple hue near base; mouth, tentacles, and radial canals translucent whitish.

Type locality. Dunwich, North Stradbroke I., Moreton Bay, Qld, Australia.

Etymology. The specific name, *violacea* (Latin: like a violet, violet-coloured), is given in regard to the deep purple tentacle bulbs.

Remarks. *Cirrholovenia violacea* differs from its congeners in possessing a peduncle. It is most similar to *C. polynema*, in having multiple tentacles per quadrant, but even in the apparently immature stage, differs from *C. polynema* in having more statocysts with more concretions, fewer tentacles, fewer cirri, and a gelatinous peduncle between the stomach and bell surface (Table 5).

A second specimen was caught and examined during the workshop, but has since been lost. Both specimens are apparently juvenile, based on the rudimentary development of the gonads, but the morphology is so distinctive that the species uniqueness is at once obvious.

It is possible that the specimens reported by Kramp (1965b: 68) as *C. polynema* are, in fact, referable to *C. violacea*, given the similar localities. However, it seems unlikely that Kramp would have overlooked the conspicuous differences between these two species.

EIRENIDAE Haeckel, 1879

Eirene Eschscholtz, 1829

Eirene Eschscholtz, 1829: 94.

Remarks. At least seven different species of *Eirene* have been found in Australian waters (Table 6). Of these, three have been reported from Moreton Bay, and are detailed below. Medusae of the genus *Eirene* comprise a significant component of the coastal gelatinous zooplankton community, being the most abundant species present in water samples taken by Surf Life Savers when monitoring for Irukandji jellyfishes in the tropical north.

Eirene ceylonensis (Browne, 1905)

Irene ceylonensis Browne, 1905b: 140-141, pl. 3, figs. 9-11.

Eirene ceylonensis. – Kramp, 1953: 285–286 (numerous localities along the GBR); Kramp, 1965: 74–75 (mouth of Moreton Bay); Hamond, 1971: 27 (Moreton Bay); Gorman, 1988: 15, pl. 5 (Moreton Bay).

[Synonymy restricted to Australian records]

Table 5. Comparison of characters of *Cirrholovenia* medusae, based on Kramp (1959, 1961), and Bouillon & Boero (2000). Abbreviations used: radial canals (RC).

Species	Bell shape	No. tentacles	No. of statocysts	No. of cirri	Stomach and mouth	Gonads
C. polynema Kramp, 1959	Sub-hemispherical, with slightly thickened apical jelly	24, with bulbs broadly conical or pear-shaped	Twice as numerous as tentacles, with 1 concretion	Up to 8 between tentacles, coiled, as long as tentacle bulbs	Small and narrow; mouth slightly crenulated	Linear along middle half of RC
C. tetranema Kramp, 1959	Umbrella cuboid, with evenly thin jelly	4, with broad basal bulbs	4 interradial or 8 adradial, large	7–8 per quadrant, coiled, as long as tentacle bulbs	Small with cruciform base; mouth tube short, with simple lips	Thick and cylindrical, occupying length of RC
C. violacea sp. nov.	Flatter than a hemisphere, with moderately thick jelly	12, long, coiled, with fig-shaped globular tapered bulbs	2–5 between adjacent tentacles, with 2 concretions	1 between adjacent statocysts, coiled, much shorter than tentacle bulbs	Stomach on broad peduncle; mouth short, simple	Midway between stomach and margin

Material examined. QM-G322306, Dunwich jetty, North Stradbroke Is., Qld, 21.02.2005; 1 spec., 15 mm BD. SAM-H1606, Pumicestone Passage, Moreton Bay, Qld, P. Petersen, Feb. 2000; 2 specs, c. 20 mm BD. SAM-H1607, Pumicestone Passage, Moreton Bay, Qld, P. Petersen, Feb. 2000; 2 specs, c. 20 mm BD. SAM-H1609, Pumicestone Passage, Moreton Bay, Qld, P. Petersen, Feb. 2000; 1 spec, c. 10 mm BD. SAM-H1610, Pumicestone Passage, Moreton Bay, Qld, P. Petersen, Feb. 2000; 2 specs, c. 20 mm BD.

Remarks. The specimens in the present collection most closely match the description of *E. ceylonensis*; the Stradbroke specimen appears to be a juvenile, with many of the tentacles not yet developed. This species was also recorded from Moreton Bay by Hamond (1971) and Gorman (1988). Furthermore, it was found in numerous places and times along the Great Barrier Reef by Kramp (1953). Thus, it appears to be fairly common in Queensland waters.

Eirene hexanemalis (Goette, 1886)

Irenopsis hexanemalis Goette, 1886: 832-833.
Eirene hexanemalis – Kramp, 1953: 281–283, fig. 5 (255 specs from the GBR); Kramp, 1961a: 201 (Green I., GBR); Kramp, 1965: 77–80, fig. 5 (NE Australia and Moreton Bay); Hamond, 1971: 27 (Moreton Bay).
[Synonymy restricted to Australian records]

Material examined. SAM-H1604, Pumicestone Passage, Moreton Bay, Qld, P. Petersen, Feb. 2000; 1 spec., c. 10 mm BD.

Remarks. Previously recorded from Moreton Bay by Kramp (1965) and Hamond (1971), and has been found in numerous places along the Great Barrier Reef by Kramp (1953, 1961a, 1965). We have found it frequently at Palm Cove, north of Cairns, during December and January when the northerlies bring in the Irukandjis, as well as in Western Australia and Northern Territory waters. Thus, the species appears to be relatively common along the tropical Australian coastline.

Eirene menoni Kramp, 1953

Eirene menoni Kramp, 1953: 286, pl. 2, fig. 6 (Low Isles, GBR); Kramp, 1965a: 272 (South Australia); Kramp, 1965b: 76 (near Sydney).
[Synonymy restricted to Australian records]

Material examined. QM-G329009, Dunwich jetty, North Stradbroke Is., Qld, L. Gershwin, 18.02.2005; 1 spec. SAM-H1605, Pumicestone Passage, Moreton Bay, Qld, P. Petersen, Feb. 2000; 1 spec, c. 15 mm BD.

Table 6. Comparison of diagnostic characters of *Eirene* medusae found in Australian waters. *Eirene troglodyta* Watson (1998) from Victoria is not included, due to lack of information on the medusa stage. Literature used: all original descriptions, plus Kramp (1953, 1961b), and Mayer (1910). Abbreviations used: bell diameter (BD), bell height (BH), radial canals (RC).

Species	Body size	Peduncle	Gonads	Tentacles	Rudimentary bulbs	Excretory papillae	Statocysts	Reported
E. ceylonensis (Browne, 1905b)	25 mm BD, watchglass-shaped	Long, cylindrical	Linear, from base of peduncle to near margin	About 100	Lacking	Probably no excretory papillae	1 between tentacles, with 1 concretion	QLD (Kramp, 1953; Hamond, 1971; Gorman, 1988).
E. hexanemalis (Goette, 1886)	15–20 mm BD	Low and broad	Linear, short, on distal portion of RC	Highly variable, up to about 50	Usually 3 between tentacles, the median one somewhat larger than the others	Distinct	Usually 4	QLD (Kramp, 1953; Kramp, 1961a; Kramp, 1965; Hamond, 1971).
E. kambara Agassiz & Mayer, 1899	8 mm BD, flat	Short, broad	Occupying the lower portions of the RC	32 small, with well developed basal bulbs	(Not described)	(Not described)	2 between tentacles, with 1 concretion	QLD (Kramp, 1953).
E. menoni Kramp, 1953	12 mm BD, 5 mm BH, evenly rounded	Slender, slightly widened at base; less than height of bell cavity	Linear, somewhat sinuous, from base of peduncle almost to ring canal	46, with conical bulbs, plus two young bulbs	(Not described)	Absent	1–3 between tentacles	QLD type locality. NSW (Kramp, 1965b). SA (Kramp, 1965a; Southcott, 1982).
E. palkensis (Browne, 1905b)	20 mm BD, watchglass-shaped	Long, cylindrical	Linear, from base of peduncle to near margin	About 50, with cone-shaped to globular bulbs	2–3 between tentacles	With excretory pores	2–4 between tentacles, with about 2 concretions	QLD (Kramp, 1953; Hamond, 1971).
E. sp.	4–5 mm high and wide, with globular apical jelly	Short, conical, very broad at base; not protruding from bell cavity	Linear, on central portion of RC	16, filiform, short, fine, with spherical bulbs, in two size classes	Lacking	Conspicuous papillae	3–4 per quadrant	TAS and SA.

Remarks. *Eirene menoni* has been reported from quite far north and south of Moreton Bay (Kramp, 1953, 1965a, 1965b), but surprisingly, none of the Moreton Bay workers reported its presence. This report, therefore, represents the first record of the species in southern Queensland. In the Cairns region, it is one of the dominant members of coastal gelatinous zooplankton blooms. We have also found this species in great abundance in Darwin Harbour (Northern Territory) and Broome (Western Australia), representing first records for those states as well.

Appears widespread throughout the Indo-Pacific, having been reported from India (Menon, 1932; Kramp, 1958), Papua New Guinea (Bouillon, 1984), New Zealand (Bouillon, 1995), and Korea (Park, 1996).

Eutima McCrady, 1859

Eutima australis Mayer, 1915
(Fig. 3B)

Eutima australis Mayer, 1915: 201–202, pl. 3 (type locality Murray I., Torres Strait).
Eutima curva – Kramp, 1953: 289, 311 (Great Barrier Reef; as *E. australis* probably identical to *E. curva*).
[Synonymy restricted to Australian records]

Material examined. QM-G322304, Harold Walker fishing jetty, Dunwich, North Stradbroke I., Qld, L. Gershwin, 12.02.2005; 1 specimen. QM-G322305, same loc. as G322304, 21.02.2005; 1 immature specimen. Unregistered, same loc. as G322304, 10.02.2005. Palm Cove, Qld, L. Gershwin, 1999–2008; hundreds of specimens 3–10 mm BD, examined in the field and released or retained in unsorted collections. SAM-XH0432, same data as QM-G322305; 2 specs in EtOH.

Remarks. Kramp (1953) thought that this species is identical with *Eutima curva* Browne, 1905 from Ceylon. However, all specimens we have seen from Qld have gonads extending well up onto the subumbrellar portion of the radial canals, and running the full length of the peduncle. Mayer (1915) described such a condition for *E. australis*, but speculated that the gonads reach maturity only on the peduncle. This was apparently incorrect, as the subumbrellar gonads and peduncular gonads are both mature in some of the examined specimens. In mature *E. curva*, the gonads are restricted to the peduncle. Furthermore, the peduncle in *E. curva* is about as long as the bell diameter, whereas in *E. australis* it is about 1.25 to 1.5x as long.

The Moreton Bay specimens are the first reported from sub-tropical Qld. We have also collected this species from Tasmania, representing the first temperate record for this species.

ORCHISTOMATIDAE Keller, 1884

Orchistoma Haeckel, 1879

Orchistoma mauropoda sp. nov.
(Fig. 3D–F)

Material examined. HOLOTYPE. QM-G329574, Horseshoe Bay, Magnetic I., Qld, Surf Life Saving lifeguard during Irukandji closure, 1.11.2005; female, 7.06 mm BD, 18 radial canals. PARATYPES. QM-G329007, Harold Walker fishing jetty, Dunwich, North Stradbroke I., Qld, L. Gershwin, 21.02.2005; 1 mature male, 4.34 mm BD, 16 radial canals. QM-G329008, Harold Walker fishing jetty, Dunwich, North Stradbroke I., Qld, L. Gershwin, 21.02.2005; 1 immature specimen, 1.81 mm BD, 8 radial canals.

Diagnosis. *Orchistoma* maturing at a very small body size; with 16-18 radial canals, each corresponding to a tentacle; tentacle bulbs flask-shaped, with blackish endodermal core; with about 12 tentaculites between adjacent tentacles, each bearing one or more black ocelli at the base; gonads bilamellar on proximal portion of radial canals; lips not well defined.

Description of holotype. Bell slightly less than hemispherical, with soft, thick jelly; apparently lacking exumbrellar nematocysts; with massive, broad peduncle, about as long as bell is tall. Stomach branched irregularly into four major lobes, each branching dendritically into 4–6 lobes, leading to radial canals, 18 in all. Radial canals extending to ring canal, simple, narrow, straight. Gonads on proximal portion of radial canals from stomach to distal edge of peduncle; bilamellar, with gonadal products on both sides of radial canals. Lips sinuous sheet-like, along proximal half of gonads, without crenulated margin; not drawn out into lobes. Margin with one flask-shaped tentacle bulb at terminus of each radial canal, plus a couple more that do not correspond to radial canals; flexible portion of tentacles lacking, probably as an artifact of collection. Typically about a dozen, rarely as few as five, filiform, cordyli-like structures between adjacent tentacles, lacking bulbs, adherent to exumbrellar wall, with free end just above bell margin. Adaxial side of velum with

Table 7. Comparison of primary diagnostic characters for medusa species in the genus *Orchistoma*. Literature used: All original descriptions, plus Mayer (1910), and Kramp (1955b). Abbreviations used: Radial canals (RC).

Species	Diameter	RC	Lips	Tentacles	Tentaculites	Ocelli	Gonads	Locality
O. agariciforme Keller, 1884	20 mm	19 or more	7	1x canals	6 per section	19 per section	Diverticula from stomach that extend outward along canals	Naples, Italy
O. collapsa (Mayer, 1900b)	7 mm	16	8, slightly crenulated	16	112, very small	1 at base of each tentacle	Linear, on proximal portion of each canal	Tortugas, Florida
O. manam Bouillon, 1984	5 mm	8	8	4	16–20	20 per octant	Pouch-like	Papua New Guinea
O. nubiae Bouillon, 1984	25–30 mm	33–38	32	Twice as many as RC	2–3 between tentacles	600–800	Linear, on peduncle portion of RC	Papua New Guinea
O. pileus (Lesson, 1843)	?	32	Many, tufted	32	?	?	Sausage-shaped, on peduncle against lips	West Africa
O. steenstrupii Haeckel, 1879	30–40 mm	32	32	64 short	100	600–800	Sausage-shaped, on peduncle against lips	Antilles
O. mauropoda sp. nov.	a few mm	16–18	Not well defined	16–20	5–12 between tentacles	1 or more at base of each tentaculite	Bilamellar, on proximal part of radial canals	Queensland

16–20 small pin-prick-sized ocelli between adjacent tentacles, not always in correspondence with tentaculiform structures. Colour in life: Bell transparent and colourless; lips, gonads, and tentaculiform structures slightly translucent whitish; tentacle bulbs with black cores; ocelli black.

Variation. In the paratype, the lips are less damaged, and it is apparent that they are drawn out into lobes resembling scyphozoan pelagiid oral arms, i.e., folded in half, and ruffly and somewhat pleated.

Etymology. The specific name, *mauropoda*, dark-footed, is from the Greek *mauros* (= dark) and *podos* (= foot), is in reference to the black tentacle bulbs that are one of the most noticeable features of this species in life. Feminine.

Type locality. Horseshoe Bay, Magnetic I., off Townsville, North Qld, Australia.

Remarks. *Orchistoma mauropoda* is most similar to Mayer's (1900b) adult *O. collapsa* from Florida, both in their incredibly small size at maturity and in overall structural similarity; however, *O. mauropoda* is only half the size of *O. collapsa* at the same stage of maturity. Mayer also described and figured a half-grown stage, i.e., at the same size as *O. mauropoda*; however, the two bear numerous dissimilarities, and it is clear from Mayer's drawings that our *O. mauropoda* specimens represent the adult form.

Mayer's *O. collapsa* is relatively taller than our *O. mauropoda*; in *O. collapsa* the side walls are straight, whereas in *O. mauropoda* the whole aboral surface is evenly rounded and subhemispherical, without straight sides. Mayer described and figured the radial canals clustering into four quite symmetrical palmate groups of four as the animal grows; in *O. mauropoda*, the canals cluster quite irregularly and dendritically, through a series of dichotomous branchings, into more or less four groupings of four; the highly irregular branching pattern in *O. mauropoda* would be unlikely to be mistaken for the simpler pattern in *O. collapsa*. Curiously, Mayer described the gonads as being distal, although he figured them as swollen pockets on the proximal half of the peduncle; whichever *mauropoda*, extending to the edge of the peduncle, and they are bilamellar, i.e., the gametes are along both sides of the midline.

Mayer figured a half-grown medusa (presumably this would correspond in bell diameter to our larger specimens of *O. mauropoda*); our Queensland species is so different from Mayer's half-grown specimen at the same size, that one would be unlikely to match them up based on peduncle, gonads, body mass, tentaculite-to-tentacle ratio, or colour. The only features in which *O. mauropoda* resembles the half-grown *O. collapsa*, are the types (but not numbers) of marginal structures, and the number and arrangement of radial canals (which differ from the adult *O. collapsa*). Furthermore, our smallest specimen, which is about half the size of the others, and thus half the size of Mayer's juvenile, resembles the adult specimens in all respects, but with only eight radial canals and less well developed features in general, rather than the juvenile morphology with 16 radial canals as illustrated by Mayer.

The species recognition criteria have been confused. The oldest species, *O. pileus* (Lesson 1843), was originally described as a *Mesonema*, a genus typically associated with the Aequoreidae. Haeckel (1879) proposed the genus *Orchistoma*, thus re-classifying Lesson's *M. pileus* and adding *O. steenstrupii* as new. While the two species bear a striking similarity (Table 7), Haeckel distinguished them on tentacle number, i.e., 32 in *O. pileus* (opposite the 32 radial canals) and 64 in *O. steenstrupii* (opposite and between the 32 radial canals). Thus, they have a fundamental structural difference, in that the former has a 1:1 correspondence between radial canals and tentacles, whereas the latter has a 1:2 correspondence. However, this difference was ignored by Mayer (1910: 211–212, pl. 25, figs 1–4), who redescribed *O. pileus* based on Caribbean material, and synonymised *O. steenstrupii* in the process; and by Kramp (1955b: 157), who examined Haeckel's original specimens at the Copenhagen Museum and concluded that they were identical to Mayer's specimens of *O. pileus* (from nowhere near the type locality, it should be noted); and by Kramp (1961b: 144–145), who followed Mayer in treating *O. steenstrupii* as a junior synonym of *O. pileus*; and by Bouillon & Boero (2000b: 197), who did not include *O. steenstrupii*. In fact, the Caribbean form described by Mayer (1910) as *O. pileus* matches Haeckel's *O. steenstrupii* quite well, but not so well for Lesson's *O. pileus*; thus, it appears that Mayer made a mistake, and others followed.

The subsequently added species *O. agariciforme* Keller, 1884, *O. collapsa* (Mayer 1900), and *O. manam* Bouillon, 1984, are distinctive, bearing different radial canal and tentacle numbers (Table 7). *Orchistoma tentaculata* Mayer (1900) was moved to a new melicertid genus, *Orchistomella*, by Kramp (1959). However, the other species, *O. nubiae* Bouillon, 1984, bears a remarkable similarity to *O. steenstrupii*. Nonetheless, the two are found in different oceans, so it is quite possible that further structural differences may be found, and quite possibly, that genetics will support specific differentiation; it seems equally possible that one represents an exotic introduction of the other. Scientific understanding would be well served by fresh collection of multiple specimens of both species for comparison.

This is the first record for the family Orchistomatidae in Australian waters.

PHIALELLIDAE Russell, 1953

Phialella Browne, 1902

Remarks. Two species of *Phialella* have been reported from Australian waters, namely *P. hyalina* (von Lendenfeld, 1885a), described from Port Jackson, NSW, and *Phialella quadrata* (Forbes, 1848), reported from southern Australia by Southcott (1982). We have also found a form of *Phialella* from southern Tasmania that appears to be new to science; this shall be described elsewhere shortly.

The following *Phialella* species have been previously reported from Australia:

Phialella hyalina (von Lendenfeld 1885a): 920, pl. 42, figs 16–18, Port Jackson, NSW [originally described as a *Eucope*, Kramp (1953: 311) placed it in *Phialella* and provided a revised description based on examination of specimens in the British Museum.]

Phialella quadrata (Forbes, 1848) — Southcott, 1982: 135; southern Australia.

Phialella spp.

(Fig. 5A)

Material examined. QM-G322310, Dunwich Jetty, Dunwich, N. Stradbroke I., Qld, L. Gershwin, 23.02.2005; 1 spec, c. 4 mm BD. QM-G322311, Amity Jetty, Amity, N. Stradbroke I., L. Gershwin, 23.02.2005; 1 specimen, c. 2 mm BD.

Descriptive notes of Moreton Bay specimens. Bell flatter than a hemisphere. Tentacles 18, one on each canal radius, plus three in each of two quadrants, four each in the other two. Gonads 4, oval, on radial canals three quarters of the way toward margin. Statocysts 8, evenly spaced at one-third and two-thirds points in each quadrant, each with two concretions. Gonads and tentacle bulbs bright green.

Remarks. The specimens have eight statocysts, which is diagnostic for the genus *Phialella*; however, we were unable to identify them to species at this time. Collection of additional material would help with this endeavour.

Subclass SIPHONOPHORA Eschscholtz, 1829

Order CYSTONECTAE Haeckel, 1888

PHYSALIIDAE Brandt, 1835

Physalia Lamarck, 1801

Remarks. Totton (1960: 365) synonymised all *Physalia* species (23 available names) under *P. physalis* (Linnaeus, 1758) on the basis that they are merely ontogenetic stages of one another, i.e., that the young colonies have a single main fishing tentacle, subsequently developing additional tentacles as they grow; most authors have followed (however, see Halstead, 1965, and Bardi & Marques, 2007). Fenner and his colleagues (1993) questioned Totton's conclusion for Australian forms, on the basis that the nematocysts of the single-tentacled and multi-tentacled forms have different responses to inhibition tests. We would further add that the size and tentacle limits are consistently different, i.e., we have never observed nor seen any account of 30 cm *Physalia* in Australian waters, nor even 20 cm, nor of a *Physalia* with more than 5 or 6 main tentacles. Finally, the single-tentacled and multi-tentacled forms do not appear to mix, with flotillas being either one form or the other. Thus, these different Australian forms do not appear to be merely ontogenetic stages of one another.

At least four different forms of *Physalia* can be easily and reliably distinguished in Australian waters:

1) A single main fishing tentacle; and the float with a prominent anterior crest not continuing onto a marked posterior elongation (Fig. 4A–C). This form appears to be the one illustrated by La Martinière (1787) as an unnamed medusa (Fig. 4B)(= *Physalia utriculus* Gmelin, 1791, see following remarks) and by Péron & Lesueur (1807) as *P. megalista* (Fig. 4C). We do not believe that the continuance of the tentacles along the entire ventral margin of the float (as figured by La Martinière 1787) is accurate as it does not otherwise occur for species of this genus.

2) A single main fishing tentacle, and a prominent crest along the full length of the float (Fig. 4D). We believe that this form has not been previously recognised.

3) A single main fishing tentacle, and no crest (Fig. 4E). We believe that this form has also not been previously recognised.

4) Multiple main fishing tentacles; with or without a crest (Fig. 4F). This form has been associated with systemic illness similar to that of Irukandji syndrome (Fenner *et al.* 1993), and has been colloquially called 'the Pacific Man-o-War'.

A proper revision of the Australian *Physalia* species is beyond the scope of the present work, but is part of a separate ongoing study. At this time we are only confident to apply the name *Physalia utriculus* Gmelin, 1791, to the form diagnosed here, and to formally synonymise with it, *P. megalista*. It appears that the true *Physalia physalis, sensu stricto,* will be confined to the Atlantic, however, with the plethora of other available names we cannot at this stage be sure whether the other three Australian forms represent one of the already described species, or whether some, or all, will need new names. Unfortunately this means we must continue to use "*Physalia* sp." for non-*P. utriculous* specimens.

In the older literature, mostly prior to the late 1950s, there has been some confusion over identification. The following records do not refer to *Physalia* species but to either the Box Jellyfish (*Chironex fleckeri*) or other cubozoans.

RECORDS REFERABLE TO *CHIRONEX FLECKERI*:

Physalia pelargica – Flecker, 1952a: 35–38; fatal cases, N Qld. [Incorrect spelling].

Physalia sp. — McNeill & Pope, 1943a: 188–191; confusion over cause of fatalities; McNeill & Pope, 1943b: 127–131; comparison with fatal cases; Flecker, 1945c: 128–129; two fatal cases, Cairns region; Southcott, 1952: 273; not the fatal agent; Pope, 1953b: 114; not the fatal agent; Flecker, 1957a: 9; reference to fatal cases; Flecker, 1957b: 556 (in part); confusion over names; Southcott, 1958b: 282; not the fatal agent; Southcott, 1959: 572; confusion over fatal agent; Trinca & Schiff, 1970: 32; blamed for fatalities.

REFERABLE TO IRUKANDJI CUBOZOANS:

Physalia sp. — Tryon, 1895: 39–45; probable agent in Irukandji sting, Moreton Bay; Flecker, 1945a: 98; Irukandji envenomations, Cairns region; Flecker, 1952c: 89–91; confusion over agent of Irukandji stings; Flecker, 1957b: 556 (in part); confusion over names.

Physalia utriculus (Gmelin, 1791)
(Fig. 4A-C)

Méduse [un-named] — La Martinière, 1787: 365, pl. 2, figs 13, 14. (North Pacific Ocean, approx. SE of Wake Island).

Medusa utriculus Gmelin 1791: 3155–3156.

Physalia physalis — Dakin & Colefax, 1933: 198 (NSW); Totton, 1960: 362 (off NSW and Tas); Southcott, 1967: 337–342 (NSW) Southcott, 1968: 1–11 (NSW); Gillett & Yaldwyn, 1969: 34–38, pl. 15, 16, text fig. 18, 19 (NSW, QLD); Edmonds, 1975: 99–101 (Australia-wide); Coleman, 1979: 63 (NSW); Turner *et al.*, 1980: 394–395 (NSW, treatment); Coleman, 1981: 20, 65 (all states except NT); Sutherland, 1981: 92–93 (Australia-wide); Southcott, 1982: 124–125, pl. 13.5 (SA); Sutherland, 1983: 382–385 (Australia-wide); Edmonds, 1984: 70–72 (Australian region); Fenner, 1986: 100 (possibly two species); Marsh & Slack-Smith, 1986: 13–16, figs 9–10 (WA); Burnett *et al.*, 1987: 86–91 (in part) (Australia); Fenner, 1987: 97 (AU); Gorman, 1988: 13 (Moreton Bay); Williamson *et al.*, 1992: 427 (confusion with *P. utriculus*); Holmes, 1996: S26 (far north Qld); Edgar, 1997: 125 (circum-Australian and Tas); Hawdon & Winkel, 1997: 1371 (sting management, Australia); Davie, 1998: 12 (Moreton Bay); White *et al.*, 1998: 109–110 (Australia-wide); Sutherland & Sutherland, 1999: 90–91 (Australia-wide); Edgar, 2000: 125 (circum-Australian and Tas); Sutherland, 2001: 609–615, fig. 26.13, 26.14 (Australian stings). All considered as erroneous identifications. [Not *Physalia physalis* (Linnaeus, 1758)].

Physalia utriculus Eschscholtz, 1829 — Whitelegge, 1889: 196 (NSW); Pope, 1947: 164–166 (NSW); Barnes, 1960: 993–999 (N Qld, stings); Barnes, 1962: 7–10, figs 1–6 (North Qld); Southcott, 1963b: 20, fig. 2C (warm coastlines of Australia); Halstead, 1965: 300, 327, pl. 15, figs 2, 3, pl. 16, pl. 17, fig. 1, pl. 65, pl. 67, fig. 1, 2, pl. 74, fig. 2); Cochrane, 1968: 16, 17 (Australia); Brown, 1973: 16 (Magnetic I., Qld); Dakin & Bennett, 1987: 165–166 (Australia-wide); Williamson *et al.*, 1992: 427 (confusion with *P. physalis*); Burnett *et al.*, 1994: 71–76 (comparison with Atlantic *P. physalis*); Williamson *et al.*, 1996: 137–139, 192–198, 200, pls. 6.5, 8.31, 8.32 (comparison with multi-tentacled forms; stings); Davie, 1998: 12 (Moreton Bay); Sutherland & Nolch, 2000: 3–5 (Australia-wide, comparison to multi-tentacled form); Sutherland, 2001: 609 (discussion of difference from multi-tentacled form); Fenner, 2006: 4 (treatment controversies).

Physalia megalista Péron & Lesueur, 1807: pl. 29, fig. 1 – Whitelegge, 1889: 196 (NSW).

Physalia pelagica — G. Bennett, 1834: 8 (NSW); G. Bennett, 1860: 5–13, pl. II (NSW stings); Cleland, 1913: 46, 47 (Australia-wide); Cleland, 1924: 345 (NSW); Flecker, 1945b: 417 (Great Barrier Reef. [Not *Physalia pelagica* Lamarck, 1801]

Physalia sp. — McNeill, 1937: 223–226 (Australia; stings); Dakin & Colefax, 1940: 210 (NSW); Johnston, 1943: 308 (Eyre Peninsula, SA); Southcott & Powys, 1944, unpublished but widely cited manuscript: 1–37; stings); McNeill, 1945: 29 (Green I., GBR); McNeill & Pope, 1945: 334–335 (comparison with causal agent in fatal stings); Flecker, 1952b: 458 (common in Cairns); Pope, 1953a: 16–21 (discussion of stings, NSW); Southcott, 1958: 54–56, fig. 1B (SA); Kingston & Southcott, 1960: 373, 381, 383, fig. 12E (confusion over cause of fatalities, nematocysts from SA); Bloomfield, 1961: 44–45 (AU); Barnes, 1964a: 5–8 (North Qld; comparison with *Velella*); Bennett, 1966: 34–38, pls. 18–20 (NSW); Gollan, 1968: 973 (near-fatal sting, Cottesloe, WA); Gurry, 1992: 31, fig. 15 (Australia); Fenner & Williamson, 1996: 658 (over 10,000 stings per year in Australia – Loten *et al.*, 2006: 329–333 (heat treatment).

[Synonymy restricted to Australian records]

Material examined. NEOTYPE: QM-G3788, Scott's Point, Moreton Bay, 27°15'S 153°06'E, 20.10.1965, J.V. Mistlin on beach after NE winds (128.41 mm float TL; 55.51 mm float height; 96.27 mm crest length). **QLD:** Stradbroke I., Main Beach, Feb. 2005, dozens of specimens used for sting experiments, and hundreds more examined casually in the field and released. Trinity Beach, Cairns, 29.01.2000; dozens of specs examined in the field and released. JHB-J840.2, c. 20 specs 1-3 cm. SAM-H1595, Palm Cove, Dec. 1999; 2

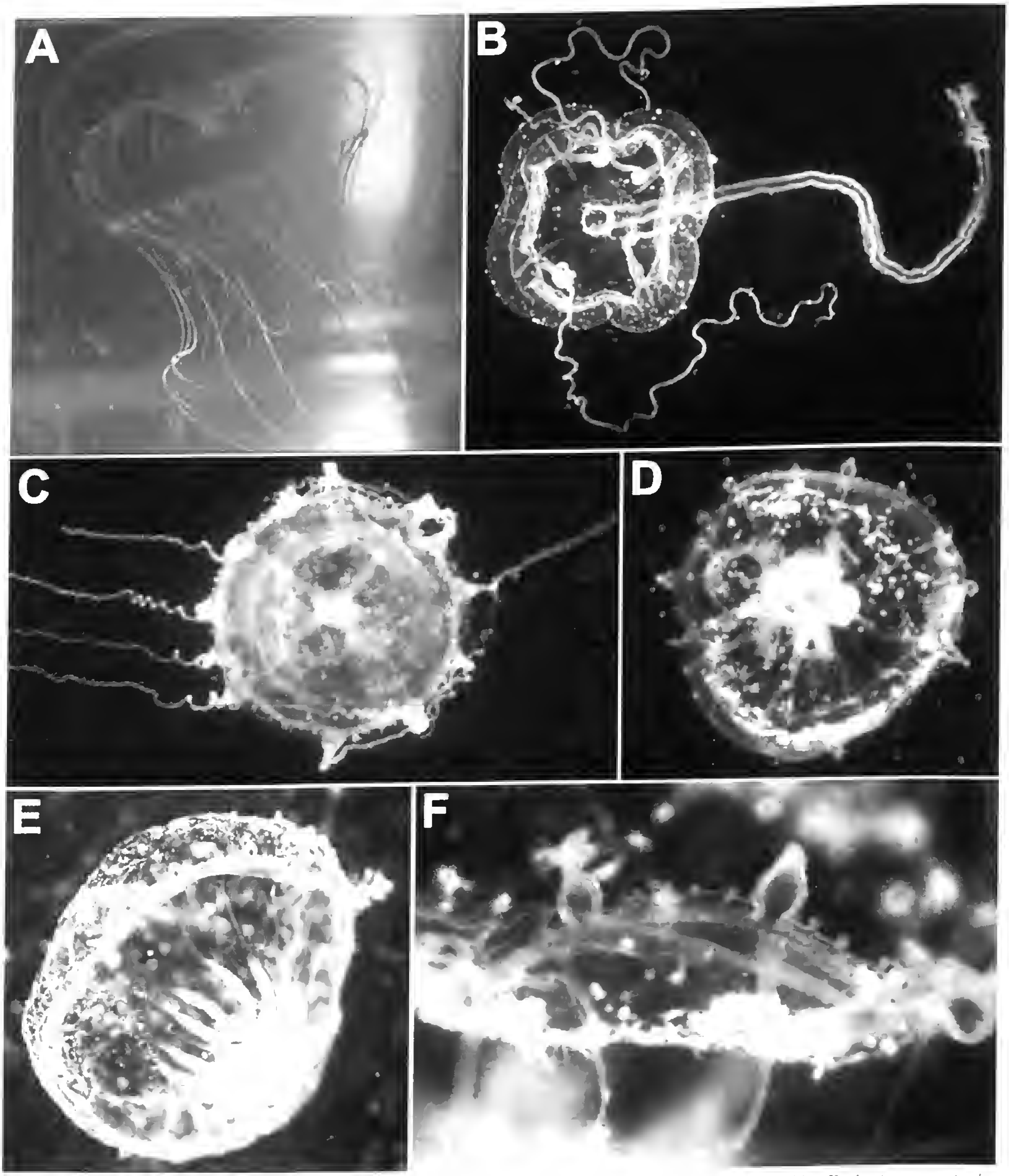


FIG. 3. **A**. *Aequorea kurangai* sp. nov., paratype, live, from Moreton Bay, (QM-G329001). **B**. *Eutima australis* Mayer, live, from Moreton Bay, QM-G322304. **C**. *Cirrholovenia violacea* sp. nov., holotype, live, from Moreton Bay (QM-G329000). **D–F**, *Orchistoma mauropoda* sp. nov., images taken while specimens were alive. D. Paratype, from Moreton Bay, (QM-G329007). E. Holotype, from Horseshoe Bay, Magnetic I., off Townsville, Qld (QM-G329574). F. Close up of marginal structures, paratype (QM-G329007), from Moreton Bay.

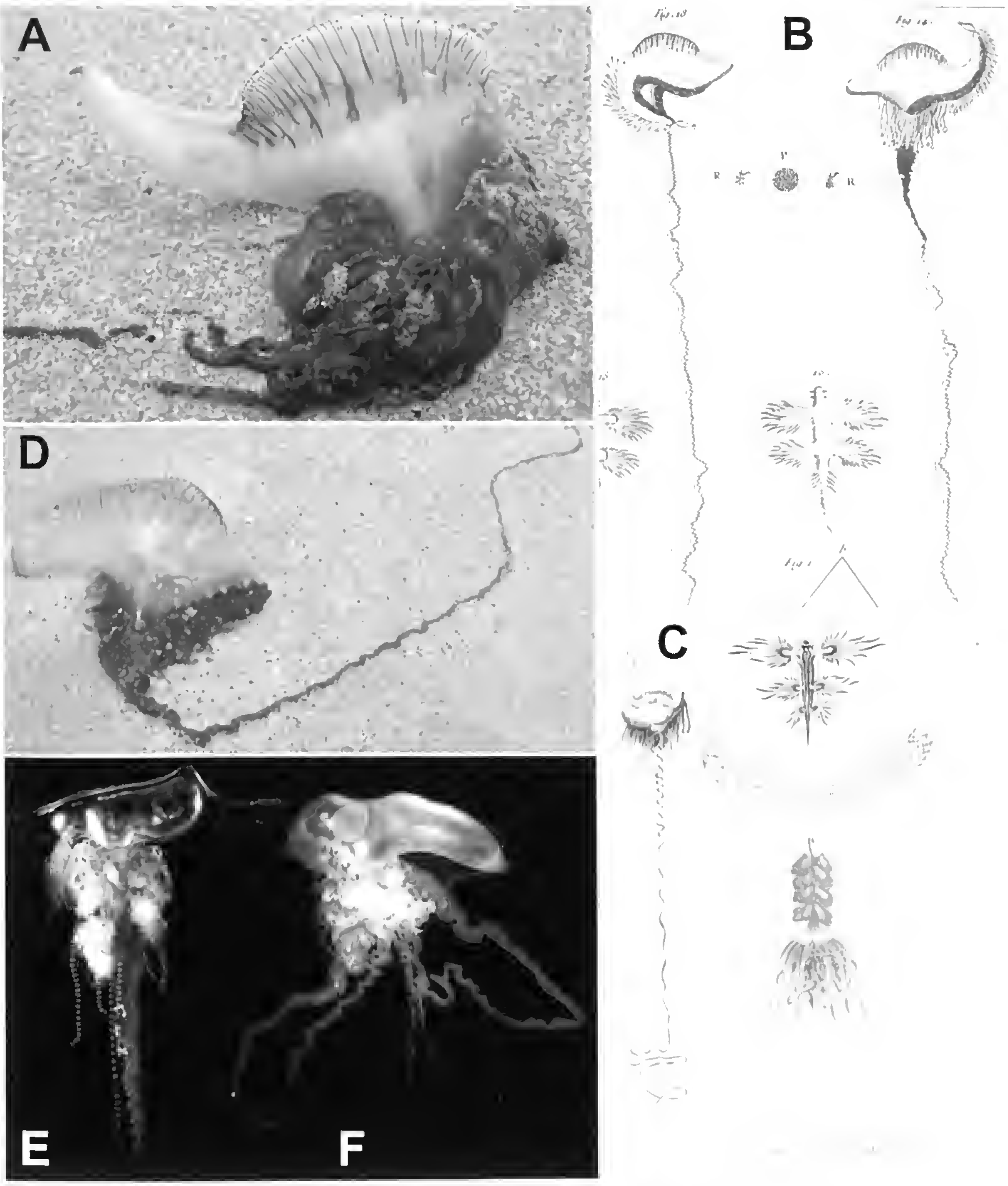


FIG. 4. A–C: *Physalia utriculus* (note shape of half-crest) , A. float length 6–7 cm, Sydney; B. Original figure of unnamed medusa in La Martinière (1787: Pl. II, figs. 13, 14). C. *Physalia megalista* (= *P. utriculus*) as figured by Péron & Lesueur (1807: pl. XXIX, fig. 1). D. *Physalia* sp. 1, common form with a full crest and no posterior prolongation of float; float length 6–7 cm; Stradbroke I., Feb. 2005. E. *Physalia* sp. 2, rarer form lacking obvious crest on float; float length 3–4 cm. F. *Physalia* sp. 3, non-crested multiple main fishing-tentacle form; float length 6–7 cm, preserved. (Photo A is copyright B. Curley; used with permission).

specs used in vinegar inhibition experiment, 1–2.5 cm float length. **WA**: WAM-Z4735, North I., Abrolhos, L. Marsh, 7.09.1976, float c. 4 cm.

Specimens determined by Dr Ronald Southcott (unpublished notes), and attributable to *Physalia utriculus*. South Australia: A253, *Physalia physalis*, Beachport, 27.07.1953. A996 *Physalia pelagica*, 1 spec, found opposite Cambridge Terrace, ¼ mile south of Brighton jetty, 18.21.1967. A997 *Physalia pelagica*, 6 specs, Brighton, 18.12.1967 [2 pages of sting notes]. A999 *Physalia physalis*, 1 spec, Tennyson, 20.12.1967. A1375 *Physalia physalis*, 1 spec, Aldinga Beach, 27.12.1972. A1929 *Physalia physalis*, 5 specs, Brighton, 28.12.1976. A2276 *Physalia physalis*, 1 spec., Marion Bay, Yorke Peninsula, 3.01.1976. **QLD**: SAM coll. A317, *Physalia*, Turtle Creek, N Qld, 14.12.1958 (scarce around Cairns). A319–322 *Physalia*, N Qld, Dec. 1958; see excellent drawings A322, SAM coll. A338 & 339 *Physalia utriculus*, Green I., 24.12.1958; 'collected on the sand of the southern beach at high tide ... These were the only *Physalia* found during a complete circuit of the island. Sky clear, water clear. Light easterly wind causing ripples only. (Northerly winds had blown 19th to 22nd inclusive, no breeze on 23rd.)', SAM coll. A407 *Physalia utriculus*, Ellis Beach, Cairns, 6.12.1959, depth 3' (i.e., at surface in water 3' deep), SAM coll. A408 same, Cairns region, found alive in bottle on back steps. A448 *Velella*, Bell's Beach, near Daintree River, Cairns, 7.07.1960, 'sky overcast but bright, tide rising, wind strong SE for three days, still blowing 20+ knots; accompanied by *Physalia* varying from ¼ to 1½ inches float length', SAM coll. A737 *Physalia utriculus*, Middle Point, nr Cape Northumberland, about middle Dec. 1963; 'hundreds of these were blowing to Middle Point', SAM coll. A1239 *Physalia physalis*, 1spec., Magnetic I., 5.11.1967. **Subantarctic**: A1043 *Physalia physalis*, Macquarie I., 20.08.1967, on beach.

Diagnosis. *Physalia* with a single main fishing tentacle. Float with high conspicuous crest confined to medial half, with short anterior uncrested extension, and long, cylindrical, tapering, posterior extension. [A fuller description will be provided as part of a future revision].

Remarks. Most reports of a *Physalia* in Australian waters have been attributed to *P. physalis* (presumably following Totton (1960) in recognising only this species). However, the most common *Physalia* around Australia is the single-tentacled form that more recent literature has begun to refer to *P. utriculus* (see synonymy). Based on morphological, molecular, biochemical, toxicological, and distributional data, it has become clear that *P. utriculus* is distinct from *P. physalis* and should therefore be recognised (Fenner 1993; Bardi 2007). See http://www.reef.crc.org.au/publications/brochures/Bluebottles.htm. Because of the many names that have been confused and synonymised with *P. physalis*, and because no type material is believed to now exist, we hereby select as a neotype for *P. utriculus* a specimen from Moreton Bay, Queensland (QM-G3788) (see Material Examined). The original type locality of 20°N, 179°E, is in the North Pacific Ocean to the south-east of Wake Island, and would not be easily resampled.

Physalia megalista Péron & Lesueur, 1807 (see original illustration reproduced in Fig. 4C), was described from off New South Wales, and it is clear to us that this is the same species that was earlier described as *P. utriculus*. Type material is also no longer extant for this species. To prevent any future nomenclatural confusion, we here simultaneosly erect the neotype specimen of *P. utriculus* (specimen from Moreton Bay, QM-G3788) as the neotype for *P. megalista*, thus making them objective synonyms, with *P. utriculus* the oldest available, and senior name.

Collection records exist for *P. utriculus* in all Australian states except the Northern Territory (P. Alderslade, NTM, pers. com., Jan. 2000). Its absence from the Northern Territory is curious, and probably simply a collection artefact as another pleustonic form, *Porpita*, has been recorded in Darwin Harbour.

The name *Physalia utriculus* is generally attributed to La Martinière (1787: 365, pl. 2, fig. 13, 14); however, in his description of the species, he attributes it to a new genus, without naming either the genus or the species. This is most perplexing, because we are unable to determine how this species got its name. Gmelin (1791: 3155–3156) appears to be the first to use the species name *Medusa utriculus* in print, crediting the species to La Martinière (1787). It therefore appears that Gmelin is actually the true author of the name, and subsequent authors perhaps simply followed Gmelin in attributing it to La Martinière.

Physalia spp.

(Fig. 4D, E, F)

Physalia physalis — Exton, 1988: 54 (treatment, QLD); Fenner *et al.*, 1993: 498–501 (stings); Williamson *et al.*, 1996: 137–139, 192–199 (comparison with other Pacific and Atlantic forms; stings); Sutherland & Nolch, 2000: 4 (comparison to *P. utriculus*); Sutherland, 2001: 609 (discussion of difference from single-tentacled form); Fenner, 2006: 4 (treatment discussion). [Not *Physalia physalis* (Linnaeus, 1758)]

Remarks. Diagnostic features separating the three Australian non-*Physalia utriculus* forms are given under Remarks for the genus. Of these three 'species', the multi-tentacled form and the full-crested single-tentacled form are both known to occur in the Moreton Bay region. The species discussed under the synonymy above is the form with numerous main fishing tentacles, the float with or without a conspicuous crest, and without a prominent uncrested aboral cylindrical extension; length typically reaching 10–15 cm. This larger, multi-tentacled form is less common than *P. utriculus*, and seems more like the true *P. physalis* of the Atlantic coasts of America and Europe. In Australian waters, the float only reaches about 10–15 cm in length, with up to four or five main fishing tentacles, whereas the Atlantic *P. physalis* is said to reach up to 30 cm with a dozen or more main tentacles. Whereas the Atlantic form has proven fatal, the multi-tentacled Australian form has not, but it has been linked with Irukandji-like symptoms (Fenner *et al.* 1993). In Queensland waters it is currently known from the Sunshine Coast (Exton 1988; Williamson *et al.* 1996: 187–198) to Townsville (M. Corkeron, pers. com., 2006). Many specimens have been collected from the Mackay region (P. Barker, Surf Life Saving, pers. com., 2008). Further details will be presented in a forthcoming paper by Fenner & Gershwin (in prep.).

Subclass TRACHYLINA Haeckel, 1879

Order TRACHYMEDUSAE Haeckel, 1866 (1879)

GERYONIIDAE Eschscholtz, 1829

Liriope Lesson, 1843

Liriope tetraphylla (Chamisso & Eysenhardt, 1821)

(Fig. 5B)

Geryonia rosacea Eschscholtz, 1829: 89.
Liriope rosacea. — Mayer, 1915: 160 (Torres Strait).
Geryonia tetraphylla Chamisso & Eysenhardt, 1821: 357.
Liriope tetraphylla. — Kramp, 1953: 301–302 (Great Barrier Reef); Blackburn, 1955: 410, 414 (SE Australia and Fremantle, WA); Kramp, 1961a: 203 (Green I., GBR); Kramp, 1965b: 135 (QLD and SE AUS, including Moreton Bay); Kramp, 1968c: 188 (SE AUS); Hamond, 1971: 27 (Moreton Bay); Hamond, 1974: 551 (WA, and eastern part of Bass Strait, Tasmania); Greenwood, 1980: 91 (Moreton Bay); Southcott, 1982: 143 (southwestern and southeastern Australia); Gorman, 1988: 14 and throughout, pl. 1 (Moreton Bay); Goy, 1990: 107–110 (Shark Bay, WA, at the front of haloclines).
[Synonymy restricted to Australian records]

Material examined. QLD: QM-G322312, Moreton Bay, L. Whale, Jan. 1981; 2.38 mm BD. QM-G4101, off Proserpine, A. Hansen, 25.04.1966. SAM-H1587 (=RVS-A323), Green I., J.H. Barnes, 20.12.1958. Palm Cove, Cairns region, approximately 500 specs collected during summers 1999–2008, examined and released, or preserved in unsorted lots. **NT:** SAM-H1246 (=GZ 0001), Stokes Hill Wharf, Darwin Harbour, 11.11.2000, W. Zeidler & L. Gershwin. SAM-H1251 (=GZ 0015), Stokes Hill Wharf, Darwin Harbour, 13.11.2000, W. Zeidler & L. Gershwin. **WA:** SAM-H1266 (=GZ 0026), mangroves north of Port of Broome jetty, Roebuck Bay, Broome, 25.11.2000, W. Zeidler & L. Gershwin. WAM-Z9943, 16 miles NW Rottnest, surface, P. Cawthorn on 'Lancelin', 9.01.1961, no. 47, 0605–0635, N 100 net at surface, over 45 fathom. WAM-Unreg., Woodman Point, Cockburn Sound, Fremantle; 6.03.1999, in plankton tow waist deep.

Remarks. Kramp (1953) noted that *Liriope* was extremely common at the Great Barrier Reef, and was taken in nearly every haul throughout the year, with a distinct peak in December–January; he also noted that he was initially inclined to divide his collection into two or three species, although he did not give further specific detail.

Other authors have also noted *Liriope* as a common species. In tropical Queensland, *Liriope* has been used in recent years as an indicator species for the presence of Irukandji jellyfishes (L. Gershwin, unpublished notes); along with salps and Narcomedusae, *Liriope* typically signals the presence an offshore water mass, which has been correlated with the influx of Irukandjis (Barnes 1964b; Kinsey 1988; Gershwin 2005a, 2005b).

CLASS SCYPHOZOA Goette, 1887

ORDER SEMAEOSTOMEAE L. Agassiz, 1862

PELAGIIDAE Gegenbaur, 1856

Chrysaora Péron & Lesueur, 1810

Chrysaora sp.

(Fig. 5C)

?*Chrysaora* sp. — Payne, 1960: 9 (Qld waters); Kramp, 1968b: 83 (Moreton Bay, as *C. hysoscella*); Dawson, 2004: 249–260 (Noosa Heads, Qld).

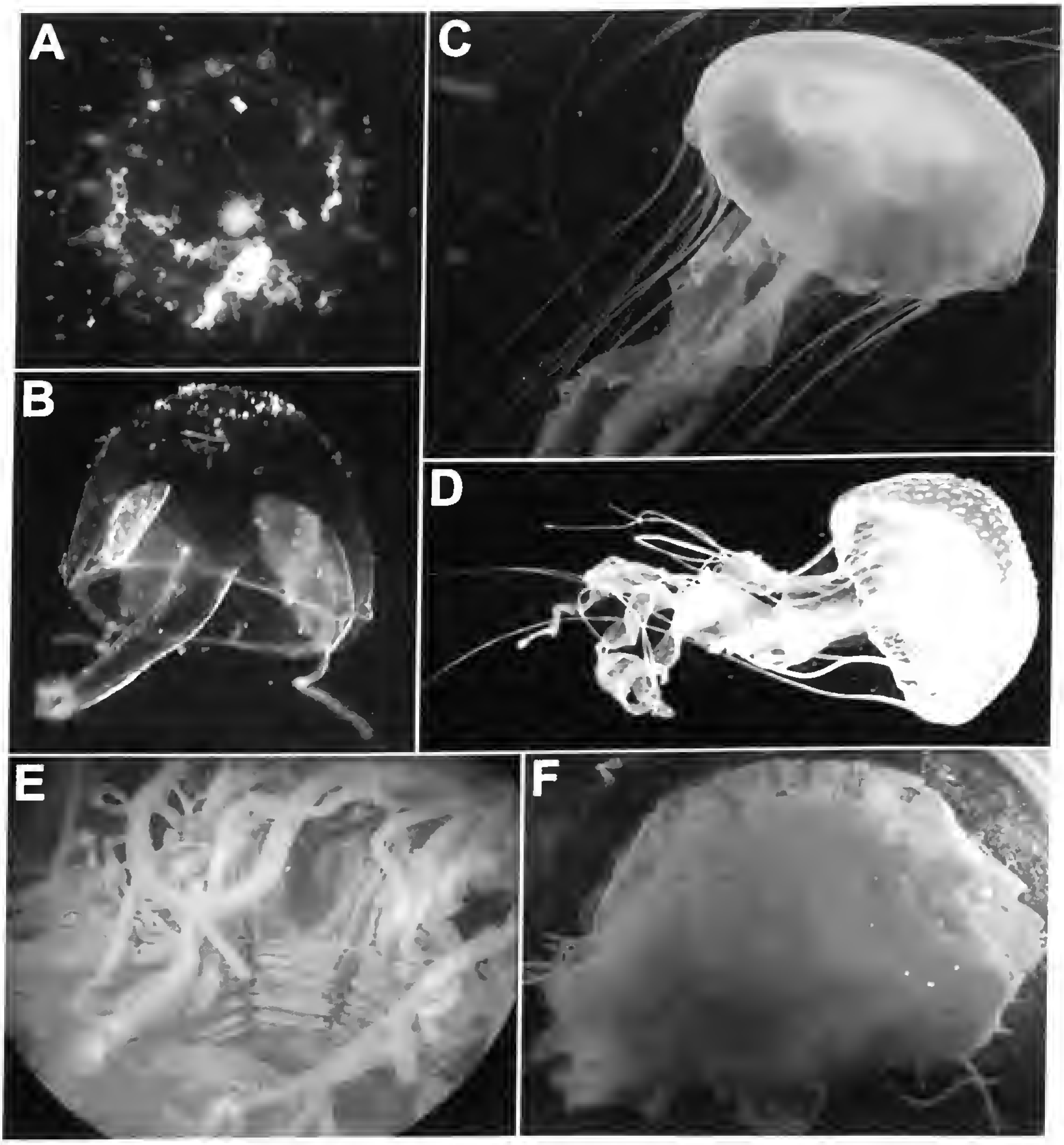
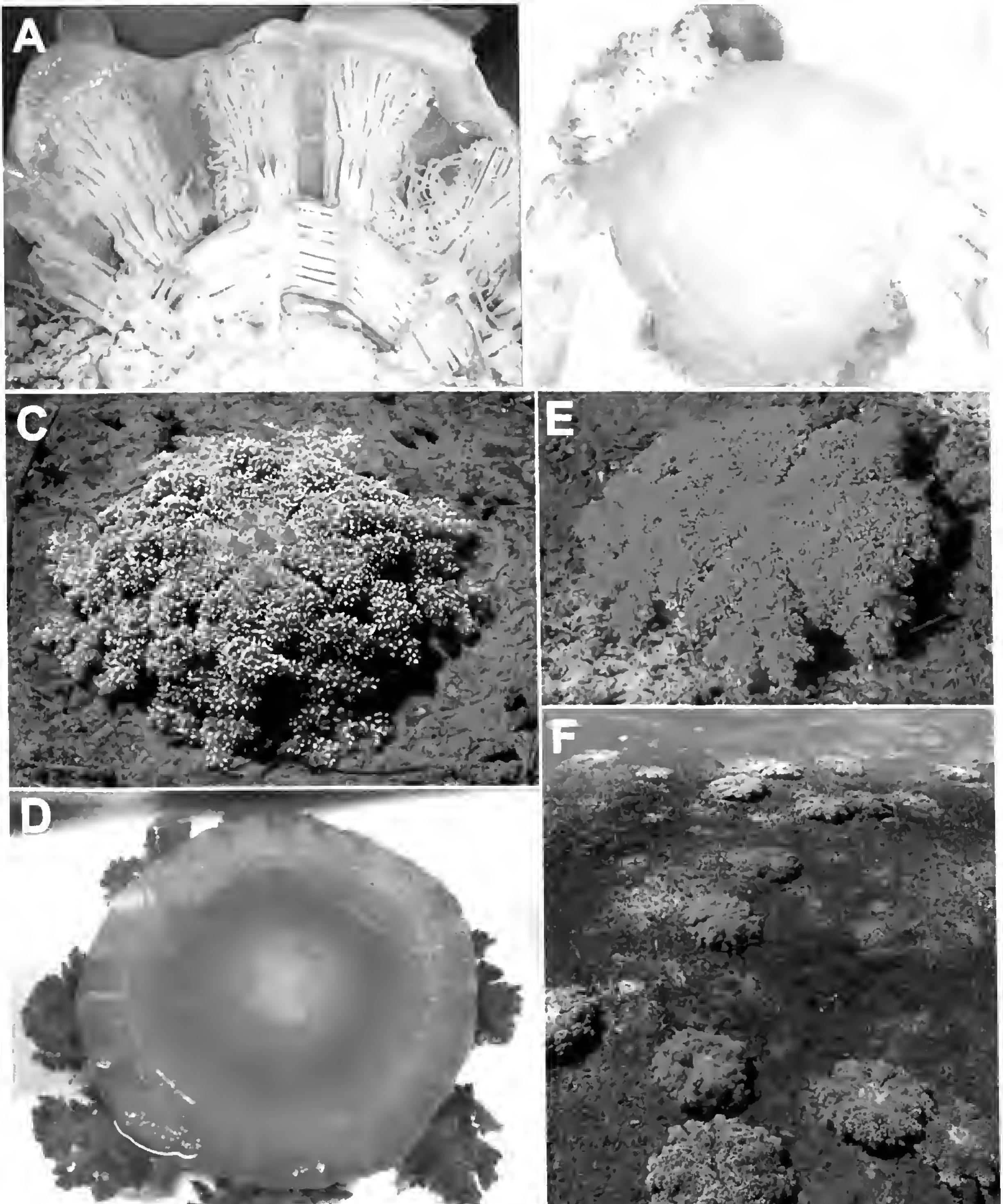


FIG. 5. **A**. *Phialella* sp., live, from Moreton Bay (QM-G322310). **B.** *Liriope tetraphylla* (Chamisso & Eysenhardt), live, from Palm Cove, Cairns region, Qld, 1999. **C.** *Chrysaora* sp., live, from Moreton Bay (Underwater World, Sunshine Coast). **D.** *Pelagia* cf. *noctiluca* (Forsskål), live, from Magnetic I., off Townsville, Qld, 2006. **E, F,** *Cyanea* cf. *rosea* Quoy & Gaimard, sensu Dawson; specimen from Myora, Moreton Bay, QM-G5299. E. Quadrant of subumbrellar surface; note intrusions into muscle bands. F. Exumbrellar view; note gelatinous warts.

FIG. 6. **A, B,** *Cyanea barkeri* sp. nov., holotype, from Moreton Bay (QM-G322752). A. Subumbrella; note heavy muscle bands lacking intrusions. B. Exumbrella; note lack of warts. **C, D,** *Cassiopea maremetens* sp. nov., holotype, from Moreton Bay (QM-G326486). C. Subumbrella, live (image copyright Queensland Museum, used with permission). D. Exumbrella, preserved; note lack of white pigment blotches. **E, F,** *Cassiopea maremetens* sp. nov. E. Live, note colour difference from holotype and similar distribution of appendages. F. Population in situ, at time of holotype collection. Both images copyright Queensland Museum, used with permission. ▶


A
C
E
D
F

Material examined. SAM-H1067, Pumicestone Passage, 27 May 2000; 1 specimen, raised by Puk Petersen (Underwater World, Sunshine Coast) from wild caught ephyra to approximately 8 cm BD; tissues preserved in EtOH [SAM-XH00438].

Remarks. This unusual species of *Chrysaora* from northern Moreton Bay resembles *Chrysaora kynthia* Gershwin & Zeidler, 2008, recently described from the Perth region, in having loosely coiled ribbon-like gonads, a colourless, somewhat cloudy body, and no star pattern or exumbrellar pigment of any sort. At 8 cm bell diameter, the specimen has 24 tentacles (i.e., 3 per octant) and the gonads are well developed. The precise relationship between the Qld and WA forms has not yet been established, but seems unlikely to be identical.

No descriptive notes were given by Payne (1960) or Dawson (2004), so it is impossible to determine whether they had the same form. This colouress, 24-tentacle form from Moreton Bay is easily distinguished from its closest geographical neighbor, *Chrysaora wurlerra* Gershwin & Zeidler, 2008, from NSW, because *C. wurlerra* has a conspicuous exumbrellar star pattern, and typically 40 tentacles.

Pelagia Péron & Lesueur, 1810

Pelagia Péron & Lesueur, 1810: 349.

Remarks. *Pelagia noctiluca* is often reported in Australian waters. However, these identifications appear to be erroneous. As noted by Gershwin & Zeidler (2008), it is apparent that there are at least two unique forms of *Pelagia* in Australian waters, neither of which matches the European form. Specifically, whereas the European form is relatively flat when relaxed, reaches about 100 mm in bell diameter, and has a transparent and colourless body with various colouration accents on the nematocyst warts, gonads, and oral arm edges (Russell 1970), the Australian form common along the east coast is smaller, uniformly translucent pink throughout, and has a more rigid, stiff, thick, helmut-shaped bell, even when preserved. Another type, found only rarely in the Sydney region, is larger and flatter, and has extremely fine tentacles; the body is colourless. A third form, found only once in the Bass Strait, is more similar to the European form, in having a larger, flatter, transparent body, with thick tentacles. The genus is in urgent need of revision.

Pelagia can deliver a painful sting, which may produce serious or ongoing health effects (Williamson *et al.* 1996). In December 2006, a massive swarm of *Pelagia* invaded Gold Coast beaches; many swimmers were treated for stings, but none life-threatening.

The following species have been reported from Australia:

Pelagia australis Péron & Lesueur, 1810: 350 (= p. 38) [Îles Joséphine, Great Australian Bight]; Goy, 1995: 284 [as 'indeterminable'].

Pink medusae — Bennett, 1860: 63–64 [bioluminescence, NSW].

Pelagia noctiluca (Forsskål, 1775) — Stiasny, 1931b: 31 [Port Jackson, NSW]; Dakin & Colefax, 1933: 198 [large numbers in Sydney Harbour]; Ranson, 1945: 315 [Port Jackson, NSW]; Payne, 1960: 9 [Moreton Bay region and Heron I.]; Kramp, 1961a: 204, 205 [Great Barrier Reef]; Southcott, 1963b: 21, fig. 3C [Pacific coastlines of Australia]; Thomas, 1963: 208 [Sydney region, NSW]; Cleland & Southcott, 1965: 156–157, text fig. 17, pl. 2, figs 16, 17 [QLD & NSW; stings]; Halstead, 1965: 304, pl. XLVIII, figs 1, 2; Kramp, 1965a: 259–260 [Sydney, NSW; Turu Cay, Qld]; Bennett, 1966: 49, pl. 26 [NSW]; Gillett & Yaldwyn, 1969: 42 [eastern Australia]; Edmonds, 1975: 97–98 [medical effects]; Coleman, 1979: 61 [VIC]; Greenwood, 1980: 91 [Moreton Bay]; Coleman, 1981: 20, 67 [NSW, VIC, TAS, SA, WA]; Sutherland, 1981: 94 [Australia-wide]; Southcott, 1982: 155–156, fig. 4.46 [south-eastern Australia]; Sutherland, 1983: 385–387, fig. 26.11 [Australia-wide]; Edmonds, 1984: 87 [twice been the cause of cancellation of Australian Surfing Championships]; Fancett, 1986: 379–384 [Port Phillip Bay, VIC]; Fenner, 1986: 100 [Hamilton I., Qld]; Marsh & Slack-Smith, 1986: 35–38, fig. 26 [WA]; Dakin & Bennett, 1987: 171 [NSW]; Fenner, 1987: 97 [rare in Qld]; Williamson *et al.*, 1987: 223 [sting effects and treatment, N Qld]; Edgar, 1997: 146 [circum-Australian and Tas]; Davie, 1998: 239 [Moreton Bay]; White *et al.*, 1998: 118 [sting information]; Sutherland & Sutherland, 1999: 92 [Australia-wide]; Edgar, 2000: 146 [circum-Australian and Tas]; Sutherland & Nolch, 2000: 16 [Australia-wide. All Australian records are likely to apply to species other than the true *P. noctiluca*, which is flatter and larger, and has a softer body].

Pelagia panopyra (Péron & Lesueur, 1807) — Haeckel, 1880: 509; von Lendenfeld, 1884b: 266–267 [tropics, Australia to Peru]; von Lendenfeld, 1887: 18–19 [tropics, Australia to Peru]; Dakin & Colefax, 1933: 198 [NSW]; Dakin & Colefax, 1940: 240 [NSW]; Bloomfield, 1961: 46–47 [Southport, Qld]; Pope, 1963: 193 [wave of stingings late November, NSW]; Thomas, 1963: 208 [NSW].

Pelagia spp. — Holmes, 1996: S26 [N Qld]; Williamson *et al.*, 1996: 228–231, pl. 8.86A [sting information; Australia-wide]; Gershwin & Zeidler, 2008: 15 [eastern Australia].

Pelagia sp.
(Fig. 5D)

Material examined. QLD: QM-G304074, Stradbroke I., 27.30'S, 152.35'E, R. Raven, 7.01.1979; 25.86 mm BD, immature. QM-G5480, Southport, 14.03.1971, in surf, prevailing south east wind, falling tide, overcast day time, 12:00; 1 spec., 2 cm BD. QM-G6312, Tallebudgera, Gold Coast, 21.09.1971, 'in surf, north east wind, colour mauve'; 1 perfect specimen, 3 cm BD. QM-G6703, Caloundra, Sunshine Coast, C.C. Wallace, 11.12.1971, Curramundi Beach, washed up on beach; 1 specimen, c. 4 cm BD. QM-G2612, Proserpine, 26.03.1964; 1 specimen, c. 3 cm BD. QM-G10514, Heron I., lagoon south, C. Limpus, 1.11.1976; 2 specs, c. 1 cm & 2 cm. Photograph by P. Petersen, Underwater World, Sunshine Coast, Qld, 17.09.2000; tisues preserved in EtOH [SAM-XH00439]. Gershwin Teaching Collection, Magnetic I., Townsville, Qld, L. Gershwin, 12.06.2005 [pictured in Fig. 5D]. **NT**: SAM-H1590, Little Bondi, Gove Peninsula, Arnhem Land, Bart Currie, 29.04.1997; 1 spec., 28.58 mm BD. NTM-C010187, Gulf of Carpentaria, P. Alderslade, 5.12.1990. **WA**: NTM-C005752, Houtman Abrolhos, P. Alderslade, 9.07.1987. **TAS**: QM-G309442, Bay with Lighthouse Jetty, Deal I., Kent Group, Bass Strait, 39.2830'S, 147.1850'E, AIMS/NCI, 20.02.1990; 2 specs, 70.29 mm BD and 80.55 mm BD, excellent condition.

Remarks. All of the specimens in the present collection appear to be of the common Australian rigid, pink form, except for those from Tasmania, which are large, flat, and colourless. See discussion above regarding problems of identification of species in this genus. This is the first report of a *Pelagia* species in the Northern Territory.

CYANEIDAE L. Agassiz, 1862

Cyanea Péron & Lesueur, 1810

Cyanea Péron & Lesueur, 1810: 363.

Remarks. The systematic of Australian *Cyanea* forms are in complete disarray at this point in time. No less than 5 species have been described, and subsequently lumped in with the European form *C. capillata*. However, we have studied at least 8 different forms of *Cyanea* in Australian waters, and none matches *C. capillata* in even basic structural features (Table 8). An excellent morphological review of several of these forms was given by Condon (1997), but unfortunately this work has not been formally published. Dawson (2005c) examined forms on both sides of Bass Strait, concluding that at least two species were identifiable, which he referred to *C. annaskala* von Lendenfeld, 1882, and *C. rosea* Quoy & Gaimard, 1824. We are currently preparing a full revision of the Australian *Cyanea*.

The following *Cyanea* species have been previously reported from Queensland:

Cyanea capillata — Pope, 1953b: 111 [NSW & QLD]; Payne, 1960: 10, 47–49 [predator of *Catostylus*; numerous locations throughout southern Qld, including Moreton Bay]; Halstead, 1965: 302, 339, pl. XLIV, figs 1, 2, SA, pl. XLV [GBR]; Kramp, 1965a: 260–261 [SA, VIC, and QLD]; Bennett, 1966: 49, pls. 27, 28 [Australia-wide]; Gillett & Yaldwyn, 1969: 40 [eastern and southern beaches]; Edmonds, 1975: 86–88 [medical effects; widespread throughout Indo-Pacific]; Greenwood, 1980: 91 [Moreton Bay]; Coleman, 1981: 66, and photo centre-right, p. 20 [QLD, NSW, Vic, Tas, SA]; Southcott, 1982: 153–154, fig. 4.45, pls. 14.3, 16.1 [Australia-wide]; Fenner & Fitzpatrick, 1986: 174 [Mackay, Qld]; Gorman, 1988: 13 [Moreton Bay]; Edgar, 1997: 145 [WA to N Qld, including Tas]; Edgar, 2000: 145 [WA to N Qld, including Tas]; Sutherland & Nolch, 2000: 17 [circum-Australian]. [Not *Medusa capillata* Linnaeus, 1758].

Cyanea nozakii — Davie, 1998: 238 [Moreton Bay]; Dawson, 2005c: 361–370 [Cairns]. [Not *Cyanea nozakii* Kishinouye, 1891]

Cyanea spp. — Barnes, 1960: 993–999 [Qld]; Southcott, 1960: 21, fig. 4A [SA]; Southcott, 1963b: 21, fig. 4A [QLD, SA]; Cleland & Southcott, 1965: 152–154 [QLD, Vic, NSW, SA]; Marsh & Slack-Smith, 1986: 40 [WA and QLD]; Williamson *et al.*, 1996: 232–235, pls. 8.57, 8.89–8.94 [stings, Australia-wide]; Condon, 1997: 1–50 (plus plates and tables), various [Australia-wide, including collections from Moreton Bay].

Cyanea cf. *rosea* Quoy & Gaimard, 1824
(Fig. 5E, F)

Cyanea rosea — Dawson, 2005c [? *Cyanea rosea* Quoy & Gaimard, 1824a, b].

Material examined. QM-G5299, 1 immature spec. (48.97 mm BD), Myora, N. Stradbroke I., SE Qld, in coral patch, D. Tranter, 27 July 1951 [identified by P. Pennycuick [*sic*] as *Cyanea* sp.].

Remarks. This specimen from Myora is clearly a juvenile, but it nonetheless possesses a combination of structural characters that separate it from those species summarised by Condon (1997: Table 4.3): a papillose exumbrella, 1:1 tentacle clusters, pleated muscles with intrusions, and raised radial septa. In comparison, *C. lamarckii*, *C. annaskala*, and *C. muellerianthe* also all have a papillose umbrella and 1:1 tentacle clusters, but have simple folds, no muscle intrusions, and flat septa; *C. buitendijki* and *C. mjobergi*, like the Myora form, have pleated muscles with intrusions, and raised septa, but both have a smooth umbrella and narrow tentacle clusters. When Dawson (2005c) applied Quoy & Gaimard's name *C. rosea* to his NSW form, he regrettably gave only brief morphological notes on the species; however, it seems to be a match for the Myora form. It would be informative to collect fresh, mature material of the Myora form, to better understand its relationship with Dawson's *C. rosea*.

Cyanea barkeri sp. nov.
(Fig. 6A, B)

Material examined. HOLOTYPE. QM-G322752, Gold Coast region, precise locality and date unknown, Qld Surf Life Savers; 32 cm BD, gravid female. PARATYPES. QM-G309332, North of Keeper Reef, 18°45'S, 147°16'E, 19-01-1989; 1 spec, c. 15 cm BD, cut in half. QM-G322753, Gold Coast region, precise locality and date unknown, Qld Surf Life Savers; approx. 25 cm BD. SAM-H1585, Mackay Harbour Beach, Mackay, 17.01.08, P. Barker (lifeguard), large swarms previous days; 1 specimen, c. 20 cm BD. OTHER MATERIAL. SAM-XH00429, ethanol-preserved tissues from paratype SAM-H1585. SAM-XH00440, Pumicestone Passage, Moreton Bay, Qld, P. Petersen, Apr. 2000; ethanol-preserved tissues, in life dark brown with white spots. SAM-XH00441, Pumicestone Passage, Moreton Bay, Qld, P. Petersen, Apr. 2000; ethanol-preserved tissues, in life light brown with dark spots. SAM-XH00442, Pumicestone Passage, Moreton Bay, Qld, P. Petersen, Apr. 2000; ethanol-preserved tissues, in life light brown with white margin. SAM-XH00443, Pumicestone Passage, Moreton Bay, Qld, P. Petersen, Apr. 2000; ethanol-preserved tissues, in life dark brown with light dots.

Description of holotype. Bell large, flat, thick, heavy, with large lappets; all specimens with damaged margin, such that marginal morphology cannot be unequivocally interpreted. Exumbrellar surface smooth, lacking gelatinous papillae; covered in finely granulated, sandpaper-like texture.

Subumbrella musculature well developed and conspicuous, in 16 proximal coronal fields and 16 distal radial fields. Coronal muscle fields completely separated by large, heavy, knobby, gelatinous septa, protruding from the subumbrellar surface approximately 1 cm in large specimens; individual muscle bands attached to septa vertically, giving each muscle field a pleated appearance; rhopaliar fields with about 9 large folds; tentacular fields half again as broad as rhopaliar fields, with about 7 large folds. Radial muscle fields protruding slightly into coronal fields, more or less 5-sided, pointed proximally, with flaring sides, and a broadly rounded distal edge; about 6–7 large muscles at base, flaring out to about 20–22 large and small near margin. Canal intrusions from the gastro-vascular sinus lacking in both coronal and radial muscles.

Tentacles arising from the subumbrellar surface near the margin, in 8 adradial horseshoe-shaped groups; groups more than twice as long as broad, each with approximately 300 fine, hollow tentacles, arranged in a crowded row up to 6 tentacles thick. Tentacular nematocysts in a crowded arrangement of fine gelatinous warts.

Oral arms 4, perradial, curtain-like, of flimsy gelatinous consistency, hanging freely under the body, co-mingling with 4 interradial gonads, also hanging freely under the body in a curtain-like manner.

Colour in life: highly variable, including uniform reddish-brown or golden, or whitish

Table 8. Comparison of *Cyanea* species reported in Australian waters. Named species data from original descriptions, plus Bigelow (1913), Kramp (1961b), Russell (1970), and Condon (1997).

Species	Bell surface	Muscles	Intrusions	Septa	Lappets	Tentacle groups
C. capillata (Linnaeus, 1758)	Smooth	Flat, simple; 13–15 circular	Present	Flat	Bifurculate	1:1; 70–150 or more
C. lamarckii Péron & Lesueur, 1810	Papillose	Simple folds; 16–20 circular	Absent	Flat	Bifurculate	1:1; 40 to 60
C. annaskala von Lendenfeld, 1882	Papillose	Simple folds; 16–20 circular	Absent	Flat	Bifurculate	1:1; Up to 150
C. muellerianthe Haacke, 1887	Papillose	Simple; 15–18 circular	Absent	Flat	Bifurculate	1:1; up to 150
C. mjobergi Stiasny, 1921	Smooth	Pleated; 6–7 circular, 4–5 radial, halfway into circulars	Present	Raised	Rounded	1.5:1; hundreds
C. buitendijki Stiasny, 1919	Smooth	Pleated; 7–9 circular	Present	Raised	Rounded	>2:1; up to 200
C. nozakii Kishinouye, 1891	Smooth	Pleated; 5 (or 9–10) circular, 5 radial	(Not indicated)	Broad, round, long, gelatinous ridges, well above muscles	No distinct rhopaliar lappets	1:1; up to about 100
C. rosea Quoy & Gaimard, 1824 (sensu Dawson, 2005c)	Papillose	Pleated; 11–14 circular	Present	(Not indicated)	Bifurculate	1:1; (no. not indicated)
C. cf. *rosea* QM-G5299, Myora	Papillose	Raised, pleated: 9 circular, 3 radial	Present	Raised	? (margin damaged)	1:1; many
C. barkeri sp. nov.	Smooth	Pleated: 7–10 circular, 6 radial	Absent	Broad, T-shaped gelatinous ridges, with muscles to top	? (margin damaged)	>2:1; c. 300

with dark spots, or cream-coloured with dark brown lappets.

Etymology. The specific name, *barkeri*, is in honour of Paul Barker, the Lifeguard Supervisor in the Mackay region, and his brother, Dave, an avid fisherman. Paul and Dave know the marine life of the Mackay region comprehensively, and this intimate knowledge and keen observations have led to their finding many species new to science. It is a great honour to thank them by naming this conspicuous species after them.

Sting notes. Like its congeners, *Cyanea barkeri* can deliver a painful sting, but not typically life threatening. According to Paul Barker, the sting presents as numerous linear whiplike raised wheals, whitish with a red lateral flare. Patients often state that it feels like a lightning rod zap when first hit, very sharp and painful, often covering a large area; the pain is easily relieved with ice, and dulls more quickly than a blue bottle; some patients, particularly with large stings to the body trunk, have trouble breathing. The stings of Cyanea barkeri are not typically prone to scarring, with the sting marks disappearing in 1.5–2 weeks. First aid should include rinsing with seawater (NOT freshwater!) to remove microscopic nematocysts, whether tentacles are present or not, followed by application of ice for pain.

Ecological notes. According to Paul Barker, every 4–5 years large masses of *Cyanea* are observed, typically coming on an easterly swell rather than northerly or southerly. The last was Christmas time, 2007–2008: the swarms arrived in Townsville first, then Mackay, then Cairns, causing beach closures due to stings. During this period, Paul treated about 40–50 stings in a single day. The swarms comprise specimens of a variety of colours and patterns, with all apparently giving the same type of sting. The largest specimens are about 40 cm BD; with most specimens being about 25–30 cm BD.

Remarks. *Cyanea barkeri* is most similar morphologically to *C. nozakii*, in that both have smooth exumbrellar surfaces, pleated subumbrellar muscle bands, and well developed gelatinous ridges separating the circular muscle fields. The most conspicuous difference is in the gelatinous septa separating the circular muscle fields: in *C. nozakii*, these septa are straight, extend well beyond the circular muscle fields into the radial muscle fields, and protrude well above the muscle attachments (see photograph in Bigelow, 1913: pl. 4, fig. 5); in *C. barkeri*, the circular muscle bands nearly cover the septa, which are shorter and T-shaped, with the radial muscle bands extending proximally to the distal edge of the circulars, and the most distal circular bands considerably shorter than the others, due to their attachment along the 'cross-bar of the T' (Fig. 6A). The tentacle groups are also different between the two species, being about as long as wide in *C. nozakii*, with bowed-out or convexly rounded side walls, whereas in *C. barkeri*, the tentacle groups are considerably longer than wide, and the side walls are very straight, giving an almost perfectly squared-off appearance to the clusters; furthermore, *C. nozakii* appears to have about 100 tentacles per group, whereas *C. barkeri* has well over 300. Finally, we have been unable to determine whether the true *C. nozakii* (i.e., from Japan) has gastro-vascular protrusions into the subumbrellar muscle bands; *C. barkeri* does not; thus, if they are present in *C. nozakii*, that would be another prominently distinguishing character. It would be helpful when revising the genus to compare *C. nozakii* type material, if available, or at least material from the type locality, in an effort to establish what other differences exist between the two forms.

Order RHIZOSTOMEAE Cuvier, 1817
Ssuorder KOLPOPHORAE Stiasny, 1921a

CASSIOPEIDAE Tilesius, 1831

Cassiopea Péron & Lesueur, 1810

Cassiopea Péron & Lesueur, 1810: 356.

Remarks. Many of the Queensland records listed below are likely to be attributable to *Cassiopea maremetens* sp. nov. However, without specimens for examination, we are forced to leave them as uncertain records.

Previous Queensland records of *Cassiopea* spp.:

Cassiopea andromeda (Forsskål, 1775) — Stephenson *et al.*, 1931: 50, 71 [Low Isles]; Stiasny, 1931a: 140–141 [Low Isles, GBR, Qld]; Stephenson, 1962: 94 [Myora, Stradbroke I.]; Holland, 2004: 1121 [Port Douglas, Qld].

Cassiopea andromeda var. *baduensis* Mayer, 1915: 183–184, fig. 3 [Badu I., Torres Strait, Qld].

Cassiopea ndrosia Agassiz & Mayer, 1899 — Stiasny, 1934: 913–921 [Hayman I., Whitsundays, Qld]; Kramp, 1965a: 265 [Hope I., Gold Coast, and Thursday I., Torres Strait, Qld]; Kramp, 1970: 18 [Japan to Tahiti, including Australia]; Southcott, 1982: 159, pl. 15.3, 15.4 [Port River, SA].

Cassiopea ornata Haeckel, 1880: 570–571, pl. 37 [northern Australia]; von Lendenfeld, 1884b: 285 [summary]; Kramp, 1970: 18 [Japan to northern Australia].

? *Cassiopea xamachana* R. P. Bigelow, 1892 [Barnes notes, unpublished: J1682, Cockle Bay Reef, Magnetic I., Qld; coll. Dr. Straughn, 19 July 1966].

Cassiopea spp. — Barnes notes, unpublished: J780 [Gon Bung Point, Weipa, Qld; coll. Geoff Webster, 30.07.1961, 'quite common on rock and mud flats at low tide']; Cleland & Southcott, 1965: 160 [Qld reports, stings]; Williamson *et al.*, 1996: 212–213 [northern, eastern and southern Australia].

Cassiopea maremetens sp. nov.
(Fig. 6C–F)

Cassiopea andromeda. – Stephenson, 1962: 94 (Myora, Stradbroke I.). [Not *Medusa andromeda* Forsskål, 1775]

? *Cassiopea ndrosia*. – Kramp, 1965a: 265 (Hope I., Gold Coast).

Material examined. HOLOTYPE. QM-G326486, Lake Magellan, off Lamerough Canal, Pelican Waters, SW of Caloundra, 26° 49′ 42′ South, 153° 6′ 48.6′ East; coll. D. Potter & G. Cranitch; 24.05.2007; about 20 cm BD [pictured in Fig. 6C, D]. PARATYPES. QM-G327932, same data as holotype; 2 specs, c. 8 cm & 15 cm BD, no vesicles among arms. QM-G2519, Myora, in pools near mangroves, N. Stradbroke I., Moreton Bay, W. Stephenson, Zoology Dept, Univ. Qld, 26.07.1961; 10 specs, 2–4 cm BD, 9 with no vesicles among arms, 1 with a single central vesicle. QM-G10491, Woogoompah, southern Moreton Bay, NE edge of Avicennia Is., 15.09.1976; 1 spec, c. 5 cm BD, poor condition, no vesicles among arms. QM-G7662, Proserpine area, A. Hansen, 1972; 1 spec, 9 cm BD, poor condition, no vesicles among arms. QM-G5328, Repulse Bay, A. Hansen, 1964; 2 specs, 6 & 9 cm BD. QM-G6645, Mud I., Moreton Bay, C. Wallace, 8.04.1972; numerous specs, c. 12 cm BD, most lacking vesicles, 1 with numerous microscopic paddle-shaped vesicles and short filaments on central disk. QM-G327970, Moneys Ck., via Bugara, Bundaberg Creek mouth, C. Limpus, no date; 1 spec, 10 cm, poor condition, 1 small vesicle at central disk and at fork in base of arms. QM-G327969, Bentinck I., estuary on NW side of island, P. Davie, 20.11.2002; 2 specs, c. 12–15 cm BD, small vesicles among mouths on central disk. OTHER MATERIAL. Photographs from Pumicestone Passage, P. Petersen, 2000; 2 specs, c. 27 cm BD, tissues preserved in EtOH [SAM-XH00446, SAM-XH00447].

Diagnosis. *Cassiopea* with a broad, shallow, aboral concavity; with about 19 rhopalia; with four square lappets per paramere; with oral arms round in cross section, about 1.5 times as long as bell radius, with 4–6 alternate branches, bifurcated distally; with 1–2 appendages stemming from the central point of the disk, plus one at the base of each pair of oral arms, plus one at distal bifurcation of each oral arm, or lacking; colouration uniform beige to brown to olive green, lacking exumbrellar white blotches or streaks, ocelli not observed.

Description of holotype. Bell flat, with a broad, shallow central concavity. Exumbrellar surface smooth, lacking warts or obvious nematocyst clusters.

Oral disk small, with 2 narrow, flat, leaf-shaped appendages arising from the middle, each about 2 cm long; 4 additional similar appendages arise from the disk, one in the axil of each pair of oral arms, which do not otherwise appear grouped.

Oral arms 8, round in cross section, about half again as long as bell radius; bearing 4–6 alternately arranged, lateral branches, shorter proximally, longer distally, with the central trunk ending in a bifurcation. Each arm bears a narrow, flat, leaf-shaped appendage at the axil of the terminal bifurcation, similar in size and form to those on the oral disk. Thus, each arm bears only a single appendage, plus the one shared near the base. Mouthlets are arranged in a crowded manner along the oral edge of all arms and branches.

Rhopalia 19, within deeply incised notches of square-shaped lappets; each rhopaliar lappet more or less alternates with another similar sized square lappet, flanked by a pair of narrower, rectangular lappets, about half as broad. Thus, there are a total of three velar lappets between successive rhopalia, and the rhopalium is embedded at the midline of a single broad ocular lappet. Lappets are demarcated near the margin of the exumbrella by permanent furrows. Ocelli not observed.

Subumbrellar surface as a repeating pattern of fine V-shaped muscle bands, the spaces on the rhopaliar radii slightly broader peripherally than the other radii.

Stomach small, occupying about one-fourth the diameter of the disk. Gonads in a poorly-defined four-leaf-clover form within the stomach diameter.

Colour in life: variable in the population, most in the uniform olive green-brown range; this specimen beige with darker brown appendages. Exumbrellar colour not documented; when studied after six months, no trace of radial whitish blotches or streaks was found, thus raising the possibility that they were never present.

Variation. Most of the specimens lack oral arm appendages; size does not appear to be an indicator for the presence or absence of vesicles.

Etymology. The specific name, *maremetens*, literally, the gardener of the sea, is from the Greek *mare* (the sea) and *metera* (to reap, to harvest), in reference to the placid habit of *Cassiopea*, which spends its time gently farming its algal symbionts. Thanks to Emeritus Prof. Robert Milns and Prof. John Pearn, University of Queensland, who suggested this name.

Type locality. Lake Magellan, off Lamerough Canal, Pelican Waters, SW of Caloundra, Gold Coast, Queensland, Australia.

Remarks. *Cassiopea maremetens* is most similar morphologically to *C. ndrosia*, in that both share a shallow aboral concavity to the body shape, about the same number of rhopalia, and cylindrical oral arms with about the same number of branches; however, *C. maremetens* differs from *C. ndrosia* in the lappets being entirely different in shape and number, the conspicuous colouration pattern of *C. ndrosia* is lacking, the oral arms have a distal bifurcation in *C. maremetens*, whereas they do not in *C. ndrosia*, and *C. maremetens* has fewer to no vesicles amongst the mouths (Table 9). Agassiz & Mayer (1899: 175) wrote for *C. ndrosia*, there are '... a large number of leaf-shaped vesicles scattered among the suction mouths. These vesicles are more numerous near the centre than they are at the free ends of the arms'; the pattern of vesicle distribution in *C. maremetens* is consistent among different sized specimens, and one would definitely not call them numerous. We are left wondering about the specimens that lack vesicles; specifically, whether this represents a hitherto unidentified cryptic species, or simply an alternate state of a polymorphic character in this form.

Cassiopea andromeda was previously reported from the Moreton Bay region (W. Stephenson 1962). Stephenson's specimens are no longer in good condition, and could not be unequivocally identified, except to say that the largest has a single central vesicle about 1 cm long; the others, which are smaller, do not appear to have vesicles.

Cassiopea has also been reportedly collected at low tide in the lagoon immediately north of the Marine Station at North Stradbroke I., but was not found during the period of the workshop.

Cassiopea medusae have been widely reported throughout Queensland, as well as many other localities around Australia. We have not studied most of these other collections, so we are unable to comment on the accuracy of their identities. However, two populations that we have studied at length, namely a man-made lake in Darwin, Northern Territory, and a tidal pool in Exmouth, both contain *Cassiopea* species new to science (but beyond the scope of this paper). Overseas workers have also found high rates of differentiation between populations of *Cassiopea*: Hummelinck (1968) found consistent morphological differences among Caribbean populations, and Holland *et al.* (2004) demonstrated molecular evidence of numerous species in the Hawaiian Islands.

An unnamed species of *Cassiopea*, distinct from but closely related to *C. andromeda*, was identified by Holland *et al.* (2004) based on genetic sequencing of a single specimen collected at Port Douglas (GenBank AY319471). We have not had the opportunity to compare the morphology of their form to ours, so we are unable to draw any firm conclusions about the relationship between the two. However, one

Table 9. Comparison of diagnostic characters between *Cassiopea ndrosia* Agassiz & Mayer (1899) and *Cassiopea maremetens* sp. nov., from the region around Moreton Bay.

Species	Bell diam.	No. of rhopalia	Lappets per paramere	Oral arm shape & length	Lateral arm branches	Appendages type & no.	Colour	Type locality
Cassiopea ndrosia	20 cm, with shallow depression	Variable 18–22	1–2 indistinct	Cylindrical, 30 mm long	4–5, pinnately branched	Many leaf-shaped vesicles, more numerous near center	Ash brown, with spearhead-shaped white spot on rhopaliar radii, plus short white radial streaks and numerous streaks and numerous scattered smaller spots	Fiji
Cassiopea maremetens sp. nov.	20 cm, with broad, shallow aboral concavity	c. 19	4, square	Round in cross-section, 1.5 times radius	4–6 alternate, with distal bifurcation	None, or 1–2 central, plus 1 at base of each pair of oral arms, plus 1 at distal bifurcation of each arm	Uniform beige to brown to olive green; lacking white blotches and streaks of *C. ndrosia*	Coastal QLD

would not easily mistake *C. maremetens* for *C. andromeda*. According to Kramp (1961b), in *C. andromeda*, the body is flat and disk-shaped; the lappets are short, blunt, and variable in number; the oral arms are wide and flat; four to six flat, short side branches arise from each arm in a tree-like manner; and numerous small and five or more club-shaped vesicles arise from each arm between the mouths. In contrast, in *C. maremetens*, the aboral surface of the body is concave, giving the impression that it is more bowl-shaped than flat; there are four square lappets in each paramere that are quite distinct; the oral arms and branches are round in cross section; and the number, shape, and location of oral appendages is entirely different (see Table 9). We are thus inclined to think that the species found by Holland *et al.* (2004) was not *C. maremetens*.

CEPHEIDAE L. Agassiz 1862

Cephea Péron & Lesueur, 1810

Cephea Péron & Lesueur, 1810: 360.

Remarks. Three species have been previously reported from Australian waters:

Cephea cephea (Forsskål, 1775) — Stiasny, 1926: 251 [Port Denison, Qld]; Kramp, 1961a: 204 [Green I., GBR]; ? Marsh, 1998: 394 [Shark Bay, WA]; Kramp, 1970: 13, 22 [northern coasts of Australia].

Cephea fusca Péron & Lesueur, 1810: no. 99, p. 361 (= 49) [W de Witt's Land: Kimberley & Pilbara]; Eschscholtz, 1829: 57; Agassiz, 1862: 156 [as *Polyrhiza fusca*]; Haeckel, 1880: 575 [valid]; von Lendenfeld, 1884a: 161 [valid]; von Lendenfeld, 1884b: 286 [valid]; von Lendenfeld, 1884c: 426 [valid]; Mayer, 1910: 654–655 ['probably the same' as *C. cephea*].

Cephea octostyla (Forsskål, 1775) — Stiasny, 1926: 251 [Rockhampton, Qld]; Payne, 1960: 12 [Moreton Bay]; Kramp, 1965a: 265 [Green I., GBR]; Kramp, 1970: 13 [northeastern Australia].

Cephea sp.

(Fig. 7A, B)

Material examined. QM-G327915, 1 spec. (103.40 mm BD), Frenchman's Beach, Point Lookout, North Stradbroke I., Qld, J. Truman, 20.07.2006. QM-G304075, immature spec. (69.34 mm BD), Hervey Bay, Qld, 25.03'S, 153.05'E, A. Pitt, Jan. 1980.

Remarks. Neither of the two specimens available allows for confident diagnosis. The Hervey Bay specimen looks like it was possibly washed up on the beach, or preserved in alcohol, or both; the exumbrellar papillae cannot be discerned. The Frenchman's Beach specimen is in very good condition; however, the lappets are somewhat tattered, making differentiation between rips and normal separation uncertain, and the oral arms are quite worn, with any appendages that may have previously been attached, now missing.

VERSURIGIDAE Kramp, 1961b

Versuriga Kramp, 1961b

Versuriga anadyomene (Maas, 1903) (Fig. 7C)

Crossostoma anadyomene Maas, 1903: 56-59, pl. 7, figs. 65-68.

Versuriga anadyomene — Stiasny, 1926: 256 (off Rockhampton, Qld [specimen number is in error, should read G 12046]); Stiasny, 1931b: 36–38 (Wilson Islet, Capricorn Group); Kramp, 1970: 10, fig. 1 (restricted to Indo-West Pacific).

[Synonymy restricted to Australian records]

Material examined. QM unregistered, 1 damaged gravid female specimen (c. 30 cm BD), 18.02.2005, Bare Rock, Moreton Bay, off N. Stradbroke I., coll. MBWS participants. SAM-HX00431, ethanol-preserved tissues taken from previous specimen.

Description of specimen. Bell relatively flat, shaped like a Portobello mushroom, with a reticulated, rugose exumbrellar surface, comprised of adjacent pointy geometric shapes, larger and taller nearer the centre, becoming shorter and more radially orientated toward the margin. Velar lappets rounded, 8 between adjacent rhopalia, the outer two lappets divided midway into 2; ocular lappets reduced in size compared to velar lappets, pointy. Subumbrellar muscle fields 8, roughly triangular, completely divided at the perradii and interradii, with many fine circular bands.

Subumbrellar canal system almost completely reticulated, with broad radial canals anastomosed along their entire length on the interradii and non-anastomosed to about halfway on the perradii.

Oral arms largely amputated in the present specimen; laterally compressed basally, liberally fringed adaxially with frilly mouthlets. Numerous filamentous appendages emit from among the mouthlets and from the oral disk.

Colour in life: Mesoglea translucent whitish, with exumbrellar purple reticulations near the centre, fading to brown near the margin; subumbrellar muscles brown; oral ams whitish with brown mouthlets.

Associations. A crab, *Charybdis feriatus* (ident. P. Davie, Qld Museum, Feb. 2005) and numerous juvenile fish (*Alepes apercna* Grant, 1987 (F. Carangidae); ident. J. Johnson, Qld Museum, Mar. 2008) were collected with the specimen.

Remarks. Apparently uncommon, but has been encountered a few times in the Australian tropics. This is the first record for a member of the Versurigidae from Australian subtropical waters.

Suborder DAKTYLIOPHORAE Stiasny, 1921

CATOSTYLIDAE Grenacher & Noll, 1876

Catostylus L. Agassiz, 1862

Catostylus mosaicus (Quoy & Gaimard, 1824) (Fig. 7D)

Cephea mosaica Quoy & Gaimard, 1824a: 569, pl. 85, fig. 3.

Rhizostoma mosaica — Huxley, 1849: 413–434, pl. 38, figs 26, 27, pl. 39, figs 28–34 (east coast of Australia and Bass Strait).

Crambessa mosaica — Haeckel, 1880: 622 (east coast Australia; NSW); von Lendenfeld, 1884b: 299–300 (Port Philip, VIC; Port Jackson, NSW); von Lendenfeld, 1884c: 428 (Port Philip, VIC; Port Jackson, NSW); von Lendenfeld, 1887: 30–31 (historical reports); Agassiz & Mayer, 1898: 16–18, pls. 2, 3 (discussion of regional colour differences; NSW and throughout Qld); Dakin & Colefax, 1940: 210 (estuaries, NSW).

Catostylus mosaicus — Agassiz, 1862: 152 (Port Jackson, NSW; systematics); Mayer, 1910: 666–667 (harbours and estuaries from Brisbane to Melbourne); Mayer, 1915: 190 (discussion of regional colours; Melbourne to Moreton Bay); Badham, 1917: 227 (Broken Bay, NSW; host of *Peachia*); Stiasny, 1922b: 554 (Port Hacking, NSW); Stiasny, 1924: 66–68 (Port Jackson, NSW); Stiasny, 1931a: 154–155 (Port Jackson, NSW); Stiasny, 1931b: 38–39 (plentiful at Port Curtis, Qld); Pope, 1947: 165–166 (NSW harbours and river-mouths); Pope, 1953a: 19 (NSW harbours and estuaries); Payne, 1960: 16 (Moreton Bay, Gladstone Harbour, and Gulf of Carpentaria); Southcott, 1960: 4–6 (Melbourne to Cairns); Kramp, 1961b: 370 (synopsis of reports); Pope, 1963: 193 (Norah Head, NSW; stings); Southcott, 1963a: 57–58, fig. 5g (medical effects; Qld to Melbourne); Southcott, 1963b: 21, fig. 4b (sting effects; east coast, Melbourne to the tropics); Thomas, 1963: 208 (Hawkesbury estuary, NSW); Cleland & Southcott, 1965: 160–162 (Brisbane, Sydney, Melbourne, Cairns; regional colour differences; stings); Halstead, 1965: 301, pl. 17, fig. 2, pl. 27, pl. 29; Kramp, 1965a: 271–272 (Cairns region); Gillett & Yaldwyn, 1969: 40–42, pl. 18 (southeastern Aus); Kramp, 1970: 15 (east coast Australia, Melbourne to Cairns, and south coast of New Guinea); Southcott, 1971: 2, 4–5, pl. 5, figs 4, 5 (Port Philip Bay, VIC); Edmonds, 1975: 83–85 (medical effects, eastern Australia); Coleman, 1977: 30 (all Australian states except NT [note that photo is of *Pseudorhiza haeckeli*, erroneously attributed to *C. mosaicus*]); Coleman, 1979: 58–59 (every state except NT); Greenwood, 1980: 91 (seasonality at Moreton Bay); Southcott, 1982: 157–157, pl. 15.1, 15.2 (Torres Strait to Port Philip Bay); Fancett, 1986: 379–384 (Port Philip Bay, VIC); Coleman, 1987: 36 (all states but NT); Gorman, 1988: 17, and throughout (Moreton Bay); Wells & Wellington, 1992: 57–61 (sustainability of harvest in eastern Australia); Williamson *et al.*, 1996: 209, 213–214, pl. 8.61 (NSW, QLD, and NT; stings); Edgar, 1997: 147 (Port Philip Bay, VIC, to Torres Strait, QLD); Davie, 1998: 237 (Moreton Bay); Coleman, 1999: 55 (sting effects; Moreton Bay); Edgar, 2000: 147 (Port Philip Bay, VIC, to Torres Strait, Qld); Kingsford *et al.*, 2000: 85–156, various pp. (fisheries management); Pitt, 2000: 269–279 (Botany Bay, NSW; life history); Pitt & Kingsford, 2000a: 143–155 (estuaries and bays, NSW); Pitt & Kingsford, 2000b: 791–799 (estuaries and bays, NSW); Rouse & Pitt 2000: 23–34 (Botany Bay, NSW); Sutherland & Nolch, 2000: 17 (stings; Brisbane to Port Philip Bay); Pitt & Kingsford, 2003a: 303–313 (Lake Illawarra, NSW); Pitt & Kingsford, 2003b: 117–125 (Botany Bay and Lake Illawarra, NSW); Dawson, 2004: 249–260 (Mooloolaba, Sunshine Coast, Qld); Pitt *et al.*, 2004: 115–123 (Lake Illawarra, NSW); Dawson, 2005a: 515–533 (phylogeography, Vic, Tas, NSW, QLD); Pitt *et al.*, 2005: 71–86 (Smiths Lake, NSW).

Catostylus wilkesii Agassiz, 1862: 152 (Lake Illawara, NSW).

Crambessa mosaica symbiotica von Lendenfeld, 1884e: 410 (NSW, brown form); von Lendenfeld, 1885b: 926 (NSW, brown form); von Lendenfeld, 1887: 31 (Port Jackson, NSW); Whitelegge, 1889: 197 (Port Jackson, NSW).

Crambessa mosaica conservativa von Lendenfeld, 1884e: 410 (VIC, blue form); von Lendenfeld, 1885b: 926 (VIC, blue form); von Lendenfeld, 1887: 31 (Port Philip, Port Jackson, Illawarra Lake).

Catostylus mosaicus conservativus — Dawson, 2005b: 723–731 (genetic clade adjacent to Bass Strait).

Catostylus mosaicus mosaicus — Dawson, 2005b: 723–731 (genetic clade NSW to southern Qld).

[Synonymy restricted to Australian records]

Material examined. QM-G850, Moreton Bay (no date); 5 specs, c. 8 cm BD. QM-G3891, Repulse Bay, Qld, 26.03.1966, 'pale creamy network pattern on dorsal surface of umbrella, arms purple, blue mushroom shaped tubercules'; 1 specimen, c. 8 cm BD. QM-G302860, NW of Peel I., Moreton Bay, J.N.A. Hooper & S. Cook, 3.06.1993; 1 specimen, c. 10 cm BD, poor condition.

Remarks. The phenomenon of different colour morphs of *Catostylus mosaicus* occurring consistently in different regions has been noted by many authors, particularly with reference to the Sydney form being typically brown due to symbiotic algae in the tissues, and the Port Philip Bay form being typically deep blue due to lack of these algae. These two forms were given sub-species status based on these colour differences, and hailed as newly evolving species (von Lendenfeld 1884e, 1885b). In tropical Queensland waters, *Catostylus* is typically white with a narrow blue band around the margin of the bell (Gershwin, unpub.). In Moreton Bay, Agassiz & Mayer (1898) and Mayer (1915) remarked that almost every individual of *Catostylus* was deep cobalt blue, and this is still the case (P. Davie, pers. obs.). For the hundred or so years following von Lendenfeld's separation of the two forms, other authors recognised the colour differences but did not adopt the nomenclatural separation.

Pitt & Kingsford (2000a) studied the population ecology of *Catostylus mosaicus* from six different bays in the Sydney region, concluding that variations in abundance and timing of recruitment differed among bays, suggesting that the populations are isolated breeding units.

Dawson (2005a) compared two genes from each of nine populations of *Catostylus mosaicus* sampled from north of Moreton Bay to Melbourne, and northern Tasmania. He found a deep genetic divergence between eastern and southern clades that geographically separate around Cape Howe, on the border between NSW and Victoria. He then went on to revalidate the nomenclatural separation of von Lendenfeld's original two forms (Dawson 2005b).

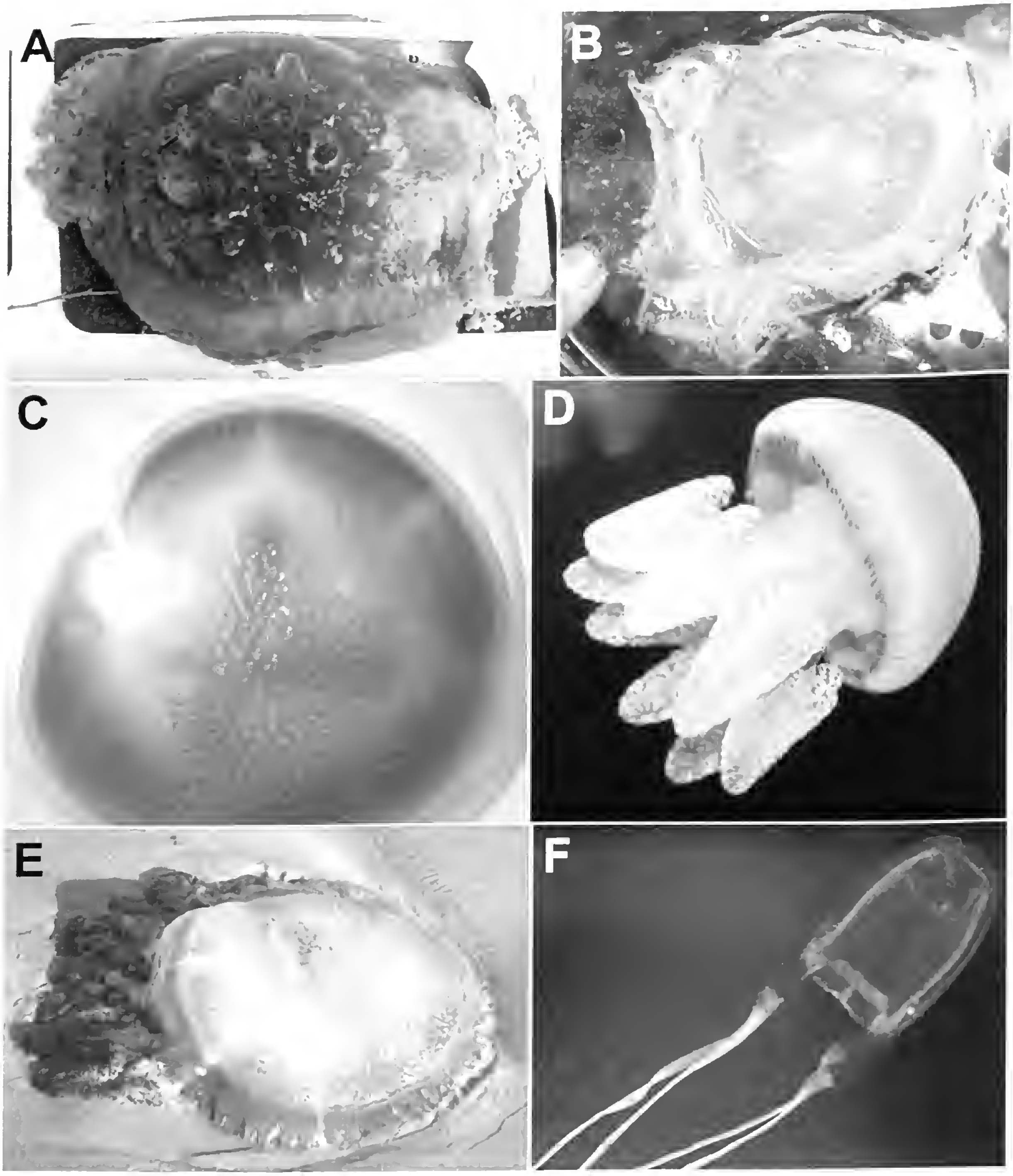


FIG. 7. **A, B**, *Cephea* sp. A. Washed up alive on sand, no specimen retained; Southport Main Beach, 13.05.2006 (photo by Col Neil, Qld Surf Lifesaving Assoc., used with permission). B. QM-G327915, Stradbroke I., Moreton Bay, preserved; fingernail = 1 cm wide. **C**, *Versuriga anadyomene*, live, (QM unregistered). **D**, *Catostylus* c.f. *mosaicus*, live, Cairns region colour morph. **E**. *Crambione cookii* Mayer, live, unregistered, washed up on beach near Mooloolaba, Sunshine Coast (photo by Puk Petersen, used with permission). **F**. 'Morbakka', live (QM-G322299), from Moreton Bay (photo copyright Queensland Museum, used with permission).

The morphology and genetics of the N Qld and Moreton Bay populations have not yet been studied in the light of this new information about the southern morphs. However based on colour alone, it seems possible that Moreton Bay and N Qld populations may also need separate species or subspecies status. Testing this hypothesis should be a priority for future research. However, before using separate names, it is important for nomenclatural stability that type specimen status be established, and neotypes, preferably with genetic voucher material, be established as required.

Crambione Maas, 1903

Crambione cookii Mayer, 1910 (Fig. 7E)

Crambione cookii Mayer, 1910: 677, pl. 74, fig. 1 (Cooktown, Qld); Kramp, 1970: 14 (only recorded from Great Barrier Reef).

[Synonymy restricted to Australian records]

Material examined. Photograph by Puk Petersen (Underwater World, Sunshine Coast), washed up on beach near Mooloolaba, Sunshine Coast, summer 1999-2000; approximately 45 cm BD, no specimen retained.

Remarks. Analysis of the photograph and witness statements suggest that this was *Crambione cookii*, which is native to tropical Queensland, but has not been reported since its original discovery. This record, therefore, comprises significant southerly range extension.

Class CUBOZOA Werner, 1973

Order CARYBDEIDA Gegenbaur, 1856 (sensu Werner, 1984)

TAMOYIDAE Haeckel, 1880 (sensu Gershwin, 2005a)

Morbakka Gershwin, 2008

Morbakka Gershwin, 2008: 24–25.

Diagnosis. Tamoyidae with tall, robust, conspicuously warty body; with flat, broad, ribbon-like tentacles; with well developed 'spike' in bend of pedalial canal; with conspicuous perradial lappets on the velarium; with long, straight 'rabbit-ear-form' rhopalial horns; exumbrellar warts typically coloured bright pink.

Morbakka fenneri Gershwin, 2008 (Fig. 7F)

Morbakka fenneri Gershwin, 2008: 26–31, figs 1–5.

Distribution. *Morbakka fenneri* was first found in the Moreton Bay region; it is said to be commonest at Redcliffe, but has also been found at Stradbroke I.. The larger form is commonest at Mackay, where one or two specimens a year are collected (P. & D. Barker, pers. com.); a few specimens have been collected at Port Douglas or Cairns (B. Cropp, pers. com.; R. Hore, pers. com.); a single specimen was collected at Balgal Beach, north of Townsville, and a couple at Ayr, south of Townsville. It has also been collected offshore from Cairns (Little *et al.* 2006). Smaller forms have been found occasionally from Coffs Harbour (NSW) to Sydney.

Remarks. The Cubozoa of Australia were recently revised by Gershwin (2005a, 2005b, 2005c, 2006a, 2006b, 2007, 2008) and Gershwin & Alderslade (2005, 2006). The species commonly referred to as 'Morbakka' (Fenner *et al.* 1985; Southcott 1985) actually comprises several regional morphs, most of which are yet to be sufficiently understood for proper diagnosis (Gershwin, 2008). The 'Moreton Bay carybdeid' (from whence the common name 'Morbakka' was derived) was formally described in volume 1 of the Moreton Bay Workshop proceedings; however, resolving the question of whether 'Morbakka' as we know it is a species or a species cluster must await collection and study of additional material.

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Hydroids (Cnidaria: Hydrozoa: Leptolida) from Moreton Bay, Queensland, and adjacent regions: a preliminary survey

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ABSTRACT

A preliminary survey of the hydroid fauna of Moreton Bay and adjacent regions, was undertaken. Fourty-four species of hydroids from 14 families were identified. Some species identifications remain tentative due to lack of reproductive material, which is essential for accurate diagnoses. Thirteen species are new records to southeast Queensland and one, *Hincksella cylindrica pusilla* (Ritchie, 1910b), is new to Australia. This brings the list of the hydroid fauna for the region to 74 species in 18 families. Twenty-five species (57%) of our collection had tropical or subtropical distributions, with only two (5%), *Opercularella humilis* (Bale, 1924) and *Hincksella cylindrica* (Bale, 1888), having predominantly temperate distributions. ❑ *Cnidaria, Hydrozoa, hydroids, southwest Pacific, Australia, Queensland, intertidal, subtidal, reef, taxonomy.*

This paper is a preliminary report on the hydroids collected during The Thirteenth International Marine Biological Workshop held at the Moreton Bay Research Station from 7–25 February, 2005. Collections were made by the authors from intertidal and shallow-water habitats in Moreton Bay, Queensland, and from adjacent regions, mainly the reefs situated in the Coral Sea due north of North Stradbroke Island.

Moreton Bay is one of the largest, shallow--estuarine bays in Australia. Its sub-tropical location supports a fauna that incorporates a wide range of both temperate and tropical species (Davie & Hooper 1994). Furthermore, the diversity of environments within the bay favours the co-occurrence of a wide variety of estuarine and oceanic species. The hydroid fauna collected during the workshop was no exception. Most species, however, were small and cryptic, apart from the few, visually-dominant species that occur on exposed reef surfaces, such as: *Macrorhynchia philippina, Idiellana pristis, Sertularella diaphana, Pennaria disticha* and *Solanderia secunda*.

Most of our current knowledge of the hydroid fauna of Moreton Bay and the southern Queensland coast comes from Pennycuik's (1959) studies covering the area between Caloundra Heads and the New South Wales border (latitudes 22°–26°S). Pennycuik reported 44 species (based on current synonymies). Subsequently, Preker (1998) reported 10 species (5 additional to Pennycuik's list), and Watson (2002) recorded 15 species (11 additional), giving a total of 60 species for SE Queensland. With the present work, we now recognise 74 species in 18 families, and the total is sure to continue to rise with more extensive field collecting.

MATERIAL AND METHODS

COLLECTION METHODS, SITES AND HABITATS

Specimens were collected by hand from intertidal areas during low tides, snorkelling in shallow-waters, SCUBA diving to depths of up to 30 m, and by grab-samples from deeper waters. Collection sites, depths, and brief descriptions of habitats are shown in Table 1.

Table 1. Locations in Moreton Bay and adjacent regions where hydroids were collected during the workshop.

Locality	Coordinates	Depth (m)	Substrate
Dunwich	27°29′28.98″S, 153°23′44.46″E	3	Sandy mud and seagrass.
Myora	27°28′06.73″S, 153°25′18.44″E	3–5	Mud and seagrass.
Amity Point	27°24′13.71″S, 153°26′11.31″E	3–12	Sand, rocks and breakwater.
Cylinder Beach	27°25′26.16″S, 153°32′05.61″E	3	Rocky headland.
Frenchmans Bay	27°25′30.28″S, 153°32′35.66″E	3	Rocky headlands and tide pools.
Shag Rock	27°24′47.92″S, 153°31′35″E	18–25	Rocky bottom, sand and coral.
Flat Rock	27°23′27″S, 153°33′12.7″E	15–25	Rocky bottom, algae and good coral growths.
Shark Gutter	27°23′30.23″S, 153°33′5.68″E	20–30	Rocky bottom, sand and coral.

EXAMINATION OF MATERIAL

Most of the collected material was placed in 70% ethanol in the field or immediately upon return to the laboratory. Descriptions, therefore, were primarily based on preserved material, which meant that information such as pigmentation, descriptions of the living hydranths, and the ability to discharge the nematocysts in order to observe them, was lost by not studying the material while it was still alive. On the other hand, the time that would have been required to sort through and examine all the material before it was preserved would have resulted in significant deterioration in the quality of voucher material.

Colonies were examined using a dissection stereomicroscope, and nematocysts were observed with a Nomarski Interference Contrast microscope. The nematocysts were separated from the epithelia by compressing pieces of the preserved tissue between slide and coverslip. Categories of nematocysts were identified according to the classification of Weill (1934).

Tragically much of the voucher collection was lost before it could be deposited at the Queensland Museum. This was the result of a violent storm that brought down a tree seriously damaging the home-based laboratory where the collection was under study.

PRESENTATION

We largely adhere to the classification of Cornelius (1995a, 1995b), while the arrangement of the families follows Bouillon *et al.* (2004). Within the families, the genera and species are listed alphabetically and do not imply a phylogeny.

TAXONOMY

Order ANTHOATHECATAE Cornelius, 1995a
Suborder FILIFERA Kühn, 1913
Family EUDENDRIIDAE L. Agassiz, 1862

Eudendrium Ehrenberg, 1834

Eudendrium pennycuikae Watson, 1985

Eudendrium pennycuikae Watson, 1985: 183–185, figs 5–8.
Eudendrium album — Pennycuik, 1959: 167 [not *Eudendrium album* Nutting, 1896]
Eudendrium cf. *pennycuikae* — Russell & Hewitt, 2000: 87.

Description. Small hydroid colonies with erect stems arising from a tubular hydrorhiza attached to seagrass. The stems reach 9 mm in height and are sparingly and irregularly branched. The perisarc is smooth, for the most part, but annulated at the base, at the origin of each branch and at other irregular intervals throughout the length of the stem. Hydranth small, surrounded by 18–20 tentacles and has a large hypostome. Female gonophores are immature and borne below the hydranth. Only one type of nematocyst present: small microbasic euryteles in the tentacles and in the body of the hydranth. Only a few were discharged.

Measurements. Stem: height 9 mm, diameter 78 µm. Pedicel diameter 60–75 µm. Hydranth length 230–395 µm. Female gonophore diameter 145–185 µm.

Remarks. The family Eudendriidae is diagnostically troublesome, and distinguishing between species is difficult as the colony morphology and reproductive structures are similar in many of them. The features of the cnidome provide the best guide for identification of species, especially when considered along with reproductive structures. The *Eudendrium* from Amity Point compares very closely with Pennycuik's (1959) *Eudendrium album* Nutting, 1896 from Bundaberg. Her description, however, does not include the nematocysts. Watson (1985) compared Pennycuik's specimen with a specimen of *E. album* and, owing to differences in the cnidome, described the Queensland material as a new species, *Eudendrium pennycuikae* Watson (1985).

Occurrence. Amity Point.

Distribution. Queensland (Bundaberg, Amity Point).

Suborder CAPITATA Kühn, 1913
Family PENNARIIDAE McCrady, 1859

Pennaria Goldfuss, 1820

Pennaria disticha Goldfuss, 1820
(Fig. 1A)

Pennaria disticha Goldfuss, 1820: 89; Brinckmann-Voss, 1970: 40, text-figs 43, 45–50; Gibbons & Ryland, 1989: 387, fig. 5; Migotto, 1996: 25; Schuchert, 1996: 142–143, fig. 85a–c; Watson, 1999: 16–18, fig. 10A–I; Preker, 2001: 154; Kirkendale & Calder, 2003: 165–166; Schuchert, 2003: 148, fig. 8A–B; Preker, 2005: 46; Preker & Lawn, 2005: 340.
Halocordyle disticha — Millard, 1975: 41–42, fig. 16C–G; Calder, 1988: 56–60, figs 43a, b, 44a, b, 45a–h (cum syn.); Hirohito, 1988: 28–30, fig. 9a–d, pl. 1 fig. C.
Halocordyle disticha var. *australis* Stechow, 1925: 194–195; Pennycuik, 1959: 160, 161–162, pl. 1 figs 3–7.
Pennaria australis — Bale, 1884: 45–46; Trebilcock, 1928: 2; Ralph, 1953: 70, figs 14, 14A.

Material Examined. QM-G331147, Amity, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Conspicuous, erect, racemose hydroid colonies with terminal hydranths and pinnately-branched stems, reaching 320 mm maximum height. Growth monopodial, main stem divided into internodes of varying length. Each internode annulated proximally and bearing alternate distal hydrocladia. Longest hydrocladia occur at approx. middle of stem. Hydrocladia divided by straight nodes into internodes, each bearing a distal ramule on its upper surface; ramules annulated for most of their length.

Hydranths are borne at end of stem, hydrocladia and ramules. Hydranths clavate with a whorl of 10-12 filiform aboral tentacles and 14-18 short irregularly-scattered capitate tentacles. Hyperstome dome shaped.

Gonophores borne between the sets of tentacles on short stems are degenerate, pear-shaped medusae, with four radial canals and four rudimentary marginal tentacles.

Colour. The stem is a shining dark brown, hydrocladia light brown and the hydranths milky white in the preserved colonies.

Remarks. A well-known species; the material examined fits the description given by Gibbons & Ryland (1989) and Watson (1999).

Occurrence. Amity Point, Cylinder Beach, Flat Rock.

Distribution. Circumglobal in tropical to warm-temperate waters.

Family SOLANDERIIDAE Marshall, 1892

Solanderia Duchassaing & Michelin, 1846

Solanderia secunda (Inaba, 1892)

Dendrocoryne secunda Inaba, 1892: 98; Stechow, 1909b: 40–42, pl. 2, figs 1, 2; Stechow, 1913: 7.
Solanderia secunda — Vervoort, 1962: 526–531, figs 6–9; Vervoort, 1966: 387, 389, fig. 8; Bouillon *et al.*, 1992: 12–14, pl. 5 figs 1–4, pl. 6 figs 1–4, pl. 10 figs 1–4, pl. 11 figs 1–4, pl. 12 figs 1–5, pl. 13 figs 1–4, pl. 14 figs 1–5; Watson, 1999: 13–16, fig. 9A–F; Schuchert, 2003: 149, fig. 8; Kirkendale & Calder, 2003: 164–165; Preker & Lawn, 2005: 340.

Material Examined. QM-G331152, Flat Rock, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Large, prominent, fan-shaped colonies reaching 10 cm height. Main stem thick and flattened in sections. Branches arise irregularly, expanding mainly in one plane and thin towards growing tips. Colonies attach to rocks by means of flattened mass of fibres and are supported by internal skeleton consisting of an anastomosing network of chitinous trabeculae. Longitudinal fibres of this skeleton are slightly raised and look rib-like, even in living material. Longitudinal fibres connected by thinner, transverse fibres. Hydrophores not well developed; consist only of pair of small, distinct spines at base of some polyps. Not all hydranths are flanked by such spines and, in some cases, they occur only on one side of hydranth. Hydranths are numerous on terminal branches, less numerous on thicker branches, and very scarce on main branches. Preserved polyps 450–540 µm long, slightly ovoid in structure with greatest diameter ranging from 190–245 µm. Zooid bearing 12–15 capitate tentacles, four arranged in an oral whorl, rest scattered over body.

No gonophores were observed.

Colour. Preserved colonies have maroon-brown stem that gradually merges into a yellowish-brown colour in the finer ramifications. The coenosarc and polyps are creamy white.

Remarks. The present material conforms with the description of *S. secunda* given by Bouillon *et al.* (1992). Apart from the presence of fewer prominent spines on the side of the polyps, the microscopic structure of the skeleton fits with the description given. The difference in spine development, however, is of some importance. Vervoort (1962) states that, aside from the presence of thorns, there are scarcely any other differences in skeletal structure between *Solanderia gracilis* Duchassaing & Michelin, 1864 and *S. secunda*. Bouillon *et al.* (1992) reduced the number of valid species of *Solanderia* from 13 to 6. The resulting valid species, therefore, encompass specimens with a great morphological variation and from a wide geographical area. This may account for the differences in spine development seen in the Moreton Bay material compared with the description given by Bouillon *et al.* (1992). *Solanderia secunda* distribution ranges from tropical and subtropical regions of the Pacific and Indian Oceans (Bouillon *et al.* 1992) whereas *S. gracilis* occurs only in the West Indies (Vervoort 1962). Pennycuik's (1959) specimens of *Solanderia fusca* (Gray, 1868) from Heron Island is very likely also *S. secunda*. Wineera (1968) found the skeleton of Queensland material to be very similar to that of *S. secunda*.

Occurrence. Flat Rock, Shark Gutter.

Distribution. Tropical and subtropical Pacific, Red Sea, Indian Ocean.

Family TUBULARIIDAE Fleming, 1828

Ectopleura L. Agassiz, 1862

Ectopleura crocea (L. Agassiz, 1862)

Tubularia crocea L. Agassiz, 1862: 249, pls. 23–23a; Allman, 1872: 416–417; Torrey, 1902: 43–46, pl. 3, figs 22–23; Pennycuik, 1959: 147; Brinckmann-Voss, 1970: 28, figs 30–34; Millard, 1975: 38.

Ectopleura crocea — Petersen, 1990: 174–175, fig. 27A–C; Schuchert, 1996: 107–109, fig. 64a–g.

Description. Colony consisting of unbranched tubulariid hydroids arising from stolon attached to old, decaying wood. Height to 38 mm. Hydranths vasiform, bearing two whorls of tentacles. Oral tentacles short, filiform, numbering 18–20; aboral tentacles longer, filiform, numbering 21–23. Stem covered with firm, brown, slightly-wavy perisarc that thins distally to become wrinkled, transparent sheath terminating below hydranth. Perisarc has a few, scattered, irregular annulations or corrugations. Gastroderm of caulus with two longitudinal ridges, expanding distally to form distinct, dilated, spherical neck region.

Gonophores spherical, borne in clusters on short stems on unbranched blastostyles just above aboral tentacles. Gonophores without radial canals, female gonophores with lateral processes around opening.

Remarks. Petersen (1990) remarks that *Ectopleura crocea* has been thoroughly confused with *E. larynx*. The main feature distinguishing them appears to be the distal processes on the older female gonophores.

Occurrence. Scott's Point, Amity Point.

Distribution. Pacific and Atlantic coasts of USA, Europe, Mediterranean, Japan, New Zealand, Queensland (Moreton Bay).

Order LEPTOTHECATAE Cornelius, 1995a
Suborder CONICA Broch, 1910

Family AGLAOPHENIIDAE L. Agassiz, 1862

Macrorhynchia Kirchenpauer, 1872

Macrorhynchia philippina (Kirchenpauer, 1872)

Aglaophenia (Macrorhynchia) Philippina Kirchenpauer, 1872: 29, 45–46, pl. 1 fig. 26, pl. 2 fig. 26a, b, pl. 7 fig. 26.

Aglaophenia urens — Bale, 1884: 155–156, pl. 14 fig. 6, pl. 17 fig. 9.

Lytocarpus Phillipinus — Bale, 1888: 786–789, pl. 21 figs 5–7.

Lytocarpus philippinus — Kirkpatrick, 1890: 604; Billard, 1913: 78–79, fig. 63; Briggs & Gardner, 1931: 193–194, text-fig. 4; Pennycuik, 1959: 186; Millard, 1975: 449–451, fig. 138A–C.

Lytocarpia philippina — Stechow, 1919: 132–124, fig. Z.

Macrorhynchia philippina — [Not Rees & Vervoort, 1987: 177–180, fig. 3 (cum syn.)]; Ryland & Gibbons, 1991: 553–555, fig. 22A–D; Watson, 1996: 79; Migotto, 1996: 40–43, figs 8e–f; Calder, 1997: 66–69, fig. 21a–b; Watson, 1997: 538–539, fig. 8F; Preker, 1998: 172; Watson, 2000: 67–68, fig. 53A–D; Preker, 2001: 155; Watson, 2002: 349, fig. 7A, B; Schuchert, 2003: 221–223, fig. 67A–E; Kirkendale & Calder, 2003: 171; Vervoort & Watson, 2003: 336–337, fig. 81D; Preker & Lawn, 2005: 344.

Material Examined. QM-G331146, Shag Rock, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Colonies erect, plumose, branched; variable sizes to 100 mm, main stem polysiphonic. Branches arising irregularly from peripheral tubes of stem, most polysiphonic. Main axial tube of stem and branches divided into internodes. Basal branch internode long and without hydrocladia but with mesial nematothecae and terminating in oblique hinge joint. Thereafter, all internodes with one antero-lateral apophysis and two nematothecae, one inferior anterior and one axillary anterior. Small mamelon present on anterior surface of apophysis.

Hydrocladia divided into regular, thecate internodes by indistinct transverse nodes. Hydrocladial internodes with two internodal septae; one near the basal constriction of hydrotheca, the other at the base of the lateral nematothecae.

Hydrothecae deep, sack shaped, widening to margin, curving abruptly outward distally. Prominent abcauline intrathecal septum reaching about half-way into hydrotheca and a small adcauline intrathecal septum or peg above the hydropore. Margin with two, rounded, lateral cusps and a median abcauline tooth.

Cauline nematothecae broad based, conical, with circular orifice on a short neck. Cauline nematothecae at branch bases bifurcate. Median inferior nematotheca tubular, adnate to abcauline hydrothecal wall for about one-half the cup height, then free and diverted upwards, reaching beyond the hydrothecal margin. It possesses three apertures: one terminal, one on the upper surface, where it becomes free, and one leading into the hydrothecal cavity. Lateral nematotheca tubular, inclined laterad and anterodistal, overtopping hydrothecal margin, with two apertures: one terminal and one mesial.

Gonothecae large, lenticular, protected by modified hydrocladia (phylactocarps) given off from front of branch.

Colour. Stem very dark brown to black, hydrocladia cream.

Measurements. Hydrocladium: internode length 256–300 µm, diameter at node 70–92 µm. Hydrotheca: adcauline length 244–264 µm, adnate abcauline length 124–150 µm, free abcauline length 56–64 µm, aperture 100–120 µm. Nematothecae: median inferior: total length 240–264 µm, adnate length168–200 µm, free length 68–80 µm; lateral: total length 144–160 µm, width at base 44–60 µm. Gonotheca: length 998–1,210 µm.

Remarks. A well-known species, distinguished from other similar species by its well-marked, abcauline ridge projecting into the hydrotheca, and its distinctive colouration. *Macrorhynchia philippina* has a painful sting if touched.

Occurrence. Polka Point, Dunwich, Myora (coral patch), Amity Point (pools), Cylinder Beach (rocky pools), Shag Rock, Flat Rock, Shark Gutter.

Distribution. Pantropical.

Macrorhynchia phoenicea (Busk, 1852) (Fig. 1C)

Plumularia phoenicea Busk, 1852: 398–399.
Aglaophenia phoenicea — Bale, 1884: 159–161, pl. 15 fig. 1–5, pl. 17 fig. 1–4, pl. 19 fig. 31.
Lytocarpus phoeniceus — Kirkpatrick, 1890: 604; Stechow, 1909b: 97–98; Billard, 1913: 74–76, figs 60–61; Jäderholm, 1916: 7, fig. 4; Briggs, 1918: 47; Jäderholm, 1919: 25; Jarvis, 1922: 354; Jäderholm, 1923: 5; Briggs & Gardner, 1931: 194–195, text-fig. 5; Stephenson *et al.*, 1931: 67; Pennycuik, 1959: 187; Millard, 1975: 451–453, fig. 137D.
Macrorhynchia phoenicea — Stechow, 1923a: 19; 1923b: 241; 1925: 259–260; Mammen, 1965b: 313–314, figs 108–109; Hirohito, 1969: 26; Ryland & Gibbons, 1991: 555–557, fig. 23A–E; Hirohito, 1995: 299, fig.106a–e; Preker, 1998: 172; Watson, 2000: 68–70, fig. 54A–F; Kirkendale & Calder, 2003:171; Schuchert, 2003: 223–226, figs 68A–F, 69A–C; Vervoort & Watson, 2003: 337; Preker & Lawn, 2005: 344.

Description. Colonies erect, branched in one plane forming a fan, up to 34 mm, stem polysiphonic. Branches arising from peripheral tubes of stem, mostly polysiphonic. Main axial tube of stem and branches divided into internodes by oblique nodes. Basal stem and branch internodes athecate and without hydrocladial apophyses but with one medial nematotheca. Distal internodes with one antero-lateral hydrocladial apophysis, one inferior anterior and one axillary anterior nematotheca and a mamelon on the anterior surface of the apophysis.

Hydrocladia divided into regular thecate internodes by slightly-oblique nodes and with three internodal septae: one near the basal constriction of the hydrotheca, one at the base of the lateral nematotheca and a small one mid-way between the two.

Hydrotheca sack shaped, widening to margin, adnate to hydrocladial internode then curving abruptly outward distally and with a thin abcauline intrathecal septum reaching into the hydrotheca. Margin turned away from internode, forming an angle of 30°–35°, with five marginal cusps: a small pair near the base of the lateral nematothecae, a low, broad pair mid-laterally, and a single small adcauline cusp; no adcauline tooth.

Cauline nematothecae conical with circular orifice on short neck and small, mesial aperture. Median inferior nematotheca tapering, tubular, reaching beyond hydrothecal margin, directed out and distal, with two apertures: one terminal, one on upper surface, where it becomes free from hydrotheca. Lateral nematothecae tubular, long, directed latero-distal and with a terminal aperture posterad and one mesial.

Gonothecae not seen.

Colour. Brown.

Measurements. Hydrocladium: internode length 256–296 µm, diameter at node 72–90 µm. Hydrotheca: adcauline length 189–220 µm, adnate abcauline length 98–114 µm, free abcauline length 20–28 µm, aperture 136–152 µm. Nematothecae: median inferior: 100–150 µm; lateral: 60–77 µm.

Remarks. *Macrorhynchia phoenicea* is easy to recognise by its bristly appearance, fan-shaped colony coloured uniformly-brown, and dense hydrocladia of a homogenous length.

Occurrence. Polka Point, Amity Point, Dunwich, Cylinder Beach (rocky pools) and Flat Rock.

Distribution. Tropical Indian Ocean, Indonesia, Japan, Australia (Torres Strait, Darwin Harbour, Gulf of Carpentaria, Moreton Bay).

Family CAMPANULINIDAE Hincks, 1868

Lafoeina G.O. Sars, 1874

Lafoeina amirantensis (Millard & Bouillon, 1973)

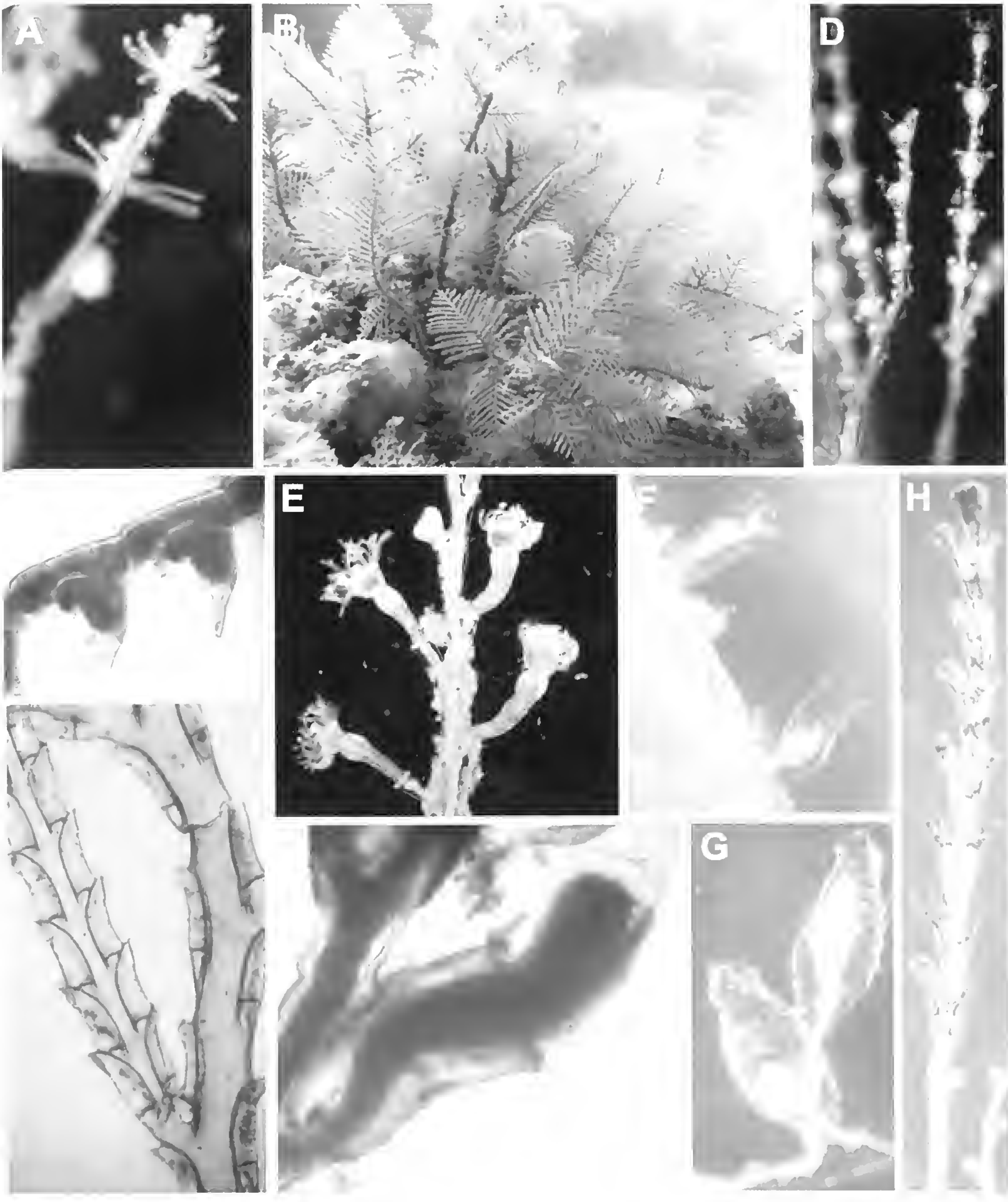
Egmundella amirantensis Millard & Bouillon, 1973: 40–42, fig. 5A–D; Millard, 1975:133, fig. 43G; Gibbons & Ryland, 1989: 389–290, fig. 7A, B; Ramil & Vervoort, 1992: 22–24, fig. 2a–d.

Lafoeina amirantensis – Calder, 1991: 10, fig. 3; Watson, 2000: 5, fig. 2A, B; Preker & Lawn, 2005: 340.

Description. Microscopic, stolonial colony reaching 0.5 mm in height, growing epiziocally on the hydroid *Pennaria disticha*. Hydrothecae arising from a tubular hydrorhiza on a very short pedicel (sometimes so inconspicuous that it appears to be sessile), asymmetrical, turbinate, constricting basally and widening slightly towards the operculum. Operculum a cone-shaped lid consisting of up to 12 opercular valves. Nematothecae arising from hydrorhiza between hydrothecae, slightly bulbous and with a distal cluster of large, elongate nematocysts. Gonothecae not seen.

Measurements. Hydrotheca: depth 176–304 µm, marginal diameter below the operculum 72–88 µm. Nematotheca: length 68–72 µm, width 16–20 µm.

FIG 1. **A**, *Pennaria disticha* Goldfuss, 1820, QM-G331147, Amity Point, Nth Stradbroke I., SE Qld; **B**, *Sertularella diaphana* (Allman, 1885), a large, fertile colony, Moreton Bay (voucher lost); **C**, *Macrorhynchia phoenicea* (Busk, 1852), showing the abcauline, intrathecal septum stretching over half way across the hydrotheca; **D**, *Antennella secundaria* (Gmelin, 1791), QM-G331139, Cylinder Beach, Nth Stradbroke I., SE Qld; **E**, *Nemalecium lighti* (Hargitt, 1924), showing thick, modified tentacles, known as the nematodactyls, which can be seen on the lower left hydranth, Moreton Bay, voucher lost; **F**, *Hebellopsis costata* (Bale, 1884), Moreton Bay, voucher lost; **G**, *Calamphora campanulata* (Warren, 1908), showing the margin with four, triangular, opercular valves, QM-G331141, Flat Rock, Nth Stradbroke I., SE Qld; **H**, *Diphasia digitalis* (Busk, 1852), showing characteristic, black-grey pigment granules within the colony, Moreton Bay, voucher lost; **I**, *Salacia tetracythara* Lamouroux, 1816, Moreton Bay, voucher lost; **J**, *Hincksella cylindrica* (Bale, 1888), showing gonothecae arising from within the hydrothecae, QM-G331144, Amity Point, Nth Stradbroke I., SE Qld.


A
B
D
E
G
H

Remarks. The Moreton Bay specimens closely agree with Millard & Bouillon's (1973) *Egmundella amirantensis* from Amirante Island, Seychelles, Indian Ocean. The nematothecae of the Moreton Bay specimen are best described as slightly bulbous rather than the club-shaped appearance of the Bermuda specimens shown by Calder (1991: fig. 3). Within this species, there does seem to be a considerable variation in nematothecae shape, as illustrated in Gibbons & Ryland (1989: fig. 7B). Migotto & Cabral (2005) discuss the uncertain affinity of *Lafoeina amirantensis* based on life-history studies. The family Campanulinidae Hincks, 1868, is now considered a polyphyletic assemblage of genera containing hydroids with a cylindrical hydrotheca and conical operculum but with dissimilar life cycles. *Lafoeina amirantensis* collected off the coast of S o Sebasti o released a medusa similar in morphology to the young medusa of *Cirrholovenia tetranema* Kramp, 1959, a species belonging to the family Cirrholoveniidae Bouillon, 1984 (Migotto & Cabral 2005). The puzzle regarding the life cycles of *C. tetranema* and *L. amirantensis* is, unfortunately, still ambiguous. Calder (1991) argues that *Lafoeina* cannot be assigned to a family until more is known concerning its affinities. Migotto & Cabral (2005) give support to both families being reunited under the family name Lovenellidae Russell, 1953, but only after further, comprehensive, phylogenetic analyses.

Occurrence. Amity Point.

Distribution. Indian Ocean, Mediterranean Sea, Bermuda, Fiji, Australia.

Opercularella Hincks, 1868

Opercularella humilis (Bale, 1924)

Campanulina humilis Bale, 1924: 235–236, fig. 5; Jäderholm, 1926: 3, fig. 2.
Opercularella humilis — Rees, 1939: 444–445 (cum syn.); Vervoort & Watson, 2003: 24–26, fig. 1E–G.
(?) *Opercularella humilis* — Pennycuik, 1959: 175, pl. 2 figs 11, 12; Ralph, 1957: 846, text-fig. 8a–f; Dawson, 1992: 14.

Description. Small stolonial colony reaching 1.25 mm in height; growing on algae, the hydroids *Pennaria disticha* and *Halecium lighti*, and a subtidal piece of rotten wood. Mostly pedicellate, but with a few sparingly-branched hydrothecae. Branches and main stem irregularly twisted or annulated throughout. Pedicel expands to base of hydrotheca. Hydrotheca very slender and terminates in an irregular operculum made up of converging segments. The hydrothecal perisarc is very delicate and most of the colony was badly crushed, making it impossible to count the number of tentacles and to see the webbing at their base.

Gonothecae not seen.

Measurements. Pedicel: length 125–700 µm, width 40 µm. Hydrotheca: depth 160–184 µm, marginal diameter below operculum 64–91 µm.

Remarks. Poor specimen, mostly unbranched and the branched colony had lost all but one of its hydrothecae. This specimen agrees with the description and illustrations given by Ralph (1957), but is smaller than the ones Pennycuik (1959) described from Currumbin.

Occurrence. Amity Point (on the rocky breakwater).

Distribution. Queensland (Currumbin), New Zealand (including Campbell Island in the sub-Antarctic).

Family HALECIIDAE Hincks, 1868

Halecium Oken, 1815

Halecium (?) *delicatulum* Coughtrey, 1876b

Halecium delicatulum Coughtrey, 1876b: 26, pl. 3 fig. 4; Bale, 1924: 235; Ralph, 1958: 334–338, figs 11e, h–n, 12a–p (syn.); Pennycuik, 1959: 173; Watson, 1973: 166; Millard, 1975: 145–147, fig. 47F–L; Watson, 1979: 234; Ramil & Vervoort, 1992: 82–85, fig. 20a–c; Migotto, 1996: 30–31, fig. 6d–e; Medel *et al.*, 1998: 31–33, fig. 1a–g; Medel & Vervoort, 2000: 12–13 (cum syn.); Vervoort & Watson, 2003: 88–91, fig. 16A–E; Watson, 2003: 245; Schuchert, 2005: 629–631, fig. 12A–B.

Description. Stiff, upright colonies. Stem monosiphonic or polysiphonic, divided into internodes by oblique nodes directed alternately left and right, branching irregularly. Hydrothecae arise from an apophysis near the distal end of each internode. Primary hydrotheca shallow, with walls widening towards the aperture, rim everted, a row of desmocytes on the wall of the hydrotheca just above the delicate diaphragm or pseudodiaphragm. Secondary hydrotheca pedicellated with a constriction at the base.

Gonophores not seen.

Measurements. Colony: height 5–6 mm, internode length 38–550 µm, diameter at node 100–110 µm. Hydrotheca: length 300–400 µm, diameter at rim 120–160 µm.

Remarks. Although the material agrees in detail with Ralph's (1958) New Zealand specimens and *H. delicatulum* from the Strait of Gibraltar (Medel *et al.* 1998), Schuchert (2005) has noted that *H. delicatulum* is almost indistinguishable from *Halecium mediterraneum* Weismann, 1883. Ralph (1958) and others considered that they might be conspecific; for details see Schuchert (2005). Vervoort and Watson (2003), however, did not synonymize them. The diagnosis is especially difficult due to the absence of clearly apomorphic characters. Schuchert (2005) suggests that genetic methods might hopefully clarify whether they really belong to the same biological species. Watson (personal communication) has noted that many species are collectively misidentified as *H. delicatulum*. In Moreton Bay, *H. delicatulum* can be found growing in profusion as an epiphyte on seaweeds and an epizoite on bryozoans and other hydroids.

Occurrence. Cylinder Beach.

Distribution. Cosmopolitan in tropical and subtropical waters.

Halecium sessile Norman, 1867

Halecium sessile Norman, 1867: 196; Ritchie, 1911: 812–813, pl. 87 figs 8, 9; Stechow, 1913: 9, 86, fig. 54; Billard, 1927: 329; Ralph, 1958: 331–332, figs 9h–i, 10c, d; Pennycuik, 1959: 174, pl. 3 fig. 3; Millard, 1975: 154–156, fig. 48K–M; Ramil & Vervoort, 1992: 85–86, fig. 20d; Watson, 1994b: 66; 2002: 340, fig. 1B, C; Hirohito, 1995: 27–29, fig. 7e–h; Preker, 2001: 154; Vervoort & Watson, 2003: 95–98, fig. 18H–M; Preker & Lawn, 2005: 341.

Description. Colonies small, stiff, erect, up to 4 mm high, geniculate and with one to two branches. Stem internodes widest distally; the nodes are transverse with only a slight slope. Hydrothecae shallow with straight sides, widening to margin which is not everted, diaphragm distinct, and a distinct row of desmocytes. Some hydrothecae are renovated, the secondary hydrothecae coming from within the primary hydrotheca where it is attached to the diaphragm. Length of internode is varied, longest towards growing tip. The hydranth is large.

Gonophore not seen.

Measurements. Length of stem internode 490–600 µm, diameter at node 145–160 µm, primary hydrotheca depth 35–49 µm, diameter at rim 140–175 µm.

Remarks. The material examined generally agrees with the description of *Halecium sessile* but, as we have not seen the gonothecae, there must remain some doubt. Nevertheless, *Halecium sessile* has been reported from this region by Watson (2002) and it is probable, therefore, that our diagnosis is correct.

Occurrence. Amity Point (breakwater wall to the south).

Distribution. Cosmopolitan. This species occurs in all temperate and subtropical oceans.

Halecium tenellum Hincks, 1861

Halecium tenellum Hincks, 1861; 252, pl. 6 figs 1–4; Stechow, 1919: 41, figs J, K; Mammen, 1965a: 9, figs 35–36; Millard, 1975: 156–157, fig. 50F–L; Ramil & Vervoort, 1992: 90–91, fig. 21f, g; Medel *et al.*, 1998: 41–43, fig. 6a–d; Medel & Vervoort, 2000: 23–25; Vervoort & Watson, 2003: 98, fig.19A, B; Preker & Lawn, 2005: 341.

Description. Colonies small, slender, monosiphonic, sparingly and irregularly branched, growing as epizoites on other hydroids. The stem is separated into distinct internodes by transverse nodes. Hydrothecae arising from short apophyses near distal ends of the internodes, and are directed to the right and left alternately, thereby giving the colony a geniculate appearance. Primary hydrotheca borne on a very short pedicel, secondary hydrotheca pedicellate. Hydrotheca shallow, widening to margin, which is strongly everted. Diaphragm and desmocytes distinct.

Gonothecae not seen.

Measurements. Colony: height 8 mm, internode length 400–650 µm, diameter at node 45–60 µm. Hydrotheca: length 30–40 µm, diameter at rim 130–141 µm.

Remarks. This small *H. tenellum* was found mainly on other hydroids, but it can be easily overlooked on other substrates. It is unfortunate that no fertile material was found as this species can only be identified with certainty if the female gonothecae are present. Among the European *Halecium* species, *H. tenellum* and *H. delicatulum* were synonymized by García Corrales *et al.* (1978) but this has been rejected by a number of other authors; for details see Schuchert (2005). This record, therefore, must be regarded as doubtful. If verified, this would be the first time it has been recorded from Moreton Bay. More samples of the Haleciidae need to be collected from this region, both spatially and temporally, to increase the chances of obtaining fertile material and a better understanding of the species composition.

Occurrence. Flat Rock.

Distribution. Cosmopolitan.

Hydrodendron Hincks, 1874

Hydrodendron mirabile (Hincks, 1866)

Ophiodes mirabilis Hincks, 1866: 422–423, pl. 14 fig 1–5.
Ophiodissa mirabilis — Stechow, 1919: 42; Cornelius, 1975a: 414–417, fig. 14a, b.
Hydrodendron mirabile — Rees & Vervoort, 1987: 12–13, 20; Cornelius, 1995a: 309–311, fig. 73A–G; Hirohito, 1995: 36–38, fig. 10a–g; Medel *et al.*, 1998: 43–45, fig. 7a–e; Medel & Vervoort, 2000: 26–28; Kirkendale & Calder, 2003: 166; Vervoort & Watson, 2003: 99–101, fig. 19E, F.
Ophiodes caciniformis — Ritchie, 1907: 500–501, pl. 23 figs 11, 12, pl. 24 fig. 1, pl. 25 fig. 5.
Phylactotheca caciniformis — Pennycuik, 1959: 174–175; Preker, 2001: 154.
Hydrodendron caciniformis — Ralph, 1958: 342–344, figs 13b, c, 14a; Mammen, 1965a: 7, fig. 34; Hirohito, 1974: 9–12, fig. 3a–k; Millard, 1975: 158–160, fig. 51A–F; Rees & Vervoort, 1987: 20; Bouillon *et al.*, 1995: 4.

Description. Small colonies, stolonial in some parts, with erect stems arising at irregular intervals from hydrorhizae attached to algae, other hydroid colonies (especially *Halecium* sp.), and a piece of wood. Colony length to 5.1 mm, monosiphonic, and sparingly branched. Stem divided into short internodes which gradually lengthen towards the distal end of the colony and are marked by a slight swelling near the node. Each internode gives rise to an apophysis near the distal end. Hydrothecae borne on large, robust pedicels which remain attached even though the hydrotheca is often lost. Hydrotheca trumpet-shaped, with flaring wall and everted margins, a delicate, straight diaphragm, and a conspicuous ring of desmocytes. Branches alternate and of variable length. Nematothecae scarce, deep, campanulate, with a slightly-everted margin, and are irregularly dispersed on hydrorhizae, stem internodes and hydrothecal pedicels.

Measurements. Internode: length 480–760 µm, diameter at node 80–100 µm. Hydrotheca: length 95–130 µm, diameter at rim 220–240 µm. Nematotheca: length 128–136 µm, diameter at rim 80–90 µm.

Remarks. The trophosome of the Moreton Bay material agrees in detail with *Hydrodendron mirabile* and with Millard's (1975) description of *H. caciniformis* from South Africa, which is now reduced to a synonym of the present species. For details in designating the species to the genus *Hydrodendron* Hincks, 1874 see Cornelius (1975a, 1995a), and for a review of the species in this genus see Rees & Vervoort (1987). We did not find large colonies in Moreton Bay matching the size or description of the New Zealand *H. mirabile* (Vervoort & Watson, 2003), which can reach 200 mm in size, have thick, polysiphonic stems and bear pinnately-arranged hydrocladia. Pennycuik (1959) and Preker (2001) previously recorded *Phylactotheca caciniformis* (Ritchie, 1907) from Queensland, a name now considered to be a synonym of *H. caciniformis*: for details see Rees & Vervoort (1987).

Occurrence. Amity Point.

Distribution. Circumglobal in tropical, subtropical and temperate waters. Recorded from the Mediterranean, Atlantic Ocean, West Indies, Africa, Indian Ocean, Australia, New Zealand.

Nemalecium Bouillon, 1986

Nemalecium lighti (Hargitt, 1924)
(Fig. 1E)

Halecium lighti Hargitt, 1924: 489–490, pl. 4 fig. 13; Pennycuik, 1959: 173–174, pl. 3 figs 1, 2.
Nemalecium lighti — Bouillon, 1986: 73–79, figs 1–4, pl. 1 figs 1–3, pl. 2 figs 1–4, pl. 3 figs 1–4; Bouillon *et al.*, 1986: 65–67, fig. 1, pls. 1, 2; Calder, 1991: 27–30, figs 17a–d, 18a–d; Kirkendale & Calder, 2003: 166–167; Preker & Lawn, 2005: 341.

Description. Erect colonies up to 18 mm high arising from a creeping hydrorhiza. Stem monosiphonic and sparingly branched, nodes distinct, internode with a distal apophysis occurring alternately on the right and then the left. Primary hydrothecae sessile, rarely renovated, margins not everted. Secondary hydrothecae pedicellate, rising either from within the primary hydrotheca, or lateral to it. Hydrotheca shallow, with a distinct diaphragm and a ring of large desmocytes. A distinguishing feature is the very large hydranth, with a prominent constriction beneath the tentacular ring. Many of the hydranths have a pair of short, thick, modified tentacles, the nematodactyls, which curve in towards the tentacles. These modified tentacles were present on all the living hydroids we examined but were easily detached when preserved, giving the impression that they occurred rarely if only preserved material were examined. The nematodactyls are heavily armed with large pseudostenoteles.

Measurements. Colony: height 16–14 mm, internode length 359–475 μm, diameter at node 80–91 μm. Hydrotheca: length to diaphragm 30 μm, diameter at rim 140–170 μm. Hydranth: length up to 1,340 μm. Nematocysts: pseudostenoteles 25x12 μm, microbasic mastigophores 6x2 μm.

Remarks. The nematodactyls and the presence of pseudostenoteles make *Nemalecium lighti* (Hargitt, 1924) a species that is easy to recognise, at least in living material. It was noted, however, that many of the preserved colonies lacked the nematodactyls entirely, underlining the importance of studying live *Nemalecium*. This species has previously been recorded from Myora and Dunwich by Pennycuik (1959). We failed to find it in these locations, but did find it to be common at Amity Point.

Occurrence. Amity Point.

Distribution. Bermuda, Indian and western Pacific Oceans.

Family HALOPTERIDIDAE Millard, 1962

Antennella Allman, 1877

Antennella secundaria (Gmelin, 1791)
(Fig. 1D)

Sertularia secundaria Gmelin, 1791: 3854.

Antennella secundaria — Billard, 1913: 8, text-fig. 1, pl. 1, figs 1–3; Pennycuik, 1959: 176–177, pl. 3, figs 4, 5; Millard, 1975: 332–334, fig. 107F–J, K–L; Rees & Vervoort, 1987: 113–117, fig. 23a, b, tab. 20; Yamada & Kubota, 1987: 40; Ryland & Gibbons, 1991: 525–527, fig. 1A–D; Ramil & Vervoort, 1992: 143–145, fig. 37a–d; Calder, 1997: 29–32, fig. 7a–f (cum syn.); Schuchert, 1997: 14–18, figs 3a–g, 4a–e (cum syn.); Watson, 2000: 45–46, fig. 34A–D; Preker, 2001: 254; Watson, 2002: 346–347, fig. 5E, F; Vervoort & Watson, 2003: 345–347, fig. 83J–L; Schuchert, 2003: 206–209, fig. 57A–G; Kirkendale & Calder, 2003: 168; Preker & Lawn, 2005: 342; Preker, 2005: 48; Watson, 2005: 536–537, fig. 14A–B.

Material Examined. QM-G331139, Cylinder Beach, N. Stradbroke I., SE Qld, M. Preker & J. Lawn, Feb. 2005.

Description. Delicate, erect colonies, sometimes with one branch, 3–7 mm high, arising from tubular stolon attached to algae and other hydroids. Stem consisting of a long, basal athecate and distal thecate part. Basal part divided into variable numbers of segments by transverse nodes, remainder of stem heteromerously segmented into thecate and athecate internodes by alternating oblique and transverse nodes. The thecate internode with one hydrotheca surrounded by four, two-chambered nematothecae: one median inferior, not reaching the hydrothecal base, two lateral on long apophyses and an axillar superior. Two small bithalamic nematothecae on the athecate internode.

Hydrothecae cup-shaped, with parallel walls, a small hydrophore at the base of the abcauline wall, and a sinous margin. Nematothecae bithalamic, small, mobile, and with a scoop-like distal chamber, the adcauline wall being greatly reduced. The lateral nematothecae reaching near the rim of hydrothecae.

Gonothecae not seen.

Measurements. Internode lengths: athecate 168–344 μm, thecate 152–384 μm. Diameter at transverse node 48–56 μm. Hydrotheca: abcauline length 120–160 μm, free adcauline length 136–140 μm, aperture 196–220 μm. Nematothecae: lateral nematothecae: overall length 88–106 μm, cup diameter 40–49 μm; mesial nematotheca: overall length 88–90 μm, cup diameter 28–40 μm.

Remarks. Unbranched colonies were the most common, but colonies with one branch were also present. The branch arises from an apophysis on the posterior surface of the basal athecate internode.

Occurrence. Dunwich (Pennycuik 1959), Flat Rock, Shark Gutter, Cylinder Beach, Amity Point.

Distribution. Cosmopolitan in temperate and tropical seas.

Halopteris Allman, 1877

Halopteris polymorpha (Billard, 1913)

Plumularia polymorpha Billard, 1913: 24–25, figs 14A–C, 15.
Antennella polymorpha — Vervoort, 1941: 218.
Halopteris buskii — Rees & Thursfield, 1965: 160; Gibbons & Ryland, 1991: 527–528, fig. 2A–C; Migotto, 1996: 48–50, fig.9f–h; Preker, 2001: 154; Preker, 2005: 48.
Halopteris polymorpha — Pennycuik, 1959: 178; Millard & Bouillon, 1973: 83–84, fig. 10F–J; Millard, 1975: 354–355, fig. 112G–L; Gibbons & Ryland, 1991: 530–532, fig. 4A–C; Schuchert, 1997: 64–73, figs 20a–f, 21a–h, 22a–h, 23a–f (rev.); Watson, 2000: 46–47, fig. 35A–H; Preker, 2001: 154; Kirkendale & Calder, 2003: 169; Preker, 2005; 49; Preker & Lawn, 2005: 342.

Description. Delicate, plumose, erect colony reaching 9 mm; basal part athecate but with various numbers of nematothecae in two rows, terminating in an oblique hinge-joint. Distal part of stem segmented into thecate internodes by oblique nodes. Each internode bears a hydrotheca on the front part of the stem, alternate hydrocladia arising by a short apophysis at the side of the hydrotheca, and six nematothecae: one median inferior, a pair of laterals, one axillar and two distal.

Hydrocladium heteromerous, bears hydrothecae on anterior surface. A long apophysis is followed by a short athecate segment without nematothecae. Remaining segments alternate between athecate and thecate internodes divided by transverse and oblique nodes. Thecate internodes with a hydrotheca and four nematothecae: one median inferior, not reaching the base of the hydrotheca, a pair of laterals on long pedicels of very-variable lengths, and a small axillar one. Athecate internode slightly shorter with one, rarely two, nematothecae.

Hydrotheca cup-shaped with straight, parallel, abcauline and adcauline walls, and adnate for about half its length, with rim slightly flaring.

Median inferior nematothecae two-chambered, scoop-shaped with no adcauline wall. Lateral nematothecae on short pedicels, movable, with shallow distal chamber, most reaching the rim of the hydrotheca, but a few overreaching the rim. Axillar nematothecae short and robust, cup with depression on adcauline side.

Gonothecae not seen.

Measurements. Stem: thecate internode length 320–420 µm, diameter at node 50–56 µm. Hydrocladium: thecate internode length 260–340 µm, athecate internode length 150–260 µm, diameter at node 33–38 µm. Hydrotheca: abcauline wall length 112–180 µm, free adcauline wall length 80–88 µm, aperture 152–160 µm.

Remarks. Only a few small colonies of this delicate, extremely variable species were collected. They fall within the range of variation of *Halopteris polymorpha* defined by Schuchert (1997). Although it is difficult to separate from *H. buskii* in the absence of gonothecae, *H. polymorpha* is a species predominantly occurring in tropical waters, whereas *H. buskii* has only been identified reliably from southern waters. *Halopteris polymorpha* has not been collected previously from Moreton Bay.

Occurrence. Flat Rock.

Distribution. Indian and Pacific Oceans, French Polynesia, Brazil (São Sebastião), tropical eastern Australia.

Family HEBELLIDAE Fraser, 1912

Anthohebella Boero, Bouillon & Kubota, 1997

Anthohebella parasitica (Ciamician, 1880)

Lafoea parasitica Ciamician, 1880: 673–676, pl. 39, figs 1–4.
Hebella parasitica — Marktanner-Turneretscher, 1890: 213–214; Vervoort & Vasseur, 1977: 12–13, fig. 3a–c; Boero, 1980a: 133–136, figs 1a, b, 2, 3a–g, 4, 5a, b, 6, 7a, b; Boero, 1980b: 142 fig. 1; Gibbons & Ryland, 1989: 394–395, fig. 13A, B; Watson, 1996: 78; Preker, 2001: 154.
Anthohebella parasitica — Boero, Bouillon & Kubota, 1997: 24–25, fig. 13a–c; Vervoort & Watson, 2003: 64, fig. 7H–K; Preker & Lawn, 2005: 203.

Description. Colonies epizoic on the hydroid *Sertularella diaphana*, stolonial, with hydrothecae arising at irregular intervals on slightly-twisted pedicels of variable length. The hydrothecae tend to occupy the free spaces between the hydrocladia of the host hydroid. Hydrotheca large, campanulate, asymmetrical, with margin strongly everted and sometimes renovated. Diaphragm thin and often very difficult to observe.

Gonotheca larger, widens towards truncated end, borne on a short pedicel.

Measurements. Hydrotheca: length 990–1,000 µm, marginal diameter 410–600 µm, pedicel length 250–480 µm. Gonotheca: length 1,895 µm.

Remarks. In the material examined, both *A. parasitica* and *Hebellopsis scandens* were found on *S. diaphana* among numerous other epizoids. The two species were never found to coexist on the same colony of *S. diaphana*.

Occurrence. Amity Point.

Distribution. Warm subtropical and tropical waters of the Atlantic, Indian and Pacific Oceans, and the Mediterranean. Recorded from Western Australia, Northern Territory (Beagle Gulf), Gulf of Carpentaria, and the Coral Sea.

Hebellopsis Hadzi, 1913

Hebellopsis costata (Bale, 1884) (Fig. 1F)

Campanularia costata Bale, 1884: 56–57, pl. 1 fig. 3.
Hebella costata — Stechow & Müller, 1923: 463; Billard, 1941: 13–15, figs 3, 4; Pennycuik, 1959: 188; Boero, Bouillon & Kubota, 1997: 35.
Hebellopsis costata — Watson, 2000: 6, fig. 3A, B; Preker & Lawn, 2005: 340.

Description. Hydrorhiza creeping on stems and branches of the hydroid *Idiellana pristis*. Hydrothecae borne on short, thick and slightly-wrinkled pedicel. Hydrothecae long and tubular, with eight or more deep annulations. The annulations are best developed distally, becoming less distinct towards the rounded base of the hydrothecae. Margin of hydrotheca circular, replicated, rim distinctly flared. Thin, indistinct diaphragm present.

Measurements. Pedicel 108–132 µm. Hydrotheca: length 992–1,312 µm, diameter at margin 448–489 µm.

Remarks. When revising *Hebella* Allman, 1888, Boero *et al.* (1997) considered *Hebellopsis costata* to be a doubtful species. Watson (2000) did not agree and gave reasons for finding this opinion untenable. Our material conforms well with Bale's (1884) description and illustrations and, as Pennycuik (1959) also recorded it from several locations within Moreton Bay, we include it here as being still abundant in Moreton Bay. Species are currently being assigned to genus based on the degree of medusae reduction, so collection of fertile material is essential to gain further information on the life cycle.

Occurrence. Amity Point. Pennycuik (1959) also recorded it from Bribie Island and between St. Helena Island and Mud Island.

Distribution. Indian Ocean, Australia.

Hebellopsis scandens (Bale, 1888)

Lafoea scandens Bale, 1888: 758–759, pl. 13 figs 16–19.
Hebella scandens — Marktanner-Turneretscher, 1890: 214, pl. 3 fig. 16; Bale, 1913: 117–120, pl. 12 fig. 10; Mulder & Trebilcock, 1915: 54, pl. 7 figs 4, 5; Stechow, 1919: 77–78, fig. Z; Mammen, 1965a: 4–5, fig. 31; Millard & Bouillon, 1973: 59–60; Millard, 1975: 182–184, fig. 60F, G; Migotto, 1996: 26-27, fig. 6a, b; Watson, 1979: 234; Gibbons & Ryland, 1989: 395, fig. 14A, B; Watson, 1994b: 66; Boero *et al.*, 1997: 8; Preker, 2001: 154; Preker, 2005: 47.
Hebellopsis scandens — Calder, 1991: 43–45, fig. 27; Watson, 2000: 6–7, fig. 3B, C; 2002: 338–340, fig. 1A; 2003: 66–68, fig. 9A–I; Preker & Lawn, 2005: 340.

Description. Epizoic on *Sertularella diaphana* (Allman, 1885), where the hydrorhiza intertwines the polysiphonic stem of the host. Hydrothecae borne on short pedicels, long and tubular, widening slightly distally and often curving towards the host. Considerable variability in shape of hydrotheca, margin entire, slightly flaring and frequently renovated.

Gonophore larger than hydrotheca, arising from a short pedicel and widening towards the margin. Gonotheca closed by an operculum consisting of four valves. It contains two medusa-buds, one above the other.

Measurements. Hydrotheca: depth 699–1,002 µm, marginal diameter 190–301 µm. Gonotheca: depth 1,200 µm, marginal diameter 620 µm.

Remarks. The Moreton Bay specimens closely resemble the descriptions and size given by

Millard (1975) for South African material. The range of the Moreton Bay material is outside the sizes given by Gibbons & Ryland (1989) for Fiji. Watson (2003), however, remarks that there is considerable variability in the shape and size of the hydrothecae in this species. Millard (1975) reported that the stolon of *H. scandens* lay within the perisarc of the host. Physical penetration of host perisarc by the hydrorhiza was not observed in the Moreton Bay specimens, but there was a very close association and there may have been penetration inside some of the host's polysiphonic stem bundles.

Occurrence. Amity Point.

Distribution. Cosmopolitan.

Family LAFOEIDAE A. Agassiz, 1865

Filellum Hincks, 1868

Filellum serratum (Clarke, 1879)

Lafoea serrata Clarke, 1879: 242, pl. 4 fig. 25; Ritchie, 1911: 818–820.
Reticularia serrata — Ralph, 1958: 312, text-figs 2j, 3a.
Filellum serratum — Hargitt, 1924: 488; Millard, 1975: 178, fig. 59A, B; Calder, 1991: 36, fig. 21; Ramil & Vervoort, 1992: 354–355; Hirohito, 1995: 110–112, fig. 31a–c; Pe a Cantero *et al.*, 1992: 304–308, figs.1a–c, 2a–c; Vervoort & Watson, 2003: 59–60.
Filellum ?serratum — Watson, 2000: 5–6, fig. 2C.

Description. Small, stolonial, sessile hydroid arising from a creeping hydrorhiza growing epizoically on the hydroid *Idiellana pristis*. The hydrotheca is tubiform and, for about half of its length, is adnate to the hydrorhiza, with the free portion bent outwards. The adnate part has various numbers of transverse ridges on the upper surface, the margin of the hydrotheca is slightly everted and many are renovated.

Coppinia not seen.

Measurements. Hydrotheca: adnate length 225–300 µm, free length 200–250 µm, aperture 75–95 µm.

Remarks. It is difficult to distinguish this species, with certainty, in the absence of a coppinia. Fertile *Filellum serratum* have not been seen frequently, with only Ritchie (1911) describing coppinia from Australian waters and Millard (1975) from South Africa. The striations are, however, typical of *F. serratum*. Specimens widely distributed, epizoic on *Idiellana pristis*.

Occurrence. Amity Point, Cylinder Beach, Shag Rock, Flat Rock.

Distribution. Circumglobal.

Family PLUMULARIIDAE McCrady, 1857

Plumularia Lamarck, 1816

Plumularia setacea (Linnaeus, 1758)

Corallina setacea Ellis, 1755: 19, pl. 11a, A.
Sertularia setacea Linnaeus, 1758: 813.
Plumularia setacea — Lamarck, 1816: 129; Hincks, 1868: 296–299, pl. 66 figs 1, 1a; Bale, 1888: 778–779, pl. 20 figs 14–18; Trebilcock, 1928: 24; Pennycuik, 1959: 180; Ralph, 1961b: 33–36, text-figs 3d–e, 4a–d; Millard, 1975: 399–401, fig. 124E–K; Calder, 1997: 17–21, fig. 4a–d (cum syn.); Watson, 2000: 53–55, fig. 41A, B; Vervoort & Watson, 2003: 398–402, fig. 97A–G; Preker & Lawn, 2005: 343.

Description. Colony consisting of erect stems arising from hydrorhizae attached to algae and to the hydroid *Sertularia turbinata*. Stems monosiphonic reaching 12 mm in height, unbranched but bearing alternate hydrocladia and supported by an athecate basal section. Thereafter, divided into regular internodes by slightly-oblique nodes. Each internode bearing one distal hydrocladial apophysis and two nematothecae, one inferior-opposite and one axillar of the apophysis. Apophysis antero-lateral, with two transverse nodes and bearing a small mamelon on the upper surface near the node.

Hydrocladia bearing hydrothecae on upper surface, separated by oblique nodes, alternating between short athecate and long thecate internodes. Thecate internodes with three nematothecae; one median inferior and two lateral, which overtop the margin of the hydrotheca. Athecate internode has two internodal septae, one proximal and one distal, and one medial nematotheca in the basal third of the internode.

Hydrotheca cup-shaped, adnate for most of its vertical height, widening to the margin and with no internal septum. Nematothecae two-chambered and mobile. Mesial nematotheca with short basal chamber and a slightly-lower wall on the adcauline side. Lateral nematothecae on long basal chambers, movable, with a small circular cup reaching or, sometimes, overreaching the hydrothecal margin, slightly lower on the adcauline side.

Gonothecae not seen.

Measurements. Stem: length 280–480 µm, diameter at node 80–96 µm. Hydrocladia: basal segment 24–48 µm, thecate internode length 177–200 µm, athecate internode length 100–116 µm, diameter at node 33–48 µm. Hydrotheca: abcauline wall length 76–80 µm, aperture 80–112 µm. Nematothecae: axial basal: stem 32–40 µm, cup 12–20 µm; hydrocladial medial inferior: stem 28–44 µm, cup 16–20 µm.

Remarks. This identification may well be doubtful for the following reasons. It is not possible to reliably distinguish between *Plumularia warreni* Stechow, 1919, *P. strictocarpa* Pictet, 1893, and *P. setacea* in the absence of gonothecae. All the Moreton Bay material was in non-reproductive condition. Furthermore, the distribution of the three species did not help in determining the most likely species as they tend to overlap. Pennycuick (1959) recorded *P. warreni* from Point Lookout and Currumbin and *P. setacea* from Point Lookout, Bribie Island and Myora. In the absence of any reliable distinguishing features, we used Pennycuik's (1959) 'Key to Species' to tentatively identify our colonies as *P. setacea*. Pennycuik noted that when the hydrothecal mouth diameter was greater than the hydrothecal depth, this was associated with mature, female gonothecae possessing external marsupia, the situation found in *P. warreni*. When the hydrothecal mouth diameter was about equal to the hydrothecal depth, this was associated with the type of female gonothecae found in *P. setacea*. The aperture diameter of our colonies was equal to, or slightly greater than, the hydrothecal depth, suggesting that they may be *P. setacea*. *Plumularia setacea* is also known to be a highly variable species and to occur as small, epizoic forms, a situation that we also encountered with our colonies.

Occurrence. Bribie Island, Point Lookout, Myora and Flat Rock.

Distribution. Circumglobal in the tropical, subtropical, and temperate regions of the Atlantic, Pacific and Indian Oceans.

Family SERTULARIIDAE Lamouroux, 1812

Calamphora Allman, 1888

Calamphora campanulata (Warren, 1908) (Fig. 1G)

Sertularella campanulata Warren, 1908: 300–302, pl. 47 figs 21, 22.
Calamphora campanulata — Stechow, 1919: 83; Mammen, 1965a: 35, fig. 67a, b; Millard, 1975: 253, fig. 83F; Gibbons & Ryland, 1989: 407, fig. 25A, B; Watson, 1996: 78; 1997: 521–522, fig. 5E, F; Preker, 2005: 47; Preker & Lawn, 2005: 339.
Thyroscyphus campanulatus — Pennycuik, 1959: 198.

Material Examined. QM-G331141, Flat Rock, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Stolonial colony creeping on algae and polychaete tubes. Hydrothecae solitary, borne on short, twisted, corrugated pedicels, some of which have up to two annulations near the base of the hydrothecae. Hydrothecae terminal, barrel-shaped, with 7–11 transverse annulations or ridges, tapering basally towards the pedicel and distally to a square neck. Margin with four, pointed, slightly-everted cusps, and four triangular opercular valves.

Gonothecae not seen.

Measurements. Pedicel length 80 µm. Hydrotheca (two size-classes given): height 400–576 µm and 656–960 µm, maximum diameter 144–160 µm and 200–295 µm, marginal diameter 144 µm.

Remarks. This is the first record of *C. campanulata* occurring epizoically, having previously been recorded only from algae. The hydrothecae and pedicels of *C. campanulata* from Moreton Bay show a much greater range in size than those found by Mammen (1965a), Millard (1975) and Gibbons & Ryland (1989). They tend to fall into two size-classes (see measurements above): both size-classes occurred on the same alga or polychaete tube, but it was not possible to determine if they actually arose from the same stolon. Mammen (1965a) describes the gonothecae as similar to the hydrothecae but wider and with a bulging shape. We had to rule out the larger forms being gonothecae when one was found to contain a hydranth with tentacles. New, fertile material needs to be examined before further conclusions can be drawn.

Occurrence. Flat Rock.

Distribution. South Africa (Natal), Madagascar, India, Indo-China, Japan, Australia.

Diphasia L. Agassiz, 1862

Diphasia digitalis (Busk, 1852) (Fig. 1H)

Sertularia digitalis Busk, 1852: 393.
Desmoscyphus longitheca — Allman, 1877: 26–27, pl. 14 figs 3–6.
Diphasia digitalis — von Lendenfeld, 1885b: 415; Bale, 1884: 101, pl. 9 figs 3–5; Jäderholm, 1916: 5; Pennycuik, 1959: 191; Millard, 1975: 257–258, fig. 85E; Watson, 1996: 78; Watson, 2000: 14–15, fig. 10A, B; Schuchert, 2003: 166, fig. 25A, B.

Description. Colony comprising short stems arising from a creeping stolon. Stems bearing from four to nine pairs of hydrothecae. Only one colony was branched, with a pair of alternate hydrocladia. A hinge-joint occurs near the base separating the athecate part of the stem; the rest of stem is subdivided by indistinct, transverse nodes. Each internode bearing one pair of lateral hydrothecae.

Hydrothecae are long tubes, expanding to distal part, which is curved slightly away, adnate for more than three-quarters of the length, consecutive pairs very close. Margin of hydrotheca quadrangular, no internal cusps or ridges, one large operculum attached to adcauline rim of hydrotheca.

Gonothecae not observed.

Colour. Colonies had characteristic, black-grey, pigment granules which give them an overall grey appearance.

Measurements. Hydrotheca: length of adnate adcauline wall 560-620 µm, length of free adcauline wall 155-280 µm, length of abcauline wall 615-760 µm, diameter across margin 200–234 µm.

Remarks. The characteristic blackish-grey colour clearly identifies this material as *Diphasia digitalis*. Found as an epizoite on the hydroid *Idiellana pristis* (Lamouroux, 1816). Previously reported from Moreton Bay by Pennycuik (1959).

Occurrence. Amity Point, Polka Point (Dunwich), channel between St. Helena and Mud Islands.

Distribution. Circumglobal in tropical and subtropical areas.

Diphasia mutulata (Busk, 1852)

Sertularia mutulata Busk, 1852: 391.
Diphasia mutulata — Bale, 1884: 101-102, pl. 9 figs 6–9; Billard, 1933: 16, text-fig. 6H-J, pl.- ?? fig. 4; Watson, 1996: 78; 2000: 12–14, fig. 9A–G; Schuchert, 2003: 166–168, fig. 26A–D.
Nigellastrum mutulatum — Stechow & Müller, 1923: 468–469.

Description. Colonies with simple stems from 4–8 mm high, arising at intervals from a tubular hydrorhiza creeping over the hydroid *Idiellana pristis*. Colonies with terminal stolonization common. Proximal stem region athecate, terminating in a hinge joint; rest of stem divided by indistinct, transverse nodes. One pair of opposite hydrothecae to an internode, successive pairs of hydrothecae well separated. Hydrothecae tubular and somewhat angular in shape, especially in the basal part of the colony, widening to margin, which is curved outwards and slightly upwards. Hydrotheca adnate for about two thirds of its adcauline length. Adcauline wall of hydrotheca with a transverse, intrathecal ridge. Margin of hydrotheca untoothed, with one large, delicate, adcauline operculum.

Gonothecae not observed.

Colour. Pale brown.

Measurements. Hydrotheca: length adnate adcauline wall 400–480 µm, length free adcauline wall 90-190 µm, diameter across margin 180–200 µm.

Remarks. *Diphasia mutulata* from Moreton Bay showed some variation in stem forms but we were unable to distinguish the two distinct morphs described by Watson (2000). The hydrothecae also showed some variation, even within the same stem, but not outside the range described for *D. mutulata* by Watson (2000) and Schuchert (2003). Bale (1884) noted that it was collected in Queensland from Port Molle (Whitsunday Is Group) by William Haswell.

Occurrence. Flat Rock.

Distribution. Indonesia, Andaman Sea, Red Sea, Torres Strait, northern Australia, Queensland.

Dynamena Lamouroux, 1812

Dynamena crisioides Lamouroux, 1824

Dynamena crisioides Lamouroux, 1824: 613, pl. 90 figs 11, 12; Billard, 1925: 181–185, figs 36A, B, 37C–E, pl. 7 fig. 21; Blackburn, 1937b: 172–173, fig. 3; Briggs & Gardner, 1931: 190–191; Pennycuik, 1959: 192; Millard, 1975: 263–264, fig. 87A–F; Gibbons & Ryland, 1989: 410–411, fig. 28A–D; Calder, 1991: 89–92, figs 47a, b, 48a–c (cum syn.); Migotto, 1996: 60–61, fig. 11e–g; Preker, 2001: 154; Schuchert, 2003: 170–171, fig. 28A–D; Preker, 2005: 48; Preker & Lawn, 2005: 341.

Material Examined. QM-G331143, Flat Rock, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Colonies small, examined material reaching 12–20 mm, monosiphonic. Stem with a short, basal, athecate section terminated by a transverse node, then a short portion lacking hydrocladia but with a pair of subopposite hydrothecae, and terminated by an oblique node. The remainder of the colony is divided into regular internodes by oblique nodes, each internode with a long, hydrocladial apophysis basally, and with a variable number of subopposite hydrothecae, one always axial of the apophysis, the others in two rows.

Hydrothecae tubular, adnate for more than half of the adcauline length, then curved outwards. Abcauline thecal wall thickened, margin with two, pointed lateral cusps and one, weak adcauline cusp. Operculum composed of two valves, upper valve smaller than the lower.

Gonothecae arising below hydrothecae on both stem and hydrocladia, ovate, and with a deeply-irregular, crinkled wall, opening on a long, off-centre, slightly-curved neck.

Measurements. Hydrotheca: length adnate adcauline wall 380–460 µm, length free adcauline wall 100–240 µm, diameter at opening 120–140 µm. Gonotheca: length 1,100 µm, diameter 420 µm, margin diameter 180 µm.

Remarks. This is recognised as a highly-variable species. The Moreton Bay samples show variation in the number of hydrothecae to an internode, with two as the usual number on the stem. The number of hydrocladia on each stem also varies, from none to three.

Occurrence. Point Lookout, Amity Point, Flat Rock, Shag Rock, Shark Gutter, Myora, Point Cartwright, Caloundra, Redcliffe, Cleveland, Nerang River, Currumbin.

Distribution. Cosmopolitan in tropical and subtropical waters.

Dynamena quadridentata (Ellis & Solander, 1786)

Sertularia quadridentata Ellis & Solander, 1786: 57 pl. 5 fig. g, G.
Pasythea quadridentata — Lamouroux, 1816: 156, pl. 3 figs 8a, B; Bale, 1884: 112, pl. 7 fig. 3.
Dynamena quadridentata — Billard, 1925: 194–198, fig. 42 U–W; Blackburn, 1938: 320; Pennycuik, 1959: 193; Ralph, 1961a: 790, fig. 13e; Millard, 1975: 266–268, fig. 87G–J; Gibbons & Ryland, 1989: 411–414, figs 29A–C, 30A–C; Calder, 1991: 96–98, fig. 51a–c; Vervoort, 1993: 108–109; Watson, 1996: 78; 1997: 520, fig. 5C; 2000: 15, fig. 10C–E; Preker, 2001: 154; Watson, 2002: 341–343, fig. 2C–F; Vervoort & Watson, 2003: 131, fig. 26C; Preker & Lawn, 2005: 339.

Material Examined. QM-G331142, Myora, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. A few, small colonies growing on the stem of *Sertularella diaphana* (Allman, 1885). The colonies were very dirty and in poor condition, so no description or measurements of the material were made. The colonies were sterile.

Remarks. This is a fairly well-known species. The material from Moreton Bay is in full agreement with Billard's (1925) account of Indonesian specimens of the typical form. Previously recorded from various southern and eastern Australian waters.

Occurrence. Myora, Flat Rock, channel between St. Helena and Mud Islands.

Distribution. Circumglobal in warm temperate and tropical waters.

Idiellana Cotton & Godfrey, 1942

Idiellana pristis (Lamouroux, 1816)

Idia pristis Lamouroux, 1816: 199, pl. 5 fig. 5; Bale, 1884: 113–114, pl. 7 figs 1, 2, pl. 19 fig. 33; Jäderholm, 1916: 7; Bale, 1924: 249.
Idiella pristis — Stechow, 1919: 106; Stechow & Müller, 1923: 469; Briggs & Gardner, 1931: 191; Blackburn, 1942: 116–117.
Idiellana pristis — Cotton & Godfrey, 1942: 234; Pennycuik, 1959: 193; Ralph, 1961a: 766, fig. 5c–e; Millard, 1975: 269–270, fig. 88A–E; Migotto, 1996: 65–68, fig. 12h, i; Watson, 1996: 78; 2000: 19–20, fig. 14A–E; Schuchert, 2001: 175–176, fig. 32A–D; Vervoort & Watson, 2003: 143; Preker & Lawn, 2005: 339.

Material Examined. QM-G331145, Flat Rock, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Large, conspicuous colonies arising from a tangled hydrorhiza. Stem up to 110 mm high, monosiphonic, divided into regular internodes by slightly-oblique nodes which slope in alternate directions. Proximal stem athecate, with hydrocladial apophyses but no hydrocladia. Subsequent stem internode with one proximal hydrocladial apophysis and three hydrothecae, one in the aphophysal axis and an alternate pair above.

Hydrocladia alternate, unbranched, hydrocladial internodes long and irregular, bearing up to nine pairs of alternate, overlapping hydrothecae on the anterior face, the two rows of hydrothecae contiguous with one another.

Hydrothecae tubular, adnate for over half their length, free part projecting outwards, each adnate to those above and below and to those opposite. Aperture rounded with two lateral cusps, directed slightly upwards. Operculum consisting of one, thin, adcauline valve not sharply demarcated from hydrotheca.

Gonothecae borne on front of stem and hydrocladia, abundant throughout colony, large, barrel-shaped, with either longitudinal ribs, or almost smooth with only faint undulations, rounded at base, truncated above, aperture on elevated, tubular neck with a slightly everted margin.

Colour. Pale brown.

Measurements. Stem: length of internode 900–1,600 µm, width at node 430–610 µm. Hydrocladium: length of internode 1,200–3,400 µm, width at node 120–140 µm. Hydrotheca: length 460–610 µm, diameter at opening 150–200 µm. Gonotheca: length 1,600–1,700 µm, diameter 820–920 µm, margin diameter 450–550 µm.

Remarks. This species is easy to identify, the double row of projecting, alternate hydrothecae on the broad, anterior surface of the hydrocladia bears a resemblance to the rostrum of the saw-fish, *Pristis*, after which the species was named. *Idiellana pristis* was not only very abundant and conspicuous, but also the host of a number of other species of hydroids such as: *Filellum serratum* (Clarke, 1879), *Diphasia digitalis* (Busk, 1852), and *Hebellopsis costata* (Bale, 1884).

Occurrence. Flat Rock, Shark Gutter, Myora, channel between St. Helena and Mud Islands.

Distribution. Circumglobal; tropical, subtropical.

Salacia Lamouroux, 1816

Salacia desmoides (Torrey, 1902)

Sertularia desmoidis Torrey, 1902: 65–66, pl.8, figs 70–72.

Sertularia desmoides — Fraser, 1911: 72; Billard, 1924a: 66; Fraser, 1938: 10, 54.

Salacia desmoides — Stechow, 1922: 150; 1923b: 213; Millard, 1975: 274, fig. 90A–C; Medel Soteras *et al.*, 1991: 510–512, fig. 3A–B; Boero & Bouillon, 1993: 264; Medel & Vervoort, 1998: 30–32; Watson, 1997: 518, fig. 5A, B; Watson, 2002: 341, fig. 2A, B; Vervoort & Watson, 2003: 148–151, fig. 33D–F.

Description. Colonies epizoic on the hydroid *Idiellana pristis*. Short stems, up to 9 mm high, rising from stolon, unbranched, with a basal athecate section ending in an oblique hinge-joint. The rest of the colony is divided into internodes by v-shaped nodes. Hydrothecae biserrate, paired, tubular, contiguous in front, separated behind, adnate for over half their length, then curved outwards. Margin without teeth and with one opercular flap attached to the abcauline wall.

Gonothecae on lower stem arising from short pedicels below hydrothecae, barrel-shaped, with some irregular, circular lines, disappearing on distal parts of gonothecae.

Colour. Cream yellow.

Measurements. Hydrotheca: length adnate adcauline wall 180–200 µm, free adcauline wall 226–300 µm, diameter at rim 150–170 µm. Gonotheca: length 1,900 µm, diameter 810 µm, margin diameter 500 µm.

Remarks. The oblique margin with the abcauline, opercular valve is characteristic of this species. The material could be identified positively because of the presence of one gonotheca. Previously recorded from south-east Queensland by Watson (2002).

Occurrence. Shark Gutter.

Distribution. Southwest North America (California), southwest Indian Ocean, Mediterranean Sea, Australia (Western Australia, southeast Queensland).

Salacia hexodon (Busk, 1852)

Pasythea hexodon Busk, 1852: 395; Bale, 1884: 113, pl. 19 fig. 13; Bale, 1888: 771, pl. 14 figs 8, 9; Jäderholm, 1916: 5.

Salacia hexodon — Billard, 1925: 207–208, fig. 49C, D; Pennycuik, 1959: 194; Watson, 1996: 78; Watson, 2000: 21–22, fig. 16A, B; Schuchert, 2003: 176–177, fig. 33: Preker & Lawn, 2005: 339, 342.

Material Examined. QM-G331148, Peel Island, Moreton Bay, SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Irregularly-branched, monosiphonic colonies. Stem divided into long, regular internodes by transverse nodes, groups of hydrothecae clustered in distal part of internode. Hydrothecae on lateral side of stem grouped in three to five overlapping, sub-opposite pairs. Hydrothecae tubular, adnate for about half their adcauline length, distal half curving out and, in many, slightly downwards, margin sinuate and closed by an abcauline operculum.

Gonothecae not seen.

Measurements. Internode length 2,000–2,100 µm. Hydrotheca: length adnate adcauline wall 300–450 µm, length free adcauline wall 285–300 µm, diameter at rim 230–270 µm.

Remarks. Although only four, small, dirty colonies were found, the characteristic clustering of the hydrothecae on the anterior surface of the hydrocladia makes this species easy to identify. Previously recorded from Moreton Bay by Pennycuik (1959).

Occurrence. Amity Point, Peel Island.

Distribution. Indonesia, tropical waters of Australia (Torres Strait, Northern Territory (Darwin), Queensland).

Salacia tetracythara Lamouroux, 1816 (Fig. 1I)

Salacia tetracythara Lamouroux, 1816: 212, pl. 6 fig. 3a–c; Billard, 1925: 202–204, pl. 8 figs 27, 28, text-fig. 48O–T, pls 27, 28; Pennycuik, 1959: 194; Mammen, 1965a: 54, fig. 87; Gibbons & Ryland, 1989: 414–415, fig. 31A–D; Hirohito, 1995: 183–185, fig. 60a–c; Watson, 2000: 23-24, fig. 18A–F; Preker, 2001: 154; Schuchert, 2003: 181–182, fig. 37A, B.

Description. Large, erect, pinnate, polysiphonic colonies with stiff stems arising from tangled hydrorhizae. Many colonies are connected to each other through distal tendrils of hydrocladia. Stem divided by transverse constrictions, each internode with alternately-arranged apophyses bearing a hydrocladium held out stiffly at approximately 60–70°, three hydrothecae arranged in a subopposite pair and one in the stem apophysis axis. Hydrocladia alternating and with numerous hydrothecae, nodes rare. Hydrothecae in subopposite pairs, members of the pairs not in contact but slightly overlapping the base of the preceding hydrothecae pairs. Hydrothecae tubular, slender, adnate for most of their adcauline length, then curved outwards with the opening curved slightly downwards. Margin elliptical with three shallow teeth and one-valved operculum attached on the abcauline side of the rim.

Gonothecae in rows on stem and hydrocladia, globular, smooth, and with an aperture on a raised collar.

Colour. Light brown.

Measurements. Internode length 750–1,000 µm. Hydrotheca: length adcauline wall 350–430 µm, diameter at margin 120–125 µm. Gonotheca: length 1,000 µm, maximum width 690–800 µm, diameter at aperture 495–520 µm.

Remarks. Moreton Bay material conforms with the description given by Watson (2000) for *Salacia tetracythara* from northern Australia. This is the first record of the species in the Bay.

Occurrence. Amity Point.

Distribution. Indian and Pacific Oceans, Japan, tropical to temperate coast of Australia.

Sertularella Gray, 1848

Sertularella diaphana (Allman, 1885) (Fig. 1B, 2A, B)

Thuiaria diaphana Allman, 1885: 145–146, pl. 18 figs 1–3.

Sertularella diaphana — Bale, 1919: 337–339, pl. 16 fig. 5; Billard, 1925: 157–160, text-fig. 22K–O, pl. 7 figs 12, 13; Pennycuik, 1959: 195; Millard, 1975: 285, fig. 93A–D; Gibbons & Ryland, 1989: 415–417, fig. 32A–E; Calder, 1991: 101–103, fig. 53; Vervoort, 1993: 214–216, figs 45d–e, 46d; Hirohito, 1995: 192, fig. 62b–d, pl. 12 fig. A; Watson, 2000: 31–33, fig. 24A–E; Preker, 2001: 154; Schuchert, 2003: 184–185, fig. 40A–D; Preker & Lawn, 2005: 342.

? *S. diaphana gigantea* — Preker, 1998: 172, unnumbered colour fig.

Material Examined. QM-G331153, Flat Rock, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Colonies variable, from unbranched, to stems with alternate hydrocladia in one plane, reaching 10 cm, lower stem thick and polysiphonic, monosiphonic distally. Stem divided into short internodes by oblique nodes sloping alternately to left and right. Each stem internode bearing one hydrocladium distally on internodes and three hydrothecae: one inferior, one subopposite and one axillary. Hydrocladia with two alternate rows of hydrothecae, divided into internodes by sloping nodes.

Hydrothecae sunken into axis of hydrocladium with only a small section of the adcauline wall free, hydrothecal aperture circular and sloping upwards with four low cusps, operculum consisting of four, thick, triangular flaps, many of which were missing or damaged. Adcauline wall curved and ending in a small thickening of the perisarc at the base; no perisarcal floor could be seen. Hydranth with deep, abcauline caecum and with about 15–17 tentacles.

Gonothecae borne on anterior surface of hydrocladia, large and cylindrical, narrowed basally, with longitudinal, undulating lines or folds.

Measurements. Internode lengths: stem 1,200–1,550 µm, hydrocladia 2,500–4,000 µm. Hydrotheca: length adnate adcauline wall 400–520 µm, length free adcauline wall 65–110 µm, diameter at margin 200–230 µm. Gonotheca: length 1,700–2,000 µm, maximum width 600–800 µm.

Remarks. The material from Moreton Bay conforms with the typical form of *Sertularella diaphana* and also, possibly, with *S. diaphana* var. *gigantea*, which forms very large colonies and has thickenings at the lower end of the adcauline, hydrothecal wall (after Billard 1925). As no measurements of hydrothecal lengths and diameters are available for the material described as *S. diaphana* var *gigantea* by Billard (1925) from the SIBOGA Expedition, we have not attempted to distinguish between the two forms at this point. The type location is Moreton Bay, where a Miss Gatty collected a dry sample which she later gave to Professor Allman for identification (Allman, 1885).

Occurrence. Flat Rock, Shark Gutter, Frenchmans Bay.

Distribution. Type location Moreton Bay. Wide distribution in tropical and subtropical waters of the Indo-Pacific and Atlantic Oceans.

Sertularella minuscula Billard, 1924b
(Fig. 2C, D)

Sertularella minuscula Billard, 1924b: 648, fig. 2F; 1925: 139–140, fig. 9A–C; Leloup, 1932b: 161–162, figs 26, 27; 1935: 45; Pennycuik, 1959: 195, pl. 6 fig. 2; Hirohito, 1974: 18–20, fig. 7a–e; Gibbons & Ryland, 1989: 417–418, fig. 33A–D; Preker, 2001: 154; Watson, 2002: 343–344, fig. 3A–E; Preker, 2005: 48.

Material Examined. QM-G331151, Shag Rock, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Small, erect, monosiphonic colony reaching 7 mm, arising from tubular hydrorhiza creeping on the distal part of some of the larger *S. diaphana* colonies. Stem unbranched, with a short, athecate, basal section, then divided into regular, thecate internodes by oblique nodes sloping alternately left and right. Internodes long and slender, often swollen or annulated at the base. Hydrothecae borne on both hydrohiza and caulus. The hydrorhizal hydrothecae are irregularly spaced, a few are sessile, but most on short pedicels. The cauline hydrothecae are sessile, one per internode, borne distally and slightly towards the front of the stem. Hydrothecae smooth, cylindrical, narrowing slightly to margin, lower third to half of adcauline wall adnate to internode, upper half curving gently outwards, abcauline wall slightly concave. Margin facing out and up, often with much renovation, with four, distinct cusps separated by deep embayments, operculum of four, very-fragile, triangular valves.

Gonothecae irregular in shape but predominantly obovate, with deep wrinkles, tapering towards a wide pedicel, a small, round mouth located on either a short collar or sunken into the apex of the gonotheca, perisarc thin.

Colour. Pale cream-white.

Measurements. Internode length 240–480 µm. Hydrotheca: length adnate adcauline wall 160–170 µm, length free adcauline wall 160–200 µm, diameter at margin 100–110 µm. Gonotheca: length 950–1,360 µm.

Remarks. The small size and the wrinkled gonothecae make this species easy to identify. Its distribution may have been underestimated, as it is easily overlooked.

Occurrence. Shag Rock.

Distribution. Caribbean, Indian Ocean, Indonesia, Micronesia, Japan, Australia (Qld).

Sertularella quadridens (Bale, 1884)

Thuiaria quadridens Bale, 1884: 119, pl. 7 figs 5, 6; Weltner, 1900: 586, pl. 46 figs 1–3.
Sertularella quadridens — Ritchie, 1910b: 818, text-fig. 79, pl. 77 fig. 12a, b; Stechow & Müller, 1923: 471–472; Bale, 1924: 242; Billard, 1925: 150–151, fig. 19 A, B; Pennycuik, 1959: 195; Mammen, 1965a: 38–39, fig. 70; Watson, 2000: 28–30, fig. 23A–F; Schuchert, 2003: 185–188, fig. 41A–I; Vervoort & Watson, 2003: 171–172.

Description. Erect colonies, pinnate, reaching heights of 45–50 mm. Stem monosiphonic, divided into indistinct internodes, especially in the basal part of the colony. Nodes are oblique and sloping alternately to left and right. Each stem internode bearing a hydrocladial apophysis and three cauline hydrothecae; inferior, axillary and opposite. Hydrocladial internodes with variable number of alternate, well-separated hydrothecae.

Hydrothecae consist of a slightly-swollen tube, curved outwards, adnate almost to the margin, or with a small free portion. Aperture facing slightly upwards, with four marginal cusps. Lower end of adcauline wall forming a perisarc extension projecting into the cavity of the stem or hydrocladia.

Gonothecae not seen.

Measurements. Stem: internode length 1,500–1,760 μm, width at node 335–420 μm. Stem hydrotheca: length adnate adcauline wall 350–435 μm, length free adcauline wall 135–190 μm, diameter at margin 140–190 μm. Hydrocladium: internode length 1,700–1,950 μm, width at node 210–310 μm. Hydrocladial hydrotheca: length adnate adcauline wall 390–450 μm, length free adcauline wall 25–90 μm, diameter at margin 240–290 μm.

Remarks. Pennycuik (1959) reported this hydroid from a number of locations in Moreton Bay. Watson (2000) re-examined the Moreton Bay material and published measurements not originally provided by Pennycuik. Our Moreton Bay specimens are slightly smaller than the material previously collected from this area but fall within the size range of the species. The basal, adcauline, perisarc spur described by Bale (1884) and Billard (1925) are not equally well developed in our material, varying within the same colony from totally absent, to large projections that almost connect to the opposite hydrotheca.

Occurrence. Amity Point, Peel Island, channel between St. Helena and Mud Islands.

Distribution. Widely distributed throughout the Indo-Pacific, Indonesia, Australia (Queensland, Western Australia).

Sertularella robusta Coughtrey, 1876 (Fig. 2E)

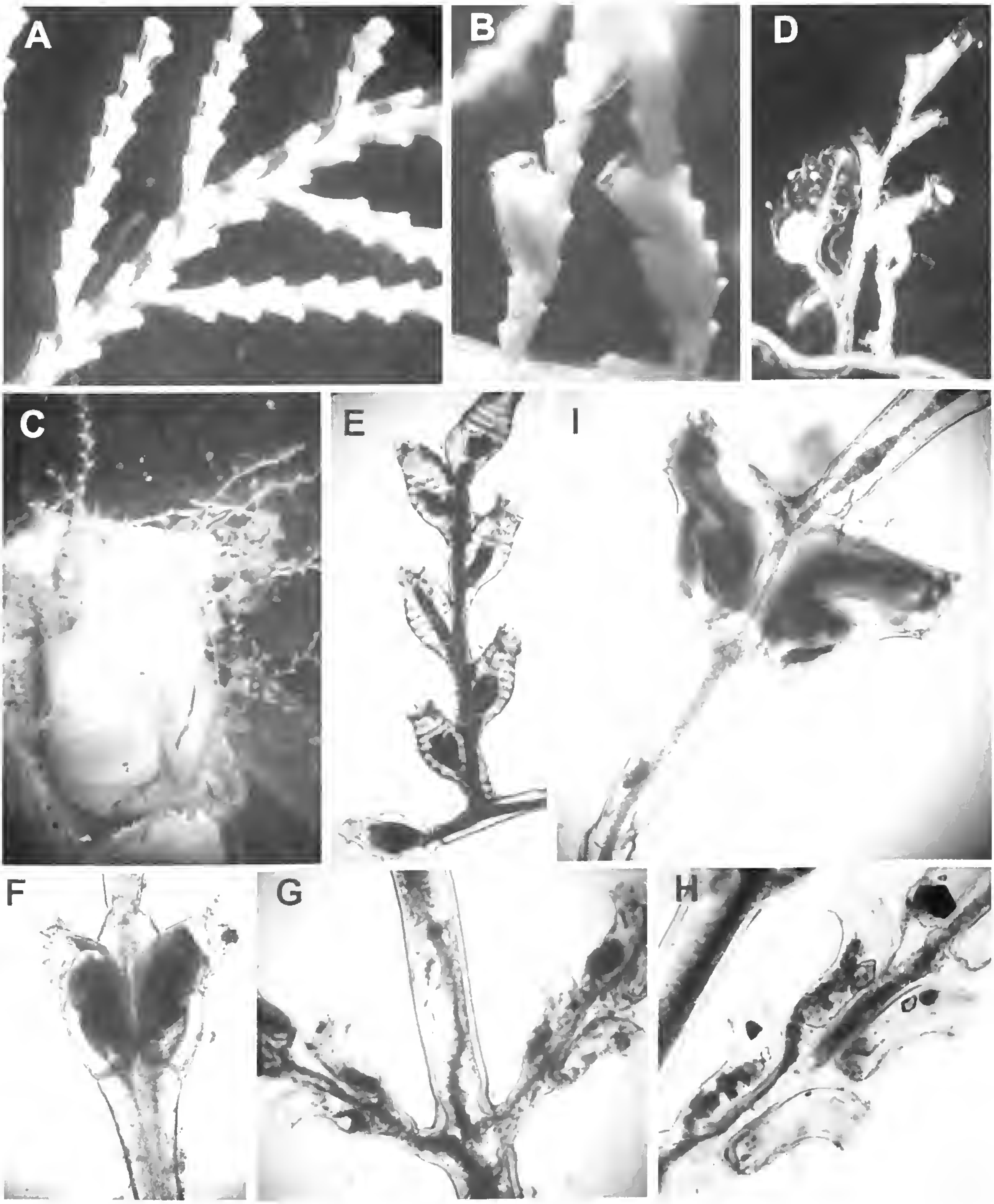
Sertularella robusta Coughtrey, 1876a: 300; Stechow, 1913: 14; Trebilcock, 1928: 16–18, pl. 6 figs 3, 3a–c; Blackburn, 1937a: 367; 1937b: 171–172, fig. 1; Pennycuik, 1959: 195–196, pl. 6 fig. 3; Ralph, 1961a: 824–825, text-fig. 22a–d; Vervoort & Vasseur, 1977: 40–52, figs 18a–c, 19, 20a–c, 21a, b, 22a–c (cum syn.); Hirohito, 1995: 200–201, fig. 65e, f; Vervoort & Watson, 2003: 172–75, fig. 39F.

Material Examined. QM-G331150, Amity, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Small, erect, geniculate colonies arising from tubular hydrorhizae growing on algae. Monosiphonic, branching stem reaching 18 mm in height. Stem and branches divided into internodes by oblique, deeply-constricted nodes, sloping alternately left and right, internodes variable in length. Hydrothecae barrel-shaped, one to each internode, adcauline wall adnate to stem or hydrocaulus for about half its length. Hydrothecae with three to five transverse rings, although they are not equally-well developed on all hydrothecae; margin with four, distinct, blunt, marginal cusps, four opercular valves and three internal vertical teeth. Gonothecae not seen.

Measurements. Internode length 320–500 μm, diameter 120–170 μm. Hydrotheca: length adnate adcauline wall 225–240 μm, length free adcauline wall 250–300 μm, diameter at margin 150–170 μm.

Remarks. The development of the transverse rings on the hydrothecal wall is variable in the


A
B
D
C
E
I
F
G
H

Moreton Bay samples. Some walls are almost smooth while others, on the same colony, can have well-defined rings. This species agree in many respects with Pennycuik's (1959) material from Myora, and has a wide distribution.

Occurrence. Amity Point, Myora.

Distribution. South Atlantic, Japan, South America, Indonesia, Australia.

Sertularia Linnaeus, 1758

Sertularia borneensis Billard, 1924b

Sertularia borneensis Billard, 1924b: 649, fig. 1D; 1925: 171–173, fig. 31A–D; Pennycuik, 1959: 197, pl. 6 fig.5; Gibbons & Ryland, 1989: 418–419, fig. 34A–D; Preker, 2001: 154; Schuchert, 2003: 189–190, fig. 43A–C.
Sertularia turbinata — Vervoort & Vasseur, 1977: 60–64, figs 26a, b, 27a, b.
Tridentata borneensis — Kirkendale & Calder, 2003: 176–177.

Description. Colony erect, monosiphonic shoots up to 15 mm, arising from hydrorhizae creeping epiphytically on the calcareous alga *Halimeda* sp. Basal part of hydrocaulus consists of an athecate section of variable length that terminates in an oblique, hinge joint. Subsequent internode separated by weak, sometimes quite-indistinct, straight nodes. Each internode bears a pair of frontally-placed, opposite hydrothecae which are slightly offset. Members of the pairs are nearly always separated frontally but, in some colonies, the distal pairs may be contiguous.

Hydrothecae swollen basally, narrowed above, adnate for about one quarter to half of adcauline length, adnate side curved outwards at angles varying from 75–90°. Margin of hydrothecae tilted slightly upwards, thickened, and with two conspicuous lateral cusps. No median, adcauline cusps were seen. Adcauline hydrothecal wall elongated into an internal cusp. Hydranth with abcauline caecum.

Gonothecae not seen.

Measurements. Internode length 496–520 µm. Hydrotheca: length adnate adcauline wall 152–160 µm, length free adcauline wall 220–440 µm, diameter at margin 100–110 µm.

Remarks. Only one colony was collected and this was sterile: it was found attached to a piece of *Halimeda* sp. growing among the corals at Flat Rock. There is little doubt, however, that the specimen was *S. borneensis*, as first described by Billard (1924b) and subsequently illustrated by him (Billard 1925) and by Gibbons & Ryland (1989). Vervoort & Vasseur (1977) synonymised this species with *Sertularia turbinata* (Lamouroux, 1816), although their material did not have an abcauline, intrathecal septum, one of the identifying characteristics of *S. turbinata*. They explained its absence as a juvenile feature, an explanation considered to be invalid by Schuchert (2003) as fertile material from Kei Island that he examined also lacked an intrathecal septum as, indeed, did ours from Moreton Bay. We, also, cannot concur with Calder (1991) by placing the Moreton Bay colonies in the genus *Tridentata*, as no median, adcauline cusps were observed and the opposite, hydrothecal pairs were slightly offset. Kirkendale & Calder (2003) did not give a detailed description of their Guam material, hence comparison between their *Tridentata borneensis* and our specimen was not possible. This is the first record of this species from southern Queensland.

Occurrence. Flat Rock.

Distribution. Indonesia, Polynesia, tropical Australia.

FIG. 2. **A**, **B**, *Sertularella diaphana* (Allman, 1885), QM-G331153, Flat Rock, Nth Stradbroke I., SE Qld, **B** shows gonothecae borne on the anterior surface of the hydrocladia; **C**, **D**, *Sertularella minuscula* Billard, 1924, QM-G331141, Shag Rock, Nth Stradbroke I., SE Qld, **C** showing small erect colonies creeping across a dead bivalve, **D**, showing wrinkled, obovate-shaped gonothecae; **E**, *Sertularella robusta* Coughtrey, 1876, QM-G331150, Amity Point, Nth Stradbroke I., SE Qld; **F**, *Sertularia loculosa* Busk, 1852, showing hydranth with a long, leaf-shaped process, the ligula, located on the adcauline side of the hydranth body, QM-G331149, Amity Point, Nth Stradbroke I., SE Qld; **G**, **H**, *Synthecium orthogonium* (Busk, 1852), QM-G331154, Flat Rock, Nth Stradbroke I., SE Qld, **H** showing a magnified view of the hydrothecae showing renovation of the margin from inside the hydrothecae; **I**, *Tridentata turbinata* (Lamouroux, 1816), showing the abcauline, intrathecal ridge characteristic of this species, QM-G331155, Point Lookout, Nth Stradbroke I., SE Qld.

Sertularia loculosa Busk, 1852
(Fig. 2F)

Sertularia loculosa Busk, 1852: 393–394; Billard, 1926: 512–513; Pennycuik, 1959: 197; Migotto, 1996: 71–73, fig. 13f–i; Schuchert, 2003: 188–189, fig. 42A, B.
Sertularia ligulata — Thornely, 1904: 116–117, pl. 2 figs 1, 1A, B; Billard, 1925: 178–181, fig. 35O–T; Millard, 1975: 307–309, fig. 100A, D; Vervoort & Vasseur, 1977: 53–57, fig. 24a–d; Gibbons & Ryland, 1989: 420–421, fig. 36A–C; Preker, 2001: 154.

Material Examined. QM-G331149, Amity, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Colony erect, monosiphonic, up to 23 mm, mostly unbranched, but two hydrocauli were found that had short branches. Basal, athecate section terminates in oblique hinge-joint, subsequent internodes separated by indistinct nodes. Each internode with a pair of opposite hydrothecae distally on the internode, contiguous in front, separated behind.

Hydrothecae swollen basally, narrowed above, curved outwards but with opening turned slightly downwards, adnate for two-thirds of the adcauline length. Hydrothecae with an intrathecal septum or ridge, aperture margin with two, weak, lateral cusps. Two opercular valves, mostly damaged, the abcauline flap larger than the adcauline. Hydranth with a long, leaf-shaped process, the ligula, located on the adcauline side of the hydranth body, its terminally-swollen tip studded with nematocysts.

Gonothecae not seen.

Measurements. Internode length 660–720 µm. Hydrotheca: length adnate adcauline wall 250–260 µm, length free adcauline wall 120–143 µm, diameter at margin 90–115 µm.

Remarks. The characteristic ligula makes this species readily identifiable. Migotto (1996) describes the rim as having two lateral cusps and a smaller, adcauline cusp: this latter cusp was always inconspicuous in our material. Previously collected from the Myora Banks and Dunwich by Pennycuick (1959).

Occurrence. Amity Point, Myora Banks, Dunwich.

Distribution. Widely distributed over the tropical and subtropical Indian and Pacific Oceans: southern Africa, Japan, Australia (Queensland, Bass Strait); also found in some regions of the Atlantic Ocean: (western Africa, Brazil).

Tridentata Stechow, 1920

Tridentata distans (Lamouroux, 1816)

Dynamena distans Lamouroux, 1816: 180, pl. 5 figs 1a, B.
Sertularia distans — Cornelius, 1979: 296–299, fig. 26a–e; Millard, 1975: 306–307, fig. 93E–H; Medel & Vervoort, 1998: 63–66, figs 6c, 20a, b (cum syn.); Vervoort & Watson, 2003: 184–185.
Sertularia gracilis — Hassall, 1848: 2223.
Sertularia distans var. *gracilis* — Billard, 1925: 175–177, fig. 33H, J, K; Pennycuik, 1959: 197.
Tridentata distans — Calder, 1991: 105–107, fig. 55a–c; Kirkendale & Calder, 2003: 177; Preker & Lawn, 2005: 339, 342.

Material Examined. QM-G331155, Flat Rock, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Colony erect, arising from a creeping hydrorhiza on a piece of alga, monosiphonic, up to 7 mm high. Basal part of hydrocaulus with up to two athecate internodes separated by oblique hinge joints, remainder separated by oblique nodes. Each internode with a distal pair of opposite hydrothecae that are contiguous in front and separated behind.

Hydrothecae tubular, slender, narrowing slightly to margin, distal part facing outwards and slightly upwards. Adcauline hydrothecal wall ending in a small, triangular, perisarcal projection into the hydrothecal cavity. Margin with two, well-developed lateral teeth and a small, median, adcauline tooth: the latter may be hard to distinguish in some parts of the colony. Hydranth with an adcauline diverticulum.

Gonothecae not seen.

Measurements. Internode length 900–1,100 µm, diameter at constriction 50–51 µm. Hydrotheca: length adnate adcauline wall 175–180 µm, length free adcauline wall 120–140 µm, diameter at margin 99–110 µm.

Remarks. The Moreton Bay material fits the description of this species given by Calder (1991).

Occurrence. Flat Rock.

Distribution. Circumglobal in temperate, subtropical and tropical waters.

Tridentata turbinata (Lamouroux, 1816) (Fig. 2I)

Dynamena turbinata Lamouroux, 1816: 180.
Sertularia turbinata — Billard, 1925: 177–178, fig. 34L–N; 1926: 512; Pennycuik, 1959: 198; Millard & Bouillon, 1973: 76, fig. 9H; Millard, 1975: 312–313, fig. 100B, C, E; Vervoort & Vasseur, 1977: 60–64, figs 26a, b, 27a, b; Gibbons & Ryland, 1989: 425, fig. 39A–C; Hirohito, 1995: 218–219, fig. 73d–f; Migotto, 1996: 78–79, fig. 14f, g; Watson, 1997: 521; Medel & Vervoort, 1998: 70–72, fig. 23a–c (cum syn.); Schuchert, 2003: 190–191, fig. 44; Preker, 2005: 48.
Tridentata turbinata — Calder, 1991: 110–112, fig. 60; Preker & Lawn, 2005: 342.

Material Examined. QM-G331156, Point Lookout, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Colony erect, up to 14 mm, arising from a creeping hydrorhiza lacking internal septa. Hydrocaulus monosiphonic, unbranched, divided into internodes by distinct oblique nodes, hinge joint terminating the short, basal, athecate part of stem. Each internode bears a pair of distal, opposite hydrotheca. Hydrothecal pairs separated in the back of the internode, contiguous frontally, tumid, adnate to hydrocaulus for about half their length, outwardly curved above. Hydrothecae with abcauline, intrathecal septum. Perisarc thick, especially near margin. Aperture oval, facing outwards and slightly upwards, with two, pointed lateral cusps and a smaller, median adcauline tooth. Hydranth with an abcauline diverticulum.

Gonothecae borne low on stem on a short pedicel, barrel shaped with 9–10 transverse rings, some raised, and with a wide, collar-shaped distal aperture.

Measurements. Internode length 400–600 µm. Hydrotheca: length adnate adcauline wall 210–234 µm, length free adcauline wall 160–255 µm, diameter at margin 107–116 µm. Gonotheca: height 1,120–1,185 µm, width (maximum) 736–800 µm.

Remarks. A variable species, but the horizontal, abcauline, intrathecal ridge and contiguous, strictly-opposite, hydrothecal pairs help separate it from *S. borneensis* which it resembles. Gonothecae were rare: only four were found out of 900 colonies examined. Pennycuik (1959) has previously recorded it from both Point Lookout and Dunwich.

Occurrence. Point Lookout, Amity Point, Dunwich.

Distribution. Tropical and subtropical waters.

Family SYNTHECIIDAE Marktanner-Turneretscher, 1890

Hincksella Billard, 1918

Hincksella cylindrica (Bale, 1888) (Fig. 1J)

Sertularella cylindrica Bale, 1888: 765–766.
Synthecium cylindricum — Ritchie, 1911: 847–849.
Hincksella cylindrica — Blackburn, 1937b: 173–174, fig. 2; Pennycuik, 1959: 189; Millard, 1975: 232; Watson, 1979: 233; Watson, 2002: 346, 5D.

Material Examined. QM-G331144, Amity, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Colony erect, up to 15 mm, unbranched, divided into internodes by distinct, oblique, alternate sloping nodes, each internode bearing one hydrotheca. Stem with slight corrugations below each hydrotheca, especially in distal part. Hydrothecae alternate, thin-walled, tubular, adnate for one half or more of total length, then bent slightly outwards and upwards. Margin smooth, circular and slightly everted.

Gonothecae arising from within hydrothecae, elongated, club shaped and slightly truncated, but this could have been the result of damage because they were extremely fragile.

Measurements. Internode length 480–592 µm, width at node 192–200 µm. Hydrotheca: length adnate adcauline wall 400–456 µm, length free adcauline wall 320–352 µm, diameter at margin (not including everted edge) 312–336 µm. Gonotheca: height 1,280 µm, width (distal end) 280 µm.

Remarks. The colonies varied from the original description of Bale (1888) in that the stem of the Moreton Bay sample was slightly corrugated. This feature distinguishes *Hincksella corrugata* Millard, 1958, from *H. cylindrica*. As the latter species, however, has not been recorded outside Madagascar and South Africa, and as Millard (1975) comments that *H. corrugata* eventually may prove to be a variety of *H.*

cylindrica, we have identified our colonies as *H. cylindrica* for the time being. Pennycuik (1959) collected a single specimen of this uncommon species from the coral patch at Myora, and Watson (2002) collected it off Palm Beach, Queensland.

Occurrence. Amity Point, Myora.

Distribution. Pacific coast of North America, Caribbean, eastern Australia (NSW, SA, Qld).

Hincksella cylindrica pusilla (Ritchie, 1910b)

Sertularella cylindrica var. *pusilla* Ritchie, 1910b: 817–818, pl. 77 fig. 9.
Synthecium cylindricum var. *pusilla* — Leloup, 1935: 31–33, fig. 14; 1940: 3, fig. 2.
Hincksella cylindrica var. *pusilla* — Vervoort, 1959: 247–248, fig. 19b, c; Vervoort, 1968: 28–30, pl. 12.
Hincksella cylindrica pusilla — Millard, 1975: 232–234, fig. 76B–D; Calder, 1991: 82–83.

Description. Colony erect, delicate, up to 8 mm, unbranched, divided into internodes by indistinct, oblique, alternate, sloping nodes, each internode bearing one hydrotheca distally. The proximal part of each internode is narrower than the distal part of the same internode and has a small corrugation. Perisarc of basal part of stem thick and slightly twisted, thinning towards distal end; the whole stem is narrower in comparison to the hydrotheca. Hydrothecae large, alternate, with very-thin collapsible walls, adnate to the internode for about one-third to one-quarter of total length, free portion curved away from stem. Margin circular and slightly everted, facing upwards and outwards.

Gonothecae not seen.

Measurements. Internode length 220–360 µm, width at node 60–80 µm. Hydrotheca: length adnate adcauline wall 176–200 µm, length free adcauline wall 216–28 µm, diameter at margin (not including everted edge) 180–216 µm.

Remarks. This specimen was a smaller, more-delicate sample of *Hincksella* and was found among the hydrorhizae of the host hydroid *Idiellana pristis*. *Hincksella cylindrica pusilla* is quite easily distinguished from *H. cylindrica* by its smaller size and its more-delicate hydrothecae that are adnate for only one-third to one-quarter of their total adcauline length. The larger *H. cylindrica*, however, always had the hydrothecae adnate for at least half of their total adcauline length. The hydrothecae of *H. cylindrica pusilla* bent outwards at a sharper angle than the hydrothecae of *H. cylindrica*. Our specimen conforms, both in size and description, with Ritchie's (1910b) *Sertularella cylindrica* var. *pusilla* from Mergui Archipelago. Locating the gonothecae of the smaller form would help to determine if the two forms are separate species. The present record extends the area of distribution considerably as it has not previously been recorded from Australian waters.

Occurrence. Amity Point.

Distribution. Burma (Mergui Arch.), South Africa, West Indies (Curaçao, Aruba), Japan (Sagami Bay), Australia (Qld; Amity Point).

Synthecium Allman, 1872

Synthecium orthogonium (Busk, 1852)
(Fig. 2G, H)

Sertularia orthogonia Busk, 1852: 390; Bale, 1884: 88, pl. 9 fig.11.
Synthecium orthogonium — Jäderholm, 1903: 289; Billard, 1910: 25; Jäderholm, 1916: 6; Watson, 2000: 41–42, fig. 32A–F; Schuchert, 2003: 202–203, fig. 54A–E.

Material Examined. QM-G331154, Flat Rock, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Erect, pinnate colony from 13–35 mm, arising from a thick hydrorhiza reptant on the hydroid *Idiellana pristis*. Basal internode athecate, subsequent internodes of variable length, nodes transverse and indistinct, each with a pair of opposite hydrocladia at the distal end of the internodes, and with a pair of opposite hydrothecae proximally. Hydrocladia long and directed slightly upwards, nodes rare or indistinct.

Hydrothecae on hydrocladia in opposite pairs, adcauline walls of pairs separated, consecutive hydrothecae not overlapping. Hydrothecae tubular, adnate for about three-fifths of their vertical height, then curving sharply outwards. Margins of hydrothecae not sinuous, tilted outwards and upwards, slightly everted and often renovated.

Gonothecae arising from within hydrothecae on lower stem, smooth, pedicellate, irregularly shaped, somewhat flattened, with a small distal aperture, perisarc thin.

Measurements. Internode length 2,080–2,195 µm, width at node 280–340 µm. Hydrotheca: length adnate adcauline wall 400–560 µm, length free adcauline wall 180–240 µm, aperture (not including everted edge) 190–240 µm. Gonotheca: length 1,000 µm, width 490 µm.

Remarks. Identification of the *Synthecium* species from Moreton Bay presented considerable difficulties. Watson (2000) remarked that, even with fertile material, it can be difficult to differentiate between species of *Synthecium* and we found this to be true. The identification of this material as *S. orthogonium*, a tropical species, was largely influenced by the size of the colonies. The dimensions of the hydrothecae also agreed best with those given for this species by Watson (2000) and Schuchert (2003). *Synthecium campylocarpum* Allman, 1888, identified from southern Queensland by Watson (2002), is a very similar species, and, although some authors consider it to be synonymous with *S. orthogonium* (Billard 1925; Rees & Vervoort 1987), Watson (2000) showed that both are distinct species, although separating the two is not a trivial task. The main differences are that *S. campylocarpum* has larger stems, less-curved hydrothecae and a sinuous hydrothecal margin compared with *S. orthogonium*. In our material, unfortunately, these traits showed considerable variation, even within the same colony, but agree best with the dimensions given for *S. orthogonium*. Schuchert (2003) questions if the differences between *S. campylocarpum* and *S. orthogonium* are significant, or if they merely represent intraspecific variations. We found only one gonotheca and the dimensions did not agree well with those given for *S. campylocarpum*, ours being considerably smaller. It was not mature, however, so this may account for its smaller size. Additional fertile material of the two *Synthecium* species needs to be examined to help determine their validity. Furthermore, observations of live material to distinguish between their natural colours may prove a reliable indicator for separating the two species.

Occurrence. Flat Rock.

Distribution. Indonesia, Papua New Guinea, Torres Strait, NT (Darwin Harbour), Qld.

Suborder PROBOSCOIDA Broch, 1910

Family CAMPANULARIIDAE Johnston, 1837

Clytia Lamouroux, 1812

***Clytia* hemisphaerica** (Linnaeus, 1767)

Medusa hemisphaerica Linnaeus, 1767: 1098.

Clytia hemisphaerica — Millard, 1966: 478–480, fig. 14A–F; 1975: 217–218, fig. 72A–D; Cornelius, 1982: 73–82, fig. 9a–m; Gibbons & Ryland, 1989: 402–404, figs 19A–E, 20A–E, 21A–E; Watson, 1994b: 67; Cornelius, 1995b: 252–255, fig. 57A–H; Medel & Vervoort, 2000: 34–38 (cum syn.); Preker, 2001: 154; Kirkendale & Calder, 2003: 172–173; Vervoort & Watson, 2003: 419–420, fig. 103A–C; Preker, 2005: 47; Preker & Lawn, 2005: 344.

Clytia ?hemisphaerica — Watson, 1994a: 151–153, fig. 2A–E.

Clytia johnstoni — Fraser, 1937: 74–75, pl. 15 fig. 71a–d; Ralph, 1957: 823–824, text-figs 1h–u, 3a–f; Mammen, 1965a: 22–23, fig. 51.

Material Examined. QM-G331140, Amity, N. Stradbroke I., SE Qld, M. Preker & I. Lawn, Feb. 2005.

Description. Colony mainly stolonal but sometimes irregularly branched, growing on other hydroids and algae. Pedicels of variable length, annulated proximally and distally, smooth in mid-section. Hydrothecae thin walled, variable in shape from broadly campanulate to deeply campanulate, depth 1–3 times diameter. Margin circular with 10–16 pointed cusps separated by rounded embayments, diaphragm straight and delicate forming a distinct basal chamber, hydrophore small.

Gonothecae borne on short, annulated pedicels arising directly from stolon, variable in shape but elongate-ovoid overall, truncated distally, possessing a wide, terminal aperture with a slight constriction below.

Measurements. Colony height 1.6–6 mm. Hydrotheca: length (diaphragm to rim) 408–720 µm, diameter at rim 128–215 µm. Gonotheca: length 376 µm, width 140 µm.

Remarks. This is recognised as an exceptionally variable species (Cornelius 1982) and the Moreton Bay material is no exception. Very numerous in areas where they are established.

Occurrence. Point Lookout, Amity Point.

Distribution. Circum-global; tropical, subtropical and temperate waters.

Clytia linearis (Thornely, 1899)

Obelia linearis Thornely, 1899: 453, pl. 44 fig. 6.
Campanularia Gravieri: Billard, 1904: 482, fig. 1.
Clytia Gravieri — Billard, 1938: 429–432, figs 1–3.
Clytia gravieri — Millard & Bouillon, 1973: 51–54, fig. 7E–G; Millard, 1975: 215–217, fig. 71F–H.
Clytia linearis — Hirohito, 1977: 14–20, text-fig. 4a–j; Cornelius, 1982: 84–86, fig. 12a–d; Rees & Vervoort, 1987: 94–95; Gibbons & Ryland, 1989: 404–405, fig. 22A–E; Calder, 1991: 62–64, fig. 34a–c; Ramil & Vervoort, 1992: 238, fig. 67b; Hirohito, 1995: 65, fig. 18h, i; Migotto, 1996: 85–87, fig. 16a, b; Medel & Vervoort, 2000: 38–41; Watson, 2000: 73–75, fig. 57D, E; Preker, 2001: 154; Schuchert, 2003: 160–162, fig. 20A–C; Kirkendale & Calder, 2003: 173.

Description. Colonies stolonal, creeping on other hydroids, barnacles, bivalve shells and artificial substrates, such as rubber bands. The Moreton Bay material consists of unbranched pedicels terminating in a hydrotheca. Pedicels either finely ringed throughout, or annulated proximally and distally, with a smooth central portion. Hydrothecae slender, deeply campanulate, with 10–16 long, narrow, sharp, marginal cusps and with internal thickening of the periderm producing a distinct keel. Cusps separated by rounded embayments. Diaphragm delicate, transverse or slightly oblique.

Gonophores borne on an annulated pedicel, club-shaped with a truncated end, perisarc very thin enclosing up to four developing medusae.

Colour. Colony white.

Measurements. Hydrotheca: length (diaphragm to rim) 515–650 µm, diameter at rim 280–330 µm. Gonotheca: length 520 µm, diameter 200 µm.

Remarks. Our specimens agree with the dimensions of *C. linearis* given by Gibbons & Ryland (1989) and Watson (2000). Our material was so frail that most hydrothecae collapsed when handled.

Occurrence. Flat Rock.

Distribution. Tropical to warm-temperate oceans: Fiji, Guam, Kei Islands, Japan, Brazil, Australia.

Obelia Péron and Lesueur, 1810

Obelia bidentata Clark, 1875

Obelia bidentata Clark, 1875: 58, pl.9 fig. 2; Cornelius, 1975b: 260–265, fig. 2a–c (cum syn.); Gibbons & Ryland, 1989: 405–406, fig. 23A–E; Calder, 1991: 70–72, fig. 37a, b (cum syn.); Cornelius, 1995b: 292–295, fig. 68A–F; Watson, 1996: 78; Medel & Vervoort, 2000: 46–49, fig. 12a–d (cum syn.); Schuchert, 2003: 164–165, fig. 24; Vervoort & Watson, 2003: 424–425.

Description. Small, erect colonies, up to 15 mm high, arising from a tangled mat of stolons anchoring the colony among sponge and the hydroid *Pennaria disticha*. Hydrocaulus sparingly branched, monosiphonic, divided into internodes at regular intervals. Internodes long, slender, annulated basally and above each branch or pedicel. Each internode bears distal, alternate hydrothecae on a short apophysis.

Hydrothecae delicate, deeply campanulate, a little asymmetrical proximally, on short pedicels with 6–12 annulations. Hydrothecal margin with 14–16 big teeth, all with simple, single cusps. Diaphragm delicate and slightly oblique, basal chamber well defined.

Gonothecae on short, annulated pedicels attached to hydrothecal pedicels, ovate in shape and truncated on top. Aperture borne on a short, but distinct, collar.

Measurements. Colony: height 15 mm, internode length 320–510 µm, diameter at node 69–78 µm. Hydrotheca: length (diaphragm to rim) 310–450 µm, diameter at rim 150–240 µm. Gonotheca: length 540 µm, width 225 µm.

Remarks. The Moreton Bay material conforms best with the description of *Obelia longicyatha* by Allman (1877), reported to have a monosiphonic hydrocaulus and single-cusped, marginal teeth separated by deep, rounded incisions. The typical *O. bidentata* has a polysiphonic, lower hydrocaulus with bimucronate, marginal cusps separated by u-shaped incisions. *Obelia longicyatha* Allman, 1877 is, however, considered to be a junior, subjective synonym of *O. bidentata* (Calder, 1991) and our material falls within the range of variations described for *O. bidentata* by Cornelius (1975b). Material without the bimucronate cusps and/or with a monosiphonic hydrocaulus has previously been identified as *O. bidentata*. Cornelius (1975b) shows a hydrothecal rim with indentations of similar depth from a Nigerian specimen, and Gibbons & Ryland (1989) describe a Fijian specimen with monosiphonic stems. This species has much the same appearance and colony structure as a number of other *Obelia* species and Vervoort & Watson (2003) have suggested that several taxa may be included under the specific name *O. bidentata*. Comparison of the medusae of this species complex does not help in separating one species from the other because they are generally considered to be indistinguishable.

Occurrence. Amity Point.

Distribution. Circumglobal, temperate to tropical.

Obelia dichotoma (Linnaeus, 1758)

Sertularia dichotoma Linnaeus, 1758: 812.

Obelia dichotoma — Leloup, 1932a: 5, fig. 4; Cornelius, 1975b: 265–272, figs 3a, b, 4a–f (cum syn.); Medel & Vervoort, 2000: 49–53, fig. 10c, d (cum syn.); Vervoort & Watson 2003: 425–427, fig. 104A–E.

Obelia australis — von Lendenfeld, 1885a: 920–922, pl. 43 figs 19–22 (descr. medusa); 1885b: 604; Bale, 1888: 753–754, pl. 12 figs 1, 2; Ralph, 1957: 830, fig. 4a–h; Pennycuik, 1959: 170; Mammen, 1965a: 11; Watson 1994b: 66.

Obelia nodosa — Bale, 1924: 230, fig. 1; Ralph, 1957: 832, text-fig. 5i–k; Pennycuik, 1959: 171; Ralph, 1961c: 109.

Obelia angulosa — Bale, 1888: 752–753, pl. 12 fig. 3; Whitelegge, 1889: 195; Watson, 2002: 349–350, fig 7C.

Description. Small colonies, up to 7 mm high, arising from a tubular hydrorhizal network attached to a sponge. Stem monosiphonic, irregularly branched and divided into long internodes that are annulated near their base. Hydrothecae borne on pedicels of variable length, a few annulated throughout, but most have a smooth mid-section. Hydrothecae delicate, campanulate, widening towards the circular aperture, no marginal teeth, diaphragm thin and transverse.

Gonothecae borne on a short, annulated pedicel situated in the axil of the hydrothecal pedicel, about twice as long as the hydrothecae, elongated cone-shape, with a truncated top and a central, tubular aperture.

Colour. Perisarc brown at base of colony, with pale-cream side branches and distal regions.

Measurements. Colony: height 7 mm, internode length 900–1,005 µm, diameter at node 105 µm. Hydrotheca: length (diaphragm to rim) 280–320 µm, diameter at rim 210–315 µm. Gonotheca: length 835 µm, width 220 µm.

Remarks. We follow the revision of Cornelius (1975b, 1995b) in identifying our small, sparingly-branched, monosiphonic colony from Moreton Bay as *O. dichotoma*. The diagnosis of the hydrotheca, pedicel, diaphragm and gonotheca falls well within the range and shape acceptable for this species, which is widely recognised as morphologically variable (Millard 1975; Cornelius 1975b, 1982). The small colony size of our material is its main feature, distinguishing it from the more commonly known growth form which forms a large, erect, bushy, polysiphonic colony to 350 mm. Pennycuik (1959) and Watson (2002) have previously reported similar, small *Obelia* colonies from southeast Queensland: *Obelia nodosa* Bale, 1924 was reported from Scott's Point by Pennycuik, and *Obelia angulosa* Bale, 1888 was found off Palm Beach by Watson (2002). Watson (2002) states that *O. angulosa* is easily distinguished from *O. dichotoma* by its smaller size and transverse diaphragm. Cornelius (1975b), however, considers both these species to be synonyms of *O. dichotoma*, and he shows, quite clearly, that a small, monosiphonic colony that almost never branched is characteristic of colonies from wave- and current-swept habitats. Leloup (1932a) also shows a small colony of *O. dichotoma* in his fig. 4. Vervoort & Watson (2003) point out that, in New Zealand specimens, transverse and oblique diaphragms of *O. dichotoma* are of approximately equal occurrence and that a structurally-oblique diaphragm may appear transverse under certain angles of observation. There does not appear to be any obvious way to separate small colonies of *O. dichotoma* from *O. angulosa* and *O. nodosa*, therefore, and we have, consequently, followed Cornelius (1975b, 1982, 1995b) in regarding them as conspecific, at least for the time being.

Occurrence. Point Lookout.

Distribution. Cosmopolitan, widespread in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans. Medel & Vervoort (2000) provide a comprehensive distribution list.

RESULTS AND DISCUSSION

As a result of the collections made during this workshop, 44 species of hydroids from 14 families have been identified. Owing to the limited time available to us in examining all of the collected material, it is probable that there are several more species that we have not listed here. Notwithstanding the tentative identifications of some of the specimens due to the lack of fertile material, we suggest that thirteen species are new to the southeast Queensland region and one, *Hincksella cylindrica pusilla* (Ritchie, 1910b), is new to Australian waters. When we combine our collection with those of others for this area, it brings the list of the hydroid fauna for the region to 74 species in 18 families (see Table 2). Twenty-five of the species from our collection have a tropical or subtropical distribution, and only two species, *Opercularella humilis* (Bale, 1924) and *Hincksella cylindrica* (Bale, 1888), have a predominantly temperate distribution.

This paper should not be regarded as a complete listing of the hydroid species for this area. Much of our collected material still needs to be worked through and some species remain unidentified. Our collection also contains a small colony of a specimen from the Family Tubulariidae that could not be matched with any known species and would, thus, appear to be undescribed. Further collections, especially from subtidal and estuarine areas, will undoubtedly increase the number of hydroid species from this region. We regard our anthoathecate fauna list to be especially depauperate and many of the samples remain unidentified to date. This is owing to the fact that accurate identification of many of the anthoathecates is dependent upon the presence of mature reproductive structures, a particular problem in immature colonies where such material is absent. Further collection of specimens at different seasons of the year may serve to ameliorate this problem.

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Table 2. A summary of the hydroids collected from Moreton Bay and adjacent regions, extending from Caloundra Heads to the New South Wales border (latitudes 22°–26°S). '<P' = earlier collections cited by Pennycuik (1959).

	Hydroids Collected	Within Moreton Bay	SE Qld, outside Moreton Bay
Order ANTHOATHECATAE			
Suborder FILIFERA			
Bougainvilliidae	*Bimeria australis*	Pennycuik (1959)	
	Bimeria currumbinensis		Pennycuik (1959)
	Garveia clevelandensis		Pennycuik (1959)
	Rhizorhagium arenosum(?)		Pennycuik (1959)
Eudendriidae	*Eudendrium currumbense*		Pennycuik (1959)
	Eudendrium ?glomeratum		Watson (2002)
	Eudendrium pennycuikae	this work	
Clavidae	*Cordylophora caspia*	Pennycuik (1959)	
Pandeidae	*Leuckartiara octona*	Pennycuik (1959)	
Suborder CAPITATA			
Pennariidae	Pennariidae unident		Pennycuik (1959)
	Pennaria disticha	Pennycuik (1959), this work	Pennycuik (1959), Preker (1998), this work
Porpitidae	*Porpita porpita*	Preker (1998)	Preker (1998)
	Velella velella	Preker (1998)	Preker (1998)
Solanderiidae	*Solanderia secunda*		this work
	Solanderia fusca ?		Preker (1998)
Tubulariidae	*Ectopleura crocea*	Pennycuik (1959), this work	
	Tubularia sp.	Preker (1998)	
Order LEPTOTHECATAE			
Suborder CONICA			
Aglaopheniidae	*Aglaophenia sinuosa*		Watson (2002)
	Lytocarpia brevirostris		Watson (2002)
	Macrorhynchia philippina	<P, Pennycuik (1959), Preker (1998), this work	this work, Watson (2002)
	Macrorhynchia phoenicea	Pennycuik (1959)	Preker (1998), this work
Campanulinidae	*Lafoeina amirantensis*	this work	
	Opercularella humilis	this work	Pennycuik (1959)
Haleciidae	*Halecium delicatulum*		Pennycuik (1959), this work
	Halecium sessile	this work	Watson (2002)
	Halecium tenellum		this work
	Halecium sp.		Watson (2002)

continued ...

Table 2 (continued) ...

	Hydroids Collected	**Within Moreton Bay**	**SE Qld, outside Moreton Bay**
Haleciidae (cont.)	*Hydrodendron daidalum*		Watson (2002)
	Hydrodendron mirabile	this work	
	Nemalecium lighti	Pennycuik (1959), this work	
Halopterididae	*Antennella secundaria*	Pennycuik (1959)	Watson (2002), this work
	Halopteris diaphana		Preker (1998)
	Halopteris polymorpha		Watson (2002), this work
Hebellidae	*Anthohebella parasitica*	this work	
	Hebella contorta		Pennycuik (1959)
	Hebellopsis costata	<P, Pennycuik (1959), this work	
	Hebellopsis scandens	Pennycuik (1959), this work	Watson (2002)
Lafoeidae	*Filellum serratum*		this work
Plumulariidae	*Plumularia badia*	Pennycuik (1959)	
	Plumularia setacea	Pennycuik (1959), this work	Pennycuik (1959), this work
	Plumularia warreni		Pennycuik (1959)
	Plumularia warreni pambanensis	Pennycuik (1959)	
	Plumularia sp.		Preker (1998)
Sertulariidae	*Amphisbetia minima*	Pennycuik (1959)	Pennycuik (1959)
	Calamphora campanulata		this work
	Diphasia digitalis	Pennycuik (1959), this work	
	Diphasia mutulata		this work
	Dynamena disticha	Pennycuik (1959)	
	Dynamena crisioides	<P, Pennycuik (1959), this work	Pennycuik (1959), this work
	Dynamena gibbosa	Pennycuik (1959)	
	Dynamena obliqua	Pennycuik (1959)	Pennycuik (1959)
	Dynamena quadridentata		Watson (2002), this work
	Idiellana pristis	<P, Pennycuik (1959), this work	this work
	Salacia desmoides		Watson (2002), this work
	Salacia hexodon	<P, this work	

Continued ...

Table 2 (continued) ...

	Hydroids Collected	Within Moreton Bay	SE Qld, outside Moreton Bay
Sertulariidae (cont.)	*Salacia tetracythara*	<P, Pennycuik (1959), this work	
	Sertularella diaphana	<P, Pennycuik (1959), this work	this work
	Sertularella diaphana gigantea	Preker (1998)	
	Sertularella minuscula		Watson (2002), this work
	Sertularella quadridens	<P, Pennycuik (1959), this work	
	Sertularella robusta	Pennycuik (1959), this work	
	Sertularia borneensis		this work
	Sertularia loculosa	Pennycuik (1959), this work	
	Symplectoscyphus sibogae		Watson (2002)
	Tridentata distans		this work
	Tridentata turbinata	Pennycuik (1959), this work	Pennycuik (1959), this work
Syntheciidae	*Hincksella cylindrica*	Pennycuik (1959), this work	Watson (2002)
	Hincksella cylindrica pusilla	this work	
	Synthecium campylocarpum		Watson (2002)
	Synthecium orthogonium		this work
	Synthecium patulum	Pennycuik (1959)	
Suborder PROBOSCOIDA			
Campanulariidae	*Clytia hemisphaerica*	this work	Pennycuik (1959), this work
	Clytia linearis		this work
	Obelia angulosa		Watson (2002)
	Obelia bidentata	Pennycuik (1959), this work	
	Obelia dichotoma	Pennycuik (1959),	Pennycuik (1959), this work
	Obelia longicyatha	Pennycuik (1959)	
	Orthopyxis integra	Pennycuik (1959)	Pennycuik (1959)
	Orthopyxis crenata subtropica	Pennycuik (1959)	
	Orthopyxis delicata		Pennycuik (1959)

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The isopod parasites (Crustacea: Isopoda: Bopyridae) of decapod Crustacea of Queensland, Australia, with descriptions of three new species

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ABSTRACT

Thirty species of Bopyridae in 25 genera and six subfamilies are listed for Queensland, of which 13 represent new state records, and eight are new to the Australian fauna. Of these, three new species are described: *Scyracepon australiana* sp. nov., infesting the crab *Australoplax tridentata* (A. Milne Edwards); *Athelges ankistron* sp. nov., infesting the hermit crab *Diogenes pallescens* Whitelegge; and *Diplophryxus negrimaculatus* sp. nov. infesting the palaemonid shrimp *Phycomenes zostericola* Bruce. Five previously described species are new records for Australia: *Pagurion tuberculata* Shiino, 1933; *Pseudione magna* Shiino, 1951; *Dactylokepon richardsonae* Stebbing, 1910; *Megacepon choprai* George, 1946; *Eophrixus kuboi* (Shiino, 1939). New Queensland records are: *Anuropodione australiensis* Bourdon, 1976; *Aporobopyrina lamellata* Shiino, 1934; *Parathelges aniculi* (Whitelegge, 1897); *Pseudostegias dulcilacuum* Markham, 1982; *Diplophryxus jordani* Richardson, 1904. Eleven species are recorded from Moreton Bay. *Parabopyrella barnardi australiensis* (Bourdon, 1980) is formally raised to full species status. *Parathelges weberi* Nierstrasz & Brender à Brandis, 1923, and *P. whiteleggei* Nierstrasz & Brender à Brandis, 1931, are considered junior synonyms of *Parathelges aniculi* (Whitelegge, 1897). An earlier record of *Pseudostegias setoensis* Shiino, 1933, from Queensland is re-identified as *P. dulcilacuum* Markham, 1982. Seventeen new bopyrid hosts are recorded. All species newly collected in Queensland waters are illustrated, and most are partially or completely described. Synonymies are complete except where otherwise noted, and are presented for all species known to occur in Queensland. ❑ *Bopyridae, new species, Queensland, Australia, Moreton Bay, taxonomy, parasitism, Decapoda*

Nine species of Bopyridae were collected during field work associated with the Thirteenth International Marine Biological Workshop on the Marine Fauna and Flora of Moreton Bay, Queensland, during February 2005. While that material forms the core of this report, the opportunity has been taken to review the bopyrid fauna of Queensland as a whole. Accordingly, other collections in the Queensland Museum were examined, and these were supplemented, as necessary, by examination of types and material from other Australian and European museums. In their catalogue of the Isopoda of Australia, Poore *et al.* (2002) list 31 species of 26 genera in 8 subfamilies of Bopyridae, including 17 species of 12 genera in 5 subfamilies from Queensland. The total for Queensland is here raised to 30 species in 25 genera in 6 subfamilies, and the Australian total is consequently raised to 39 species. Table 1 gives a full listing of the species dealt with in this paper and a summary of their host records and localities in Australian waters.

Abbreviations: AM, Australian Museum, Sydney; QM, Queensland Museum; ZMA, Zoological

Table 1. Queensland Bopyridae. Species new to the Queensland fauna are marked [QR], new Australian records as [AR], and new host records [HoR].

Subfamily/Species	Australian Hosts	Australian Localities
Pseudioninae		
Albunione australiana Markham & Boyko, 1999	*Albunea microps*	Rudder Reef, off Mossman, Qld
Anuropodione australiensis Bourdon, 1976 [QR]	*Pisidia dispar*	Moreton Bay
Aporobopyrina lamellata Shiino, 1934 [QR]	*Petrolisthes scabriculus* [HoR] *Petrolisthes lamarckii*	Heron Island
Pagurion tuberculata Shiino, 1933 [AR]	*Dardanus arrosor* [HoR] *Dardanus hessii* [HoR]	Capricorn Channel, SE Qld Gulf of Carpentaria
Pseudione magna Shiino, 1951 [AR]	*Heterocarpus sibogae*	Capricorn Channel, SE Qld
Bopyrinae		
Bopyrina ocellata (Czerniavsky, 1869)	*Hippolyte* sp.	Moreton Bay
Parabopyrella australiensis (Bourdon, 1980)	*Alpheus richardsoni* [HoR] ?	Moreton Bay
Parabopyrella indica (Chopra, 1923)	*Synalpheus* sp.	Sandy Strait, Qld
Parabopyrus kiiensis Shiino, 1934	*Athanas* sp.	Bustard Bay, Qld
Probynia obstipa Bourdon & Bruce, 1983	*Periclimenaeus hecate* *Typton wasini*	Great Barrier Reef; Moreton Bay
Schizobopyrina andamanica (Chopra, 1923)	*Periclimenes* & *Periclimenaeus* species	off NE coast of Qld
Schizobopyrina lobata (Bourdon & Bruce, 1983)	*Tozeuma* sp.	Bribie Passage, off Caloundra, Moreton Bay
Schizobopyrina platylobata (Bourdon, 1983)	*Anchistus custos*	Port Denison, N. Qld; Moreton Bay
Ioninae		
Allokepon tiariniae (Shiino, 1937)	*Tiarinia* sp.	Lizard I., Qld
Dactylokepon richardsonae Stebbing, 1910 [AR]	*Charybdis anisodon* [HoR]	Cape York
Megacepon choprai George, 1946 [AR]	*Perisesarma erythodactyla*	Susan R., Hervey Bay, SE Qld
Scyracepon australiana, sp. nov. [AR]	*Australoplax tridentata* [HoR]	Moreton Bay
Orbioninae		
Epipenaeon ingens Nobili, 1906	*Penaeus semisulcatus* *P. merguiensis* *P. indicus*	N Australia from Darwin, NT to Maryborough, SE Qld
Orbione halipori Nierstrasz & Brender à Brandis, 1923	*Metapenaeopsis rosea* [HoR]	Cairns
Parapenaeon expansa Bourdon, 1979	*Penaeus indicus* *P. latisulcatus, P. longistylus, P. merguiensis, P. monodon, P. plebjus*	Widespread across northern Australia and eastern Qld south to Moreton Bay
Parapenaeonella lamellata Bourdon, 1979	*Metapenaeus ensis* *M. endeavouri*	Gulf of Carpentaria, Qld

continued ...

Table 1 (continued) ....

Subfamily/Species	Australian Hosts	Australian Localities
Athelginae		
Athelges ankistron sp. nov. [AR]	*Diogenes pallescens* [HoR]	Moreton Bay
Parathelges aniculi (Whitelegge, 1897) [QR]	*Clibanarius* sp. [HoR]? *Dardanus* sp. [HoR]?	Cape York Peninsula; Great Barrier Reef
Pseudostegias dulcilacuum Markham, 1982 [QR]	*Clibanarius taeniatus* *Clibanarius virescens*	Gulf of Carpentaria; nr Rockhampton, E Qld
Pseudostegias setoensis Shiino, 1933	*Diogenes pallescens* [HoR]	Gulf of Carpentaria
Hemiarthrinae		
Diplophryxus jordani Richardson, 1904 [QR]	*Palaemon serenus* [HoR] *Periclimenes sarkanae* [HoR]	Moreton Bay; Townsville
Diplophryxus negrimaculatus sp. nov. [AR]	*Phycomenes zostericola* [HoR]	Gold Coast
Eophrixus kuboi (Shiino, 1939) [AR]	*Periclimenaeus obscurus* [HoR] *Periclimenes sarkanae* [HoR]	Moreton Bay
Filophryxus dorsalis Bruce, 1972	*Periclimenes hertwigi*	off coast of SE Qld
Metaphryxus intutus Bruce, 1965	*Periclimenes* (?) *grandis* *Palaemonella rotumanus* *Periclimenes platycheles*	John Brewer Reef, Qld; Darwin Harbour, NT; Northern Great Barrier Reef

Museum, Amsterdam; ZMUC, Zoological Museum, University of Copenhagen.

SYSTEMATICS

BOPYRIDAE Rafinesque, 1815

PSEUDIONINAE Codreanu, 1967

Albunione Markham & Boyko, 1999

Type-species: *Ione indecora* Markham, 1988, by original designation.

Remarks. *Albunione* was originally placed in the Ioninae as the only representative of that subfamily in Australia (Poore *et al.* 2002), but Markham & Boyko (2003) have since reassessed its relationships and moved it to the Pseudioninae.

Albunione australiana Markham & Boyko, 1999

Albunione australiana Markham & Boyko, 1999: 1, 5–7, figs 3, 4 [Type-locality: Rudder Reef, off Mossman, Qld, 16°11′S, 145°40′E; infesting *Albunea microps* Miers]; Boyko, 2002: 253; Poore, 2002: 2; Poore *et al.*, 2002: 124; Markham & Boyko, 2003: 1, 4–6.

Remarks. *Albunione australiana* is known only from the type specimens from Queensland.

Anuropodione Bourdon, 1967

Type-species: *Anuropodione senegalensis* Bourdon, 1967, by original designation.

Anuropodione australiensis Bourdon, 1976 (Figs 1, 2)

Anuropodione australiensis Bourdon, 1976: 166, 233–236, 241, figs 41, 42 [Type-locality: Cockburn Sound, Western Australia; infesting *Pisidia dispar* (Stimpson)]; Poore *et al.*, 2002: 127.

Material Examined. QM-W10272, ♀, ♂, infesting *Pisidia dispar* (Stimpson, 1858) from unidentified sponge, intertidal seagrass flats, Polka Point, Dunwich, North Stradbroke I., Moreton Bay, Qld, 27°29.6′ S, 153°23.9′ E, 14.07.1980, T.S. Hailstone. QM-W29063, ♀, ♂, in unidentified grey sponge, same locality, 09.02.2005, J.C. Markham.

Remarks. This is only the second discovery of *Anuropodione australiensis*, and a new record for Queensland. Its host, *Pisidia dispar*, is the same as previously reported for the type from Cockburn Sound, Western Australia. In both sexes, there is notable variation from the types, but this only extends the considerable intraspecific variability already illustrated and commented on by Bourdon (1976). In the females, the body outline and general aspect are quite similar,

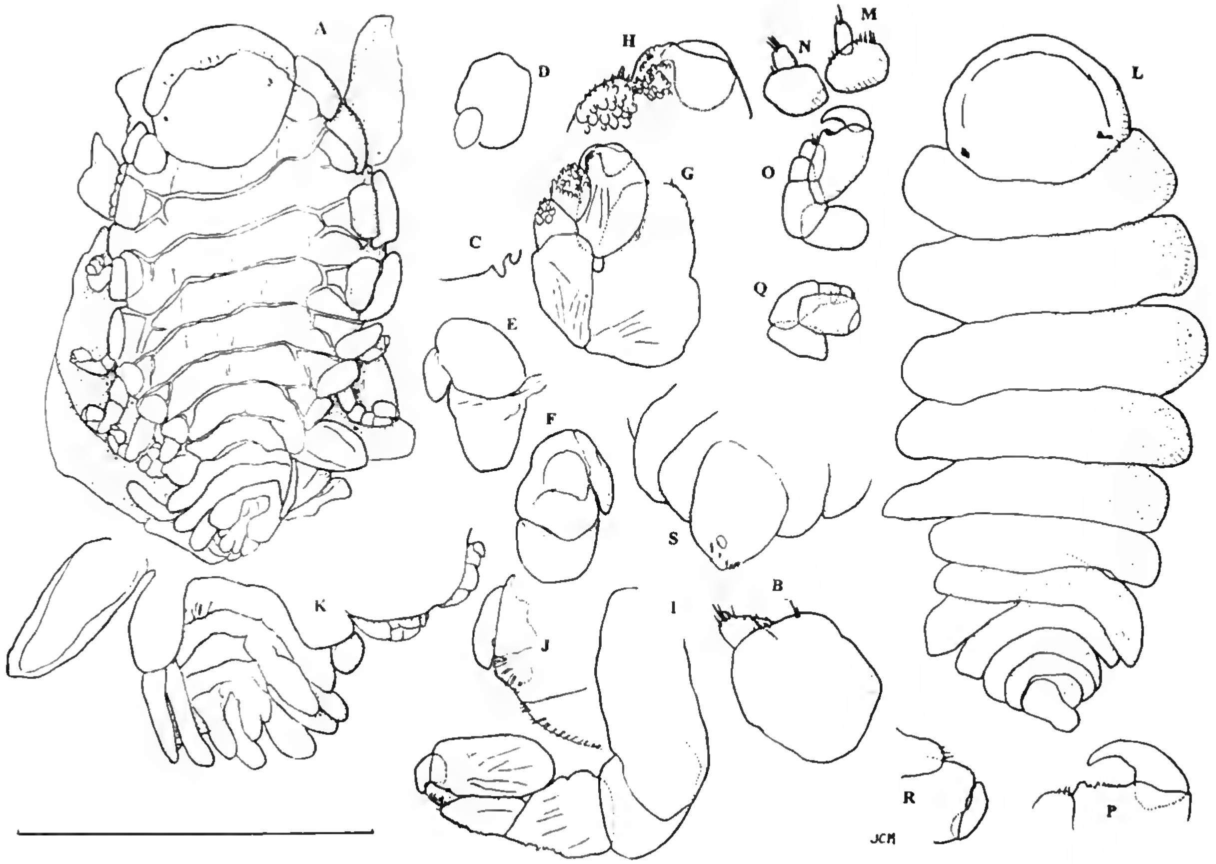

FIG. 1. *Anuropodione australiensis* Bourdon, 1976. **A-K** female; **L-R** male, QM-W10272 **A**, dorsal view. **B**, right antenna 1. **C**, left side of barbula. **D**, right maxilliped, external view. **E**, right oostegite 1, external. **F**, same, internal. **G**, right pereopod 1. **H**, distal region of same. **I**, right pereopod 7. **J**, distal region of same. **K**, pleon, ventral. **L**, dorsal view. **M**, right antennae. **N**, left pereopod 1. **O**, distal region of same. **P**, left pereopod 7. **Q**, distal region of same. **R**, posterior end of pleon, ventral. Scale: 1.84 mm for A, C-F; 1 mm for K; 0.32 mm for B, G, I, L, O, Q; 0.16 mm for H, J, M, N, P, R, S.

though the present females lack the distinctive falcate posterolateral point on the first oostegite (Fig. 1E, F); the markedly corneous surfaces of the propodi, carpi and meri (Fig. 1G, H) of the first pereopod were not previously mentioned. Males (Fig. 1K-Q, Fig. 2) are quite similar except for their pleons, previously reported to be highly variable within this species (Bourdon 1976). All of the newly examined specimens have distinct eyes, in contrast with the types, but those specimens probably lost their eyes during lengthy preservation prior to examination.

Aporobopyrina Shiino, 1934

Type-species: *Aporobopyrina lamellata* Shiino, 1934, by original designation.

Aporobopyrina lamellata Shiino, 1934
(Figs 3–5)

Aporobopyrina lamellata Shiino, 1934: 263–265, 267, fig. 3 [Seto, Japan; infesting *Petrolisthes pubescens* Holmes (identification corrected to *P. coccineus* (Owen) by Bourdon, 1976a)]; Shiino, 1936a: 161 [Shimoda, Japan; infesting *P. hastatus* Stimpson]; 1952: 39; 1972: 8; Bourdon, 1972: 114; 1976: 166, 215–219, 240, 241, figs 31, 32 [Madagascar, infesting *Petrolisthes penicillatus* (Heller) and *P. lamarckii* (Leach); and Mindanao, Philippines, infesting *P. lamarckii*]; 1983: 851 [Moluccas, Indonesia, infesting *P. hastatus*]; Ghani, 1974: 71, 72, figs C, D [Northern Arabian Sea, infesting *Pachycheles tomentosus* Henderson]; Markham, 1980: 623, 624–625, figs 3–5 [Karachi, Pakistan, infesting *P. rufescens* Heller]; 1985b: 3, 10–12, 62, fig. 4, table 1 [Phuket, Thailand, infesting *P. lamarckii*]; Harada, 1991: 199; Schotte, 1995: 117 [Karachi and Manora Islands, Pakistan, infesting *P. rufescens*]; Kazmi & Bourdon, 1997: 59; Saito *et al*., 2000: 35; Hussain, 2001: 65; Kensley, 2001: 222; Kazmi *et al*., 2002: 59.

? '*A. microniscus*' — Lester, 2005: 142, fig. 4.8 [Heron I.; larva infesting unident. copepod].

Material Examined. QM-W16924, ♀, ♂, infesting *Petrolisthes scabriculus* (Dana, 1852), Wistari Reef, Heron I., Qld, 23°27'S, 151°55'E, 15.02.1990, J.D. Shields & F.S. Wood. QM-W16925, ♀, infesting *Petrolisthes lamarckii* (Leach, 1820), beach rock, Heron I., Qld, 23°27'S, 151°55'E, 14.09.1989, J.D. Shields.

Remarks. The new material is the first record of *Aporobopyrina lamellata* from Australia. *Petrolisthes lamarckii* was previously recorded as its host, but *P. scabriculus* is a new record. *P. scabriculus* is known to host two other species of pseudionines in the Philippines and Moluccas belonging to different genera (Bourdon 1976a, 1983). The female infesting *P. lamarckii* (Fig. 5) is more similar to those previously recorded, than is the female from *P. scabriculus* (Fig. 3), the latter being proportionately more slender and having a distinct palp on the mandible. Both show well the strongly carinate basis of the seventh pereopod.

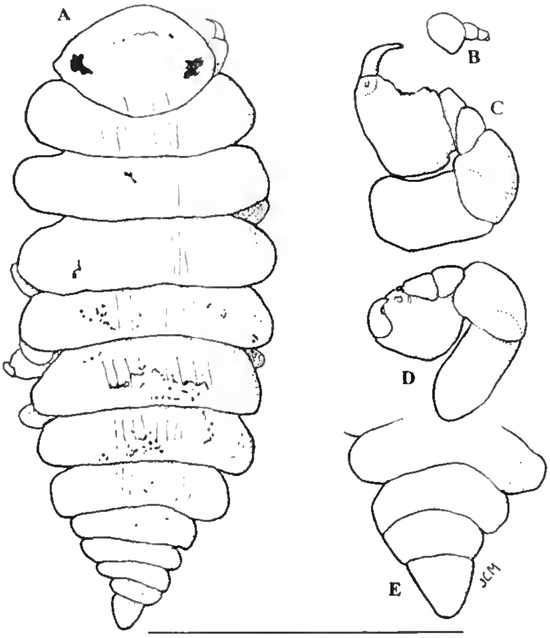

FIG. 2. *Anuropodione australiensis* Bourdon, 1976, male, QM-W29063. **A**, dorsal view. **B**, left antenna 1. **C**, right pereopod 1. **D**, end of pleon, ventral. Scale: 0.5 mm for A; 0.25 mm for B-E.

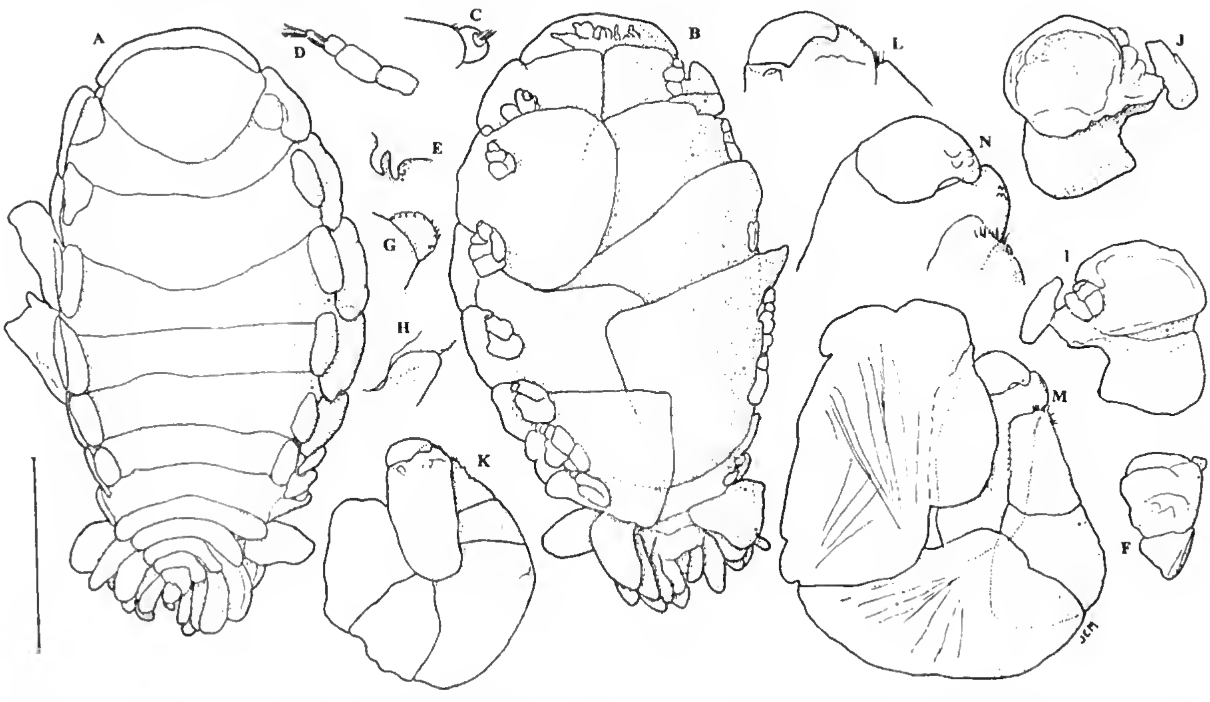

FIG. 3. *Aporobopyrina lamellata* Shiino, 1934, female. QM-W16924. **A**, dorsal view. **B**, ventral view. **C**, right antenna 1. **D**, right antenna 2. **E**, right side of barbula. **F**, right maxilliped. **G**, palp of same. **H**, plectron of same. **I**, right oostegite 1, external, **J**, same, internal. **K**, right pereopod 1. **L**, distal region of same. **M**, right pereopod 7. **N**, distal region of same. Scale: 1 mm for A, B, E, F, I, J; 0.43 mm for G, H; 0.22 mm for C, D, K, M; 0.1 mm for L, N.

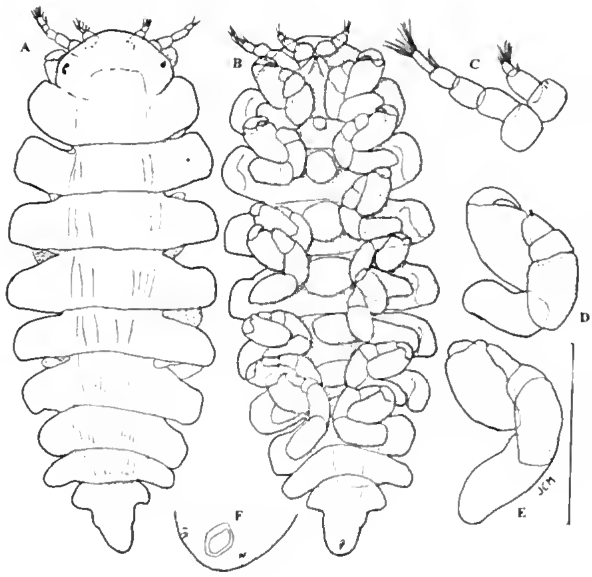

FIG. 4. *Aporobopyrina lamellata* Shiino, 1934, male. QM-W16924. **A**, dorsal view. **B**, ventral view. **C**, right antennae. **D**, right pereopod 1. **E**, right pereopod 7, Scale: 0.4 mm for A, B; 0.2 mm for C-E; 0.1 mm for F.

The male (Fig. 4) is closely similar to those seen before; its outline is most like that of the male from Thailand (Markham 1985b), while its pleon, which appears to be quite variable in this species, is most like that of the male shown by Bourdon (1976a). *Aporobopyrina lamellata* is now known to range far, from Australia and Thailand through Japan and Indonesia across the Indian Ocean to Pakistan. All six host species belong to the porcellanid genus *Petrolisthes*.

Lester (2005) shows a photograph of a microniscan larva from Heron I., where the present studied material was collected. That larva could belong to *Aporobopyrina lamellata*, but it could as easily belong to almost any other species of Australian bopyrid.

Pagurion Shiino, 1933

Type-species: *Pagurion tuberculata* Shiino, 1933, by monotypy.

Pagurion tuberculata Shiino, 1933
(Figs 6, 7)

Pagurion tuberculata Shiino, 1933: 254–256, fig. 2 [Tanabe Bay, Japan, infesting *Pagurus watasei* Terao (=

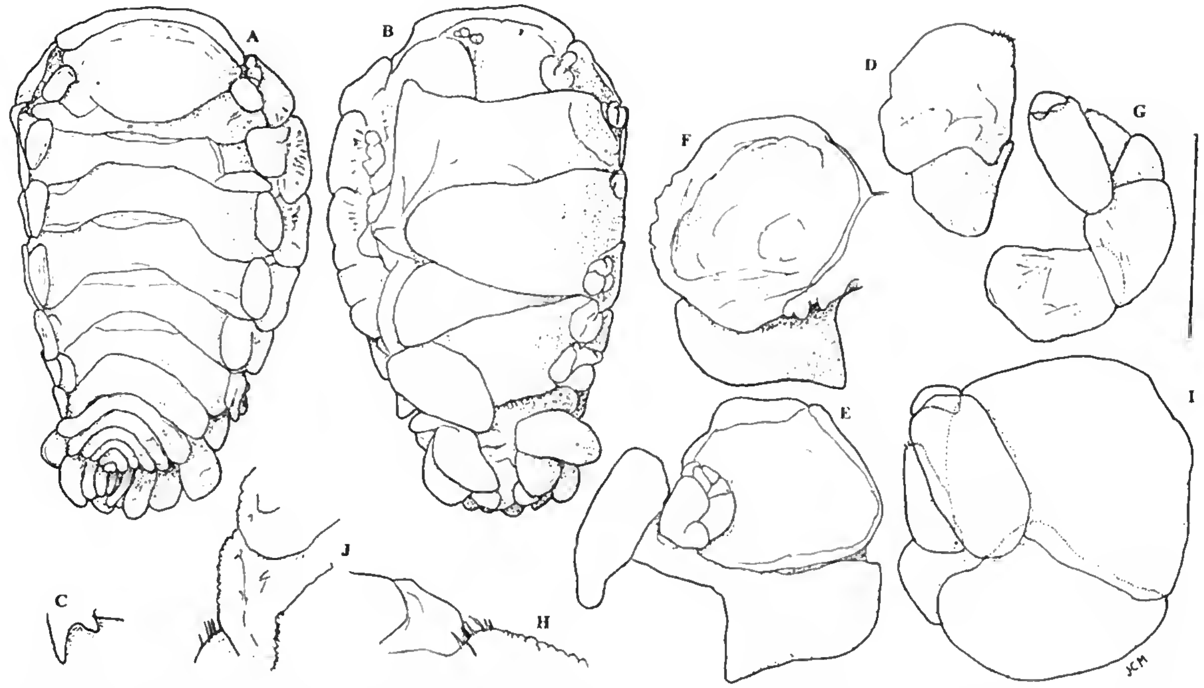

FIG. 5. *Aporobopyrina lamellata* Shiino, 1934, female. QM-W16925. **A**, dorsal view. **B**, ventral view. **C**, right side of barbula. **D**, right maxilliped. **E**, right oostegite 1, external. **F**, same, internal. **G**, right pereopod 1. **H**, distal edge of same. **I**, right pereopod 7. **J**, distal edge of same. Scale: 2.0 mm for A, B; 1 mm for C-F; 0.36 mm for G, I; 0.09 mm for H, J.

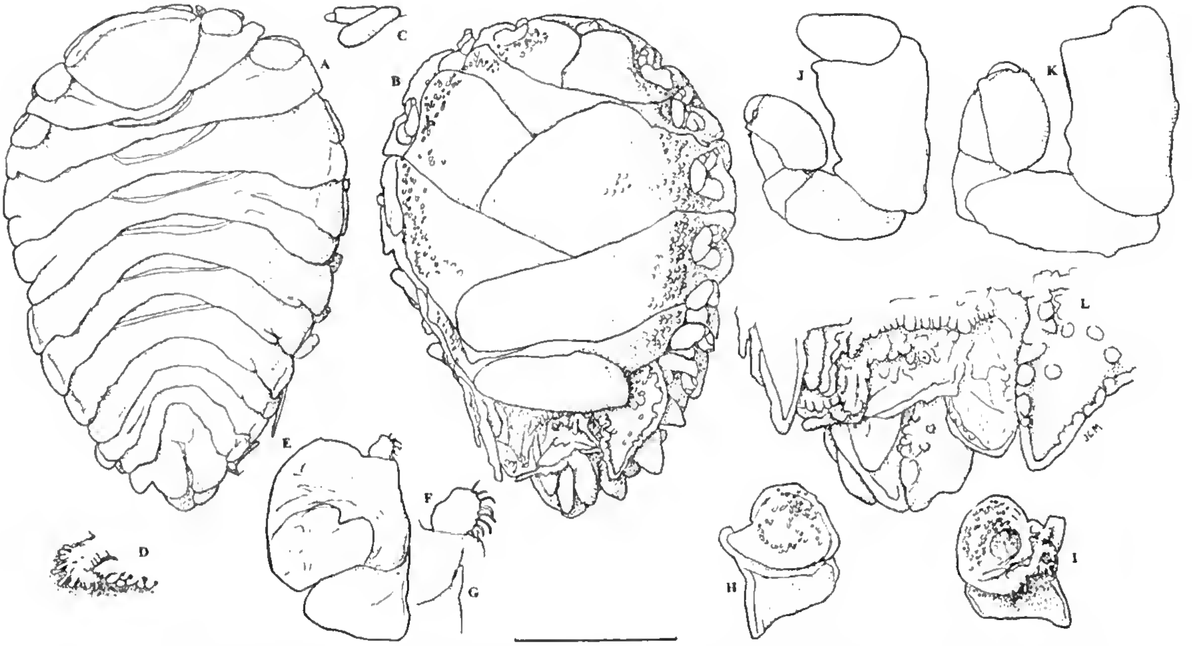

FIG. 6. *Pagurion tuberculata* Shiino, 1933, female, QM-W10843. **A**, dorsal view. **B**, ventral view. **C**, right antenna 1. **D**, right side of barbula. **E**, right maxilliped. **F**, palp of same. **G**, right oostegite 1, external. **H**, same, internal. **I**, right pereopod 1. **J**, right pereopod 7. **K**, pleon, ventral view. Scale: 4.35 mm for A, B, H, I; 2.0 mm for D, E, L; 1 mm for C, F, G; 0.9 mm for J, K.

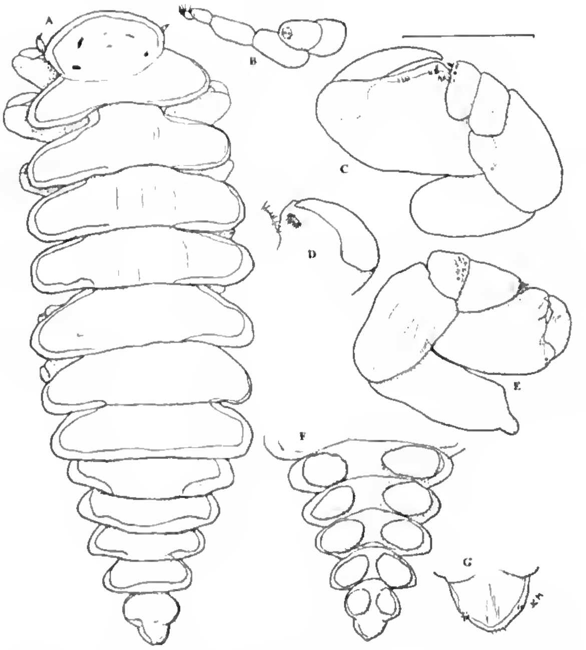

FIG. 7. *Pagurion tuberculata* Shiino, 1933, male, QM-W10843. **A**, dorsal view. **B**, right antennae. **C**, right pereopod 1. **D**, distal region of same. **E**, right pereopod 7. **F**, pleon, ventral. **G**, end of pleon, ventral. Scale: 1 mm for A, F; 0.36 mm for B-E, G.

Dardanus scutellatus (H. Milne Edwards))]; Shiino, 1972: 7; Harada, 1991: 201; Saito *et al.*, 2000: 36; Markham, 2003: 72.

Pagurion — Shiino, 1934: 263; Bruce, 1968: 19.

Material Examined. QM-W10843, ♀, ♂, infesting *Dardanus arrosor* (Herbst, 1796), Craigmin Survey, Capricorn Channel, off SE Qld, 23° 58′S, 152°45′E, 212 m, 29.09.1980. QM-W17450, ♀, ♂, infesting *Dardanus hessii* (Miers, 1884), CSIRO, F.R.V. *Southern Surveyor*, Stn. 67, Gulf of Carpentaria, Qld, 14°30.5′S, 140°42′E, 46 m, dredged, 05.12.1991.

Remarks. This is only the second discovery of *Pagurion tuberculata*, so it constitutes a new record for Australia, as well as for Queensland. *Dardanus arrosor* and *D. hessii* are both new host records, though congeneric with the host of the types in Japan. Both sexes match the types well, the female especially. The maxilliped palp of the type female is not completely separated, while that of the new female (Fig. 6E, F) is separate. The type-female bears four coxal plates on both sides of the body, while the new female (Fig. 6A) shows only two on each side. The new male (Fig. 7A) has a less completely separated head than the type, its body is broadest farther forward, its final two pleomeres are fused together both

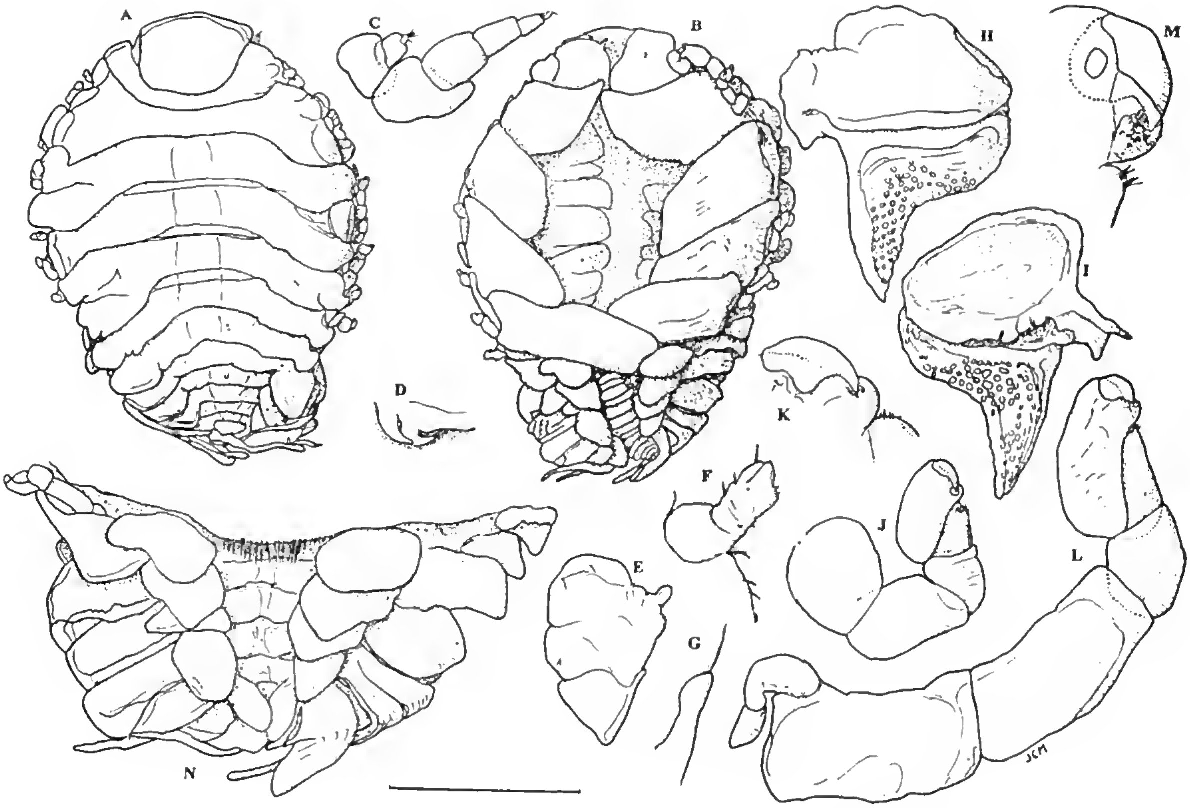

FIG. 8. *Pseudione magna* Shiino, 1951, female, QM-W10840. **A**, dorsal view. **B**, ventral view. **C**, left antennae. **D**, right side of barbula. **E**, right maxilliped. **F**, palp of same. **G**, plectron of same. **H**, right oostegite 1, external. **I**, same, internal. **J**, right pereopod 1. **K**, distal edge of same. **L**, right pereopod 7. **M**, distal edge of same. **N**, pleon, ventral. Scale: 8.16 mm for A, B; 4.11 mm for D, E, H, I, N; 1 mm for C, F, G, J, L; 0.36 mm for K, M.

dorsally and ventrally (Fig. 7A, F, G) not separate dorsally, and its pleopods (Fig. 7F) are five pairs of sessile disks, not three pairs of small flaps. A detail of the male not previously noted is that the dactyli of the first two pereopods (Fig. 7C) are long and sharply pointed, while those of the last three pairs (Fig. 7D, E) are small, and those of pereopods 3 and 4 (not illustrated) are intermediate in size.

Pseudione Kossmann, 1881

Type-species: *Pseudione callianassae* Kossmann, 1881, by monotypy.

Pseudione magna Shiino, 1951
(Figs 8, 9)

? 'Epicarid' — de Man, 1920: 163 [Bali Sea, Indonesia, infesting *Heterocarpus gibbosus* Bate].

Pseudione magna Shiino, 1951: 29–32, figs 3, 4 [off Owase, Mie Prefecture, Japan, infesting *Heterocarpus sibogae* de Man]; Şadoğlu, 1969: 197; Danforth, 1976: 79–80 [Guam, infesting *Heterocarpus ensifer* A. Milne Edwards]; Markham, 1988: 21–22; Román-Contreras & Wehrtmann, 1997: 242, 247; Saito *et al*., 2000: 37–38.

Pseudione compressa — Shiino, 1972: 7 [not *Pseudione compressa* Shiino, 1964].

Material Examined. QM-W10840, ♀, ♂, infesting *Heterocarpus sibogae* de Man, 1917, Craigmin Survey, Stn. Cr. 2, shot 1, Capricorn Channel, off SE Qld, 23° 58'S, 153°19'E, 562 m, 20.09.1980.

Remarks. The present material closely resembles the types in both sexes. The head of the type--female tapers posteriorly, unlike that of the present female (Fig. 8A), and its first oostegite is evidently not tuberculate, unlike that examined herein (Fig. 8G, H). There was no mention of the pereopods of the holotype, but those of the present

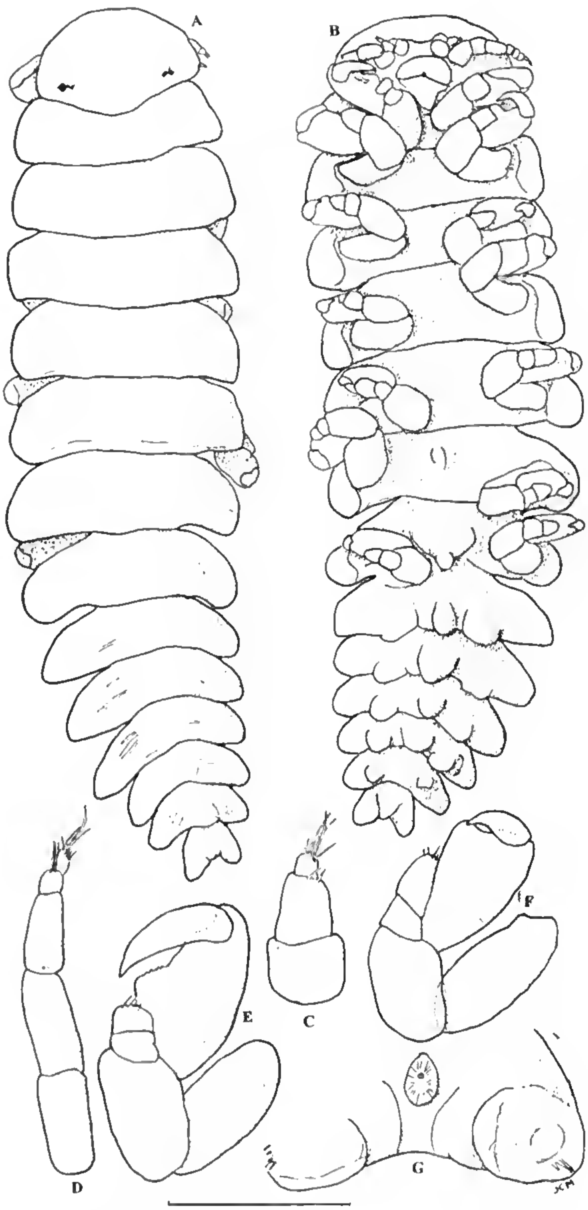

FIG. 9. *Pseudione magna* Shiino, 1951, male, QM-W10840. **A**, dorsal view. **B**, ventral view. **C**, left antenna 1. **D**, left antenna 2. **E**, left pereopod 1. **F**, left pereopod 7. **G**, end of pleon, distal. Scale: 1 mm for A, B; 0.36 mm for E, F; 0.18 mm for C, D, G.

female (Fig. 8I, K) are markedly larger posteriorly; all of them have reduced dactyli (Fig. 8J, L). The present male has a slightly longer head (Fig. 9A) and rather more extended tuberculiform pleopods and has midventral tubercles on the first four pleomeres, like that from Guam (Danforth 1976), while the type has such tubercles on only the first three pleomeres. Danforth (1976) reported that the female from Guam had fewer coxal plates than the type; the present female has still fewer. The male from Guam showed fusion of the head and first pereomere, while there is distinct separation in both the present male and the type.

The present material represents a new Australian and Queensland distributional record for *Pseudione magna*. *Heterocarpus sibogae* is the same host that bore the type-specimens, so it is not a new host record. *H. sibogae* has also been reported to host *Discorsobopyrus stebbingi* (Nierstrasz & Brender à Brandis) in Indonesia and near Taiwan (Boyko 2004). One of these two species of bopyrids was probably the parasite found infesting *Heterocarpus gibbosus* in the Bali Sea by de Man (1920), though that material is evidently long lost, so its identity cannot be determined. The other known host of *P. magna*, *Heterocarpus ensifer*, reported by Danforth (1976) at Guam, also hosts the closely similar species *Pseudione ampla* Markham, in the western Atlantic Ocean (Markham 1988).

BOPYRINAE Rafinesque, 1815

Bopyrina Kossmann, 1881

Type-species: *Bopyrus virbii* Walz, 1881, by monotypy.

Bopyrina ocellata (Czerniavsky, 1869) (Fig. 10)

Abbreviated synonymy (only original descriptions, detailed synonymies, alternate names, redescriptions and Australian records included).

Bopyrus ocellatus Czerniavsky, 1869: 79; pl. VI, figs 1–3 [Pontus, shore of Black Sea, infesting *Virbius gracilis* Heller (= *Hippolyte longirostris* (Czerniavsky))].

Bopyrus virbii — Walz, 1881: 159–164 [Trieste and Naples, Italy, infesting *Virbius viridis* Heller (= *Hippolyte inermis* Leach)]; Kossmann, 1881: 667 [made type of *Bopyrina*]; Walz, 1882: 200 [synonymised with *Bopyrus ocellatus*].

Bopyrina ocellata forma *pontica* (typica) Czerniavsky, 1881: 529 [new name for original material, above]; Bourdon, 1968: 388 [synonymised with *Bopyrina ocellata*].

Bopyrina ocellata forma *mediterranea*; Czerniavsky, 1881: 529 [new name for *Bopyrus virbii*]; Bourdon, 1968: 388 [synonymised with *Bopyrina ocellata*].

Bopyrina ocellata — Giard & Bonnier, 1890: 383 [synonymy and summary of records]; Bonnier, 1900: 48, 61, 221, 369–370, 381, fig. 60 [Gulf of Yalta, Black Sea, infesting *Virbius gracilis* (= *Hippolyte longirostris*); synonymy and summary of records]; Bourdon, 1968: 188, 388–409, figs 183–190, tables 64–68, graphs 27–30 [France and Britain, infesting *Hippolyte varians* (Leach), *H. inermis*, *H. longirostris* and *H. longirostris armoricana* Sollaud; complete summary of European records and synonymy to date]; Bourdon & Bruce, 1983b: 99 [Moreton Bay, Qld, infesting *Hippolyte* sp. and *H.* cf. *ventricosa* H. Milne Edwards; and Port Curtis, Qld, infesting *Hippolyte* sp; and Heron I., Qld, infesting *H.* cf. *commensalis* Kemp]; Lester & Sewell, 1989: 120, 125 [summary of records at Heron I.]; Humphrey, 1995: table 48 [Australian records]; Poore *et al.*, 2002: 117; Shimomura *et al.*, 2006: 1, 4–7, figs 3, 4 [synonymy, diagnosis, redescription; Seto Inland Sea, Japan, infesting *Hippolyte* sp.]

Bopyrina ocellata var. (sic) *mediterranea* —Giard & Bonnier, 1890: 383 [synonymised with *Bopyrina virbii*].

?*Bopyrina nitescens* Giard & Bonnier, 1890: 383 [nomen nudum].

Bopyrina hippolytes Giard & Bonnier, 1890: 384 [nomen nudum].

Bopyrina Giardi Bonnier, 1900: 14, 18, 24–27, 48, 61, 83, 165, 365–368, 372, 382, 471–476; pls XXXIX, XL [Wimereux, France, infesting *Virbius varians* Leach (= *Hippolyte varians* (Leach))].

Bopyrina sullata [sic]; Bonnier, 1900: 382 [list of hosts and localities known].

Bopyrina giardi — Tattersall, 1911: 268, fig. 203; Chopra, 1923: 417, 418, 523–527, 532–534; text fig. 31 [Andaman Islands, India, infesting *Hippolyte ventricosus* H. Milne Edwards; synonymy; redescription]; Motaş & Băleanu, 1937: 164–172, figs 1–6 [Black Sea, Romania, infesting *Hippolyte varians* var. *fascigera* Gosse; redescription]; Bourdon, 1968: 388, 396–397 [synonymised with *Bopyrina ocellata*].

Bopyrina ocellatus [sic] — Chopra, 1923: 542.

Bopyrella [sic] *ocellata* — Restivo, 1971: 153.

?*Bopyrella* (?) *nitescens* — Bourdon, 1980a: 233 [nomen nudum; called possible synonym].

?*Bopyrina ocellata* — Tsukamoto, 1981: 394–401, figs 1–21, table 1 [four Brazilian localities, from 08° S to 24°S, infesting *Hippolyte curacaoensis* Schmitt; probably = *Bopyrina abbreviata* Richardson, 1904; see remarks below].

Material Examined. AM-P21779, ♀, infesting *Hippolyte* sp., Myora Springs, North Stradbroke I., Moreton Bay, Qld, 27°40.8′S, 153°24.6′E.

Remarks. The female illustrated (Fig. 10) is one of those examined by Bourdon & Bruce (1983). Being minute, it is difficult to illustrate in detail, but because no specimen collected in Australia was previously illustrated, it seemed advisable to present at least this one drawing to confirm the identification for the species there. Hiraiwa (1933) remarked that *B. ocellata* is the smallest bopyrid known, and the material examined herein certainly bears out that observation.

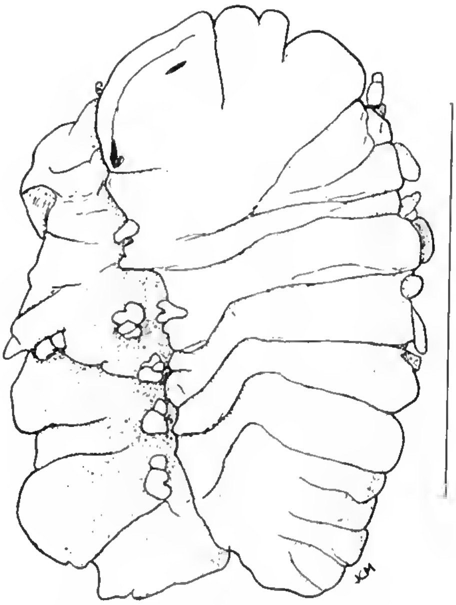

FIG. 10. *Bopyrina ocellata* (Czerniavsky, 1869), female, AM P 21779. dorsal view. Scale: 1 mm.

The synonymy presented above contains only a small fraction of the published citations of *B. ocellata*. Approximately 100 more, including additional original discoveries in European waters are known. All reported hosts of *B. ocellata* throughout its very wide known range, from Britain thorough the Mediterranean and Black Sea, to India, Japan and Australia, are in the hippolytid genus *Hippolyte*.

The record by Tsukamoto (1981) listed in the synonymy above from Brazil probably should have been for the closely similar *B. abbreviata* Richardson, which that author considered a possible synonym. Markham (1985) examined a sizable amount of material of *B. abbreviata* collected along much of its extensive range in the western Atlantic and presented evidence that it is properly considered distinct from *B. ocellata*, though it is indeed very similar.

Parabopyrella Markham, 1985

Type-species: *Bopyrella mortenseni* Nierstrasz & Brender à Brandis, 1929, by original designation.

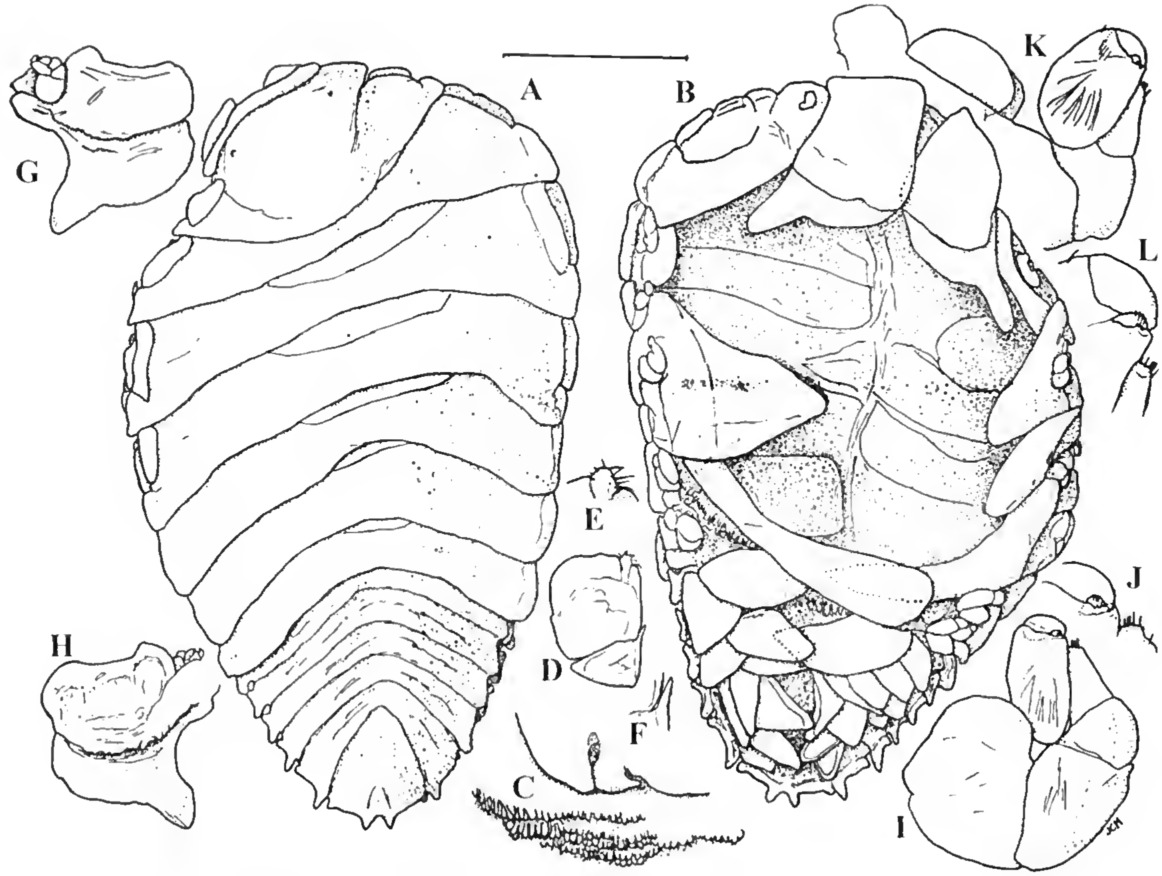

FIG. 11. *Parabopyrella australiensis* (Bourdon, 1980), new status, female, QM-W29064. **A**, dorsal view. **B**, ventral view. **C**, right side of barbula and adjacent region of pereon. **D**, right maxilliped. **E**, palp of same. **F**, plectron of same. **G**, right oostegite 1, external. **H**, same, internal. **I**, right pereopod 1. **J**, distal region of same. **K**, right pereopod 7 with attached vestigial oostegite. **L**, distal region of same. Scale: 2.0 mm for A, B, D, G, H; 1.0 mm for C, E, F; 0.36 mm for I, K; 0.18 mm for J, L.

Parabopyrella australiensis (Bourdon, 1980) (Figs 11, 12)

Bopyrella barnardi australiensis Bourdon, 1980a: 187, 192–194, 197, fig. 3 [Port Curtis, Qld, 23°51'S, 151°15'E, infesting *Alpheus* sp.]; Bourdon & Bruce, 1983b: 96.

Parabopyrella barnardi australiensis — Markham, 1985a: 67 [transferred to *Parabopyrella* by implication]; Poore *et al.*, 2002: 118.

Material Examined. QM-W29064, ♀, ♂, infesting *Alpheus euphrosyne richardsoni* Yaldwyn, 1971, in intertidal seagrass, Amity Point, North Stradbroke I., Qld, 27 23.7'S, 153 26.8'E, 20.02.2005, X. Li .

Remarks. This is only the second discovery of *Parabopyrella australiensis,* which was previously found in Queensland as a parasite of a congeneric host. Although Bourdon (1980a) considered this to be a subspecies of *Bopyrella barnardi* Nierstrasz & Brender à Brandis, 1931, I believe that it differs sufficiently from that species to be regarded as separate, so I am hereby raising it to full species status as *Parabopyrella australiensis* (Bourdon, 1980). In particular, the male, in having a fused and anteriorly enlarged pleon, is very different from that of *Bopyrella* (now *Parabopyrella*) *barnardi*, which is shown tapered and with at least five distinct pleomeres (Nierstrasz & Brender à Brandis 1931). The two females differ sufficiently in the shapes of their first oostegites and other characters presented in Table 1 of Bourdon (1980a) to justify such a separation as well. Differences from the type female seen in the present material include the less indented anterior edge of the head (Fig. 11A),

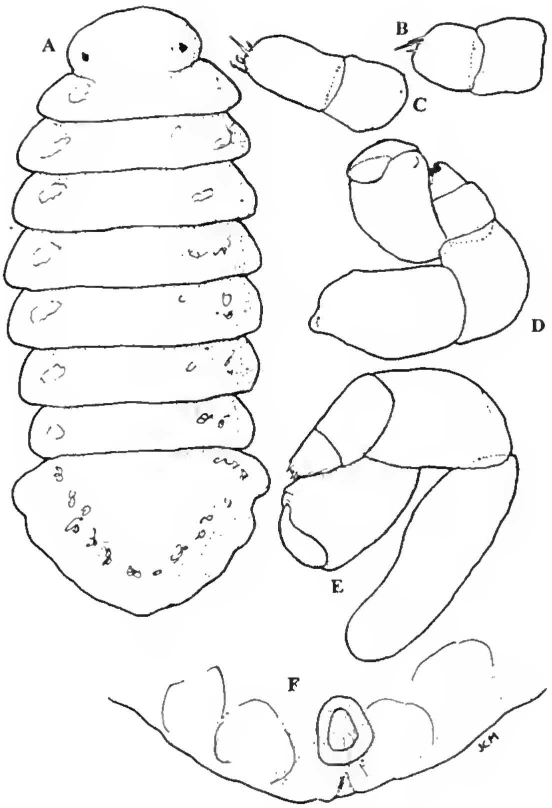

FIG. 12. *Parabopyrella australiensis* (Bourdon, 1980), new status, male, QM-W29064. **A**, dorsal view. B, left antenna 1. **C**, left antenna 2. **D**, right pereopod 1. **E**, right pereopod 7. **F**, posterior edge of pleon, ventral. Scale: 1 mm for A; 0.32 mm for D-F; 0.16 mm for B, C.

the lack of a tubercle on the pleotelson and the extension of that segment into two sharp points; the beaded appearance of the anterior ventral region of the pereon (Fig. 11C) was not mentioned previously. The present male (Fig. 12), in contrast with the type, has a slightly more rounded body, a proportionately smaller head and proportionately shorter and wider pleon.

Parabopyrella indica (Chopra, 1923)

Limited synonymy, restricted to newly collected material, changes of name and Australian records.

'A subspecies of Hay's *B. deformans*' — Chopra, 1922: 70.

Bopyrella deformans indica Chopra, 1923: 470–473; text-fig. 9; pl. XIV, figs 1–6 [Karachi (Pakistan) and Madras, India, infesting *Synalpheus biunguiculatus* Coutière; and northeast of Ceylon, infesting *S. nilandensis* Coutière]; Nierstrasz & Brender à Brandis, 1929: 38, fig. 48 [Hong Kong, infesting *Synalpheus* sp.].

Bopyrella deformans var. *indica* — Monod, 1933: 155 [Egyptian coast of Red Sea, infesting unidentified alpheid].

Bopyrella indica — Bourdon, 1979a: 501–503, fig. 21 [Tulear, Madagascar, infesting *Synalpheus* sp.]; 1980a: 187, 208–210, fig. 10 [full synonymy; Hong Kong, infesting *Synalpheus* sp.; Kei Islands, Indonesia, infesting *Synalpheus* sp.; New Caledonia, infesting *S. gravieri* Coutière; Deep Hole, Tyron Roads, Sandy Strait, Qld, infesting *Synalpheus* sp.; unnamed locality, infesting *S. gravieri*].

Bopyrella distincta [sic] — Bourdon, 1980a: 210.

Synsynella deformans var. *indica* — Shiino, 1949a: 49.

Parabopyrella indica — Markham, 1982: 345; Kazmi *et al*., 2002: 61, fig. 18. [unspecified locality, northern Arabian Sea, infesting *Synalpheus tumidomanus* (Paulson)]; Poore *et al*., 2002: 119.

Remarks. No new material examined.

Parabopyrus Shiino, 1934

Type-species: *Parabopyrus kiiensis* Shiino, 1934, by monotypy.

Parabopyrus kiiensis Shiino, 1934

Parabopyrus kiiensis Shiino, 1934: 268–269, fig. 5 [Yusaki and Shisojima, Seto, Japan, infesting *Hippolysmata* sp. (=*Lysmata* sp.)]; 1972: 8; Bourdon & Bruce, 1983a: 314, 316, table 1; Bourdon & Bruce, 1983b: 101–102, fig. 4 [Bustard Bay, Qld, infesting *Athanas* sp.]; Harada, 1991: 201; Saito *et al*, 2000: 41; Poore *et al*., 2002: 119.

Remarks. No new material examined.

Probynia Bourdon & Bruce, 1983

Type-species: *Probynia obstipa* Bourdon & Bruce, 1983, by original designation.

Probynia obstipa Bourdon & Bruce, 1983 (Fig. 13)

Probynia obstipa Bourdon & Bruce, 1983a: 310, 311–316, figs 1–6 [Heron I., Great Barrier Reef, Qld, infesting *Periclimenaeus hecate* (Nobili) and *Typton wasini* Bruce]; Bourdon & Bruce, 1983b: 96; Lester & Sewell, 1989: 119, 120, 125 [summary of records from Heron I.]; Humphrey, 1995: table 48 [summary of Australian records]; Bruce, 2000: 99; Poore *et al*., 2002: 119.

Material Examined. QM-W29065, ♀, infesting *Periclimenaeus hecate* (Nobili, 1904), Shag Rock, North Stradbroke I., Moreton Bay, Qld, 27°24.9'S, 153°31.6E, 10 m, 18.02.2005, X. Li.

Remarks. *Probynia obstipa* was previously known only from the types collected from Heron Island,

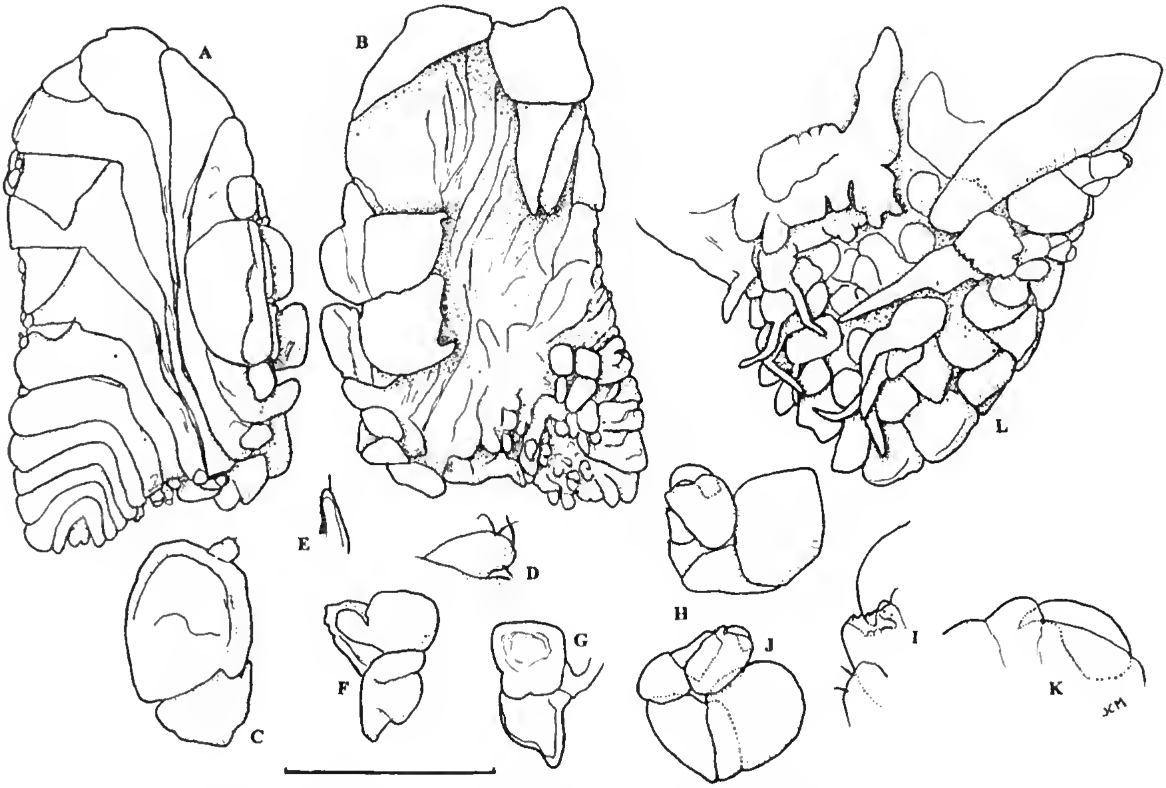

FIG. 13. *Probynia obstipa* Bourdon & Bruce, 1983, female, QM-W29065. **A**, dorsal view. **B**, ventral view. C, right maxilliped. **D**, palp of same. **E**. plectron of same. F, right oostegite 1, external. **G**, same, internal. **H**, right pereopod 1. I, distal region of same. J, right pereopod 7 distal region of same. Scale: 2.0 mm for A, B, F, G; 1 mm for C, L; 0.36 mm for D, E, H, J; 0.09 mm for I, K.

so this is only the second record. Its host is the same as that of one of the type specimens. The female examined differs in some details from those previously seen. The sides of its greatly distorted body are more nearly parallel; its head is farther back on the short side of its body; its maxillipedal palp is slightly less prominent; and its pleopods are somewhat longer and less regularly shaped. The two females of the type-lot, however, varied more from each other than this female does from the holotype. Unfortunately, the present material did not contain a male.

Schizobopyrina Markham, 1985

Type-species: *Bopyrina urocaridis* Richardson, 1904, by original designation.

Schizobopyrina andamanica (Chopra, 1923)

Bopyrina andamanica Chopra, 1923: 525–531, 542–543; text figs 27, 28; pl. XX, figs 1–6 [Port Blair, Andaman Islands, Indian Ocean, infesting *Periclimenes elegans* Paulson]; Monod, 1933: 230; Shiino, 1939a: 597–601 [Palau, infesting *Anchistus miersi* (de Man)]; Shiino, 1942: 440; Danforth, 1970b: 462; Bourdon & Stock, 1979: 211; Bourdon, 1983: 868, 869.

Schizobopyrina andamanica — Markham, 1985a: 46; 1990a: 55, 59–61, figs 4–5 [New Caledonia, infesting *Periclimenes* n. sp. and *Periclimenaeus bidentatus* Bruce]; Bruce, 1991: 250–254 [New Caledonia, infesting *Perclimenes tenuirostris* Bruce and *Periclimenaeus bidentatus* Bruce]; Kensley, 2001: 226; Poore *et al.*, 2002: 120 [off NE coast of Qld, 200 m; host not mentioned]; Williams & Boyko, 2004: 444.

Schizobopyrina andamica [sic] — Campos & Campos, 1990: 640, 641, table 1.

Remarks. No new material examined.

Schizobopyrina lobata (Bourdon & Bruce, 1983)

Bopyrina lobata Bourdon & Bruce, 1983b: 100–101, 106, fig. 3 [Bribie Passage, Coral Sea, off Caloundra, Qld, c. 26°50'S, 153°10'E, infesting *Tozeuma* sp.].

Schizobopyrina lobata — Markham, 1985a: 46; Campos & Campos, 1990: 633, 634, 640, 641, table 1; Poore *et al.*, 2002: 120; Williams & Boyko, 2004: 444.

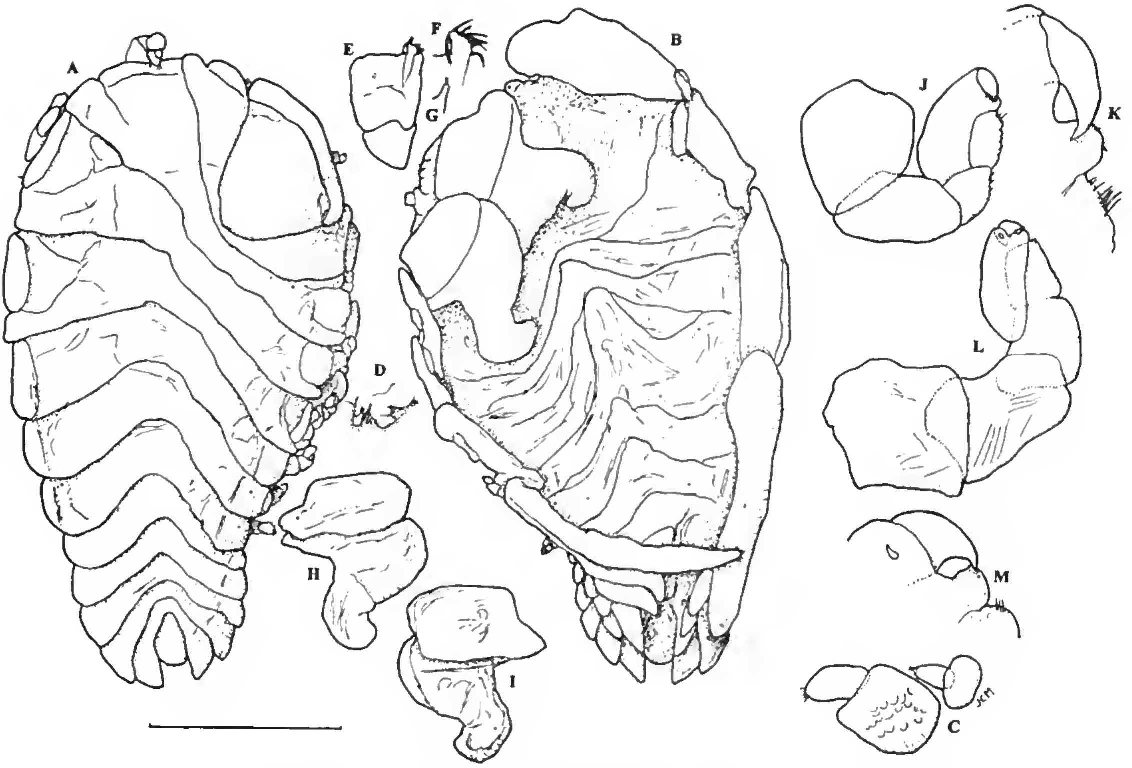

FIG. 14. *Schizobopyrina platylobata* (Bourdon, 1983), female, QM-W29066. **A**, dorsal view. **B**, ventral view. **C**, right antenna. **D**, right side of barbula. **E**, right maxilliped. **F**, palp of same. **G**, plectron of same. **H**, right oostegite 1, external. **I**, same, internal. **J**, .right pereopod 1. **K**, distal edge of same. **L**, right pereopod 7. **M**, distal edge of same. Scale: 2.0 mm for A, B, D, E, H, I; 1.00 mm for F, G; 0.36 mm for C, J, L; 0.09 mm for K, M.

Schizobopyrina (?) *lobata* — Campos & Campos, 1990: 638.
Non *Bopyrina lobata* — Humphrey, 1995: table 48 [cited as synonym of *Schizobopyrina platylobata* (Bourdon, 1983) below].

Remarks. No new material examined. Both Campos & Campos (1990) and Williams & Boyko (2004) expressed the opinion that this species does not properly belong in the genus *Schizobopyrina*, but neither proposed an alternative placement. Having examined no material of the species, I am venturing no opinion on the matter.

Schizobopyrina platylobata (Bourdon, 1983) (Figs 14, 15)

Bopyrina platylobata Bourdon, 1983: 867–869, fig. 13 [Seram, Moluccas, Indonesia, infesting *Anchistus australis* Bruce].
Bopyrina platylobae [sic] — Bourdon & Bruce, 1983b: 99 [Port Denison, Qld, infesting *Anchistus custos* (Forskål)].
Schizobopyrina platylobata — Campos & Campos, 1990: 633, 634, 637, 640, 641, table 1; Poore *et al.*, 2002: 120; Humphrey, 1995: table 48 [Queensland record].
Bopyrina lobata — Humphrey, 1995: table 48 [cited as synonym of *S. platylobata;* non *Bopyrina lobata* Bourdon & Bruce, 1983 (= *Schizobopyrina lobata* (Bourdon & Bruce, 1983), see above)].
[B]opyrid — Li, 2008: 235 [Moreton Bay, material examined herein, infesting *Anchistus custos*].
[P]arasite — Li, 2008: 235, fig. 2 [same material as above].

Material Examined. QM-W29066, ♀, ♂, infesting *Anchistus custos* (Forskål, 1775), in shell of *Pinna bicolor* Gmelin, 1791, intertidal seagrass flat, Amity Point, North Stradbroke I., Qld, 27°23.6′S, 153°26.4′E, X.Li & J.C. Markham. QM-W28020, ♀, ♂, infesting *Vir* sp. (nov. ?), on scleractinian *Plerogyra sinuosa* (Dana, 1846), Tomini Bay, Molucca Sea, Gorontalo Province, Sulawesi, Indonesia, ca. 00°N, 122°E, 16 m, 14.04.2006, R. Wadley.

Remarks. The only published illustrations of *Schizobopyrina platylobata*, those of Bourdon (1983), were incomplete, so some details of the species are uncertain. The present female from *Anchistus custos* (Fig. 14) matches the type well in such details as body shape and proportions,

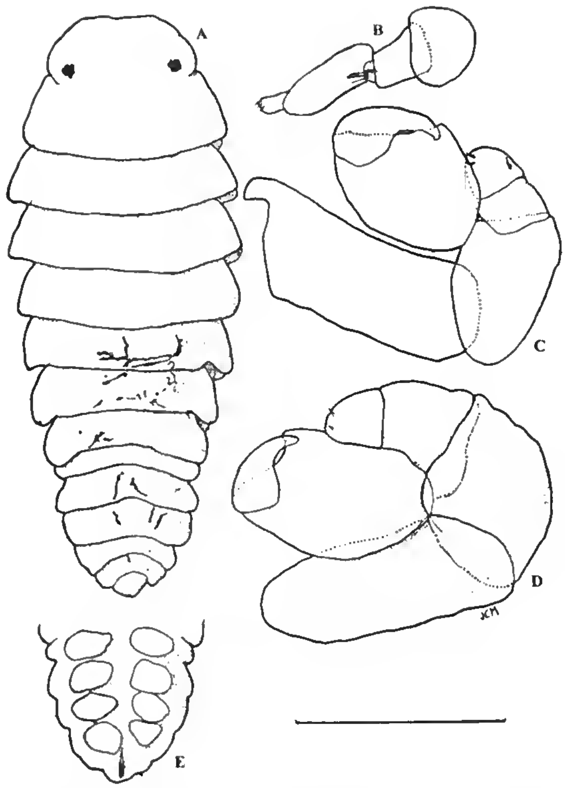

FIG. 15. *Schizobopyrina platylobata* (Bourdon, 1983), male, QM-29066. A, dorsal view. B, right antennae. C, right pereopod 1. D, right pereopod 7. E, posterior edge of pleon, ventral. Scale: 0.40 mm for A; 0.2 mm for E; 0.1 mm for B-D.

nature of maxilliped palp and shape of first oostegite. In contrast, its head and first pereomere are separated, and its pleomeres are much more completely distinct dorsally (Fig. 14A). Each antenna (Fig. 14C) has only two articles (Bourdon, 1983, called their segmentation 'non apparente'). The accompanying male (Fig. 15) is also clearly similar to the type male except that its pleomeres are distinct dorsally, while those of the type were fused.

The host of the new material from Queensland, *Anchistus custos*, is the same one already reported to bear *Schizobopyrina platylobata* in that state (Bourdon & Bruce, 1983b). Although from outside of the intended geographical scope of this report, the individuals from Sulawesi are included because they became available as this report was being prepared. Their host, *Vir* sp., is the first record in that genus for any bopyrid parasite. A.J. Bruce, who identified the host to genus and kindly furnished the material to me, states (pers. comm.) that the genus *Vir* is in need of revision, with the result that the exact identity of the species here involved cannot be established.

IONINAE H. Milne Edwards, 1840

Remarks. Poore *et al.* (2002) list *Albunione australiana* and *Portunicepon tiariniae* as the only members of the subfamily Ioninae known from Queensland. The former species has now been transferred to the Pseudioninae, above, and the latter is now considered to belong to the genus *Allokepon*. The other species discussed in this section are new to Queensland and to Australia as a whole.

Allokepon Markham, 1982

Type-species: *Portunicepon hendersoni* Giard & Bonnier, 1888, by original designation.

Allokepon tiariniae (Shiino, 1937)

Portunicepon tiariniae Shiino, 1937b: 486–489, figs 6–8 [Seto, Japan, infesting *Tiarinia cornigera* (Latreille)]; Shiino, 1942b: 71 [Seto, Japan, infesting *T. cornigera*]; Shiino, 1958: 68 [Seto, Japan, infesting *Menaethius monoceros* (Latreille)]; Shiino, 1972: 9; Markham, 1982: 357; Shields & Ward, 1998: 595 [Lizard I., Great Barrier Reef, Qld, infesting *Tiarinia* sp.]; Saito *et al.*, 2000: 42–43; Poore *et al.*, 2002: 124.

Allokepon tiariniae — Boyko, 2003: 5, 10 [transferred to *Allokepon*].

Remarks. No new material examined.

Dactylokepon Stebbing, 1910

Type-species: *Dactylokepon richardsonae* Stebbing, 1910, by subsequent designation.

Dactylokepon richardsonae Stebbing, 1910 (Figs 16, 17)

? *Bopyrus* sp — de Man, 1881: 94 [Near Jeddah, Saudi Arabia, Red Sea, infesting *Trapezia cymodoce* (Herbst)].

? 'Bopiride' — Nobili, 1901: 15 [Eritrea, infesting *Trapezia cymodoce*].

Dactylokepon richardsonae Stebbing, 1910: 85, 113; pl. 11C [Seychelles, infesting *Trapezia cymodoce*]; Nierstrasz & Brender à Brandis, 1923: 83; Shiino, 1942: 444, 447; Markham, 1975c: 61, 64–66, table 1 [designated type-species of genus]; Bourdon, 1983: 855–857 [Marsegu I., Moluccas, Indonesia, infesting *Trapezia cymodoce*]; Markham, 1991: 289, 291–294, fig. 2 [Bangkok Bight, Thailand, infesting *Portunus tuberculosus* (A. Milne Edwards); redescrip-

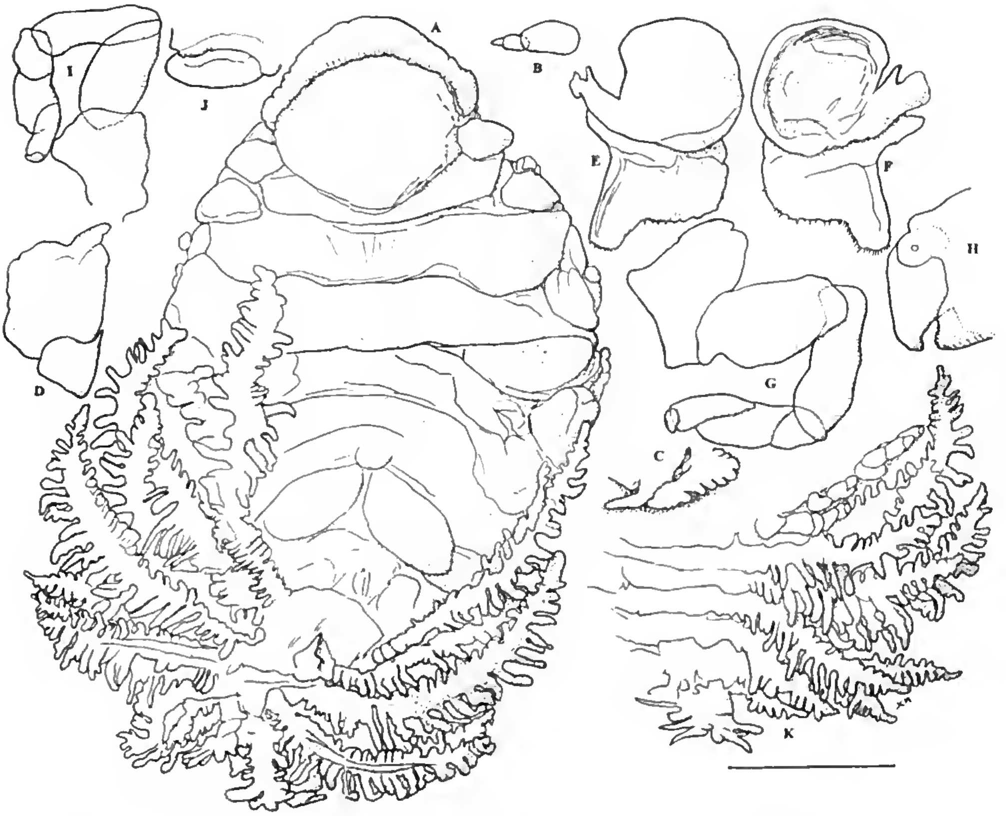

FIG. 16. *Dactylokepon richardsonae* Stebbing, 1910, female. QM-W12025. **A**, dorsal view. **B**, right antenna 1. **C**, left side of barbula. **D**, right maxilliped. **E**, right oostegite 1, external. **F**, same, internal. **G**, right pereopod 1. **H**, distal edge of same. **I**. right pereopod 7. **J**, distal edge of same. **K**, left side of pleon, ventral. Scale: 2.0 mm for A, D-F, K; 1 mm for B, C; 0.89 mm for G, I; 0.18 mm for H, J.

tion]; Kensley, 2001: 223; An *et al.*, 2007: 2063, 2064-2066, 2068, fig. 1 [Nansha, China; infesting *Portunus argentatus* (White); synonymy, descriptive notes].

Dactylocepon richardsonae — Bourdon, 1967a: 122; 1980b: 243; 1983: 856, fig. 7.

? 'C ponien' — Bourdon, 1980b: 243.

Material Examined. QM-W12025, 2 ♀♀, ♂, bilaterally infesting male *Charybdis anisodon* (de Haan, 1850) (carapace length 15.7 mm), Embly River, south of Weipa, western Cape York, Qld, 12°44'S, 141°56'E, 16.11.1981, L. Owens.

Remarks. *Dactylokepon richardsonae* shows some variation among the collections so far made, but the present material appears to lie well within that range. The female illustrated (Fig. 16) matches the type the least, but the drawing of Stebbing (1910) appears somewhat diagrammatic, and his description was quite brief. Its general body shape and proportions, head (Fig. 16A) and pleon (Fig. 16A, K) are most like those reported from Thailand (Markham 1991); its barbula (Fig. 16C) most similar to that of the type (Stebbing, 1910); and its first oostegite most resembles that of the female from the Moluccas (Bourdon, 1983). The female from China (An *et al.* 2007) uniquely has tubercles on the frontal lamina and on the tergal projections of the second pereomere, the processes on its barbula are shorter and broader, and its first oostegite is more sharply pointed. All males known (there being none in the type material) share diagnostic characters, namely the prominent antennae (Fig. 17C); large first pereopods (Fig. 17D) ending in sharp slender dactyli bearing long setae on their retractor margins and having their meri and carpi fused; and the nearly sessile flaplike pleopods each extending posteriorly over the front of the following pleomere. The present male is shaped and proportioned like that from Thailand (Markham 1991) but lacks its fusion of the head and first pereo-

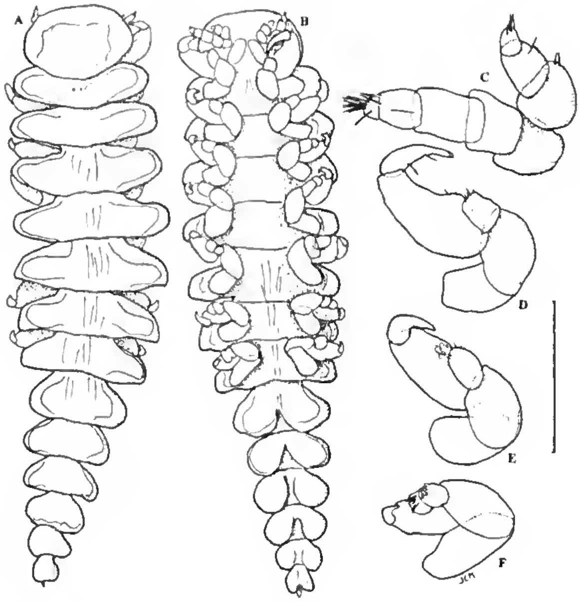

FIG. 17. *Dactylokepon richardsonae* Stebbing, 1910, male, QM-W12025. **A**, dorsal view. **B**, ventral view. **C**, right antennae. **D**, right pereopod 1. **E**, right pereopod 2. **F**, right pereopod 7. Scale: 1 mm for A, B; 0.36 mm for D-F; 0.18 mm for C.

mere and its midventral pereonal tubercles; in the latter characters, it agrees with the male from the Moluccas (Bourdon 1983), which is proportionately much shorter. The male from China (An *et al.* 2007) is also quite similar except for having midventral tubercles on all pereomeres.

Charybdis (*Charybdis*) *anisodon* is a new host record for this or any bopyrid, and Queensland (and Australia) is a new geographical record for *Dactylokepon richardsonae*. It is highly unusual for a single host specimen to be bilaterally infested by bopyrids, but such was the case. Interestingly, An *et al.* (2007), report that bilateral infestation by another species of *Dactylokepon*, *D. barbuladigitus* An, Yu & Williams, 2007, was common in the material they examined from Chinese localities. The right branchial chamber contained both female and male specimens, the ones drawn. Opposite, there was only a female. Aside from being a mirror image of the female illustrated, it differs slightly in lacking setae on the posterior margin of the first oostegite and in having no middorsal projection on the first pleomere.

Megacepon George, 1946

Type-species: *Megacepon choprai* George, 1946, by original designation.

Megacepon choprai George, 1946
(Fig. 18)

Megacepon choprai George, 1946: 385-390, figs 1-3 [Adyar River near Madras, India, infesting *Sesarma tetragonum* (Fabricius) (= *Muradium tetragonum* (Fabricius))]; Shiino, 1958: 65-68, figs 20-21 [River Asahi, Okayama, Japan, infesting *Sesarma* (*Holometopus*) *dehaani* A. Milne Edwards (= *Chiromantes dehaani* (A. Milne Edwards))]; Shiino, 1972: 9; Bourdon & Stock, 1979: 216, 217, table II; Markham, 1980: 623, 625-630, figs 6-7 [Samat Sakhan, Thailand, infesting *Sesarma mederi* H. Milne Edwards (= *Episesarma mederi* (H. Milne Edwards))]; 1982: 361; 1990b: 555, 560 [Hong Kong, infesting *Sesarma* (*Chiromanthes*) *maipoensis* Soh (= *Perisesarma maipoensis* (Soh))]; 1992b: 299, table 1; 2002: 335, table 1; Bourdon, 1981a: 105-106, 107; Saito *et al.*, 2000: 48; Kensley, 2001: 224; Mizoguchi *et al.*, 2002: 81; Li, 2003: 140, 154, 158, tables 1, 3.

Megacepon choprae [sic] — Bourdon & Bowman, 1970: 422.

Metacepon [sic] *choprai* — Huang, 1994: 530.

Material Examined. QM-W7451, ♀, infesting *Perisesarma erythodactyla* (Hess, 1865)(QM-W7450), Kangaroo I., Susan R., Hervey Bay, Qld, 25°15'S, 152°40'E, 25.07.1975, P. Davie.

Remarks. This is the fifth reported collection of *Megacepon choprai*, and the first from Australia. *M. choprai* is now known to be widespread, ranging from eastern Asia and eastern Australia across the Indian Ocean. In each collection, the host was a different species, but all are members of the intertidal crab family Sesarmidae.

The most diagnostic features of the female of *M. choprai* are the extended head bearing a reflexed frontal lamina incompletely covering its anterior margin, the broad extended middorsal projection on the first pleomere and the distinctive shapes, proportions and margins of the pleonal appendages. The original drawings of the species (George 1948) are highly diagrammatic and hard to interpret, but the present female conforms well with the other drawings published. In particular, its maxilliped and first oostegite are very similar to those seen in the Japanese material (Shiino 1958). Its middorsal pereonal tubercles are much more reduced than those of the Thai material (Markham 1980)

FIG. 18. *Megacepon choprai* George, 1946, female, QM-W7451. **A**, dorsal view. **B**, right antenna 1. **C**, left antenna 2. **D**, right side of barbula.E, right maxilliped. **F** right and left oostegites 1. **G**, right oostegite 1, external. **H**, same, internal. **I**, left pereopod 1. **J**, left pereopod 7. Scale: 4.11 mm for F; 2.0 mm for A, E, G, H; 1 mm for D; 0.36 mm for B, C, I, J.

but better developed than those of the type (George,1948) and the Japanese female (Shiino 1958). Regrettably, there was no male in the present collection.

Scyracepon Tattersall, 1905

Type-species: *Scyracepon tuberculosa* Tattersall, 1905, by monotypy.

Scyracepon australiana sp. nov.
(Fig. 19)

Material Examined. HOLOTYPE: QM-W5008, ♀, infesting *Australoplax tridentata* (A. Milne Edwards, 1873) (Ocypodidae), Serpentine Creek, Anabranch, 2.1 km from mouth, SE Qld, 27° 24′S, 153°06′E, 03.12.1973, B. Campbell *et al.*

Description. Female. Length 5.35 mm, maximal width 2.94 mm, head length 1.00 mm, head width 0.72 mm, pleon length 1.56 mm, body distortion 15°. All body regions and segments distinct. Body outline smoothly suboval. Unpigmented except for small eyespots. (Fig. 19A).

Head broadly oval, its anterior margin completely covered by prominent slightly askew ornamented frontal lamina. Reduced dark eyespots slightly forward of lateral corners. Antennae indiscernible. Barbula (Fig. 19B) with pair of simple slender sharply pointed projections on each side. Maxilliped (Fig. 19C) about twice as long as wide, produced anteromedially into small nonarticulating palp, with prominent plectron.

Sides of pereon smoothly rounded, broadest across pereomere 3, with prominent coxal plates on sides of anterior pereomeres. No middorsal bosses, but irregular dorsal swellings on some pereomeres. Oostegites incompletely enclosing brood pouch; first oostegite (Fig. 19D, E) about twice as long as broad, its sides nearly parallel, its anterior article much shorter than posterior one, internal ridge produced into row of stubby digitate projections. Pereopods (Fig. 19F, G) proportionately small, with all articles distinct,

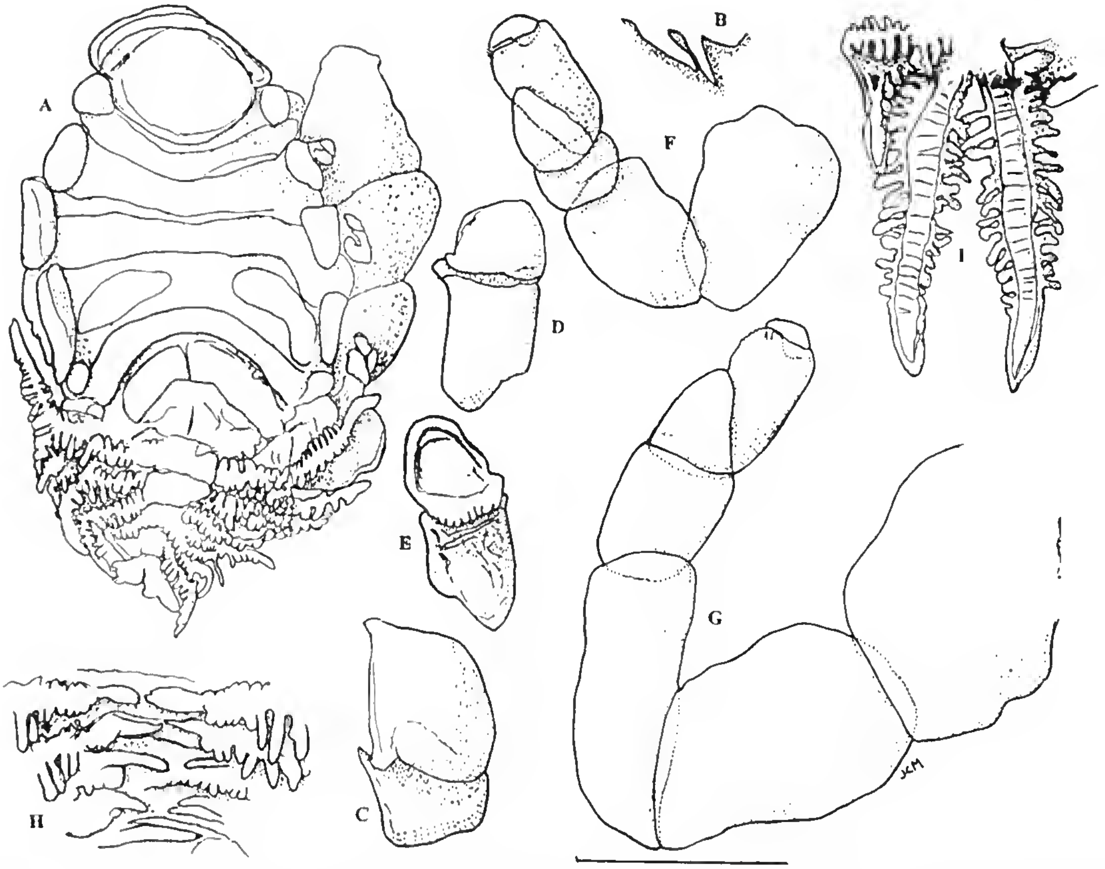

FIG. 19. *Scyracepon australiana*, n. sp., holotype female, QM-W5008. A, dorsal view. B, right side of barbula. C, right maxilliped. D, right oostegite 1, external. E, same, internal. F, right pereopod 1. G, right pereopod 7. H, middle of pleon, ventral. I, uropods. Scale: 2 mm for A, D, E; 1 mm for B, C, H; 0.18 mm for F, G.

meri, carpi, propodi and dactyli all nearly same size and shape; coxae, bases and ischia of posterior pereopods much larger.

Pleon of six pleomeres, margins of first five covered by long slender deeply digitate lanceolate exopodites of biramous pleopods, those of first pair directed anteriorly; endopodites of pleopods (Fig. 19H) medially directed minute versions of exopodites. Pleomere 6 bearing uniramous uropods (Fig. 19I) of structure and digitate margins similar to those of pleopodal exopodites but markedly broader. Male unknown.

Etymology. First declension Latin adjective *australiana* denoting the type-locality.

Remarks. *Scyracepon* has previously included five species, only one of which, *S. tuberculosa*, has been collected more than once. They are *S. hawaiiensis* Richardson, 1911, from Hawai'i infesting *Pilumnoplax cooki* Rathbun [= *Carcinoplax cooki* (Rathbun)] (Carcinoplacidae); *S. levis* Barnard, 1940, from South Africa, infesting *Scyramathis hertwigi* Doflein (Majidae); *S. oceanicum* Shiino, 1942, from Palau, infesting *Eriphia scabricula* Dana (Eriphiidae); *S. quadrihamatum* Shiino, 1936, from Shimoda, Japan, infesting *Maja japonicus* Rathbun (Majidae); and *S. tuberculosa* Tattersall, 1905, from Ireland infesting *Scyramathia carpenteri* (Thompson) (Majidae) (Tattersall 1905), from Congo infesting *Geryon quinquedens* Smith (Geryonidae) (Bourdon 1971), and from the Azores infesting *Rochinia carpenteri* (Norman) (Majidae) (Bourdon 1979b). With the description of *Scyracepon australiana*, the genus is now known to infest crabs belonging to five different brachyuran families.

Females of *Scyracepon australiana* share the following characters with other *Scyracepon* species: similar proportions of body regions and appendages; head relatively large and somewhat extended and bearing prominent broad slightly reflexed frontal lamina; production of barbula into two slender sharp points on each side; non-articulating maxilliped palp bluntly rounded and slightly curved, plectron prominent; first oostegite with multiple rounded lobes on internal ridge and posterolateral region very broadly pointed; pereopods all with reduced dactyli; pleomeres with fairly short digitate-margined exopodites, tiny endopoites; uniramous uropods similar to exopodites but somewhat larger.

Scyracepon australiana differs from other species in having no evident mid-dorsal pereonal bosses. Also, the pleopodal endopodites of the other species are knoblike, not minute versions of the exopodites. It appears most similar to *S. hawaiiensis*, but the female of that species differs in being somewhat broader, having a small middorsal projection on the seventh pereomere, and in bearing numerous extensions along the margin of the maxillipedal palp and on the posterior edge of the first oostegite (Richardson 1911).

The name *Scyracepon* would appear to be Greek neuter noun, but Tattersall (1905) clearly treated it as feminine in writing the name of the type-species, *S. tuberculosa*, as a feminine adjective. Accordingly, the name of the new species, *S. australiana*, is also presented in the feminine form. This is the first record of bopyrid infestation in the monotypic genus *Australoplax*.

ORBIONINAE Codreanu, 1967

Epipenaeon Nobili, 1906

Type-species: *Epipenaeon ingens* Nobili, 1906, by monotypy

Epipenaeon ingens Nobili, 1906

Synonymy restricted to original names, major reviews and Australian records.

Epipenaeon ingens Nobili, 1906: 1099–1101, 1104, fig. 1 [Red Sea, infesting *Penaeus ashiaka* Kishinouye (= *Penaeus semisulcatus* De Haan)]; Bourdon, 1968: 327–333, figs 145–158 [Mersin, northeastern Mediterranean Sea, Turkey, infesting *P. semisulcatus*; redescription and summary of records]; 1979c: 429, 430 [Port Darwin, Australia, infesting *Penaeus esculentus* Haswell; reexamination of types of *E. nobili* and *E. grande*]; Owens, 1983: 477–480, figs 1, 2, table 1 [southeastern Gulf of Carpentaria, infesting *P. merguiensis* de Man]; Nearhos & Lester, 1984: 257–258 [Karumba, Gulf of Carpentaria, Qld, and Maryborough, Qld, infesting *P. semisulcatus*; Karumba, Roselyn Bay, Qld, infesting *P. merguiensis*; re-examination of type of *E. grande*]; Owens, 1985: 291; Owens & Glazebrook, 1985a: 105–112, figs 1, 4, tables 2–4 [numerous localities, Gulf of Carpentaria, infesting *P. semisulcatus*, *P. merguiensis* and *P. indicus* Milne Edwards]; Owens & Glazebrook, 1985b: 135 [same collection]; Glazebrook *et al.*, 1986: 196, 197, table 5 [summary of occurrence and hosts in Gulf of Carpentaria]; Owens, 1986: iii–iv, x, xi, xvi, 14, 55–60, 71–79, 82, 84–103, tables 2.4.1, 7.1, 8.2, figs 8.2, 8.4 [study of biology in Gulf of Carpentaria]; Lotz & Overstreet, 1990: 110 [summary of Australian records]; Owens, 1990: 35, 37, 38, table 1 [summary and analysis of occurrence in Australia]; Rohde, 1990: 568; Courtney, 1991: 617, 620–621, table 2 [discussion of occurrence in Australia]; Owens & Rothlisberg, 1991: 779–786 [numerous localities, Gulf of Carpentaria, infesting *P. semisulcatus*, *P. merguiensis* and *P. indicus*]; Somers & Kirkwood, 1991: 349-365 [Gulf of Carpentaria, infesting *P. semisulcatus*]; Owens, 1993: 381, 383–385, figs 2, 3, 5 [Qld, infesting *P. semisulcatus*]; Humphrey, 1995: 14-1, 14-9, table 48 [summary of Australian records]; Owens, 1987: 119, 120, 122 [summary of Australian records; remarks on range]; Owens & Rothlisberg, 1995: 159–164 [numerous localities, Gulf of Carpentaria; study of larvae]; Lester, 2005: 139, 142, fig. 4.7B [summary of research in Australia].

Epipenaeon nobili Nierstrasz & Brender à Brandis, 1929: 299–302, figs 5–9 [Suez, Egypt, Red Sea, infesting *Penaeus semisulcatus*]; Bourdon, 1979c: 429 [synonymised with *E. ingens*].

Epipenaeon grande Nierstrasz & Brender à Brandis, 1931: 157–158, fig. 18 [Hong Kong, infesting *Penaeus monodon* (Bate) (= *P. semisulcatus*)]; Bourdon, 1979c: 429 [synonymised with *E. ingens*].

Epipenaeon Nobili — Monod, 1933: 220, 222, 223–224.

? *Epipenaeon* sp. — Tuma, 1967: 73, 77, 78, 83 84, 85, 87, pl. 2 figs 4–5 [Gulf of Carpentaria, infesting *P. merguiensis*]; Kirkegaard *et al.*, 1970: 3, 5; Kirkwood & Somers, 1984: 711; Owens, 1986: 25.

Epipenaeon ingens latifrons Bourdon, 1979c: 425, 429–430, fig. 4 [near Darwin, Northern Territory, infesting unident. penaeid]; Bourdon *et al.*, 1981: 497, 498, 500; Nearhos & Lester, 1984: 257, 258 [synonymised with *E. ingens*]; Poore *et al.*, 2002: 125 [catalog of Australian records].

Epipenaeon ingens ingens: Hansson, 1998: 64

Remarks. No new material examined. *Epipenaeon ingens* has been recorded more times and studied more thoroughly than any other species of bopyrid isopod in Australia, because its

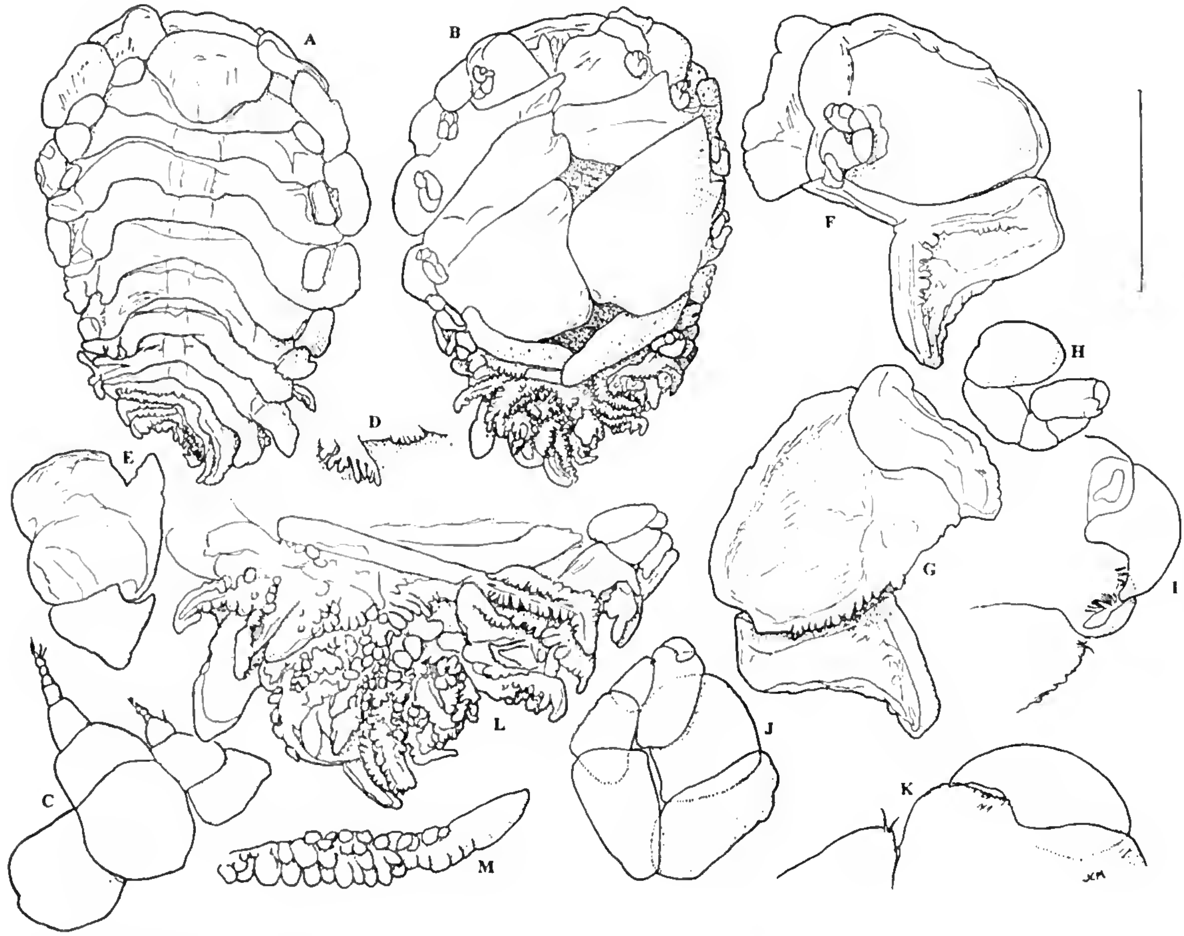

FIG. 20. *Orbione halipori* Nierstrasz & Brender à Brandis, 1923, female, QM-W10842. **A**, dorsal view. **B**, ventral view. **C**, right antennae. **D**, right side of barbula. **E**, right maxilliped. **F**, right oostegite 1, external. **G**, same, internal. **H**, right pereopod 1. **I**, distal edge of same. **J**, right pereopod 7. **K**, distal edge of same. **L**, pleon, ventral view. **M**, endopodite of pleopod 4. Scale: 4.15 mm for A, B; 2.0 mm for D-G, L; 1.08 mm for H, J; 1 mm for M; 0.43 mm for C; 0.22 mm for I, K.

hosts in Australian waters, especially the Gulf of Carpentaria, belong to three commercially important species of *Penaeus*.

Orbione Bonnier, 1900

Type-species: *Orbione penei* Bourdon, 1900, by monotypy.

Orbione halipori Nierstrasz & Brender à Brandis, 1923
(Figs 20, 21)

Synonymy restricted to original names, major reviews and Australian records.

Orbione halipori Nierstrasz & Brender à Brandis, 1923: 64–65, 66, fig. 2A–H [Paternoster and Kei Islands, Indonesia, infesting *Haliporus sibogae* de Man (= *Haliporoides sibogae* (de Man))]; Bourdon, 1979a: 471–477, 480, figs 1–3 [re-examination of type specimens and those of *Crassione aristaei*; Madagascar, infesting *Hymenopenaeus sibogae madagascariensis* Crosnier; offshore, New South Wales, infesting *Aristeomorpha foliacea* Risso; Madagascar, infesting *Hymenopenaeus halli* Bruce; complete redescription with remarks on variation]; Bourdon, 1979c: 431 [updated synonymy; Mozambique, host unknown; Kei Islands, Indonesia, infesting *Hymenopenaeus lucasi* (Bate); Lorenzo Marques, infesting *H. triarthrus* (Stebbing) (=*Haliporoides triarthrus* (Stebbing)); Sydney, New South Wales, infesting *Aristeomorpha foliacea*]; Markham, 1982: 362–365, 385, figs 21, 22 [synonymy; Hong Kong, infesting *Metapenaeus ensis* (Fabricius)]; Owens & Glazebrook, 1985: 107, table 2; Owens, 1986: 14, 84, 98, table 2.4.1 [Gulf of Carpentaria, infesting *M. ensis*]; Owens, 1987: 117, 118, 122 [summary of

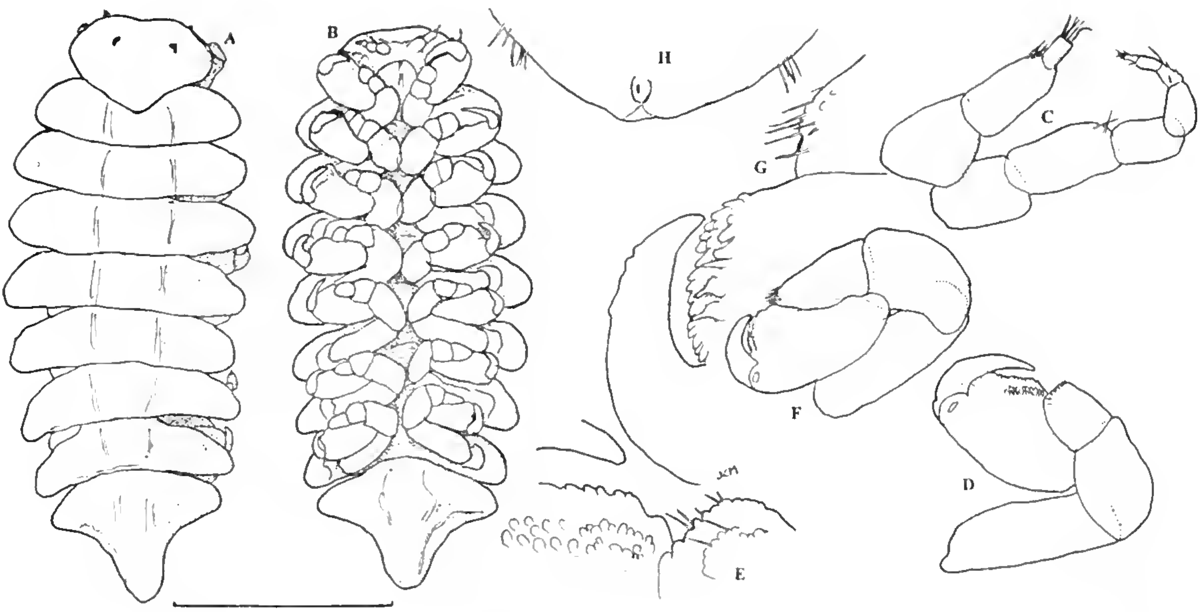

FIG. 21. *Orbione halipori* Nierstrasz & Brender à Brandis, 1923, male, QM-W10843. **A**, dorsal view. **B**, ventral view. **C**, right antennae. **D**, right pereopod 1. **E**, distal region of same. **F**. right pereopod 7. **G**, distal region of same. **H**, end of pleon, ventral. Scale: 1.1 mm for A, B; 1 mm for D, F; 0.2 mm for C; 0.1 mm for E, G, H.

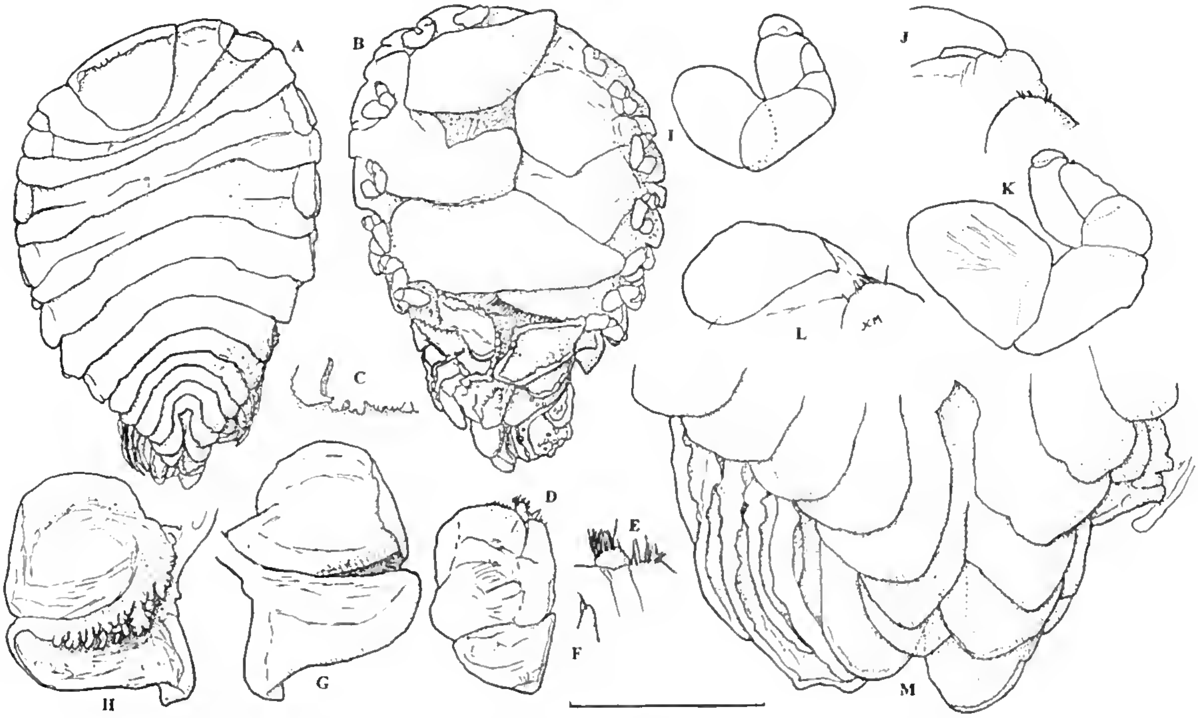

FIG.22. *Parapenaeon expansa* Bourdon, 1979, female, QM-W17450. **A**, dorsal view. **B**, ventral view. **C**, left side of barbula. **D**, right maxilliped. **E**, palp of same. **F**, plectron of same. **G**, right oostegite I, external. **H**, same, internal. **I**, right pereopod 1. **J**, distal edge of same. **K**, right pereopod 7. **L**. distal edge of same. Scale: 4.35 mm for A, B; 2.0 mm for C, D, G, H; 1.1 mm for E, F, I, K; 1 mm for M; 0.18 mm for J. L.

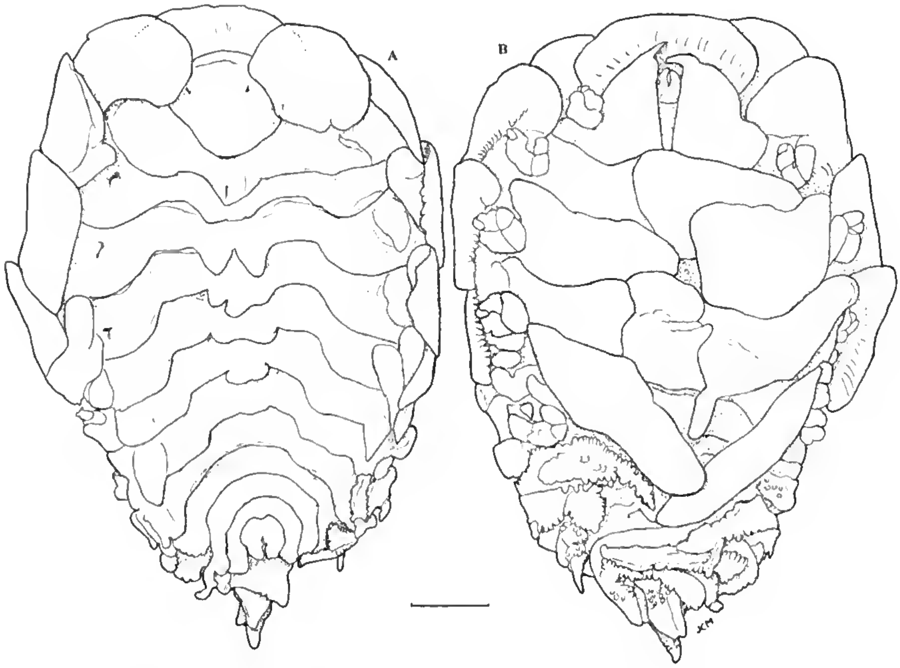

FIG. 23. *Parapenaeon expansa* Bourdon, 1979, female, QM-W12031. **A**, dorsal view. **B**, ventral view. Scale: 2.0 mm.

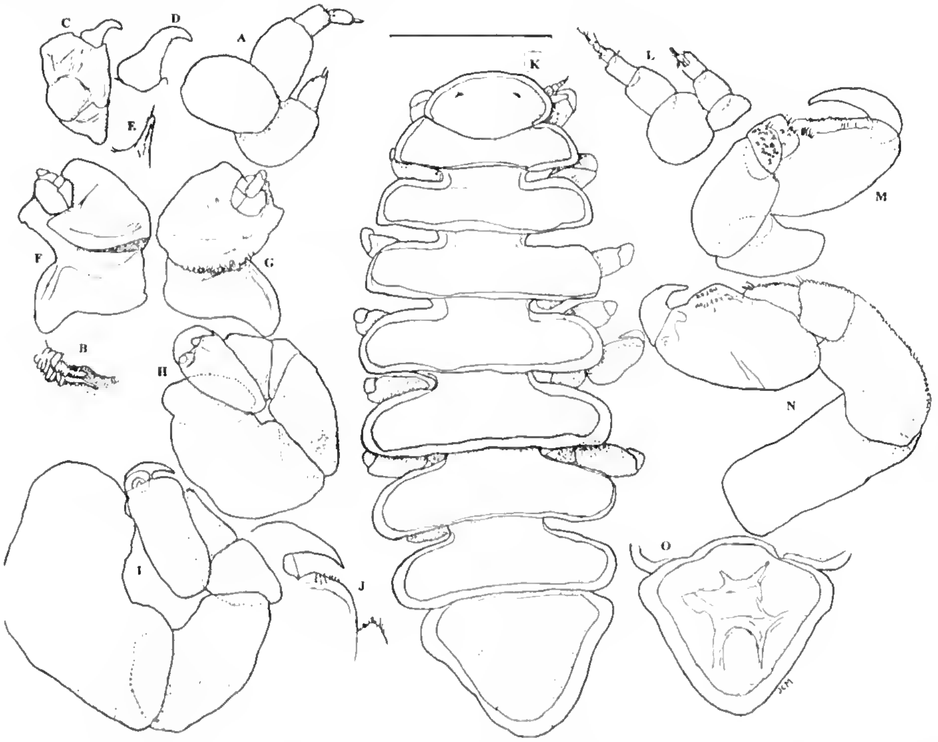

FIG. 24. *Parapenaeon expansa* Bourdon, 1979, QM-W12031, **A-J**, female; **K-O**, male. A, right antennae. **B**, right side of barbula. **C**, right maxilliped. **D**, palp of same. **E**, plectron of same. **F**. right oostegite 1, external. **G**, same, internal. **H**, right pereopod 1. **I**, right pereopod 7. **J**, distal edge of same. **K**, dorsal view. **L**, right antennae. **M**, right pereopod 1. **N**, right pereopod 7. **O**, pleon, ventral. Scale: 4.52 mm for B, C, F, G; 1.82 mm for D; 1 mm for A, H, I; 0.91 mm for E, K, O; 0.4 mm for J, L-N.

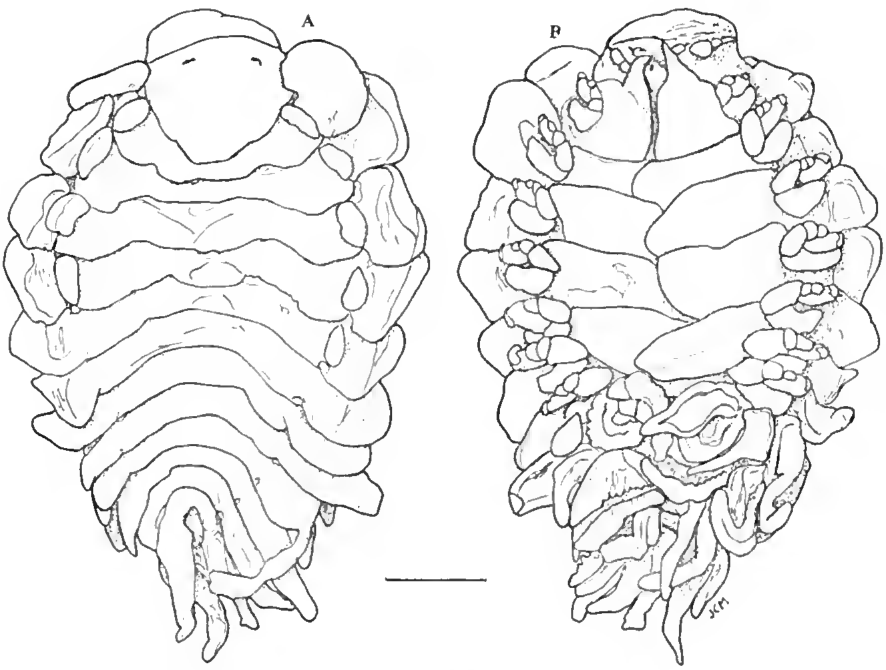

FIG. 25. *Parapenaeon expansa* Bourdon, 1979, immature female, QM-W10442. A, dorsal view. B, ventral view. Scale: 2.0 mm.

Australian records; remarks on range]; Markham, 1994: 225, 226, 235–237, fig. 6 [synonymy; West of Batangas Province, Luzon, Philippines, infesting *Haliporoides sibogae*]; Chu & Leong, 1996: 835–838, fig. 1 [Hong Kong, infesting *Metapenaeus joyneri* (Miers)]; Leung, 1997: 88, 90, table II [Hong Kong; infesting *Metapenaeus ensis*]; Poore *et al.*, 2002: 125–126 [Australian records].

Crassione aristei Dakin, 1931: 268–272, text-figs 1–9, pl. XIV [off New South Wales, infesting *Aristeus foliaceus* (Risso) (= *Aristaeomorpha foliacea*)]; Bourdon, 1979a: 471, 477 [synonymised with *Orbione halipori*].

Orbione halipori var. *libera* Nierstrasz & Brender à Brandis, 1931: 155 [Moluccas, Indonesia, infesting host subsequently identified as *Hymenopenaeus lucasii*]; Bourdon, 1979c: 431 [synonymised with *Orbione halipori*].

Non *Orbione halipori libera* — Shiino, 1934: 258–260, fig. 1 [Tanabe Bay, Japan, infesting *Solenocera distincta* (de Haan); redescription] (= *Orbione* prox. *halipori libera* sensu Shiino).

Non *Orbione* prox. *halipori libera* — Bourdon, 1981c: 239, 240–242, fig. 4 [re-examination of original material; considered member of different genus].

Orbione natalensis Carton, 1970: 47 [nomen nudum; Mozambique Channel, infesting *Hymenopenaeus triarthrus* (= *Haliporoides triarthrus*)]; Poore *et al.*, 2002: 136.

Orbiono (sic) *halipori* — Humphrey, 1995: table 48 [summary of Australian records].

Material Examined. QM-W10842, ♀, ♂, infesting *Metapenaeopsis rosea* Racek & Dall, 1965, off Cairns, Qld, 17°08.7′S, 146°15.2′E, 44 m, Oct. 1979.

Remarks. *Orbione halipori* has been reported many times and thoroughly described and redescribed. The present material lies within the known range of characters in most respects. The new female lacks the frilly margins usually found on the first two coxal plates, and the pleon of the male tapers into a slender point rather than being broadly rounded. This is the first known record of bopyrid infestation of *Metapenaeopsis rosea*, although otherwise previously known from Australia.

Parapenaeon Richardson, 1904

Type-species: *Parapenaeon consolidata* Richardson, 1904, by monotypy.

Parapenaeon expansa Bourdon, 1979 (Figs 22–25)

Parapenaeon expansus Bourdon, 1979a: 494, 495–498, figs 15–17, 18b, c [near Madagascar, infesting *Penaeus teraoi* Kubo]; Nearhos & Lester, 1984: 257, 258 [synonymy; Moreton Bay, Qld, infesting *Penaeus plebejus* Hess; and Karumba, Gulf of Carpentaria, infesting *Penaeus* sp.]; Owens &

Glazebrook, 1985a: 105–112, tables 2–4 [localities in northern Australia, infesting *Penaeus indicus* H. Milne Edwards, *P. merguiensis* de Man, *P. longistylus* Kubo]; 1985b: 134–135 [same collection]; Owens, 1986: iv, 15, 84, 85, 91, 92, 95–100, tables 2.4.1, 8.2, 8.4 (a, b) [Gulf of Carpenteria, infesting *Penaeus merguiensis, P. indicus, P. longistylus*; extensive study of biology]; Owens, 1987: 119 [summary of Australian records]; Anderson, 1990: 290; Owens, 1990: 35–39, table 1 [analysis of distribution in Australia; Owens & Rothlisberg, 1991: 779; Owens, 1993: 381, 384, 386 [NE Qld, infesting *Penaeus latisulcatus* Kishinouye]; Humphrey, 1995: table 48 [summary of Australian records]; Owens & Rothlisberg, 1995: 159 [study of larvae in Gulf of Carpentaria]; Poore *et al.*, 2002: 126.

? *Parapenaeon* prox *expansus* — Bourdon, 1979c: 435 [north of Darwin, NT, infesting 'tiger prawn' (= *Penaeus monodon* (Fabricius))]; Courtney, 1991: 615, 617, 620, table 2 [central coast of Qld, infesting *Penaeus longistylus* and *P. latisulcatus*]; Choi *et al.*, 2004: 239.

Parapenaeon expansa — Markham, 1994: 225, 226, 242, 244–245, fig. 14 [New Caledonia, infesting *Metapenaeopsis gaillardi* Crosnier; Strait of Makassar, Indonesia, infesting *M. sinica* Liu & Zhong; Seychelles, infesting *M. faouzii* (Ramadan); Madagascar, infesting *M. mogiensis consobrina* (Nobili)] ; N. Bruce, 2007: 278.

Material Examined. QM-W12031, ♀, ♂, Brisbane R., Qld, S.P. Nearhos, 12–14.03.1984. QM-W12033, ♀, ♂, infesting *Penaeus plebejus* Hess, 1865 (host, 212 mm long), data as for QM-W12031. QM-W10442, immature ♀, Moreton Bay, Qld, S.P. Nearhos.

Remarks. The material examined is part of that reported by Nearhos & Lester (1984). Heretofore, however, despite frequent collections around the continent, no Australian specimens of *Parapenaeon expansa* have been illustrated, so the female, male and immature female are pictured here. All conform well with previous knowledge of the species. Although Bourdon (1979a), and most subsequent authors, designated the species *Parapenaeon expansus*, I have used the feminine form on grounds that Richardson (1904), in erecting the genus *Parapenaeon*, considered it be feminine, as indicated by her writing the name of the type species with a feminine ending.

Parapenaeonella Shiino, 1949

Type-species: *Parapenaeonella distincta* Shiino, 1949, by monotypy

Parapenaeonella lamellata Bourdon, 1979

Parapenaeonella lamellata Bourdon, 1979c: 425–428, figs 1–3 [west coast of India, infesting *Metapenaeus monoceros* (Fabricius); west coast of Thailand, infesting *M. ensis* (de Man)]; Bourdon, 1981c: 255; Markham, 1982: 365; Miquel, 1982: 94; Owens & Glazebrook, 1985: 107, table 2 [Gulf of Carpentaria, infesting *M. ensis*]; Owens, 1986: 15, 84, 98, tables 2.4.1, 8.2 [Gulf of Carpenteria, infesting *M. ensis*]; Owens, 1987: 118 [summary of Australian records]; Owens, 1990: 35, 37, table 1 [Gulf of Carpentaria, Qld, infesting *M. ensis* and *M. endeavouri* (Schmitt)]; Owens, 1993: 384; Humphrey, 1995: table 48 [summary of Australian records]; Kensley, 2001: 225; Poore *et al.*, 2002: 126 [systematic history; summary of Australian records]; Kazmi *et al.*, 2002: 55, fig. 8.

Parapenaeolla [sic] *lamellata* — Kazmi *et al.*, 2002: 54.

Remarks. No new material examined.

ATHELGINAE Codreanu & Codreanu, 1956

Athelges Hesse, 1861

Type-species: *Phryxus paguri* Rathke, 1843, by subsequent designation.

Athelges ankistron sp. nov.

(Figs 26, 27)

Material Examined. HOLOTYPE ♀, ALLOTYPE ♂, QM-W29067, (♀ carapace length 3.4 mm, shield length 2.1 mm), infesting *Diogenes pallescens* Whitelegge, 1897, in shallow water seagrass, Myora Springs, North Stradbroke I., Qld, 27°40.8'S, 153°24.6'E, 20.02.2005, J.C. Markham. PARATYPES: QM-W29068, ♀, ♂, same host (♀ shield length 1.7 mm), North Stradbroke I., Qld, 27°28.1'S, 153°25.3 E, 14.02.2005, J.C. Markham.

Description. *Female holotype* (Fig. 26A, C–L). Attached to dorsal surface of host's abdomen, facing posteriorly (Fig. 26A). Length 5.4 mm, maximal width 2.6 mm, head length 0.8 mm, head width 0.8 mm. Body outline nearly rectangular, head–pereon axis straight, but pleon extending sharply to side and reflexed back, barely extending beyond pereon; all body regions and segments distinct (Fig. 26C, D).

Head deeply embedded in pereon, greatly overreached anteriorly by oostegites, subcircular in outline behind antennae. First antenna minute, of 3 articles, second antenna long, of 6 articles, both setose distally (Fig. 26E). Barbula (Fig. 26F) with 2 unadorned lanceolate lateral projections rounded proximally and pointed

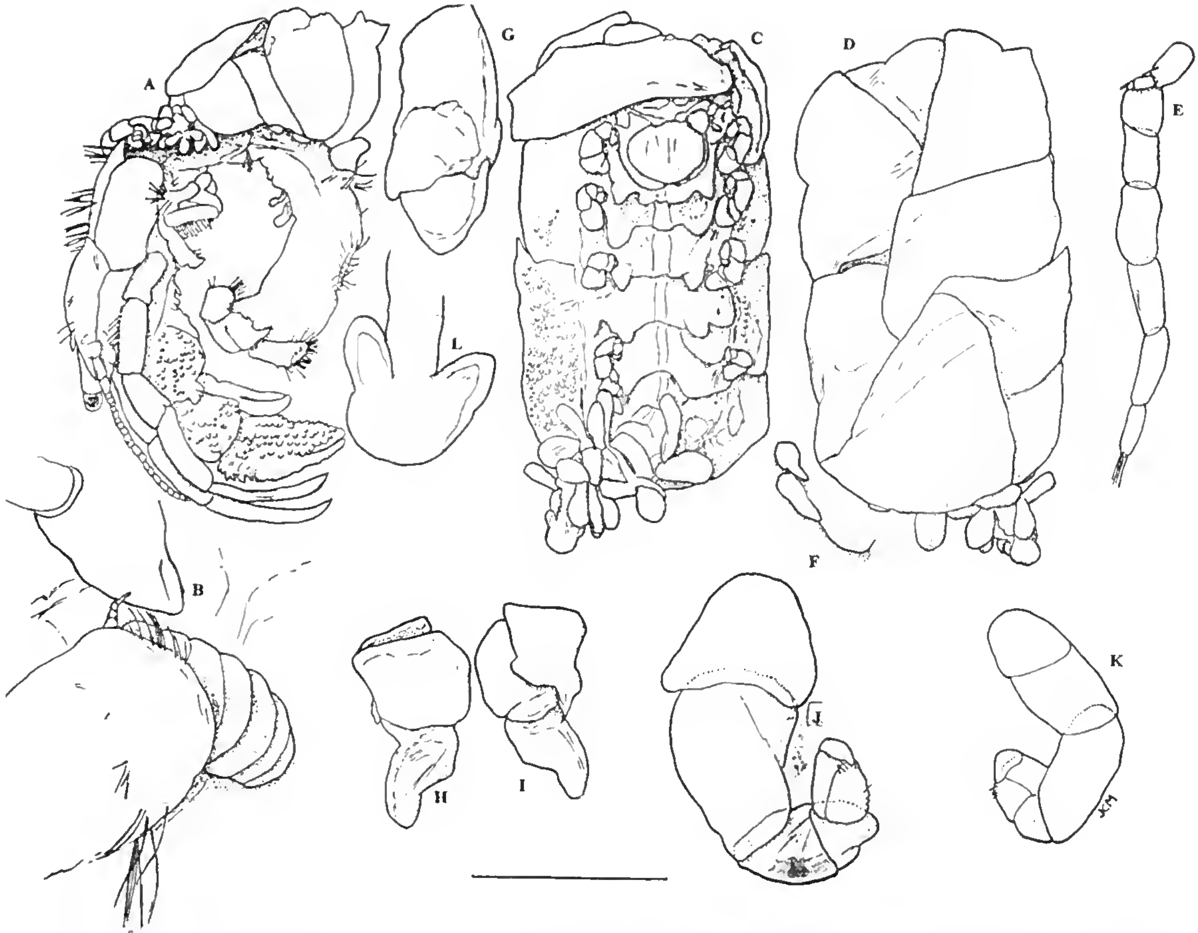

FIG. 26. *Athelges ankistron* n. sp., **A**, **C-K**, holotype female; **B**, allotype male. QM-W29067. A, in place on abdomen of host. **B**, in place in gill chamber of host. **C**, dorsal view. **D**, ventral view. **E**, right antennae. **F**, right side of barbula. **G**, right maxilliped. **H**, right oostegite 1, external view. **I**, same, internal view. **J**, right pereopod 1. **K**. left pereopod 6. **L**, posterior of pleon. Scale: 4.26 mm for A; 2.0 mm for C, D, H, I; 1 mm for B, F, G; 0.56 mm for L; 0.36 mm for E, J, K.

distally. Maxilliped (Fig. 26G) long and slender, its sides nearly parallel, anterior article more than twice as long as posterior one; palp indicated only as short anteromedial point; bluntly pointed plectron prominent, extended straight forward.

Pereon with all 7 pereomeres distinct dorsally, but first one ventrally obliterated by head. Pereomeres 3–5 longest, all of same width. First pereomere wrapped around head, others medially straight across except for paired chevron-like flaps extending posteriorly near sides of pereomeres 2–6. First oostegites (Fig. 26H, I) much smaller than others and completely hidden inside brood pouch, both articles about same length, anterior one broadly rounded, posterior produced into bluntly falcate points, internal ridge completely unornamented. Other oostegites much larger, all of about same size. Oostegites of second pair arching across and enclosing anterior end of body, others variously fused into fully closed brood pouch. Pereopods (Fig. 26J, K) small but slightly larger posteriorly, all sharply bent. First pair of pereopods hidden beneath oostegite, second through fifth pairs in nearly straight lines on dorsal surface.

Pleon narrow and somewhat extended, sides of first four pleomeres lined with small lanceolate uniramous lateral plates and similarly shaped and sized rami of uniramous pleopods. Final, fifth, pleomere devoid of appendages but produced into prominent reflexed anchor-shaped end.

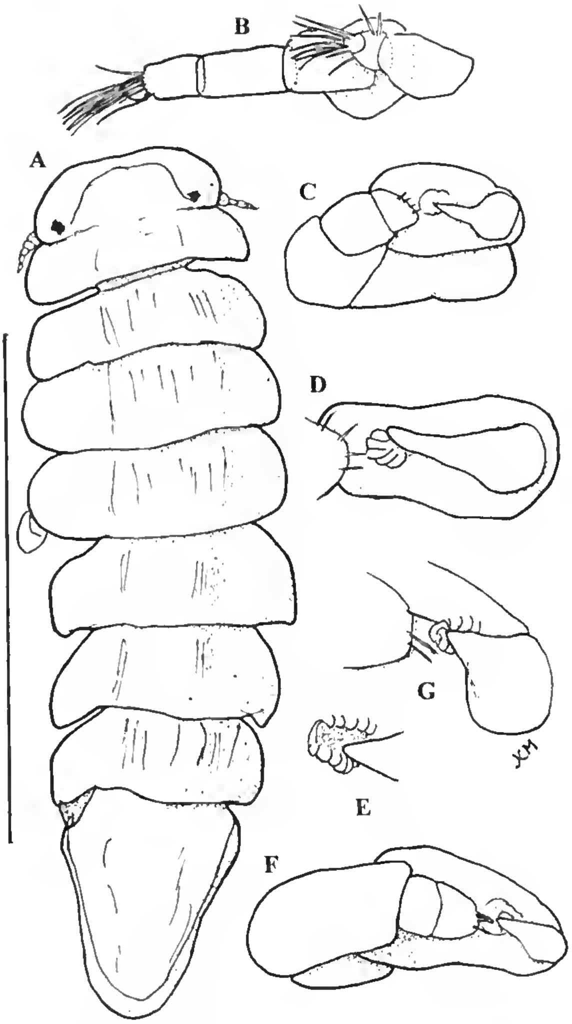

FIG. 27. *Athelges ankistron* n. sp., allotype male, QM-W29067 A, dorsal. **B**, right antennae. **C**, left pereopod 1. **D**, distal end of same. **E**, left pereopod 7. **F**. distal end of same. I. Tip of dactylus of same. Scale: 1 mm for A; 0.33 mm for B, C, F; 0.16 mm for D, E, G.

Male allotype (Figs 26B, 27). Partly enclosed in left branchial chamber of host, only posterior half extending out (Fig. 26B). Length 1.7 mm, maximal width 0.5 mm, head length 0.1 mm, head length 0.4 mm, pleon length 0.4 mm. Head fused with firth pereomere, pleon fused, all pereomeres separate (Fig. 27A).

Head subrectangular, truncate anteriorly, broadest near posterior edge though slightly narrower than front of first pereomere nearly completely fused with it, anterior corners rounded. Dark circular eyes near posterolateral corners. Antennae (Fig. 27B) prominent, first of three articles, second of five articles extending well beyond sides of head, distal article of each tipped by thick tuft of long setae, some setae also on penultimate article of each antenna.

Pereon with nearly parallel sides, all pereomeres sharply separated. Pereopods (Fig. 27 C, F) slightly larger posteriorly, all of similar structure and proportions, with all articles distinct; dactyli (Fig. 27D, E, G) somewhat smaller posteriorly, each reflexing into receptacle on surface of propodus surrounded by row of overlapping corneous plates.

Pleon anteriorly nearly as broad as preceding pereomere, slightly widest immediately behind anterior edge, tapering smoothly posteriorly, overall shaped as broadly rounded isosceles triangle. All indication of appendages completely absent.

Etymology. From the Greek *ankistron* meaning 'anchor', selected in reference to the distinctive shape of the end of the female's pleon; used as a noun in apposition.

Remarks. The new species, *Athelges ankistron*, matches other species of *Athelges* by the female having: second oostegites crossing over front end of body; no pereomere markedly longer than others; pereopods small and sharply reflexed; pleon abruptly narrower than pereon; two appendages on each side of each of first four pleomeres; final, fifth, pleomere greatly extended, ending in variously enlarged terminal region, lacking all appendages.

Males of the Athelginae are diagnostic for that subfamily, but difficult to distinguish by genus. *Athelges* contains ten currently recognised species found infesting several pagurid and diogenid hosts from Europe through the Indian Ocean to Japan and New Zealand. Some of these have never been fully described. Of those that are well known, the female of *A. ankistron* is most similar to that of *A. tenuicaudis* Sars, 1898, known to infest three species in the pagurid genus *Anapagurus* from Norway to France (Markham 2003a). Well illustrated by Sars (1898), it has most nearly the same body proportions, orientation of oostegites and shape of 'chevrons' on the dorsal surfaces of the pereomeres. The males of both species are also quite similar, especially in the shapes of their pleons, but only

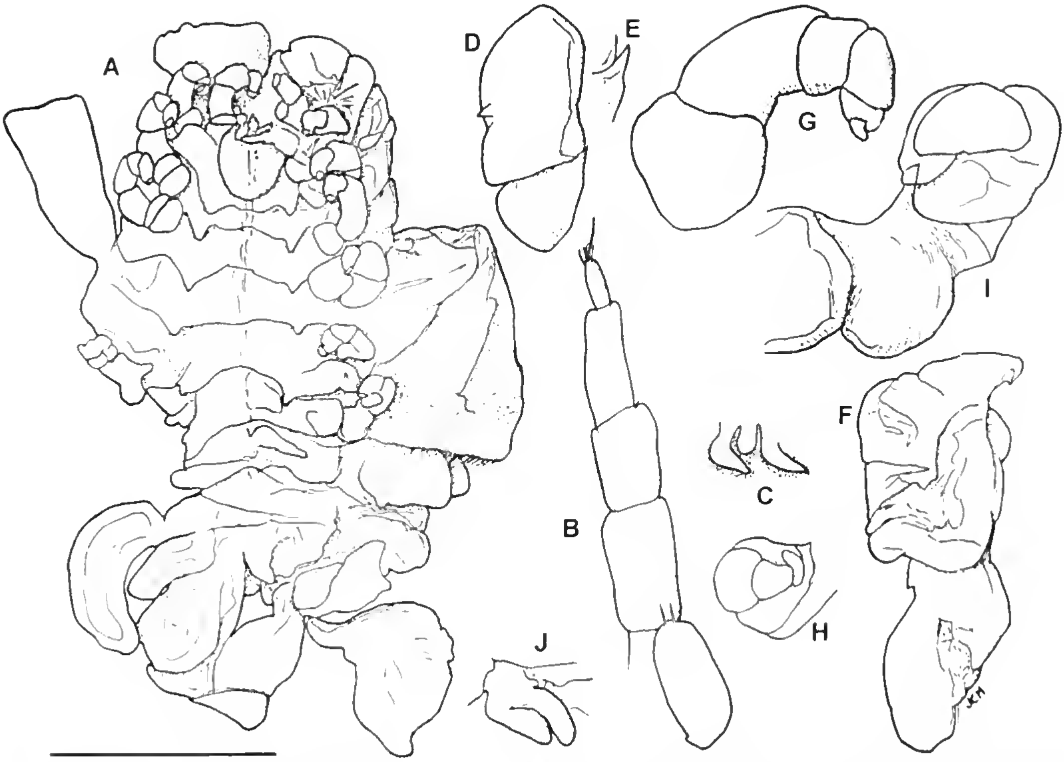

FIG. 28. *Parathelges aniculi* (Whitelegge, 1897), holotype female. AM-G1423. A, dorsal. B, right antennae. C, right side of barbula. D, right maxilliped. E, palp of same. F, right oostegite 1, external view. G, left pereopod 1. H, end of left pereopod 2. I. right pereopod 7. J, Pleotelson, ventral. Scale: 4.69 mm for A; 2.14 mm for C, D, F, J; 1.1 mm for I; 1 mm for G; 0.61 mm for E, H; 0.4 mm for B.

the male of *A. aegyptius* Codreanu, Codreanu & Pike, 1965, shares with the male of *A. ankistron* the fusion of its head with the first pereomere. Two characters of the female of *A. ankistron* sp. nov., the nearly parallel sides of the pereon and the uniquely anchor-shaped end of the pleon, immediately distinguish it from all other known *Athelges*. The paratypes are closely similar to the types described. The female is 4.8 mm long and 6.8 mm broad. It is slightly more pyriform in outline and widest across pereomeres 6 and 7. Contained eggs make its body appear purple. The accompanying male is 1.8 mm long and 0.6 mm wide.

I originally identified the host as *Diogenes gardineri* Alcock, 1905, but Mclaughlin (2002) regards that species as a junior synonym of *D. pallescens* Whitelegge, 1897, and this is thus the name used here.

There are published records of the occurrence of immature females of abdominally infesting bopyrids in the branchial chambers of their decapod hosts, but it is unusual for males of those species to be found there while their mates are attached in the usual positions. For that reason, I have made particular note of that occurrence here.

On the basis of a preliminary identification that I made, Haig & Ball (1988) reported the presence of an 'undescribed species of *Athelges*' infesting the diogenid hermit crabs *Calcinus* n. sp. and *Trizopagurus strigatus* (Herbst) (names subsequently updated to *Calcinus lineapropodus* Morgan & Forest and *Ciliopagurus strigatus* (Herbst) respectively in Markham, 2003a) in the Banda Sea, Indonesia. Unfortunately, the material of that parasite has subsequently been lost (E. E. Ball, pers. comm.), so it cannot be determined whether it was conspecific with *Athelges ankistron* sp. nov. I have, however, examined another specimen from a different station of the same expedition at the same locality in Indonesia and

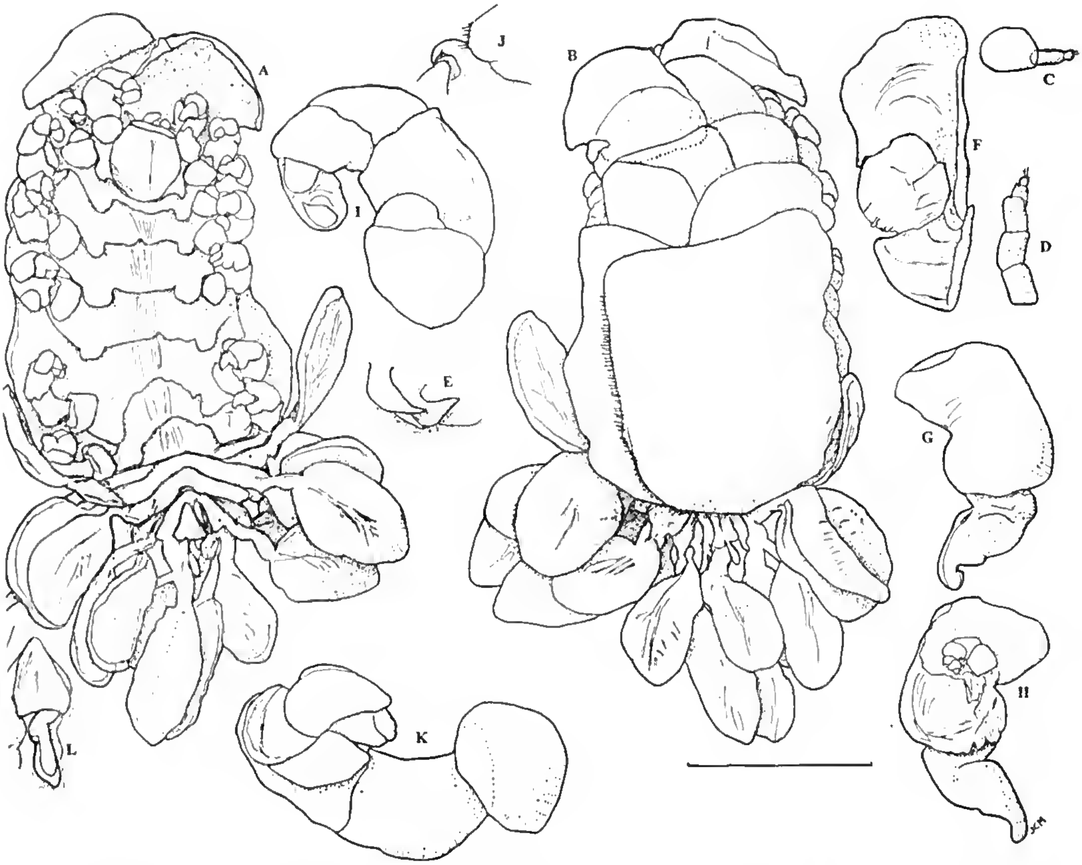

FIG. 29. *Parathelges aniculi* (Whitelegge, 1897), holotype female of *Parathelges whiteleggei* Nierstrasz & Brender à Brandis, 1931, ZMA-CRU8616. **A**, dorsal view. **B**, ventral view. **C**, right antenna 1. **D**, right antenna 2. **E**, right side of barbula. **F**, right maxilliped. **G**, right oostegite 1, external. **H**, same, internal. **I**, right pereopod 1. **J**, distal edge of same. **K**, right pereopod 7. **L**, end of pleon, dorsal view. Scale: 4.26 mm for A, B, G, H; 1.00 mm for C, D, I, K; 0.5 mm for E, F, L; 0.36 mm for J.

also infesting the '*Calcinus* n. sp.'. It is an unaccompanied very immature female clearly in *Athelges*; it probably belongs to *A. takanoshimensis* Ishii, 1914, which is widely known throughout the western Pacific, but its immaturity makes its assignment to species uncertain.

Parathelges Bonnier, 1900

Type-species: *Athelgue aniculi* Whitelegge, 1897, by original designation.

Parathelges aniculi (Whitelegge, 1897) (Figs 28–31)

Athelgue aniculi Whitelegge, 1897: 149–151, pl. VII, figs 5-5c [Funafuti Atoll, Ellice Archipelago (= Tuvalu), infesting *Aniculus typicus* Dana (=*Aniculus aniculus* (Herbst))]; Bonnier, 1900: 85, footnote [cited as type of *Parathelges*, n. g.].

'Un type voisin...' — Bonnier, 1900: 215 [designated type of *Parathelges*, n. g.].

Parathelges aniculi — Bonnier, 1900: 217, 380; Nierstrasz & Brender à Brandis, 1923: 105; 1929b: 302; 1931: 200–201; Barnard, 1936: 191; Codreanu, 1940: 680–681; 1941: 1125; 1961: 137, fig. 1; Shiino, 1950: 164; Danforth, 1971: 99; Markham, 1972: 58, 59–60, 76, fig. 16 ; 2003: 73; Jones & Morgan, 2002: 59. unnumbered fig. [from unnamed locality in Australia, infesting *Dardanus megistos* (Herbst)].

Athelges aniculi — Richard, 1900: 72; Markham, 1978: 112 [cited as type-species of *Parathelges*].

Parathelges weberi Nierstrasz & Brender à Brandis, 1923: 105, 107, fig. 28a–d ['Wirt und Fundort leider unbekannt'; somewhere in Indonesia]; 1929b: 302, figs 10–11 [Indonesia; host unspecified; first description of male]; 1931: 200, 201; Barnard, 1936: 191 [Great Coco I., Andaman Islands; host not mentioned]; Codreanu, 1940: 680–681; 1961: 137, fig. 1; Shiino, 1950: 164; Caroli, 1953: 86;

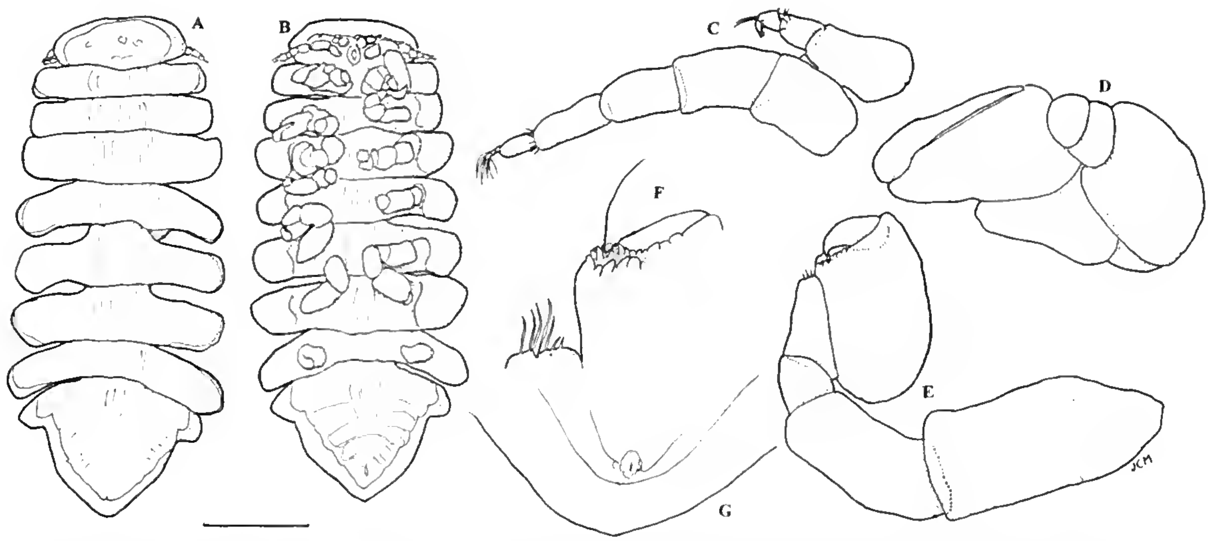

FIG. 30. *Parathelges aniculi* (Whitelegge, 1897), allotype male of *Parathelges whiteleggei* Nierstrasz & Brender à Brandis, 1931, ZMA-CRU8616. **A**, dorsal view. **B**, ventral view. **C**, right antennae. **D**, right pereopod I. **E**, right pereopod 7. **F**. distal region of same. **G**, end of pleon, ventral. Scale: 1 mm for A, B; 0.18 mm for C-E, G; 0.05 mm for F.

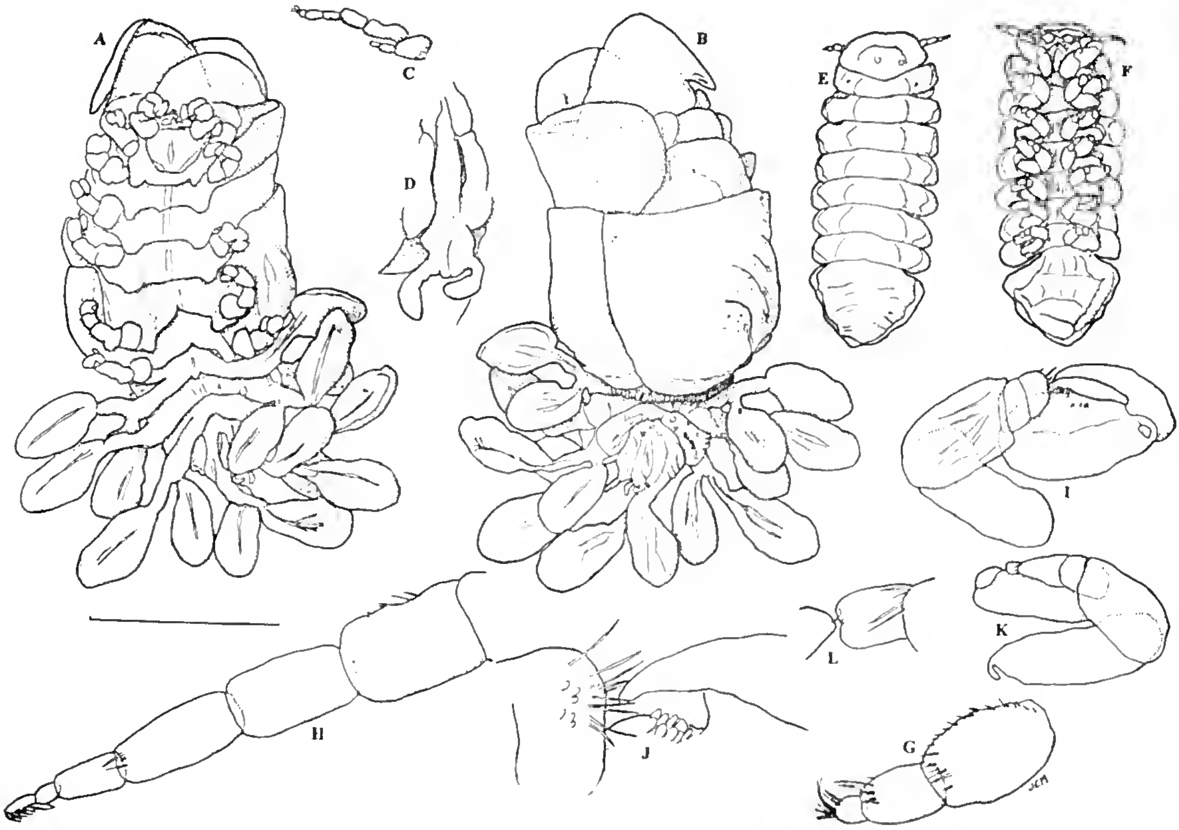

FIG. 31. *Parathelges aniculi* (Whitelegge, 1897), **A-D**, female; **E-L**, male, QM-W21541. A, dorsal. **B**, ventral. **C**, right antennae. **D**, end of pleon, dorsal view. E, dorsal. **F**, ventral. **G**, right antenna 1. **H**, right antenna 2. **I**, right pereopod 1. **J**, distal region of same. **K**, left pereopod 7. **L**, distal region of same. Scale: 4.00 mm for A, B; 2.0 mm for E, F; 1 mm for C, D; 0.36 mm for I, K; 0.18 mm for G, H; 0.09 mm for J, L.

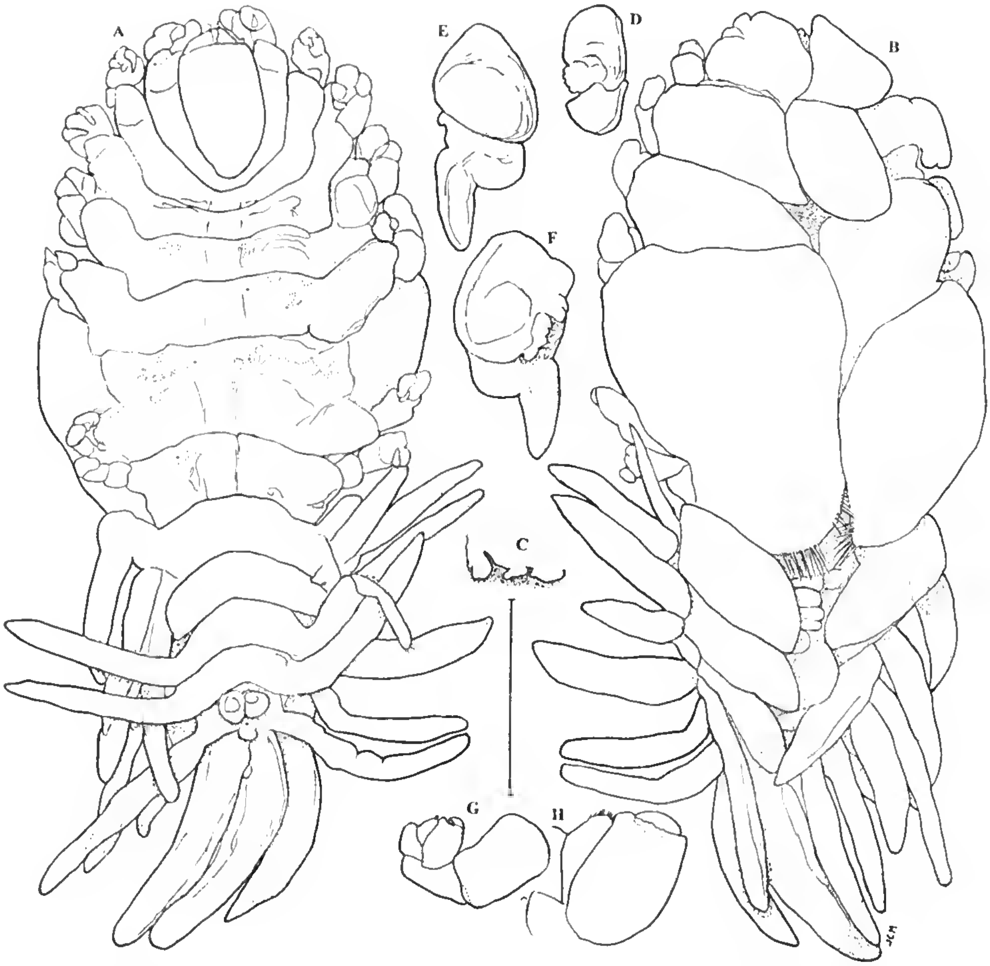

FIG. 32. *Pseudostegias dulcilacuum* Markham, 1982, female, QM-W27088. **A**, dorsal view. **B**, ventral view. **C**, right side of barbula. **D**, right maxilliped. **E**. right oostegite 1, external. **F**, same, internal. **G**, right pereopod. **H**, distal region of same. Scale: 2.0 mm for A, B, D-F; 1.1 mm for G; 1 mm for C; 0.43 mm for H.

Barnard, 1955: 77–78; Danforth, 1971: 99, 100, fig. 1A [near Maiwara, New Guinea, infesting *Calcinus laevimanus* (Randall)]; Ball & Haig, 1972: 100 [same material as in Danforth, 1971]; Markham, 1972b: 58, 59, 76, 77, fig. 16; Haig & Ball, 1988: 160 [Banda Sea, south of Irian Jaya, Indonesia, infesting *C. laevimanus*]; Høeg & Rybakov, 1992: 601, table 1.

Parathelges whiteleggei Nierstrasz & Brender à Brandis, 1931: 200–201, fig. 92, pl. I fig. 4 [Java Sea, Indonesia, infesting *Pagurus* sp. (= *Dardanus hessi* (Miers))]; Codreanu, 1940: 681; 1941: 1125; 1961: 137, fig. 1; Shiino, 1950: 164; Caroli, 1953: 86; Barnard, 1955: 77, 78; Danforth, 1971: 99; Markham, 1972b: 58, 70 footnote, 76, 77, fig. 16; 2003a: 73, 74.

Athelge aniculi — Nordenstam, 1946: 2.

Parathelges ? whiteleggei — Haig & Ball, 1988: 173 [Banda I., off Irian Jaya, Indonesia, infesting *Paguristes monoporus* Morgan].

'Bopyridae' — Jones & Morgan, 1994: 59; unnumbered fig. [Same photograph as in Jones & Morgan (2002), above].

Material Examined. *Athelgue aniculi*: holotype ♀, AM-G1423, infesting *Aniculus aniculus* (Fabricius, 1787), Funafuti, Tuvalu, south Pacific Ocean, 08°31'S, 179°14'E, coll. prior to 1897 (Fig. 28). *Parathelges whiteleggei*: holotype ♀, allotype ♂, ZMUC-CRU8616, infesting *Dardanus hessi* (Miers, 1884), Java Sea, central Indonesia, 04.12.1910 (Figs 29, 30). QM-W21541, ♀, ♂, infesting *Clibanarius* sp., Portland Roads, Cape York Peninsula, Qld, 12° 36'S, 143°25'E, Nov. 1983, K. Lamprell (Fig. 31). QM-W29069, 3 ♀♀, 3 ♂♂, infesting *Dardanus* sp., Wreck I. lagoon, Capricorn Group,

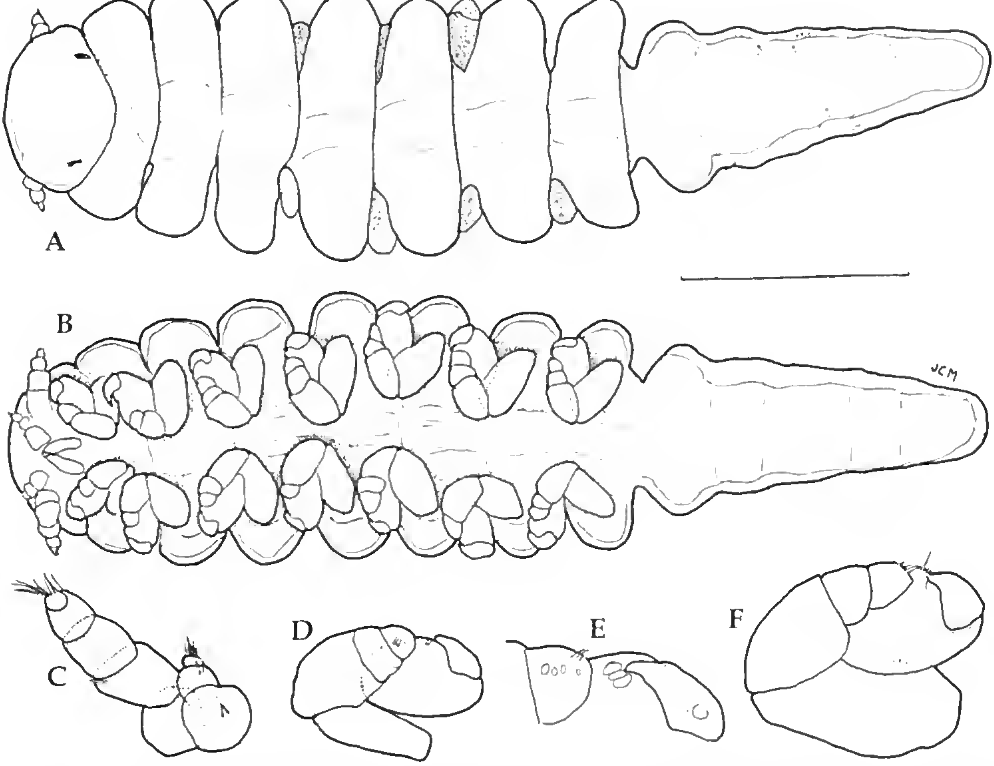

FIG. 33. *Pseudostegias dulcilacuum* Markham, 1982, male, QM-W27088. **A**, dorsal view. **B**, ventral view. **C**, right antennae. **D**, right pereopod 1. E, distal region of same. **F**, right pereopod 7. Scale: 0.59 mm for A, B; 0.20 mm for C, D, F; 0.1 mm for E.

Great Barrier Reef, Qld, 23°19'S, 151°56'E, 0.5 m, 06.12.1979, D. Snow & A.J. Bruce.

Remarks. The original description of *Athelgue aniculi* was incomplete and the illustrations diagrammatic. The type female (Fig. 28), though still extant, is in very poor condition, but I hope that the new figure provided here will provide enough additional information to allow the species to be identified in the future. The types of *Parathelges whiteleggei* (Figs 29, 30), have not previously been adequately described or illustrated (the female being still completely intact), but they remain in excellent condition, so I have illustrated them in considerable detail. The host had also never been properly identified, but as it was still in the container with the types, Dr. P. A. McLaughlin graciously identified it as *Dardanus hessi* (Miers).

I have not examined material referred to *Parathelges weberi*, but the original description by Nierstrasz & Brender à Brandis (1923), in which those authors considered it to be very similar to *P. aniculi*, seems to show no greater variation than would be expected within a single species. Accordingly, I am hereby incorporating both *P. weberi* and *P. whiteleggei* into the synonymy of *Parathelges aniculi*. There are differences in such characters as the shapes of the 'chevrons' extending from the posterior margins of the pereomeres (Fig. 28A, 29A. 30A), from being sharply pointed to more broadly rounded, and of the maxilliped (Fig. 28D, E, 29F). The shorter middle projection on the side of the barbula of the type female (Fig. 28B) is probably the consequence of general deterioration of that specimen, while the presence of only a single ramus on the uropod of the type of *P. whiteleggei* (Fig. 29L), contrary to the generic diagnosis, is almost certainly an individual anomaly.

The superb photograph of an abdominal parasite of *Dardanus megistos* (Herbst) published

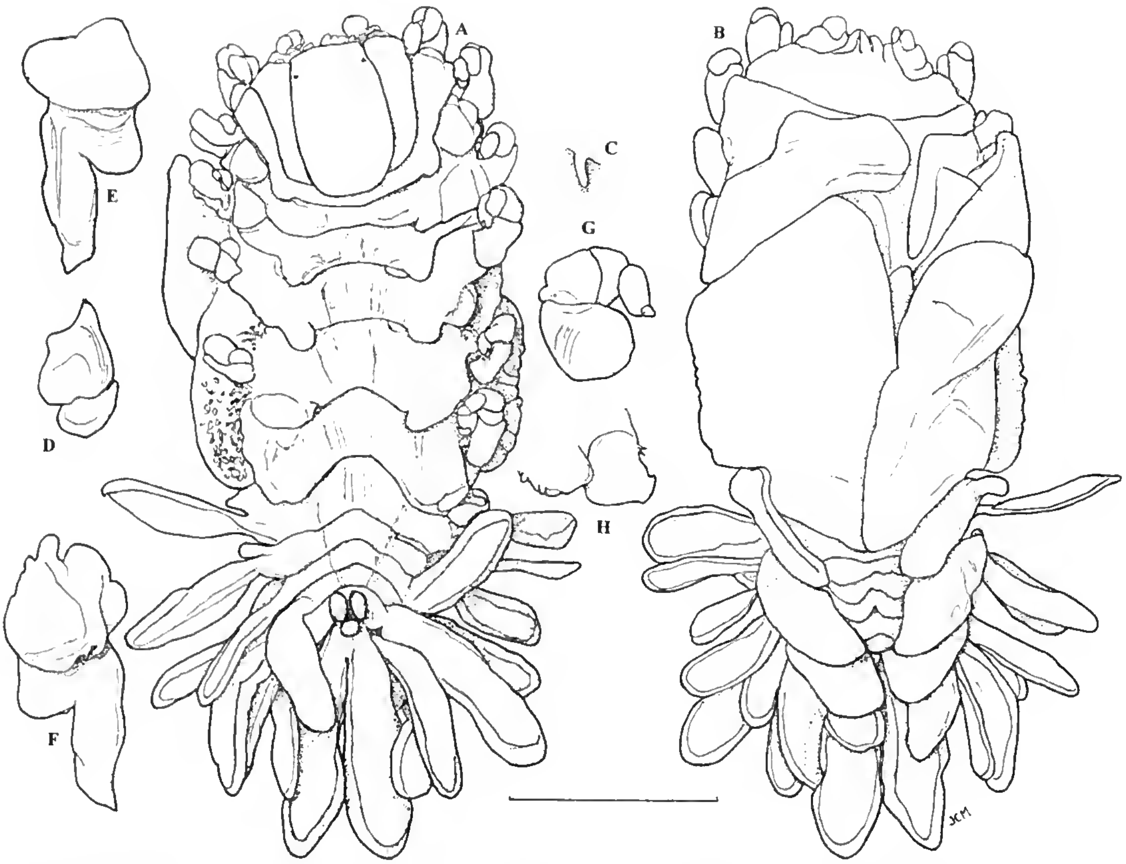

FIG. 34. *Pseudostegias setoensis* Shiino, 1933, female, QM-W25103. **A**, dorsal view. **B**, ventral view. **C**, right side of barbula. **D**, right maxilliped. **E**, right ostegite 1, external. **F**. same, internal. **G**, right pereopod 1. **H**, globose fifth lateral plates. Scale: 2.0 mm for A-F; 0.89 mm for G; 0.19 mm for H.

twice by Jones & Morgan (1994, 2002) is clearly referable to *P. aniculi*, as are unpublished photographs of a parasite of the same host emailed to me by Tristan Lougher of Cheshire Wildlife Corporation (pers. comm.). In both cases, however, I have been unable to examine the specimens directly or to learn the localities of their collection.

With the incorporation of two other species into *Parathelges aniculi*, only one other species of the genus, *P. enoshimensis* Shiino, 1950, remains known from the western Pacific. It has been recorded to infest a '*Eupagurus* sp.' in Japan (Shiino, 1950) and two identified species of *Pagurus* in Korea (Kim & Kwon, 1988a). Those authors described and redescribed and illustrated it in excellent detail, so it is very well known. Females of *P. enoshimensis* differ from those of *P. aniculi* by: body narrowing more strongly forward; projections on sides of barbula relatively longer and sharper; pleonal appendages shorter, more compact and their terminal lobes closer to being circular; uropods slightly smaller. Males of *P. enoshimensis* differ by: head and first pereomere fused; and pleon more deeply separated from last pereomere.

Pseudostegias Shiino, 1933

Type-species: *Pseudostegias setoensis* Shiino, 1933, by monotypy.

Pseudostegias dulcilacuum Markham, 1982
(Figs 32, 33)

Pseudostegias dulcilacuum Markham, 1982: 370–373, figs 25, 26 [Hong Kong, infesting *Diogenes* aff. *edwardsi* (de Haan) – Markham, 1985b: 3, 53–55, 63, figs 26–28, table 1 [Phuket, Thailand, infesting *Clibanarius merguiensis* de Man]; Page, 1985: 201, 203; Kim & Kwon, 1988b: 199, 214–215, 220, 215,

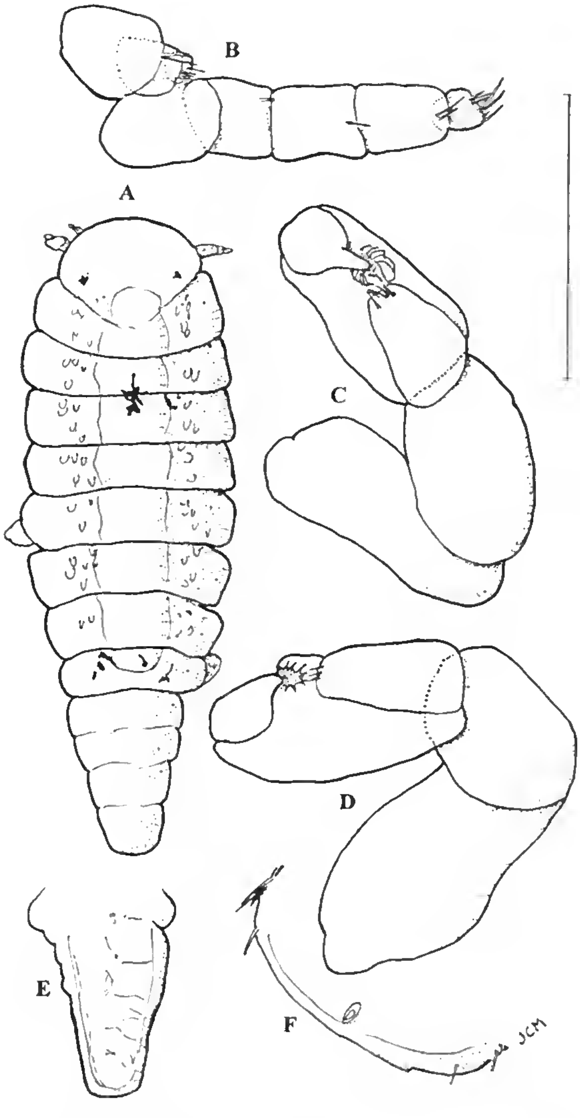

FIG. 35. *Pseudostegias setoensis* Shiino, 1933, male, QM-W25103. **A**, dorsal view. **B**, left antennae. **C**, right pereopod 2. **D**, right pereopod 7. **E**, pleon, ventral. **F**, posterior tip of pleon. Scale: 1.13 mm for A, E; 0.2 mm for B-D.

fig. 9 [west coast of Korea, infesting *Diogenes* sp.]; Markham, 1992b: 299, table 1; Li, 2003: 140, table 2; Morton, 2003: 37, table 2.

Pseudostegias dulcilaeum [sic] — Page, 1985: 203.

Pseudostegias dulcilaeuum [sic] — Huang, 1994: 530; 2001: 327.

Pseudostegias setoensis — Dunbar & Coates, 2000: 49, fig 1 [South Cooe Bay, Qld, infesting *Clibanarius taeniatus* (H. Milne Edwards) and *C. virescens* (Krauss)]; Poore *et al*., 2002: 116 [non *Pseudostegias setoensis* Shiino, 1933].

Material Examined. QM-W27088, ♀, ♂, infesting *Clibanarius taeniatus* (H. Milne Edwards, 1848), intertidal on rocky shore, Sweers I., SW coast Gulf of Carpentaria, Qld, 17°06'S, 139°36'E, P. Davie, 17.09.2002. QM-W25103, ♀, QM-W25094, ♂, infesting *Clibanarius virescens* (Krauss, 1843), south side of Cooee Bay, Qld, 23°08.5'S, 150°45.7'E, S. Dunbar, 02.11.1998 [material reported by Dunbar & Coates, 2000]. QM-W23187, ♀, ♂, infesting *Clibanarius* sp., in pool on sandy-rocky shore, south side of Cooee Bay, Qld, 23°08.6'S, 150°45.7'E, S. Dunbar, 15.01.1998 [material reported by Dunbar & Coates, 2000].

Remarks. The material reported by Dunbar & Coates (2000), which I had identified for those authors, I have decided, upon reexamination, to represent *Pseudostegias dulcilacuum* instead. Because most of the material herein examined has already been reported from Queensland, it is not a new geographical or host record. The female of *Pseudostegias dulcilacuum* can be separated most reliably from *P. setoensis* by the former having a simple, not digitately divided, lateral projection of the barbula (Fig. 32C); nearly parallel, not tapered, posterolateral projection of the first oostegite (Fig. 32E); and oval, not lanceolate, anterior pleonal appendages (Fig. 32A).

Pseudostegias setoensis Shiino, 1933
(Figs 34, 35)

Pseudostegias setoensis Shiino, 1933: 290–293, fig. 16 [Seto, Japan, infesting *Clibanarius bimaculatus* (de Haan)]; Shiino, 1950: 161–162; 1952: 35, 36; 1958: 68 [Wakayama Prefecture, Japan, infesting *C. bimaculatus*; Taiwan, infesting *C. striolatus* Dana]; 1972: 9; Lemos de Castro, 1965: 105, 106–108; Markham, 1982: 369–373, 385 [Hong Kong, infesting *C. bimaculatus* and *C. ransoni* Forest[; Morton & Morton, 1983: 96, 98, 201, fig. 7.5, table 10.2; Markham, 1985: 3, 51–52, 55, 63, fig. 25, table 1 [Phuket, Thailand, infesting *C. padavensis* de Man]; Page, 1985: 201, 203; Harada, 1991: 202; Markham, 1992: 299, table 1; 1994: 226 [Chesterfield Islands and New Caledonia, infesting '*Trizopagurus*' sp. n. (=*Striopagurus boreonotus* Forest)]; Huang, 1994: 530; Williams & Boyko, 1999: 720; Saito *et al*., 2000: 45; Kensley, 2001: 226; Kensley & Chan, 2001: 481; Poore *et al*., 2002: 116; Li, 2003: 140, 155, table 1; Markham, 2003: 72, 73; Boyko, 2004: 677.

Non *Pseudostegias setoensis* — Dunbar & Coates, 2000: 49, fig 1 [South Cooee Bay, Qld, infesting *Clibanarius taeniatus* (H. Milne Edwards) and *C. virescens* (Krauss)]; Poore *et al*., 2002: 116 [=*Pseudostegias dulcilacuum* Markham, 1982]; *Pseudostegia* [sic] *setoensis* — N. Bruce, 2007: 278.

FIG. 36. *Diplophryxus jordani* Richardson, 1904, female, QM-W29070, dorsal view (ex *Palaemon serenus*). Scale: 1 mm.

Material examined. QM-W27086, ♀, ♂, infesting *Diogenes pallescens* Whitelegge, 1897. Sweers I., SW coast Gulf of Carpentaria, Qld, 17°06'S, 139°36'E, 22.11. 2002, P. Davie.

Remarks. The material examined conforms well with previous knowledge of *Pseudostegias setoensis*, which has been redescribed several times. Upon reexamination of the material reported by Dunbar & Coates (2000) from mid-eastern Queensland, I have concluded that it should have been assigned to *P. dulcilacuum* Markham, reported and discussed above, so the present material becomes the first confirmed record of *P. setoensis* in Australia. It is also the first record of infestation of *Diogenes pallescens* by *Pseudostegias setoensis*.

HEMIARTHRINAE Markham, 1972

Diplophryxus Richardson, 1904

Type-species: *Diplophryxus jordani* Richardson, 1904, by monotypy.

Diplophryxus jordani Richardson, 1904 (Fig. 36)

Diplophryxus jordani Richardson, 1904: 50–51, figs 26–28 [Misaki, Japan, infesting *Palaemon serrifer* (Stimpson)]; Thielemann, 1910: 106–107, table 8; Chopra, 1923: 419, 442, 443–444 [Uni I., Mergui Archipelago, Indian Ocean, infesting *Leander serrifer* Stimpson (= *Palaemon serrifer*)]; Chopra, 1930: 114, 119–121, 123, 126–127, pl. IV fig. 1 [Kilkarai, Gulf of Manaar, infesting *Leander tenuicornis* (Say)]; Nierstrasz & Brender à Brandis, 1923: 108; Shiino, 1933: 71 [Noto Peninsula and Sagami Bay, Japan, infesting *Leander serrifer* (= *Palaemon serrifer*); and Deto, infesting *L. pacificus* (Stimpson) (=*Palaemon pacificus* Stimpson)]; Pearse, 1950: 43; Yoshida, 1952: 362–365 [Misaki, Japan]; Bruce, 1972b: 357; Shiino, 1972: 9; Shiino, 1974: 553, figs; Bruce, 1975: 123; Bourdon, 1981b: 632; Markham, 1985a: 95; Poore *et al*., 2002: 122 [Gulf of Carpentaria, Northern Territory, Australia, infesting *Periclimenes spiniferus* de Man].

Diplophryxus Jordani — Thielemann, 1910: 78.

Diplophyrus [sic] *jordani* — Noble & Noble, 1964: 535.

[H]emiarthrinid bopyrids [in part] — A. Bruce, 2007: 68 [Moreton Bay, Qld, infesting *Periclimenes sarkanae* Bruce type specimen].

Material Examined. QM-W29070, ♀ infesting *Palaemon serenus* (Heller, 1862), in intertidal seagrass, near Myora Springs, North Stradbroke I., Qld, 27°40.8'S, 153°24.6'E, 12.02.2005, X. Li. QM-W28071, ♀, infesting *Periclimenes sarkanae* Bruce, 2007 (paratype), Fisherman I., mouth of Brisbane River, Moreton Bay, Qld, 27° 22'S, 153°10'E, 0.2- 0.5 m, netted, P.J.F. Davie.

Remarks. The present two unaccompanied females represent a new record of *Diplophryxus jordani* for Queensland, as well as two new host records for *Palaemon serenus* and *Periclimenes sarkanae*. Because neither female differs significantly from other known representatives of this widespread and well described species, it is not here illustrated or described in detail. The female infesting *Periclimenes sarkanae* was collected with a single female of *Eophrixus kuboi* reported from the same host species (see later).

Diplophryxus negrimaculatus sp. nov. (Fig. 37)

Material examined. HOLOTYPE: QM-W28355, ♀, infesting *Phycomenes zostericola* Bruce, 2008, 1–1.5 m depth, mouth of Loder's Creek, Broadwater, Gold Coast, Queensland, 27°57'15"S, 153°24'39"E, 20.09.2007, J. Haig.

Description. Holotype female (Fig. 37). Length 2.12 mm, maximal width 1.84 mm, head length

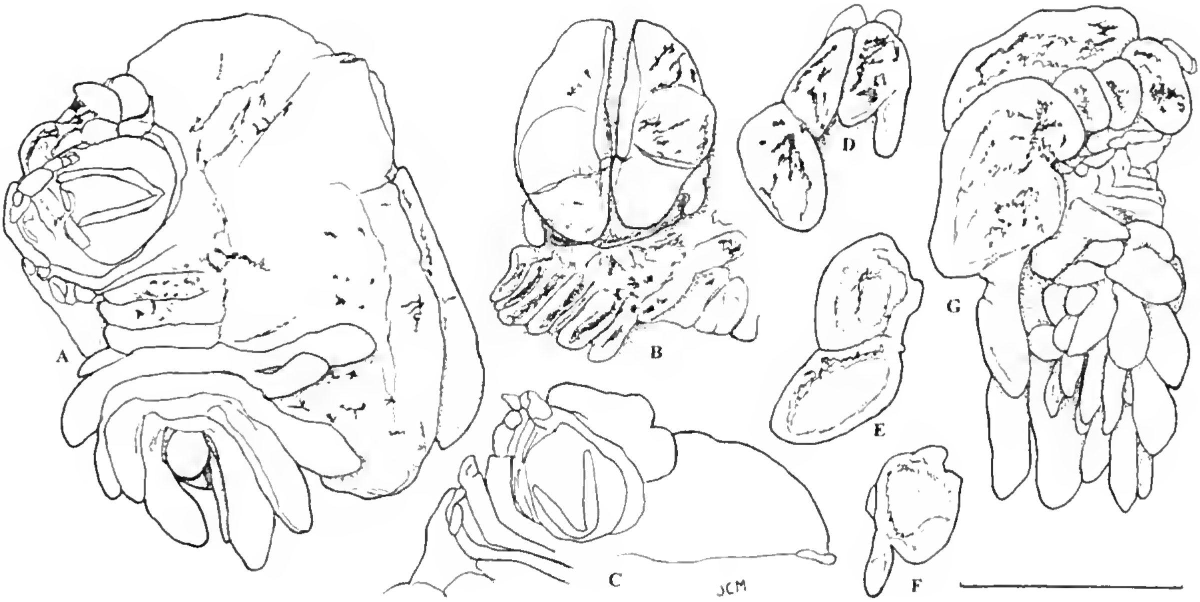

FIG. 37. *Diplophryxus negromaculatus*, sp. nov., holotype female. **A**, dorsal view. **B**, maxillipeds, barbula and anteromedial region of pereon, ventral view. **C**, head and adjacent region of pereon, dorsal. **D**, first oostegites in place, external view. **E**, right oostegite 1, internal view. **F**, left oostegite 1, internal view. **G**, left side of body showing left oostegites and pleonal appendages. Scale: 1 mm.

0.55 mm, head width 0.58 mm, pleon length 0.58 mm. Head and pleon distinctly set off from pereon, some pereomeres incompletely separated but all pleomeres distinct. Body outline irregularly ovate. Body distortion 97°, dextral. Dark pigment splotches widely scattered over body (Fig. 37 A).

Head nearly circular, completely embedded in pereon. First antennae (Fig. 37A, C) unsegmented flaps on anterior edge, second antennae (Fig. 37A, C) forming V-shape across nearly entire length of dorsal surface of head. Each maxilliped (Fig. 37B) with anterior article more than twice as long as posterior one, outline long and slender, convex laterally, nearly straight medially, roundly angled anteriorly without palp, lacking plectron, medial margin of anterior article reflexed over external face. Barbula (Fig. 37B) with bluntly pointed short process on each side, midregon unornamented.

Pereon incompletely segmented, first two pereomeres sharply curved around head and extending beyond it, their medial regions obscured by head. Dorsally, pereomeres 3 and 4 incomplete, pereomeres 5–7 mostly separate; ventrally, all 7 pereomeres medially distinct (Fig. 37B). Inflated closed brood pouch (Fig. 37A) extending far forward, laterally and posteriorly beyond margins of head and pleon, formed of fused right oostegites 2–5. Right oostegite 1 (Fig. 37D, E) separate, both articles of about same size, posterior one extending far laterally, no evident internal ridge. Left oostegite 1 (Fig. 37D, F) much smaller than its mate, its posterior article reduced to slender flap. Internal ridges of both first oostegites unornamented. Left oostegites 2–5 (Fig. 37G) all separate and aligned, fifth one much larger than those preceding it, its posterior article somewhat shorter and much more slender than anterior one. Pereopods of first two pairs large and complete, beside or in front of head; third pereopod of long (right) side represented only by scar on brood pouch and others on that side absent; pereopods 3–6 of short (left) side reduced and tightly clumped, seventh absent.

Pleon of five distinct pleomeres, first four produced into long slender biramous lateral plates (Fig. 37A) and completely covered ventrally by similar but smaller biramous pleopods (Fig. 37G). Final (fifth) pleomere in form of simple bulbous pleotelson lacking appendages.

Male unknown.

Etymology. Species name *negrimaculatus* ("black-spotted") selected to denote spots of black pigment scattered over much of female's body.

Remarks. *Diplophryxus* contains six previously described recognised species, of which three are known from the western Pacific, one from the Indian Ocean and one each from western Europe and the western Atlantic. *D. negrimaculatus* is placed in the genus because its female has the following characters: body greatly distorted, typically 60° to 100°; head deeply embedded in pereon and surrounded by first two pleomeres; second antennae as v-shaped line across dorsal surface of head; only two complete pereopods on long side of body, third one as basal scar far out on brood pouch; pleon of five pleomeres, first four with both lateral plates and pleopods biramous, fifth pleomere as bulbous pleotelson lacking appendages.

The female of *D. negrimaculatus* is most similar to those of *D. jordani* Richardson (discussed above) and *D. kempi* Chopra, from both of which it differs in having the body axis more distorted and no oostegite reflexed over the head; the female of *D. kempi* has a proportionately much larger brood pouch extending far beyond the pleonal appendages (Chopra 1930).

Diplophryxus species infest a wide variety of caridean hosts. This is the first record of any bopyrid infestation in the newly described pontoniine genus *Phycomenes* and the first record of a species of *Diplophryxus* infesting a host in the subfamily Pontoniinae of the family Palaemonidae.

FIG. 38. *Eophrixus kuboi* (Shiino, 1939), female, QM-W29062. **A**, dorsal view. **B**, left antennae. **C**, right antenna 1. **D**, left maxilliped. **E**, left oostegite 1, external. **F**, same, internal. **G**, right oostegite 1, external. **H**, same, internal. **I**, right pereopod 1. **J**, distal region of same. **K**, right pereopod 4 with oostegite attached. **L**, distal region of same. **M**. left pereopod 5. **N**, distal region of same. **O**. pleon, ventral. **P**, pleotelson, ventral. Scale: 1 mm for A, D-H, O; 0.36 mm for I, K, M; 0.18 mm for B, C, P; 0.09 mm for J, L, N.

Diplophryxus alpheus Shiino (Shiino 1934; Barnard 1956) infests species of *Alpheus* (family Alpheidae), as do *D. alveolatus* Bourdon (Bourdon 1981b), *D. siankaanensis* Markham (Markham 1988a) and *D. alphei* Shiino (Shiino 1934; Barnard 1956); *D. gracilis* Markham is recorded from a host subsequently reidentified as *Leander urocaridella* Holthuis (family Palaemonidae, subfamily Palaemoninae) (Markham 1989); *D. jordani* infests species of the palaemonine genera *Palaemon* and *Leander* (see synonymy for *D. jordani* above); and *D. kempi* Chopra, infests a species of *Gnathophyllum* (Gnathophyllidae) (Chopra 1930).

Eophrixus Caroli, 1930

Type-species: *Phrixus (Eophrixus) lysmatae* Caroli, 1930, by monotypy.

Eophrixus kuboi (Shiino, 1939)
(Figs 38, 39)

'Bopyrid isopods' — Kubo, 1936: 48–50; pl. 14A [Inland Sea, Japan, infesting *Periclimenes (Ancylocaris) akiensis*, n. sp. (=*Kemponia akiensis* (Kubo, 1936)); material subsequently described by Shiino, 1939b, below].

Hypophryxus kuboi Shiino, 1939b: 17–20, figs 1, 2 [Inland Sea, Aki Prefecture, Japan, infesting *Periclimenes (Ancylocaris) akiensis* Kubo (=*Kemponia akiensis*)]; Pillai, 1966: 185; Bruce, 1968: 18–19; Shiino, 1972: 9; Saito *et al.*, 2000: 46.

Hypophrixus kuboi — Caroli, 1949: 234 [called member of *Eophrixus*].

Eophrixus kuboi — Caroli, 1949: 234; Markham, 1972: 53.

Anisarthrus kuboi — Codreanu & Codreanu, 1956a: 119; 1956b: 577; Codreanu, 1961: fig. 1.

[H]emiarthrinid bopyrids [in part] — Bruce, 2007: 68 [Moreton Bay, Qld, infesting *Periclimenes sarkanae* Bruce].

Material Examined. QM-W29071, ♀, (Fig. 38), ♂ (Fig. 39), infesting *Periclimenaeus obscurus* Kemp, 1922, intertidal seagrass flats, Polka Point, Dunwich, North Stradbroke I., Qld, 27°29.6′ S, 153°23.9′ E, 11.02.2005, X. Li. QM-W29062, ♀, infesting *Periclimenes sarkanae* Bruce, 2007 (paratype), Fisherman I., mouth of Brisbane River, Moreton Bay, Qld, 27°22′S, 153°10′E, 0.2–0.5 m, netted, P.J.F. Davie. QM-W25712, ♀, infesting *Periclimenes terangeri* Bruce, 1998, Townsville, Qld, 19°16′S, 146°49.0′E.

Remarks. *Eophrixus kuboi* was previously known only from the type material from Japan; thus these are the first records for Australia, as well as the first records of bopyrid infestation of *Periclimenaeus obscurus* and *Periclimenes terangeri*; it is also the first record of hemarthrine infestation of any species of *Periclimenaeus*, though two other species of the genus are known to bear (branchial) bopyrine parasites. *E. kuboi* has been transferred twice to other genera since its original description, but I accept its placement in *Eophrixus*, to which Caroli (1949) reassigned it. The material infesting *Periclimenaeus obscurus* differs from the types in some details, but this seems to be the correct identification. The type female (Shiino 1939b) has a more pyriform than

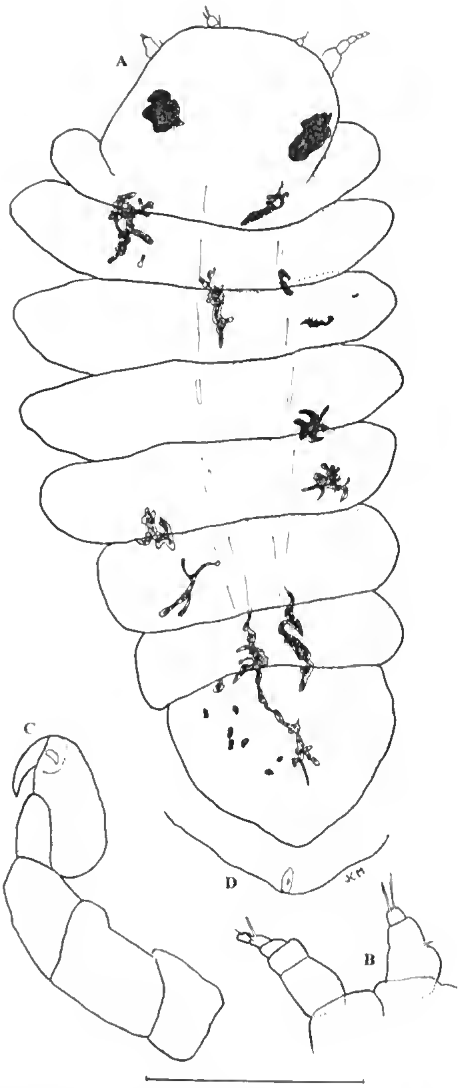

FIG. 39. *Eophrixus kuboi* (Shiino, 1939), male, QM-W29071. A, dorsal view. B, left antennae. C, right pereopod 3. D, end of pleon, ventral. Scale: 0.2 mm for A; 0.1 mm for B-D.

rectangular head, pigment in a better defined belt-like band, pleonal lateral plates more constricted proximally and a larger pleotelson. The present female (Fig. 38) corresponds with it in general body shape, placement of head, proportion of brood pouch in front of head, presence of a conspicuous band of dark pigment around the pereon, size, shape and placement of pereopods, and structure and proportions of the rami of the pleopods. The present, minute, male (Fig. 39) corresponds with the type (Shiino, 1939b) in having the head fused with the first pereomere and antennae markedly extended, though its eyes are proportionately larger; the sides of its body less regular; its dorsal surface more highly pigmented; and its pleon proportionately shorter. The second female infesting *Periclimenes surkunae*, which was collected with a single female of *Diplophryxus jordani* reported from the same host species above, is quite similar.

Filophryxus Bruce, 1972

Type-species: *Filophryxus dorsalis* Bruce, 1972, by original designation.

Filophryxus dorsalis Bruce, 1972

Filophryxus dorsalis Bruce, 1972b: 351–358, figs 1–8 [off coast of Qld, 26°32'S, 153°50'E, 275 m, infesting *Periclimenes hertwigi* Balss]; 1973: 522; 1975: 124; Ross, 1983: 167, table I; Markham, 1990a: 55, 68 [New Caledonia, infesting *Periclimenes uniunguiculatus* Bruce]; Trilles, 1999: 322, fig. 8.39D, E; Poore *et al.*, 2002: 122; N. Bruce, 2007: 278.

Remarks. No new material examined. *Filophryxus dorsalis* is distinctive for being found attached to the dorsal surface of its host's abdomen both times it was collected, rather than on the ventral surface, as is typical for hemiarthrines.

Metaphrixus Nierstrasz & Brender à Brandis, 1931

Type-species: *Metaphrixus carolii* Nierstrasz & Brender à Brandis, 1931, by monotypy.

Metaphrixus intutus Bruce, 1965

Metaphryxus intutus Bruce, 1965: 385–390, figs 1–3 [Zanzibar, infesting *Palaemonella vestigialis* Kemp]; 1972a: 445, 450; 1972b: 351; 1973: 523; 1979: 217 [Singapore, infesting *Palaemonella rotumanus* (Borradaile)]; 1986: 213 [John Brewer Reef, Qld, infesting *Periclimenes* sp. (probably = *P. grandis* (Stimpson)); Darwin Harbour, Darwin, Northern Territory, infesting *Palaemonella rotumanus*]; 1992: 64 [Eagle I. and Lizard I., Qld, infesting *Periclimenes platycheles* Holthuis]; Bourdon, 1967b: 173–174; Trilles, 1999: 322, fig. 8.39A.

Metaphrixus intutus — Markham, 1972: 40, 54, table II; 1985a: 113; 1989: 145; 1990a: 64–65; Kensley, 2001: 224; Bruce, 2002: 292; Poore *et al.*, 2002: 123; Shimomura *et al.*, 2006: 4.

'Hemiarthrinid bopyrid' — Bruce, 1992: 62.

Remarks. No new material. *Metaphrixus intutus* has been collected several times, including from three localities in Queensland. Like *Filophryxus dorsalis*, it has a distinctive mode of attachment, but it occurs on the side of its host's abdomen, not dorsally or ventrally.

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The littoral and shallow-water barnacles (Crustacea: Cirripedia) of south-eastern Queensland

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ABSTRACT

Seventy-four littoral and shallow-water (0–100 m) barnacle species from south-eastern Queensland are documented. Data from new collections of littoral and shallow-water barnacle species made during the February 2005 workshop, are combined with older SE Queensland barnacle collection data from Australian museums. South-eastern Queensland represents a transitional area between southern temperate and tropical zones and this transitional position is reflected in the composition of the barnacle fauna. The number of Australian endemic species (12) is relatively high, reflecting the influence of the southern fauna, but the fauna is dominated by species with Indo-west Pacific (25), cosmopolitan (22) and, to a lesser extent, Indo-Japanese (9) affinities, with Australasian (2), western Pacific (2) and Indo-Australasian (1) species minor components. One new species, *Arcalepas brucei* Jones & Morton, 2009, was collected during the Workshop. *Neonrosella* subgen. nov. is proposed to replace *Rosella* Ross & Perreault, 1999, which is preoccupied. ❑ *Cirripedia, Queensland, checklist, biogeography, littoral, shallow-water.*

First collections of Australian barnacles were made from temperate waters by the early French expeditions of discovery at the beginning of the 19th century. However, Darwin's monographs (1852; 1854) first documented the barnacles of temperate Australian waters (Jones 1991). Darwin (1854) made collections and records of barnacles from Moreton Bay, south-eastern Queensland, describing two new species, *Chthamalus antennatus* sp. nov. and *Austrobalanus imperator* sp. nov. (as *Balanus*). He also recorded *Tetraclita rosea* (Krauss, 1848), now placed in *Tesseropora*; *Platylepas bissexlobata* (de Blainville, 1824), now recognised as a synonym of *Platylepas hexastylos* (Fabricius, 1798), from a dugong, and the sponge barnacle, *Acasta sulcata* Lamarck, 1818.

During the late 19th and early part of the 20th century, knowledge of the Australian cirripede fauna was increased, often through investigations by various expeditions, and barnacles collected from south-eastern Queensland waters were again briefly detailed in some of their reports. For example, *Austrobalanus imperator* (Hoek 1883; *Challenger* Expedition, 1873–1876; as *Balanus imperator* Darwin, 1854); *Amphibalanus amphitrite* (Weltner 1897; Hamburg Expedition, 1905; as *Balanus amphitrite* var. *communis* Darwin, 1854); and *Striatobalanus amaryllis* (Hoek 1907; 1913; *Siboga* Expedition 1899–1900, as *Balanus amaryllis* Darwin, 1854). In 1869, MacDonald described an 'apparently new genus of minute parasitic cirripede', *Paradolepas neptuni* (now recognized as *Octolasmis n. neptuni*), on the gills and respiratory appendages of the swimming crab *Portunus pelagicus* (as *Neptunus pelagicus* Linnaeus) in Moreton Bay.

Nineteen barnacle species from the rocky shores and islands of Queensland were listed by Endean *et al.* (1956a, 1956b), including nine from south-eastern Queensland waters: *Ibla cumingii* Darwin, 1852; *I. quadrivalvis* (Cuvier, 1817); *Catophragmus polymerus* Darwin, 1854; *Chthamalus antennatus* Darwin, 1854; *Austrobalanus imperator* (Darwin, 1854); *Tetraclita purpurascens* (Wood, 1815); *Tessero-*

pora rosea (Krauss, 1848); *Striatobalanus amaryllis* (Darwin, 1854); and *Austromegabalanus nigrescens* (Lamarck, 1818).

In a review of all intertidal species of the family Chthamalidae known from Australian shores, Pope (1965) documented five species from south-eastern Queensland waters: *Catophragmus polymerus* Darwin, 1854 (now in Catophragmidae), *Caudoeuraphia caudata* Pilsbry, 1916 (as *Chthamalus caudatus*), *Microeuraphia withersi* Pilsbry, 1916 (as *Chthamalus withersi*), *Chthamalus antennatus* Darwin, 1854 and *C. malayensis* Pilsbry, 1916.

Stephenson *et al.* (1970: 492) recorded three species, *Smilium peronii* (Quoy & Gaimard, 1834), *Striatobalanus amaryllis* (Darwin, 1854) and *Amphibalanus amphitrite* (Darwin, 1854), in a survey of the macrobenthos of Moreton Bay. Seventeen barnacle species associated with turtles in southern Queensland were recorded by Monroe & Limpus (1979), including three new species, *Platylepas coriacea* sp. nov., *Stomatolepas eretmochelys* sp. nov. and *Tubicinella* [now *Chelolepas*] *cheloniae* sp. nov. Monroe (1981) discussed shell morphology, growth and function and their bearing on subfamily classification in the Coronulidae. Various ecological studies in southern Queensland have also documented distributions of intertidal barnacles (e.g. Coates & McKillup 1995; Coates 1998).

In 1990, the shallow and deep-water barnacle faunas of Australia were documented for the first time, from museum holdings and literature records (Jones *et al.* 1990). Twelve littoral, three neustonic, 29 sublittoral (to 200 m) and four deep-water (> 200 m) cirripede species were identified as occurring along the coast of central eastern Australia (northern NSW and south-eastern Queensland).

The present report amalgamates the results of Jones *et al.* (1990) with records of shallow water barnacles collected during the 13th International Marine Biological Workshop held at the Moreton Bay Research Station and Study Centre, North Stradbroke Island, Queensland (2005), plus more recent cirripede additions in collections of Australian museums, to produce a checklist of the littoral and shallow water barnacle species of the waters of south-eastern Queensland (latitudes 23°S and above).

METHODS AND MATERIALS

Specimens were collected at low tide by hand from a wide variety of habitats (e.g. rocks, mangrove trees, hard substrata and animate hosts). Subtidal samples were collected by SCUBA or by dredging.

Cirripedes contained in the collections of the Queensland Museum and other Australian museums, were reviewed for records from south-eastern Queensland. Museum acronyms are: AM, Australian Museum, Sydney; NMV, Museum Victoria, Melbourne; NTM, Museum and Art Gallery of the Northern Territory, Darwin; QM, Queensland Museum, Brisbane; SAM, South Australian Museum, Adelaide; WAM, Western Australian Museum, Perth.

The general arrangement of taxa follows Newman (1996). Genera are listed alphabetically within families, and species alphabetically within genera. Primary synonyms and some key secondary literature are included.

Abbreviations used in the text are as follows: GAB, Great Australian Bight; GBR, Great Barrier Reef, Queensland; NSW, New South Wales; NT, Northern Territory; Qld, Queensland; SA, South Australia; Tas., Tasmania; Vic., Victoria; WA, Western Australia.

SYSTEMATICS

Subclass CIRRIPEDIA Burmeister, 1834
Superorder THORACICA Darwin, 1854
Order IBLIFORMES Buckeridge & Newman, 2006
Suborder IBLOMORPHA Newman, 1987
Family IBLIDAE Leach, 1825

Ibla Leach, 1825

Ibla cumingii Darwin, 1852

Ibla cumingii Darwin, 1852: 183, pl. 4 fig. 8, pl. 5 figs 1–8, pl. 10 figs 4, 11.

Material Examined. AM-P19306, Wreck Pt, S Yeppoon (23°09'S, 150°46'E); AM-P19307, S end of Curtis I., Port Curtis (23°38'S, 151°10'E); AM-P19308, Bustard Head, Port Curtis (24°01'S, 151°46'E); AM-P19312, Wreck Pt, Cooee Bay, nr Yeppoon (23°09'S, 150°46'E); AM-P23577, Heron I. (23°27'S, 151°55'E); SAM-Tc11478, Moreton Bay (27°15'S, 153°15'E), from buoy; WAM-C19267, Cooee Bay (23°08'S, 150°45'E).

Remarks. Nilsson-Cantell (1930: 5) recorded the species at the Pisang Islands, to the south-west of New Guinea and to the north of Australia, but Endean *et al.* (1956a: 106) published the first record of the occurrence of *Ibla cumingi* in Australia, from material collected in tropical Queensland (from Point Vernon northward). Jones *et al.* (1990: 7) further extended the distribution of the species in northern Australian waters, from WA through the NT to tropical Queensland. The present contribution confirms the presence of the species in Moreton Bay from material contained in the collections of the SAM. This represents the most southern record of *I. cumingi* in eastern Australia.

Distribution. WA (NW), NT, Qld (SE); Indo-west Pacific.

Habitat. Littoral, MTL–LWN; in shady rock crevices, on reefs and coastal rocks; semi to full wave exposure.

Ibla quadrivalvis (Cuvier, 1817)

Anatifa quadrivalvis Cuvier, 1817: pl. 1 figs 15, 16.
Ibla quadrivalvis — Darwin, 1852: 203, pl. 4 fig. 9.

Material Examined. None; literature records only.

Remarks. This Australian endemic species was originally described by Cuvier (1817) from material collected by *Astrolabe* at Princess Royal Harbour (Albany), WA, and Darwin (1852: 204) recorded the species from WA, SA and NSW. The species has been recorded from Queensland waters by Endean *et al.* (1956a: 106; common from Currumbin southward) and Jones *et al.* (1990: 7; WA across southern Australia to SE Qld). Additional southern Australian records are those of Hoek (1883: 32; SA); Weltner (1897: 251; van Diemensland [= Tas.]); Gruvel (1905: 148; WA, southern Australia); Hiro (1936b: 215; Madagascar. Australia, New Zealand, Fiji); Krüger (1914: 435; WA); Broch (1922: 262; NSW); Nilsson-Cantell (1938: 8; south coast of Australia); Pope (1943: 240; NSW); Dakin *et al.* (1948: 216; NSW); Guiler (1950: 179; 1951b: 63; 1952: 20; Tas.); Dakin *et al.* (1953: 207; SE Australia); Wisely & Blick (1964: 166; NSW); Anderson (1965: 2; NSW); Daniel (1972: 180; S coast of Australia); Underwood (1977: 25; NSW); Marine Research Group of Victoria (1984: 104; southern WA, Tas., Vic., NSW); Jones (1990b: 344; 2003: 498; WA to NSW) and Jones *et al.* (1990: 7; WA, across southern Australia to SE Qld); Buckeridge & Newman (2006: 5; Madagascar, Australia, New Zealand).

Distribution. WA (S), SA, Vic., Tas., NSW, Qld (SE); Indo-Australasian.

Habitat. MTL to LWN; often associated with *Galeolaria* spp, mussels and barnacles.

Order LEPADIFORMES Buckeridge & Newman, 2006
Suborder HETERALEPDOMORPHA Newman, 1987
Family HETERALEPADIDAE Nilsson-Cantell, 1921

Heteralepas Pilsbry, 1907

Heteralepas adiposa Zevina, 1982

Heteralepas adiposa Zevina, 1982: 120, fig. 107.

Material Examined. AM-P40887, E Moreton I. (27°11'S, 153°24'E).

Remarks. This species was first reported from Australia by Jones *et al.* (1990: 6) from SE Queensland.

Distribution. SE Qld; West Pacific Ocean.

Habitat. Depth 40–400 m.

Heteralepas cornuta (Darwin, 1852)

Alepas cornuta Darwin, 1852: 165, pl. 3 fig. 6, pl. 10 figs 8, 28.
Heteralepas (Heteralepas) cornuta — Pilsbry, 1907: 101.

Material Examined. AM-P40882, Pt Lookout, N Stradbroke I. (27°30'S, 153°30'E); SAM-Tc11470, Peel I., Moreton Bay (27°30'S, 153°21'E), on antipatharian.

Remarks. First reported from Australia by Jones *et al.* (1990: 6) from SE Queensland.

Distribution. Qld (SE); cosmopolitan.

Habitat. Depth 90–4315 m; attached to *Antipathes* sp.

Heteralepas japonica (Aurivillius, 1892)

Alepas japonica Aurivillius, 1892: 125.
Heteralepas japonica — Pilsbry, 1911: 71, fig. 4.

Material Examined. AM-P23775, Moreton Bay (27°25'S, 153°20'E).

Remarks. This species was first reported from north-western and south-eastern Australia by Jones *et al.* (1990: 6).

Distribution. WA (NW), NSW, Qld (SE); Indo-west Pacific.

Habitat. Depth 48–915 m; attached to inanimate and animate substrata.

Family MALACOLEPADIDAE Hiro, 1933

Arcalepas Jones & Morton, 2009

Arcalepas brucei Jones & Morton, 2009

Arcalepas brucei Jones & Morton, 2009: 847–868.

Material Examined. Holotype. QM-W28660; Moreton Bay, (27°28´00"S, 153°28´00"E); commensal with *Arca navicularis* Bruguière, dredged, J.D. Taylor & E. Glover on R.V. *Tom Marshall*, 10.02.05, 6.5 m, sand with shell debris. Paratypes. QM-W28661, 1 spec.; NHM 2008.4552, 1 specimen; WAM-C40046, 1 dissected spec.; paratypes with same data as holotype.

Remarks. This commensal species was collected from Moreton Bay during the 13th International Marine Biological Workshop but has been published separately. The barnacles occur inside the mantle cavity and attach to the shell of the bivalve, *Arca navicularis* Bruguière, 1789. This is the first record of such an association from Australian waters.

Distribution. Eastern Australia.

Habitat. Depth 6.5 m; commensal, attached to the inside of the shell of the living epibenthic bivalve, *Arca navicularis* Bruguière.

Suborder LEPADOMORPHA Pilsbry, 1916

Family LEPADIDAE Darwin, 1852

Alepas Sander-Rang, 1829

Alepas pacifica Pilsbry, 1907

Alepas pacifica Pilsbry, 1907: 105, fig. 36, pl. 5 figs 2, 4–6.

Material Examined. QM-W23113, 1 spec., Peregian Beach (26°29'S, 153°05'E), J. Hooper, 24.01.1998, flotsam, symbiotic with *Cyanea* sp.

Remarks. The species was recorded from the Java Sea (6°19'S, 110°50'E) at a depth of 38 m by Nilsson-Cantell (1934: 39) but was first recorded from Australia by Tubb (1946: 383) from Tasmanian waters. Subsequent records are those of Utinomi (1968: 167; Tasman Sea, depth 610 m, attached to *Phacelophora camtchatica* (Brandt)) and Jones *et al.* (1990: 8; NSW, Qld).

Distribution. Tas., NSW, Qld (SE); Tropical Indo-west Pacific.

Habitat. Pelagic; epizoic on Scyphomedusae.

Conchoderma Olfers, 1814

Conchoderma aurita Linnaeus, 1767

Lepas aurita Linnaeus, 1767: 1110.
Conchoderma aurita — Darwin, 1852: 141, pl. 3 fig. 4, 4a–c.

Material Examined. QM-W16411, 39 specs, Fraser I., 0.4 km N of Browns Rocks (24°36'S, 153°20'E), 03.07.1989, R. Paterson, S. Van Dyck, attached to *Coronula diadema* ex humpback whale, *Megaptera novaeangliae* (QM JM 7302); QM-W16410, 03.07.1989, R. Paterson, S. Van Dyck; QM-W16933, 6 specs, Fraser I., 0.4 km N of Browns Rocks (24°47'S, 153°16'E), 05.07.1989, R. Paterson, S. Van Dyck, ex stranded humpback whale, *Megaptera novaeangliae*; QM-W4637, Heron I. lagoon (23°27'S, 151°55'E), 19.12.1974, C. Limpus, ex *Platylepas hexastylos* on *Caretta caretta*; QM-W12173, Noosa Heads, 04.06.1986, S. Van Dyke, attached to tooth of male dense beak whale.

Remarks. *Conchoderma aurita* is a cosmopolitan species which has been reported from western, southern and eastern Australia (Jones *et al.* 1990: 8; Jones 1990a: 215; 1990b: 369); Qld (Monroe & Limpus 1979: 199, on *Platylepas hexastylos* attached to *Caretta caretta*); Tas. (Guiler 1956: 3, on *Coronula* sp. attached to *Megaptera* sp.) and western areas of the continent (Jones 1990a: 215; 1990b: 369; 1991: 167; 1992b: 90; 2003: 483; 2004: 145).

Distribution. WA, SA, Vic., Tas., NSW, Qld; cosmopolitan in all seas.

Habitat. Pelagic, nektonic, epizoic on pelagic animals; also fouling ships and boats.

Conchoderma hunteri (Owen, 1830)

Cineras Hunteri Owen, 1830: 71.
Conchoderma Hunteri — Darwin, 1852: 153, pl. 3 fig. 3.

Material Examined. QM-W752, Pt Lookout, Stradbroke I. (27°26'S, 153°32.0'E).

Remarks. Darwin (1852: 153) described *Conchoderma hunteri* 'attached to the skin of a snake, probably *Hydeus* or *Pelamis bicolor* and therefore from the tropical Indian or Pacific Oceans'. The species is known from the waters of SE Queensland and the GBR (QM material) and from NSW (AM material). Specimens of *C. hunteri* held in the WAM record the species from Scarborough, WA, north to the Montebello Islands (Jones & Berry 2000: 60) and across north-western WA to NT. In Australia the species has been found attached to sea-snakes, e.g. *Pelamis platura* (Linnaeus), crustaceans, e.g. *Dardanus australis* Forest & Morgan, and fouling ships and submerged structures.

Distribution. WA, NSW, Qld; Indo-west Pacific.

Habitat. Attached to animate and inanimate substrates in pelagic and benthic environments; also fouling boats and ships.

Conchoderma virgatum (Spengler, 1790)

Lepas virgata Spengler, 1790: 207, pl. 6 fig. 9.
Conchoderma virgatum — Olfers, 1814: 177.

Material Examined. QM-W20754, 4 specs, C. Moreton (27°02'S, 153°.28'E), 06.02.1988, P. Speare, pelagic, symbiotic on copepod (*Pennella instructa*) in muscle of sailfish, *Istiophorus platypterus*, 06.02.1988; QM-W7368, 3 specs, Heron I. (23°27'S, 151°55'E), 31.10.1977, C. Limpus, ex *Caretta caretta* (ex 2698) subsp. *chelonophilum* (ex mouth), 31.10.1977; QM- W7369, 2 specs, Heron I. (23°27'S, 151°55'E), 31.10.1977, C. Limpus, ex *Caretta caretta* (ex 2698), 31.10.1977; QM-W4636, 3 specs, Heron I. lagoon (23°27'S, 151°55'E), 19.12.1974, C. Limpus, attached to W 4635 (*Platylepas hexastylos*) and stored with it; QM-W6496, Mon Repos (24°53'S, 152°28'E), July 1974, C. Limpus, ex *Caretta caretta*; W 7369, Heron I., ex *Caretta caretta* (Linnaeus); W 4636, Heron I., ex *Caretta caretta* (Linnaeus); QM-W431, 10 specs, Moreton Bay (27°00'S, 153°00'E); QM-W440, Caloundra, on seasnake, *Hydrus platurus*.

Remarks. *Conchoderma virgatum* is a cosmopolitan species that has been reported from western, southern and eastern Australia (Jones 1990a: 215; 1990b: 371; 1991: 167; 1992b: 90; 2003: 483; 2004: 145; Jones *et al.* 1990: 8) and Qld (Monroe & Limpus 1979: 198, ex *Caretta caretta* (Linnaeus)).

Distribution. WA, Tas., NSW, Qld; cosmopolitan in all tropical and warm temperate seas.

Habitat. Attached to inanimate objects and animals in pelagic and benthic environments; also fouling boats and ships.

Lepas Linnaeus, 1758

Lepas (Anatifa) Bruguière, 1789

Lepas (Anatifa) anatifera Linnaeus, 1758

Lepas anatifera Linnaeus, 1758: 668.
Lepas (Anatifa) anatifera — Zevina, 1982: 17, fig. 8.

Material Examined. AM-P11766, Caloundra (153°08'S, 26°48'E); AM-P21757, Brennan Shoals, off C. Moreton (153°28'S, 27°02'E); AM-P21923, Caloundra (153°08'S, 26°48'E); AM-P21924, Noosa (153°07'S, 26°25'E); AM--P21926, Caloundra (153°08'S, 26°48'E); QM-W80, Noosa Heads (26°23'S, 153°06'E), on log washed up on shore; QM-W6453, 6 specs, Mon Repos (24°53'S, 152°28'E), C. Limpus, ex *Caretta caretta*; QM-W6454, 7 specs, Mon Repos (24°53'S, 152°28'E), 13.01.1976, C. Limpus, ex *Caretta caretta*, 13.01.1976; QM-W6455, 7 specs, Mon Repos (24°53'S, 152°28'E), 21.12.1975, C. Limpus, ex *Caretta caretta* (ex 3508), 21.12.1975; QM-W7375, Mon Repos (24°53'S, 152°28'E), 13.01.1977, C. Limpus, ex *Caretta caretta* (ex 4300), 13.01.1977; QM-W7465, 2 specs, Mon Repos Beach (24°53'S, 152°28'E), 17.12.1978, C. Limpus and party; SAM-Tc11655, Smith's Rock, Moreton Bay (27°15'S, 153°15'E), on buoy; SAM-Tc11656, Smith's Rock, Moreton Bay (27°15'S, 153°15'E), on buoy; SAM-Tc11657, Smith's Rock, Moreton Bay (27°15'S, 153°15'E), on buoy.

Remarks. This cosmopolitan species has been reported from around the Australian continent (Jones *et al.* 1990: 7). Records from eastern Australia are those of Darwin 1852: 73 (Bass Str., Van Diemen's Land [Tas.]); Krüger 1911a: 25 (Bass Str., Van Diemen's Land [Tas.]); Guiler 1952a: 20 (Tas.); Dakin *et* al. 1953: 206 (NSW); Pope 1959: 118 (NSW); Underwood 1977: 27 (NSW, description of *L. anatifera* but photograph = *L. australis* Darwin, 1852); Zann & Harker 1978: 207 (Qld); Monroe & Limpus 1979: 197 (Qld). Records from the western and north-western coasts of Australia are those of Nilsson-Cantell (1927: 752) and Jones (1989: 81; 1990a: 215; 1990b: 347; 1991: 150; 1992b: 90; 1994: 6; 2003: 483).

Distribution. Cocos-Keeling Is, WA, SA, Vic., Tas., NSW, Lord Howe I., Qld, NT; cosmopolitan in temperate, subtropical and tropical seas.

Habitat. Pelagic, neuston; on floating objects, pelagic animals and plants in open water.

Lepas (Anatifa) anserifera Linnaeus, 1767

Lepas anserifera Linnaeus, 1767: 1109.
Lepas (Anatifa) anserifera — Zevina, 1982: 14, fig. 4.

Material Examined. AM-P23507, Stradbroke I. (27°25'S, 153°20'E); QM-W24695, 6 specs, Frenchmans Bay, N Stradbroke I. (27°25'S, 153°32'E), M.P. Hines, 05.02.1999, flotsam, ex beached fishing float; QM-W24696, 22 specs, Frenchmans Bay, N Stradbroke I. (27°25'S, 153°32'E), M.P. Hines, 18.01.1999, flotsam, ex beached fishing float; QM-W6456, Mon Repos (24°53'S, 152°28'E), 23.12.1975, C. Limpus, ex *Caretta caretta* (ex 3564); QM-W6457, Mon Repos (24°53'S, 152°28'E), C. Limpus, ex *Caretta caretta* (ex 3535); QM-W6458, Mon Repos (24°53'S, 152°28'E), summer 1975/1976, C. Limpus, ex *Caretta caretta*; QM-W16028, 8 specs, South I., nr Lord Howe I. (31°28'S, 159°09'E), 12.10.1987, N. Coleman, surface.

Remarks. *Lepas anserifera* is a cosmopolitan species that has been reported from the waters of all Australian states (Jones *et al.* 1990: 7); e.g. NSW (Darwin 1852: 82; Dakin *et al.* 1953: 206; Pope 1959: 118; Utinomi 1968: 166; Underwood

1977: 27); Qld (Hoek 1883: 39; Monroe & Limpus 1979: 197); Tas., on *Janthina* sp. (Guiler 1952a: 20); and WA (Jones, 1989: 89; 1990b: 351; 1991: 155, 1992b: 90; 1993: 122; 1994: 6; 2003 483; 2004: 144).

Distribution. WA, SA, Vic., Tas., NSW, Qld, NT; cosmopolitan in temperate and tropical seas.

Habitat. Pelagic, neuston; on floating objects, pelagic animals and plants in open water.

Lepas (Anatifa) hilli (Leach, 1818)

Pentalasmis Hillii Leach, 1818: 413.
Lepas hillii — Darwin, 1852: 77, pl. 1 fig. 2.
Lepas (Anatifa) hilli — Zevina, 1982: 14, fig. 5.

Material Examined. QM-W6452, Mon Repos (24°53'S, 152°28'E), C. Limpus, ex *Caretta caretta*; AM-P11767, Lady Elliot I. (24°07'S, 152°43'E); AM-P21974, Pt Curtis, 16 km W of Lady Elliot I. (23°55'S, 151°23'E); AM-P21975, Heron I. (23°27'S, 151°55'E).

Remarks. *Lepas hillii* has been recorded from eastern and western parts of the Australian continent (Jones *et al.* 1990: 7), e.g. eastern Australia (Fischer 1884: 355); Qld (Monroe & Limpus 1979: 1981); NSW (Darwin 1852: 78; Dakin *et al.* 1953: 206; Pope 1959: 118); and southern WA to SE Qld (Jones 1990b: 357; Jones 1992: 90; Jones *et al.* 1990: 7).

Distribution. WA (S), Vic., Tas., NSW, Qld (SE); cosmopolitan.

Habitat. Pelagic, neuston; on floating objects, pelagic animals and plants in open water.

Lepas (Anatifa) pectinata Spengler, 1793

Lepas pectinata Spengler, 1793: 106, pl. 10 fig. 2.
Lepas (Anatifa) pectinata — Zevina, 1982: 15, fig. 6.

Material Examined. AM-P21982, Caloundra (26°48'S, 153°08'E).

Remarks. This species was first collected in Australian waters by *Challenger*, between Sydney, NSW and Wellington, New Zealand, on *Spirula* sp. (Hoek 1883: 40). It has since been reported from the southern areas of Australia (Jones *et al.* 1990: 8); e.g. south eastern Australia (Weltner 1899: 442; Broch 1922: 266; Fischer 1940: 283; Utinomi 1968: 166; Anderson 1980: 147) and the western side of the continent (Jones 1990b: 357; 1993: 122; 2003: 483; 2004: 145).

Distribution. WA (S), SA, NSW, Lord Howe I., Qld (SE); cosmopolitan in subtropical and tropical seas.

Habitat. Pelagic, neuston; attached to floating objects, epizoic on pelagic animals.

Family OXYNASPIDIDAE Gruvel, 1905

Oxynaspis Darwin, 1852

Oxynaspis celata Darwin, 1852

Oxynaspis celata Darwin, 1852: 134, pl. 3 fig. 1.
Oxynaspis celata indica Annandale, 1910: 69.
Oxynaspis indica — Foster, 1979: 22, fig. 9.

Material Examined. QM-W7810, Wistari Reef (23°29'S, 151°53'E), 18–24 m, D. Fisk, 1978, ex mooring rope.

Remarks. Specimens of *Oxynaspis celata* were collected in WA by Nilsson-Cantell (1921: 226). Material from Tasmanian waters, as *O. celata* forma *novae-zealandica*, was collected on antipatharians by *Endeavour*, at a depth of 183 to 293 m (Broch 1922: 275). Jones (1990b: 375) and Jones *et al.* (1990: 8) recorded the species, as *O. indica*, from WA across southern Australia to SE Queensland.

Distribution. WA, Vic, Qld (SE); cosmopolitan in tropical and warm temperate seas.

Habitat. Depth 29–1425 m; attached to inanimate objects and epizoic on antipatharians (e.g. *Antipathes* sp., *Aphanipathes* sp.).

Family POECILASMATIDAE Annandale, 1910

Octolasmis Gray, 1825

Octolasmis angulata (Aurivillius, 1894)

Dichelaspis angulata Aurivillius, 1894: 22, pl. 2 figs 9–11, pl. 8, figs 18, 24.
Dichelaspis aperta Aurivillius, 1894: 22, pl. 1 figs 14–16.
Dichelaspis bullata Aurivillius, 1894: 26, pl. 2 figs 12–13, pl. 6 figs 10–11, pl. 8 figs 19, 25.
Octolasmis angulata — Nilsson-Cantell, 1934: 46.

Material Examined. QM-W16917, Moreton Bay (27°00'S, 153°00'E), Feb. 1989, J.D. Shields, stn 3-51, sublittoral, symbiotic with swimming crab; QM-W16919, Moreton Bay (27°00'S, 153°00'E), Sept. 1990, J.D. Shields, stn 25A, sublittoral, symbiotic with brachyuran crab, *Galene bispinosa*, in branchial cavity; WAM-C32653 Moreton Bay (27°15'S, 153°15'E), on *Portunus pelagicus*.

Remarks. This endozoic species has been reported from the waters of north-western WA, from the Dampier Archipelago and the Kimberley (Jones 1992: 52; 2003: 483; 2004: 144; as *O. angulata*). Specimens are also held in the QM from decapods collected in Moreton Bay.

Distribution. WA, Qld; Indo-west Pacific.

Habitat. Sublittoral; endozoic on gills of crustaceans (e.g. brachyuran crabs, rock lobsters).

Octolasmis cor Aurivillius, 1892

Dichelaspis cor Aurivillius, 1892: 124 — 1894: 20, pl. 2 figs 1–2.
Octolasmis cor — Barnard, 1924: 58.

Material Examined. QM-W18116, 18 specs, Moreton Bay (22°25'S, 153°20'E), Jan. 1992, D.A. Hudson, sublittoral, symbiotic on gills, gill cleaners and carapace of *Scylla serrata* (Forsskål); AM-P40881, Deception Bay (27°12'S, 153°02'E); SAM-Tc11475, Tallebudgera Ck (28°06'S, 153°28'E), from branchial chamber of large, edible common crab (*Leptodius* type).

Remarks. Jones *et al.* (1990: 9) recorded *Octolasmis cor* from NSW and Queensland waters and the species has been recorded subsequently from WA (Jones 2003: 483). Specimens from Gove, NT, are also held in the collections of the WAM.

Distribution. WA, NT, NSW, Qld (SE); Indo-west Pacific.

Habitat. Depth 0–50 m, endozoic on decapod crustaceans (e.g. *Scylla serrata* (Forsskål)).

Octolasmis neptuni (MacDonald, 1869)

Paradolepas neptuni MacDonald, 1869: 440, fig. 1, pls 33, 34.
Dichelaspis neptuni — Hoek, 1883: 32.
Octolasmis (Octolasmis) neptuni neptuni — Newman, 1961: 100, pl. 21, figs 1–9.

Material Examined. QM-W16921, Heron I. (23°27'S, 151°55'E), Feb. 1990, J.D. Shields, reef, symbiotic with brachyuran crab, *Atergatopsis*, on gills; QM-W21396, Moreton Bay (27°00'S, 153°00'E), Feb. 1989, J.D. Shields, stn 3-51, sublittoral, symbiotic with *Portunus pelagicus*.

Remarks. MacDonald (1869: 442) originally described *Paradolepas neptuni* from specimens attached to the gills of *Portunus pelagicus* from Moreton Bay, Qld, and Sydney, NSW. *Octolasmis neptuni* has been reported from Australia (Hoek 1883: 32; Jones *et al.* 1990: 9); WA (Jones 2003: 483); Tas. (Nilsson-Cantell 1927: 768); NSW and Qld (MacDonald 1869: 40; Gruvel 1905: 128; Wu 1967: 277); and Qld (Newman 1961: 100).

Distribution. WA, Tas., NSW, Qld; Indo-west Pacific.

Habitat. Depth 0–30 m; endozoic, attached to gills of decapod crustaceans (e.g. *Charybdis jaubertensis* Rathbun, *Portunus pelagicus* (Linnaeus), *Thalamita* sp.).

Octolasmis warwickii (Gray, 1825)

Octolasmis warwickii Gray, 1825: 100 — 1830: pl. 6 fig. 16.
Dichelaspis warwicki — Darwin, 1852: 120, pl. 2 fig. 6–6b.
Dichelaspis equina Lanchester, 1902: 385, pl. 35 figs 7a–d.

Material Examined. AM-P21915, Raby Bay (27°32'S, 153°16'E); QM-W4618 (as *Dichelaspis* cf *equina*), Scarness (25°17'S, 152°51.0'E), ex *Thenus orientalis* (W 1710); QM-W16918, Moreton Bay (27°00'S, 153°00'E), Mar. 1989, J.D. Shields, stn 4-62, sublittoral, symbiotic with *Portunus pelagicus*, on gills; WAM-C32651, Moreton Bay (27°15'S, 153°15'E).

Remarks. This species has been recorded from WA, NT, Qld and NSW (Jones *et al* 1990: 10); WA (Jones 2003: 483; Jones & Hewitt 1995: 54); and northern Qld (Zann & Harker 1978: 207; on *Thenus orientalis* 10–40 m, and observed on *Charybdis callianassa, C. jaubertensis* and *Portunus pelagicus*).

Distribution. WA, NT, Qld, NSW; Indo-west Pacific.

Habitat. Depth 0–100 m; epizoic, e.g. on antipatharians, decapod crustaceans (attached to mouthparts, limbs and carapace).

Temnaspis Hinds, 1844

Temnaspis tridens asymmetrica Broch, 1947

Temnaspis tridens asymmetrica Broch, 1947: 20, fig. 4.

Material Examined. [as *Octolasmis tridens*] QM-W16922, Heron I. (23°27'S, 151°55'E), Feb. 1990, J.D. Shields, reef, symbiotic with spiny lobster, *Panulirus penicillatus*, on legs.

Remarks. Material in the AM from east of Townsville (AM-P40900) was reported by Jones *et al.* (1990: 10), a first record from Australia. The QM material reported herein confirms the presence of this species in Queensland.

Distribution. Qld; Indo-Malayan.

Habitat. Depth 16–296 m; epizoic on decapod crustaceans (e.g. Portunidae, Palinuridae).

Trilasmis Hinds, 1844

Trilasmis eburnea Hinds, 1844

Trilasmis eburnea Hinds, 1844: 60, pl. 21 fig. 5.
Poecilasma eburneum — Darwin, 1852: 112, pl. 2 fig. 5, pl. 10 fig. 15.

Material Examined. [as *Poecilasma eburneum*] QM-W12090 Swains Survey (21°46.9′S, 152°50′E), 54 m, 27.06.1980, Queensland Fisheries Service, stn 12, ex *Prionocidaris bispinosa*.

Remarks. This species has been recorded previously from WA (Jones *et al.* 1990: 8; Taylor & Rainbow 1997: 385).

Distribution. WA, Qld; Indo-west Pacific.

Habitat. Depth 20–448 m; epizoic (on cidarians).

Order SCALPELLIFORMES Buckeridge & Newman (2006)

Suborder SCALPELLOMORPHA Newman, 1987

Family CALANTICIDAE Zevina, 1978

Smilium Gray, 1825

Smilium peronii (Quoy & Gaimard, 1834)

Anatifa obliqua Quoy & Gaimard, 1834: 628, pl. 93 fig. 16.

Smilium peronii Gray, 1825: 100 — 1830: pl. 53, fig. 10.

Scalpellum peronii — Darwin, 1852: 264, pl. 6 fig. 6.

Material Examined. AM-P21151, 600 m W of Mud I. (27°20′S, 153°15′E); AM-P21152, off Tin Can Bay (25°54′S, 153°01′E); AM-P23739, Caloundra (26°48′S, 153°08′E); QM-W2791, Moreton Bay, 0.5 ml W of Mud I, (27°20′S, 153°15′E), 7–10 m, 22.02.1962.

Remarks. Darwin (1852: 265) first recorded specimens from the Swan River, WA and Port Western, Bass Strait, Vic., which had been collected by *Astrolabe*. Further specimens were recorded by Krüger (1914: 431) from WA, at Shark Bay and Fremantle. The species was first recorded from Queensland (Moreton Bay) by Stephenson *et al.* (1970: 492). Jones (1990a: 214; 1990b: 338; 1993: 122) and Jones *et al.* (1990: 4) subsequently recorded the species across southern Australia, from WA (Abrolhos Islands southward) to southern Qld (Tin Can Bay). This Australian endemic differs from all other shallow water Scalpellidae known from Australian waters in the lack of calcareous scales on the peduncle. In life the thin integument covering the capitulum is characteristically claret-purple or royal purple.

Distribution. WA, SA, Bass Str. (E), Vic., NSW, Qld (SE); Australia (southern).

Habitat. Depth 0–135 m; attached to a variety of substrata, e.g. seagrasses (*Cymodocea* sp.), corallines, wooden stakes, *Pyura* sp.

Order SESSILIA Lamarck, 1818

Suborder BALANOMORPHA Pilsbry, 1916

Superfamily CHTHAMALOIDEA Darwin, 1854

Family CATOPHRAGMIDAE Utinomi, 1968

Catomerus Pilsbry, 1916

Catomerus polymerus (Darwin, 1854)

Catophragmus polymerus Darwin, 1854: 487, pl. 20 figs 4a–e.

Catomerus polymerus — Newman & Ross, 1976: 40.

Material Examined. None; south eastern Queensland literature records are those of Endean *et al.* (1956a: 107), Pope (1965: 16) and Westcott *et al.* (1980: 53).

Remarks. This endemic species was described by Darwin (1854: 487) from material collected from NSW and WA and cited by Hoek (1883: 33) and Gruvel (1905: 196), but the locality of the WA material is questionable (see Pope 1965: 19). Queensland records are those of Endean *et al.* (1956a: 107; Qld); Pope (1965: 16; Qld from Currumbin southward, NSW, Vic., GAB, Tas.); and Westcott *et al.* (1980: 53; Qld, NSW, Vic., Tas., SA). Additional records for eastern Australia are Pilsbry (1916: 336; NSW, Vic.); Nilsson-Cantell (1926: 8; NSW, Tas.); Fischer (1940: 312; temperate Australia); Pope (1943: 236, NSW; 1945: 356, NSW); Dakin *et al.* (1948: 199; NSW); Guiler (1950: 179, Tas.; 1951b: 60, Tas.; 1952: 20, Tas.); Dakin *et al.* (1953: 208; eastern Australia); Bennet & Pope (1953: 105, Vic.); Womersley & Edmonds (1958: 217; SA); Bennet & Pope (1960: 182; Tas.); Wisely & Blick (1964: 164; NSW); Underwood (1977: 11, 19; NSW); and Anderson (1983: 7; SE Australia).

Distribution. Australian endemic: GAB, SA, Vic., Tas., NSW, Qld (SE). ?WA (see Remarks).

Habitat. Littoral; MTL–LWS; favouring turbulent seas and high energy coasts.

Family CHTHAMALIDAE Darwin, 1854

Subfamily CHTHAMALINAE Darwin, 1854

Chthamalus Ranzani, 1817

Chthamalus antennatus Darwin, 1854

Chthamalus antennatus Darwin, 1854: 460, pl. 18 fig. 2, pl. 29 fig. 3.

Material Examined. AM-P19737, Pt Lookout, Stradbroke I., Moreton Bay (27°40′S, 153°30′E); AM-P19738, Pt Lookout, Stradbroke I., Moreton Bay (27°40′S, 153°30′E); AM-P19739, Bustard Heads (24°01′S, 151°46′E); AM-P19740, Caloundra (26°48′S, 153°08′E); AM--P52083, Pt Lookout, N Stradbroke I. (27°26′S, 153°32′E); SAM-Tc11479, Moreton Bay (27°15′S, 153°15′E); WAM-C19259, Cooee Bay (23°08′S, 150°45′E).

Remarks. This endemic species was first recorded from Australian waters by Darwin (1854: 460) from Tas., NSW and Queensland. Further Queensland records are those of Fischer (1940: 292, 301, 307; NSW, Qld, Tas.); Endean *et al.* (1956a: 107; Qld); Pope (1965: 45; Qld, NSW, Vic., Tas., SA, WA); Rosell (1972: 178; Qld, NSW, Vic., Tas., WA); and Jones *et al.* (1990: 11; WA, across southern Australia to Qld).

Distribution. WA (from Eucla eastward), SA, Tas., Vic., NSW, Qld (SE, to Bustard Head); Australia (southern).

Habitat. Littoral extending to supralittoral.

Chthamalus malayensis Pilsbry, 1916

Chthamalus malayensis Pilsbry, 1916: 310, fig. 90, pl. 72 figs 5, 5a.

Material Examined. AM-P19781, Wooded I., off Urangan (25°17′S, 152°54′E); AM-P19783, C. Capricorn (23°29′S, 151°14′E); AM-P19785, Bustard Head (24°01′S, 151°46′E); AM-P19786, Double I. Pt (25°56′S, 153°11′E); AM-P19787, Sarina (21°26′S, 149°13′E); AM-P19789, Niggerhead, Heron I. (23°27′S, 151°55′E); AM-P19791, island off High Peak I. (21°58′S, 150°41′E); AM-P19792, Pt Vernon, Hervey Bay (25°15′S, 152°49′E); AM-P19793, Bagara (24°49′S, 152°28′E); AM-P19794, Slade Pt, nr Mackay (21°04′S, 149°14′E); AM-P19795, Bargara (24°50′S, 152°28′E); WAM-C19264, Cooee Bay (23°08′S, 150°45′E), high barnacle zone, N edge.

Remarks. The species is recorded from WA (Shark Bay northward) across northern Australia to Queensland (~25°S). The first Australian records of the species are from WA (Krüger 1914: 435, as *C. stellatus* var. *communis*; Broch 1916: 14, as *C. antennatus*) and thence from Queensland (Endean *et al.* 1956a: 88; Endean *et al.* 1956b: 317; Stephenson *et al.* 1958: 268) and Qld, NT and WA (Pope 1965: 51; Foster 1974: 4; Lewis 1981: 4; Jones 1990a: 216; 1991: 165; 1992a: 52; 1992b: 90; 1993: 216; 2003: 483; 2004: 146; Jones & Hewitt 1996: 51; Jones *et al.* 1990: 11).

Distribution. WA (from Garden I. north), NT, Torres Str., Qld (to 25°S); Tropical Indo-west Pacific.

Habitat. Littoral, HWS–LWN; on open rock faces.

Subfamily EURAPHIINAE Newman & Ross, 1976

Caudoeuraphia Poltarukha, 1997

Caudoeuraphia caudata (Pilsbry, 1916)

Chthamalus caudatus Pilsbry, 1916: 314, fig. 92, pl. 73 figs 1, 1a, 1b.
Euraphia caudata — Newman & Ross, 1976: 41.
Caudoeuraphia caudata — Poltarukha, 1997: 1110, figs 1, 6.

Material Examined. AM-P19746, Bargara (24°49′S, 152°28′E); AM-P19747, C. Capricorn, NW side (23°29′S, 151°14′E); AM-P19749, Port Vernon, Hervey Bay (25°15′S, 152°49′E); AM-P19750, Port Vernon (25°15′S, 152°49′E); AM-P19751, Clews Pt, Bustard Head (24°00′S, 151°44′E); AM-P19752, Bargara (24°49′S, 152°28′E); AM-P19753, Elliot R. Heads (24°55′S, 152°29′E).

Remarks. The species was first recorded from Australia by Endean *et al.* (1956a: 107; 1956b: 332) on the NE Queensland coast and later at the Low Islands (Stephenson *et al.* 1958: 268). Pope (1965: 35) recorded the species from Queensland (from Point Vernon northward to Port Douglas) and WA; Foster (1974: 42) from the Queensland coast to 25°S; Jones *et al.* (1990: 11) from north-western WA and Queensland, and Jones (2003: 483; 2004: 145) from north-western WA. The species is characterized by the presence of a pair of long, slender caudal appendages.

Distribution. WA (from Dampier northward), NT, Qld (to 25°S); Indo-Malaya.

Habitat. MHW–MLW; shaded areas in the upper intertidal zone.

Microeuraphia Poltarukha, 1997

Microeuraphia withersi (Pilsbry, 1916)

Chthamalus withersi Pilsbry, 1916: 312, fig. 91, pl. 73 figs 2–2e.
Euraphia withersi — Newman & Ross, 1976: 41.
Microeuraphia withersi — Poltarukha, 1997: 1116, figs 3(6), 4(3), 6.

Material Examined. AM-P19815, Urangan, Hervey Bay (25°17′S, 152°54′E); AM-P19817, Urangan (25°17′S, 152°54′E); AM-P19831, Pt Vernon (25°15′S, 152°49′E); AM-P19834, S Yeppoon (23°08′S, 150°44′E); AM-P19837, Wreck Pt, nr Cooee Bay, Yeppoon (23°09′S, 150°46′E); AM-P19838, Little Woody I., off Urangan (25°19′S, 153°01′E); AM-P19844, River Heads (24°55′S, 152°29′E); AM-P19845, Bargara (24°49′S 152°28′E); WAM-C19263, Cooee Bay (23°08′S, 150°45′E), highest barnacle zone, sheltered.

Remarks. The species has been reported from the east coast of Queensland and NT (Pope 1965: 44; Endean *et al.* 1956a: 107; 1965b: 332) and northern WA, NT and Qld (Jones 2003: 483; 2004: 145; Jones *et al.* 1990: 11).

Distribution. WA (Carnarvon northward), NT, Qld (to ~ 25°S); Indo-west Pacific.

Habitat. Littoral, HWS–HWN; on sheltered shores in crevices or areas of slight shade.

Octomeris Conrad, 1837

Octomeris brunnea Darwin, 1854

Octomeris brunnea Darwin, 1854: 484, pl. 20 figs 3a–b.

Material Examined. AM-P19853, Wreck Pt, Cooee Bay, Yeppon (23°09′S, 150°46′E); AM-P19859, N Keppell I., E of Yeppoon (23°08′S, 150°56′E).

Remarks. *Octomeris brunnea* was first discovered in Australia on the Queensland coast in 1952 (Pope 1965: 21). Further Queensland records are those of Endean *et al.* (1956a: 107; 1956b: 332), Pope (1965: 20), Foster (1974: 39) and Jones *et al.* (1990: 11). The species has not been recorded elsewhere along the northern Australian coast.

Distribution. Qld: from Cooktown southward to Yeppon (~23°S); Malay Arch. and Western Pacific.

Habitat. Littoral HWS–MHW; hypobiotic, deep in crevices, on underside of small boulders, or walls on intertidal caves.

Family CHELONIBIIDAE Pilsbry, 1916

Chelonibia Leach, 1817

Chelonibia caretta (Spengler, 1790)

Lepas caretta Spengler, 1790: 185, pl. 6 fig. 4.
Chelonibia caretta — Darwin, 1854: 394, pl. 14 fig. 2.

Material Examined. AM-P21323, Moreton Bay (27°25′S, 153°20′E); AM-P21324, Moreton Bay (27°25′S, 153°20′E); AM-P21330, Woody Pt, Moreton Bay (27°16′S, 153° 06′E); AM-P2371, 8 specs, Victoria Pt, Moreton Bay (27°35′S, 153°19′E); AM-P24135, Moreton Bay (27°25′S, 153°20′E); AM-P23716, Heron I. (23°27′S, 151°55′E); QM-W3654, North Reef (23°11′S, 151°54′E), 10.12.1951, ex *Caretta caretta*; QM-W4903, 5 specs, Heron I. lagoon (23°27′S, 151°55′E), 11.07.1975, R. Monroe, from male *Caretta caretta* (ex 2159); QM-W6498, Wistari Reef, Capricorn Gp (23°29′S, 151°53′E), C. Limpus ex *Caretta caretta*; QM-W7372, Boydong I, C. York (11°29′S, 143°01′E), 09.12.1976, C. Limpus, ex *Eretmochelys imbricata* (ex 4115); QM-W7374, Wistari Reef (23°29′S, 151°53′E), 27.05.1976, C. Limpus, ex *Eretmochelys imbricata* (ex 2803); QM-W7489, 5 specs, Mon Repos Beach (24°53′S, 152°28′E), 28.12.1977, C. Limpus and party, ex *Caretta caretta* (ex 8287); QM-W7490, 6 specs, Mon Repos Beach (24°53′S, 152° 28′E), 27.12.1977, C. Limpus and party, ex *Caretta caretta* (ex 8301); QM-W7491, 3 specs, Mon Repos Beach (24°53′S, 152°28′E), 20.12.1977, C. Limpus and party, ex *Caretta caretta* (ex 8131); SAM-Tc11471, Moreton Bay (27°15′S, 153°15′E).

Remarks. The species was first recorded from northern Australia by Darwin (1854: 394). Subsequent records are those of Weltner (1899: 443), Broch (1931: 133), Hiro (1937: 69), Jones (2003: 483; 2004: 147) and Jones *et al.* (1990: 11). Specific records from Queensland are those of Monroe & Limpus (1979: 199) and Monroe (1981: 237).

Distribution. WA, NT, Torres Str., Qld; cosmopolitan in tropical seas.

Habitat. Surface, epizoic on turtles (e.g. *Caretta caretta* (Linnaeus), *Chelonia mydas* (Linnaeus), *Eretmochelys imbricata* (Linnaeus), *Eretmochelys squamosa* Girard).

Chelonibia patula (Ranzani, 1818)

Coronula patula Ranzani, 1818: 86, pl. 3 figs 25–28.
Chelonibia patula — Darwin, 1854: 396, pl. 14 figs 3a–b, 4.

Material Examined. QM-W7354, Moreton Bay, nr Tangalooma (27°27′S, 151°26′E), 10.07.1977, fishing trawl, from left human femur; QM-W7847, Moreton Bay, central (27°25′S, 153°20′E), 03.02.1972, C. Boel, ex *Portunus pelagicus*; QM-W7870, North Reefs (23°11′S, 151°54′E), 31.07.1973, W. Phillips, ex sacculinized *Portunus pelagicus*; SAM-Tc11473, Stradbroke (27°28′S, 153°27′E), on sand crab.

Remarks. *Chelonibia patula* was first recorded from 'Australia' by Darwin (1854: 396). Subsequent Australian records are those of Gruvel (1905: 269), Pilsbry (1916: 268), Broch (1931: 133) and Nilsson-Cantell (1934a: 71, 1934b: 61, 1937: 95). Specific Queensland records are those of Monroe (1981: 242) and Jones *et al.* (1990: 11; WA, NSW, Qld, NT). The species is also recorded from brachyuran crabs in the waters of WA (Jones 2003: 483; 2004: 147; Jones & Hewitt 1996: 53).

Distribution. WA, NT, Qld, NSW; cosmopolitan in tropical and subtropical seas.

Habitat. Epizoic on decapod crustaceans, e.g. *Portunus pelagicus* (Linnaeus), *Scylla serrata* (Forsskål); less often on molluscs, e.g. *Busycon contrarius* (Conrad) and xiphosurans, e.g. *Limulus* spp; occasionally on ships.

Chelonibia testudinaria Linnaeus, 1758

Lepas testudinaria Linnaeus, 1758: 668.
Coronula testudinaria – Ranzani, 1820: 13, pl. 3.
Chelonibia testudinaria – Darwin, 1854: 392, pl. 14 figs 1a–1d, 5, pl. 15 fig. 1.

Material Examined. AM G 4973, Masthead I. (23°32′S, 151°44′E); AM-P21334, Bird I., Moreton Bay (27°31′S, 153°23′E); AM-P21335, Heron I., Capricorn Gp (23°27′S, 151°55′E); AM-P21338, Heron I., Capricorn Gp (23°27′S, 151°55′E); AM-P21340, Wistari Reef, Capricorn Gp (23° 29′S, 151°53′E); AM-P24136, Sarina (21°26′S, 149°13′E); QM-W3067, 3 specs, Mon Repos (24°53′S, 152°28′E), ex carapace of loggerhead *Caretta caretta*; QM-W4840, 4 males, Heron I. lagoon (23°27′S, 151°55′E), May 1975, C. Limpus, from *Caretta caretta*, sub-adult male in poor condition; QM-W4846, 1 male, Heron I. lagoon (23°27′S, 151°55′E), May 1975, C. Limpus, from *Caretta caretta* (ex 2083) sub-adult male in poor condition, from plastron; QM-W4902, 2 specs, Heron I (23°27′S, 151°55′E), 10.08.1975, R. Monroe, from male *Chelonia mydas* (ex 2115); QM-W4904, 9 specs, Heron I. lagoon (23°27′S, 151.55′E), 11.07.1975, R. Monroe, from *Chelonia mydas* (ex 1009); QM-W6499, Mon Repos (24°53′S, 152°8′E), Dec. 1968, C. Limpus, ex *Chelonia depressus*; QM-W6500, Mon Repos (24°53′S, 152°8′E), 28.12.1970, C. Limpus, from turtle (ex 3608), 28.12.1970; QM-W7370, Mon Repos (24°53′S, 152°8′E), 20.01.1977, C. Limpus, ex *Caretta caretta* (ex 4283); QM-W7371, Mon Repos (24°53′S, 152°8′E), 16.01.1977, C. Limpus, ex *Caretta caretta* (ex 3865); QM-W7736, Mon Repos (24°53′S, 152°28′E), 17.12.1977, C. Limpus and party; QM-W7737, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8313), from under flippers; QM-W7738, Mon Repos (24°53′S, 152°28′E), 20.04.1977, C. Limpus and party, ex *Caretta caretta*, female (ex 8408); QM-W7739, Mon Repos (24°53′S, 152°28′E), 24.11.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8102), from head; QM-W7740, Mon Repos (24°53′S, 152°28′E), 01.12.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8102), from head; QM-W7741, Mon Repos (24°53′S, 152°28′E), 10.05.1977, C. Limpus and party, ex *Caretta caretta*, female (ex 8102) from carapace; QM-W7743, Mon Repos (24°53′S, 152°28′E), 01.12.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 72), from carapace; QM-W7744, Curtis I, (23°38′S, 151°10′E), 16.04.1977, C. Limpus and party, ex *Chelonia depressa*; QM-W7745, Mon Repos (24°53′S, 152°28′E), 24.11.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8102); QM-W7746, Moreton Bay (27°25′S, 153°20′E), 10.10.1977, R. Monroe, L. Connor, ex *Chelonia mydas* from carapace; QM-W7747, Mon Repos (24°53′S, 152°28′E), 10.12.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8102), from head; QM-W7748, Mon Repos (24°53′S, 152°28′E), 10.01.1978, R. Monroe, ex *Chelonia depressa*, female (ex 8244), from carapace; QM-W7749, Mon Repos at 'The Oaks' (24°53′S, 152°28′E), 27.11.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8286); QM-W7750, Mon Repos (24°53′S, 152°28′E), 12.12.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8473), from carapace; QM-W7751, Mon Repos (24°53′S, 152°28′E), 12.11.1977, C. Limpus and party, ex female (ex 8244), from carapace; QM-W7752, Mon Repos (24°53′S, 152°28′E), 08.12.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8244), from carapace; QM-W7753, Mon Repos (24°53′S, 152°28′E), 01.12.1977, C. Limpus and party, ex *Caretta caretta*, female (ex 72), from plastron; QM-W7754, Mon Repos (24°53′S, 152°28′E), 04.12.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8145), from carapace; QM-W7755, Moreton Bay (27°25′S, 153°20′E), 10.10.1977, R. Monroe, L.R.G. Cannon, ex *Chelonia mydas*, from plastron; QM-W7838, Wynnum (27°27′S, 153°10′E), 10.01.1977, P. Davie, ex carapace and flippers of female green turtle; QM-W7839, Wynnum (27°27′S, 153°10′E), 10.01.1977, P. Davie, ex ventral side of female green turtle; QM-W7840, Mon Repos (24°53′S, 152°28′E), 08.12.1977, C. Limpus, ex plastron of *Chelonia depressa* (ex 8244); QM-W7841, Mon Repos (24°53′S, 152°28′E), 10.12.1977, C. Limpus, ex flippers of *Caretta caretta* (ex 8102); QM-W7842, Mon Repos (24°53′S, 152°28′E), 22.11.1977, C. Limpus, ex plastron of *Chelonia depressa* (ex 8244); QM-W7843, Mon Repos (24°53′S, 152°28′E), 28.12.1978, C. Limpus, ex *Chelonia depressa* (ex 8102); QM-W7844, Mon Repos (24°53′S, 152°28′E), summer 1977–78, C. Limpus, ex *Caretta caretta*; QM-W15953, 2 specs, Heron I. (23°27′S, 151°55′E), from back of turtle, Nov. 1949.

Remarks. The species was first recorded by Darwin (1854: 392) from the NE coast of Australia. It has since been recorded from the west coast of Australia and Torres Str. (Krüger 1911: 57); WA (Broch 1916: 14; Jones 1990b: 383; 1991: 167; 2003:484; 2004: 147; Jones & Berry 2000: 60; Jones & Hewitt 1995: 54).); and Qld (Monroe & Limpus 1979: 199; Monroe 1981: 237) and WA, NT and Qld (Jones *et al*. 1990: 11).

Distribution. WA, NT, Torres Str., Qld; cosmopolitan in temperate and tropical seas.

Habitat. Epizoic, attached to sea turtles, e.g. *Caretta caretta* (Linnaeus); *Chelonia depressa* Garman; *Chelonia japonica* (Thunberg); *Chelonia mydas* (Linnaeus); *Eretmochelys imbricata* (Linnaeus); *Eretmochelys squamosa* Girard), *Lepidochelys olivacea* (Eschscholtz).

Superfamily CORONULOIDEA Leach, 1817

Family CORONULIDAE Leach, 1817

Coronula Lamarck, 1802

Coronula diadema (Linnaeus, 1767)

Lepas diadema Linnaeus, 1767: 1108.
Coronula diadema – Lamarck, 1818: 387.

Material Examined. QM-W7464, 4 specs, ocean beach, Fraser I. (25°22'S, 153°07'E), Mar. 1978, Anatomy Dept, University of Qld, ex humpback whale, tip of flipper; QM-W16410, 26 specs, 0.4 km N. of Browns Rocks, Fraser I. (24°36'S, 153°20'E), 03.07.1989, R. Paterson, S. Van Dyck, ex humpback whale, *Megaptera novaeangliae* (QM JM 7302); QM-W16932, 11 specs, 0.4 km of Browns Rocks, Fraser I. (24°47'S, 153°16'E), 05.07.1989, R. Paterson, S. Van Dyck, ex stranded humpback whale, *Megaptera novaeangliae*.

Remarks. The first Australian record of this species is that of Guiler (1956: 3), recorded from *Coronula diadema* on *Megaptera* sp. in Tasmanian waters. Jones (1990a: 218; 1990b: 386; 1993: 218; 2003: 484) and Jones *et al.* (1990: 12) further documented the species from WA, Vic., Tas., NSW and southern Queensland.

Distribution. WA, Vic., Tas., NSW, Qld; cosmopolitan.

Habitat. Epizoic, attached to fin, blue, sperm and humpback whales, e.g. *Megaptera novaeangliae* Borowski; *M. nodosa* (Bonnaterre); *M. versabilis* Cope.

Xenobalanus Steenstrup, 1851

Xenobalanus globicipitis Steenstrup, 1851

Xenobalanus globicipitus Steenstrup, 1851: pl. 3 figs 11–15; 1852: 158, 161.

Material Examined. AM-P12975, Heron I., Capricorn Group (23°27'S, 151°55'E).

Remarks. The first western Pacific record of this cosmopolitan species is that of Pope (1958: 159), who recorded eight specimens from the tail flukes of a dolphin stranded on Heron Island, SE Queensland. Since that time, *X. globicipitus* has also been recorded from the NT and NSW (Jones *et al.* 1990: 13).

Distribution. NT, Qld, NSW; cosmopolitan.

Habitat. Epizoic on a wide range of marine mammals (fishes, dolphins, porpoises, whales).

Family PLATYLEPADIDAE Newman & Ross, 1976

Chelolepas Ross & Frick, 2007

Chelolepas cheloniae (Monroe & Limpus, 1979)

Stephanolepas muricata — Nilsson-Cantell, 1932: 258; Hendrickson, 1958: 52.

Tubicinella cheloniae Monroe & Limpus, 1979: 199, fig. 6, pl. 1 figs 5–6; Monroe 1981: 241; Jones *et al.* 1990; Limpus *et al.* 1994: 147.

Chelolepas cheloniae — Ross & Frick, 2007: 3–5, figs 1D, E, 2A.

Material Examined. Holotype: QM-W7248, Mon Repos (24°53'S, 152°28'E), C. Limpus, Dec. 1968, ex dead *Caretta caretta* (re-registered from W 6501). Paratypes: QM-W6501, 2 specs, Mon Repos (24°53'S, 152°28'E), C. Limpus, Dec. 1968, ex *Caretta caretta* (dead); QM-W6502, 1 specimen, Mon Repos (24°53'S, 152°28'E), ex *Caretta caretta*. Other material: AM-P40885, Mon Repos, Bundaberg (24°52'S, 152°28'E); QM-W6502, Mon Repos (24°53'S, 152°28'E), C. Limpus, ex *Caretta caretta*; QM-W7356, 7 specs, Mon Repos (24°53'S, 152°28'E), 21.01.1977, C. Limpus, ex *Caretta caretta* (ex 4417), 21.01.1977; QM-W7473, Wynnum, Moreton Bay (27°27'S, 153°10'E), 10.01.1978, P. Davie, ex *Chelonia mydas* male; QM-W7474, Mon Repos (24°53'S, 152°28'E), 12.11.1977, C. Limpus and party, ex *Caretta caretta* (ex 8108).

Remarks. Ross & Frick (2007) reviewed earlier accounts of this species and erected the genus *Chelolepas* to accept it, also indicating that Monroe & Limpus (1979) had misinterpreted some generic and familial characters when they placed it in *Tubicinella*. *Tubicinella* species are otherwise exclusively associated with cetaceans. *Chelolepas cheloniae* is recorded from Queensland (Monroe & Limpus 1979: 199; Jones *et al.* 1990: 13) and specimens in the collections of the WAM now extend the distribution of this species to the waters of WA.

Distribution. WA, Qld; Indo-Malayan.

Habitat. Epizoic on carapace or plastron of turtles, e.g. *Caretta caretta* (Linnaeus), *Chelonia mydas* (Linnaeus), *Eretmochelys imbricata* (Linnaeus) (Dobbs & Landry 2004). Shell flanges serve to anchor the barnacle in the tissues of the host, where they are commonly entwined with fibrous connective tissue (Monroe 1981).

Cylindrolepas Pilsbry, 1916

Cylindrolepas darwiniana Pilsbry, 1916

Cylindrolepas darwiniana Pilsbry, 1916: 288, pl. 68 figs 3–3b.

Material Examined. AM-P40880, St. Helena I., Moreton Bay (27°40'S, 153°30'E).

Remarks. In Australia this species has been reported from Queensland waters (Monroe, 1981: 237; Jones *et al.* 1990: 12).

Distribution. Qld; cosmopolitan.

Habitat. Epizoic; attached to turtles, e.g. *Chelonia mydas* (Linnaeus), *Eretmochelys coriacea* (Vandelli), *Lepidochelys olivacea* (Eschscholtz).

Platylepas Gray, 1825

Platylepas coriacea Monroe & Limpus, 1979

Platylepas coriacea Monroe & Limpus, 1979: 208, fig. 12, pl. 5 figs 1–8.

Material Examined. Holotype: QM-W7247, Wreck Rock, nr Bundaberg (24°19'S, 151°58'E), 17.01.1975, C. Limpus, ex *Eretmochelys coriacea*. Paratypes: QM-W4638, 2 specs, Wreck Rock, nr Bundaberg (24°16'S, 151°58'E), 17.01.1975, C. Limpus, ex *Eretmochelys coriacea*; QM-W4640, 7 specs, Mon Repos Beach, nr Bundaberg (24°53'S, 152°28'E), 11.01.1975, C. Limpus, ex leatherback turtle; QM-W4872, 2 specs, Alexander Headlands (26°40'S, 153°07'E), 12.09.1967, C.O. Harris, ex *Eretmochelys coriacea* (J 16133).

Remarks. Monroe & Limpus (1979: 208) described the species from SE Queensland (Mon Repos) attached to the Leatherback Turtle, *Eretmochelys coriacea* (Vandelli). Jones *et al.* (1990: 12) subsequently reported the species from Queensland and Tasmanian waters.

Distribution. Qld, Tas; Australia.

Habitat. Epizoic on turtles (e.g. *Eretmochelys coriacea* (Vandelli)).

Platylepas decorata Darwin, 1854

Platylepas decorata Darwin, 1854: 429, pl. 17 figs 2a–b.

Material Examined. QM-W4913, 6 specs, Heron I. lagoon (23°27'S, 151°55'E), 10.07.1975, R. Monroe, from *Chelonia mydas* female (ex 2111); QM-W4914, 4 specs, Heron I. lagoon (23°27'S, 151°55'E), 10.07.1975, R. Monroe, from *Chelonia mydas* sub-adult (ex 2146); QM-W4915, 6 specs, Heron I. lagoon (23°27'S, 151°55'E), 11.07.1975, R. Monroe, from *Chelonia mydas* sub-adult (ex 2157); QM-W4916, 3 specs, Heron I. lagoon (23°27'S, 151°55'E), 11.07.1975, R. Monroe, from *Caretta caretta* female (ex 2149); QM-W4917, 16 specs, Heron I. lagoon (23°27'S, 151°55'E), 10.07.1975, R. Monroe, from *Chelonia mydas* sub-adult (ex 2143); QM-W4919, 4 specs, Heron I. lagoon (23°27'S, 151°55'E), 11.07.1975, R. Monroe, from *Chelonia mydas* sub-adult female (ex 2091); QM-W4920, Heron I. lagoon (23°27'S, 151°55'E), 10.07.1975, R. Monroe, from *Chelonia mydas* male (ex 2117); QM-W4921, Heron I. lagoon (23°27'S, 151°55'E), 10.07.1975, R. Monroe, from *Caretta caretta* female (ex 647); QM-W4922, 2 specs, Heron I. lagoon (23°27'S, 151°55'E), 11.07.1975, R. Monroe, from *Caretta caretta* male (ex 2151); QM-W7142, Mon Repos (24°53'S, 152°28'E), Dec. 1975, C. Limpus, ex *Caretta caretta*; QM-W7183, Mon Repos (24°53'S, 152°28'E), Dec. 1975, C. Limpus, ex *Caretta caretta*; QM-W7184, 1 male, Heron I. lagoon (23°27'S, 151°55'E), May 1975, C. Limpus, ex *Caretta caretta*. sub-adult male in poor condition; QM-W7343, Heron I. lagoon (23°27'S, 151°55'E), 10.07.1975, R. Monroe, ex *Caretta caretta*, female (ex 2126); QM 7361, 2 specs, Wistari Reef (23°29'S, 151°53'E), 27.05.1977, C. Limpus, ex *Eretmochelys imbricata* (ex 2803); QM 7362, 5 specs, Wistari Reef (23° 29'S, 151°53'E), 23.05.1977, C. Limpus, ex *Eretmochelys imbricata* (ex 2773); QM 7363, 6 specs, Wistari Reef (23°29'S, 151°53'E), 23.05.1977, C. Limpus, ex *Eretmochelys imbricata* (ex 2774); QM-W7861, Heron I. (23°27'S, 151°55'E), 05.02.1978, C. Limpus, ex *Chelonia mydas*, male, barnacles from dorsal side of tail; QM 7867, Stradbroke I. (27°30'S, 153°30'E, June 1977, J. Johnson, ex *Caretta caretta* jaw.

Remarks. Darwin (1854: 429) described this species from material collected in the Pacific Ocean (Galapagos Archipelago, Lord Hood's, Island and the Low Archipelago). Monroe & Limpus (1979: 206) first recorded the species from Queensland waters and Jones *et al.* (1990: 12) extended the distribution to NSW and Queensland. The species is also now recorded from the waters of WA (Jones 2003: 484; 2004: 147).

Distribution. WA (N), Qld, NSW; Indo-west Pacific.

Habitat. Surface; epizoic, attached to turtles, e.g. *Caretta caretta* (Linnaeus), *Chelonia mydas* (Linnaeus), *Eretmochelys imbricata* (Linnaeus).

Platylepas hexastylos (Fabricius, 1798)

Lepas hexastylos Fabricius, 1798: 35, pl. 10 figs 1–2.

Platylepas bissexlobata — Darwin, 1854: 428. pl. 17 figs 1a–1d.

Platylepas hexastylos — Pilsbry, 1916: 285, pl. 67 figs 1–1c, 3.

Material Examined. QM-W4635, Heron I. lagoon (23° 27. S, 151°55.0 E), 19.12.1974, C. Limpus, ex *Caretta caretta*; QM-W4844, 6 males, Heron I. lagoon (23°27'S, 151°55.0 E), May 1975, C. Limpus, from *Caretta caretta* (ex 2083) sub-adult male in poor condition, from flippers and neck; QM-W4847, 4 males, Heron I. lagoon (23°27'S, 151°55'E), May 1975, C. Limpus, from *Caretta caretta* (ex 2083) sub-adult male in poor condition, from plastron; QM-W4918, 3 specs, Heron I. lagoon (23°27'S, 151°55'E), R. Monroe, from *Caretta caretta* female (ex 2126); QM-W6503, Heron I. (23°27'S, 151°55'E), C. Limpus (ex 2151); QM-W6504, Mon Repos at 'The Oaks' (24°52'S, 152°21'E), Dec. 1974, C. Limpus, sublittoral, symbiotic with turtle *Caretta caretta*; QM-W7304, Moreton Bay (27°25'S, 153°20'E), 06.03.1977, ex *Chelonia mydas*; QM-W7364, Heron I. lagoon (23°27'S, 151°55'E), 31.10.1976, C. Limpus, ex *Caretta caretta* (ex 2698); QM-W7366, 8 specs, Mon Repos (24°53'S, 152°28'E), 18.12.1976, C. Limpus, ex *Chelonia depressa* (ex 8189); QM-W7367, 2 specs, Wistari Reef (23°29'S, 151°53'E), 27.05.1977, C. Limpus, ex *Eretmochelys imbricata* (ex 2803); QM-W7514, specs, Mon Repos (24°53'S, 152°28'E), 10.12.1977, C. Limpus and party, ex *Caretta caretta*, female, from flippers (ex 8459); QM-W7515, Mon Repos (24°53′S, 152°28′E), 09.11.1977, C. Limpus and party, ex *Caretta caretta*, female, from plastron and flippers (ex 5212); QM-W7516, Mon Repos (24°53′S, 152°28′E), 12.12.1977, C. Limpus and party, ex *Caretta caretta*, female (ex 8143); QM-W7517, Mon Repos (24°53′S, 152°28′E), 07.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8163); QM-W7518, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Chelonia depressa*, female from neck (ex 8145); QM-W7519, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Chelonia depressa*, female (ex 8145), from flippers and neck; QM-W7520, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Chelonia depressa*, female (ex 8145), from flippers; QM-W7521, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Chelonia depressa*, female (ex 8145), from plastron; QM-W7522, Mon Repos (24°53′S, 152°28′E), 25.12.1977, R. Monroe, ex *Caretta caretta*, female (ex 8254); QM-W7523, Mon Repos (24°53′S, 152°28′E), 17.12.1977, R. Monroe, ex *Chelonia depressa*, female (ex 72), from flippers; QM-W7524, Mon Repos (24°53′S, 152°28′E), 01.12.1977, R. Monroe, ex *Chelonia depressa*, female (ex 72), from carapace; QM-W7525, Mon Repos (24°53′S, 152°28′E), 08.12.1977, R. Monroe, ex *Chelonia depressa*, female (ex 8244), from plastron; QM-W7526, Mon Repos (24°53′S, 152°28′E), 08.12.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8244), from flipper; QM-W7527, Mon Repos (24°53′S, 152°28′E), 10.01.1978, C. Limpus and party, ex *Chelonia depressa*, female (ex 8244), from flipper; QM-W7528, Mon Repos (24°53′S, 152°28′E), 01.12.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 72), from flippers; QM-W7529, Mon Repos (24°53′S, 152°28′E), 24.11.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8102), from carapace; QM-W7530, Mon Repos (24°53′S, 152°28′E), 10.12.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8102), from carapace; QM-W7531, Mon Repos (24°53′S, 152°28′E), 10.12.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8102), from flipper; QM-W7532, Mon Repos (24°53′S, 152°28′E), 24.11.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8102), from flippers; QM-W7533, Mon Repos at 'The Oaks' (24°53′S, 152°28′E), 23.11.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 296), from flippers; QM-W7534, Mon Repos at 'The Oaks' (24°53′S, 152°28′E), 23.11.1977, C. Limpus and party, ex *Chelonia depressa*, female (ex 8296), from carapace; QM-W7535, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8313); from tail; QM-W7536, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8332), from soft skin in front of carapace; QM-W7537, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8332); QM-W7538, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8332), from rear soft parts; QM-W7539, Mon Repos (24°53′S, 152°28′E), 10.12.1977, C. Limpus and party, ex *Caretta caretta*, female (ex 8503), from flippers; QM-W7540, Mon Repos (24°53′S, 152°28′E), 12.01.1978, C. Limpus and party, ex *Caretta caretta*, female (ex 8580), from soft tail skin; QM-W7541, Mon Repos (24°53′S, 152°28′E), C. Limpus and party, ex *Caretta caretta*, female (ex 8580); QM W7542, Mon Repos (24°53′S, 152°28′E), C. Limpus and party, ex *Caretta caretta*, female (ex 8580), embedded in carapace; QM-W7543, Mon Repos (24°53′S, 152°28′E), C. Limpus and party, ex *Caretta caretta*, female (ex 8622), from soft skin in front of carapace; QM-W7544, Moreton Bay (27°25′S, 153°20′E), 10.10.1977, R. Monroe, ex *Chelonia mydas*; QM-W7545, Moreton Bay (27°25′S, 153°20′E), 10.10.1977, R. Monroe, ex *Chelonia mydas* at base of tail; QM-W7546, Moreton Bay (27°25′S, 153°20′E), 10.10.1977, R. Monroe, ex *Chelonia mydas*, anterior soft skin; QM-W7547, Moreton Bay (27°25′S, 153°20′E), 10.10.1977, R. Monroe, ex *Chelonia mydas*, posterior soft skin; QM-W7548, Wilson I. (23°18′S, 151°55′E), Oct 1977, C. Limpus and party, ex *Chelonia mydas*; QM-W7549, Heron I. (23°27′S, 151°55′E), 04.02.1978, C. Limpus and party, ex *Caretta caretta*, female (ex 2394), from around tail; QM-W7550, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8622), from flipper; QM-W7551, Mon Repos (24°53′S, 152°28′E), 21.12.1977, C. Limpus and party, ex *Caretta caretta*, female (ex 8213), from shoulder; QM-W7552, Mon Repos (24°53′S, 152°28′E), 24.01.1977, C. Limpus and party, ex *Caretta caretta*, female (ex 8588); QM-W7553, Mon Repos (24°53′S, 152°28′E), 12.01.1977, R. Monroe, ex *Caretta caretta*, female (ex 8622), belly ahead of plastron; QM-W7554, Curtis I. (23°38′S, 151°10′E), 16.12.1977, C. Limpus and party, ex *Chelonia depressa*; QM-W7555, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8622), from carapace ahead of rear right flipper; QM-W7556, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8160), from front right flipper; QM-W7557, Mon Repos (24°53′S, 152°28′E), 20.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8408); QM-W7811, Heron I. (23°27′S, 151°55′E), 05.02.1978, C. Limpus, ex *Chelonia mydas*; QM-W7814, Mon Repos (24°53′S, 152°28′E), 12.01.1978, R. Monroe, ex *Caretta caretta*, female (ex 8313), from back right flipper; SAM-Tc11522, E Masthead I. (23°32′S, 151°43′E).

Remarks. The first report of the species in Australian waters was from Moreton Bay, from a dugong (Darwin 1854: 428). Further Queensland records were documented by Zann & Harker (1978: 206, ex *Dugon dugon* and *Chelonia mydas*) and Monroe & Limpus (1979: 205, ex *Caretta caretta*, *Chelonia depressa*, *Chelonia mydas* and *Eretmocheyls imbricata*). The distribution of the species has been further extended by Jones (2003: 485; 2004: 147) and Jones *et al.* (1990) to include WA (N), NT, Qld and NSW.

Distribution. WA, NT, Qld, NSW; cosmopolitan in tropical and subtropical waters.

Habitat. Surface; attached to a variety of hosts: chelonians, e.g. *Caretta caretta* (Linnaeus); *Chelonia depressa* Garman; *Chelonia mydas* (Linnaeus); *Eretmochelys coriacea* (Linnaeus); *E. imbricata* (Linnaeus); *E. squamosa* Girard, *Lepidochelys olivacea* (Eschscholtz); sirenians, e.g. *Dugong dugon* (Müller); fish, e.g. *Lepidosteus* sp.; and crabs, e.g. *Charybdis jaubertensis* Rathbun.

Platylepas ophiophilus Lanchester, 1902

Platylepas ophiophilus Lanchester, 1902: 371, pl. 35 figs 5–5b.

Platylepas decorata — Nilsson-Cantell, 1921: 376.

Material Examined. QM-W7862, Mon Repos (24°53′S, 152°28′E), 11.11.1978, C. Limpus, ex sea snake *Hydrophis elegans*; QM-W7863, Noosa Heads (26°23′S, 153° 06′E), 1975, P. Sutton, on beach, ex sea snake; QM-W7865, Manly, Moreton Bay (27°28′S, 153°11′E), 19.11.1951, U.A. Rallings, ex *H. elegans*.

Remarks. Nilsson-Cantell (1921: 376) recorded *Platylepas decorata* Darwin, 1854 from a sea-snake off the West Australian coast. Utinomi (1970: 363) suggested that this was a misidentification of *P. ophiophilus*. This view was supported by Newman & Ross (1976: 44), Monroe & Limpus (1979: 208) and Jones *et al.* (1990: 12) and is supported herein.

Distribution. WA, Qld; Indo-west Pacific.

Habitat. Epizoic, attached to sea-snakes (e.g. *Enhydris curtus* Boulenger; *E. hardwickii* Boulenger; *Enhydrina valakadyn* (Boie); *Hydrophis cyanocinctus* Daudin; *Hydrophis elegans* Gray).

Stephanolepas Fischer, 1886

Stephanolepas muricata Fischer, 1886

Stephanolepas muricata Fischer, 1886: 193, pl. 4 figs 9–11; Monroe & Limpus, 1979: 201.

Material Examined. QM-W4845, 1 male, Heron I. lagoon (23°27′S, 151°55′E), May 1975, C. Limpus, from *Caretta caretta* (ex 2083), sub-adult male in poor condition, from flippers; QM-W4906, 10 specs, Heron I. lagoon (23°27′S, 151°55′E), 11.07.1975, R. Monroe, from *Chelonia mydas* sub-adult (ex 2091); QM-W4907, 7 specs, Heron I. lagoon (23°27′S, 151°55′E), 10.07.1975, R. Monroe, from *Chelonia mydas* sub-adult (ex 2145); QM-W4908, 1 male, Heron I. lagoon (23°27′S, 151°55′E), 11.07.1975, R. Monroe, from *Caretta caretta* (ex 2159); QM W4909, 2 specs, Heron I. lagoon (23°27′S, 151° 55′E), 10.07.1975, R. Monroe, from *Caretta caretta* female (ex 2133); QM-W4910, 4 specs, Heron I. lagoon (23°27′S, 151°55′E), 11.07.1975, R. Monroe, from *Caretta caretta* male (ex 2151); QM-W4911, 10 specs, Heron I. lagoon (23°27′S, 151°55′E), 10.07.1975, R. Monroe, from *Chelonia mydas* sub-adult (ex 2134); QM-W4912, Heron I. lagoon (23°27′S, 151°55′E), 10.07.1975, R. Monroe, from *Chelonia mydas* male (ex 2117); QM-W7303, Moreton Bay (27°25′S, 153°20′E), 06.03.1977, ex *Chelonia mydas*, from leading edge of front flipper; QM-W7466, Moreton Bay (27°25′S, 153°20′E), 10.10.1972, R. Monroe, ex *Chelonia mydas*; QM-W7467, 2 specs, Heron I, Capricorn Gp (23°27′S, 151°55′E), 04.02.1978, C. Limpus and party, ex *Caretta caretta* (ex 2691), sub-adult, between and through scales of front flippers.

Remarks. The record of Monroe & Limpus (1979: 201) represents the first for Australian waters and possibly the first record of the species since it was described by Fischer in 1886. Material in the WAM now extends the distribution of this species to WA.

Distribution. WA, Qld; Indo-Malayan.

Habitat. Epizoic on turtles, e.g. *Caretta caretta* (Linnaeus); *Chelonia mydas* (Linnaeus); *Eretmochelys imbricata* (Linnaeus).

Stomatolepas Pilsbry, 1910

Stomatolepas dermochelys Monroe & Limpus, 1979

Stomatolepas dermochelys Monroe & Limpus, 1979: 203, fig. 9, pl. 3 figs 1–5.

Material Examined. Holotype: QM-W6505, Wreck Rock, nr Bundaberg (24°16′S, 151°58′E), 17.01.1975, C. Limpus, from *Eretmochelys coriacea*. Paratypes: QM-W4639, 8 specs, Wreck Rock, nr Bundaberg (24°16′S, 151°58′E), 17.01.1975, C. Limpus, ex *Eretmochelys coriacea*. Other material: NMV-J42337, 6 specs from turtle host caught in fishing trawl net off Grassy, King I., Tas. (39°52′S, 143°59′E), 08.02.1996.

Remarks. The species was described from SE Queensland by Monroe & Limpus (1979: 203) attached to the Leatherback Turtle *Eretmochelys coriacea* (Linnaeus). It is here also recorded from King I., Tasmania.

Distribution. Qld, Tas; cosmopolitan.

Habitat. Surface, epizoic on the Leatherback Turtle, *Eretmochelys coriacea* (Linnaeus).

Stomatolepas praegustator Pilsbry, 1910

Stomatolepas praegustator Pilsbry, 1910: 304, pl. 68 figs 1–1b.

Material Examined. AM-P40879, Mon Repos, Bundaberg (24°52′S, 152°21′E); QM-W4848, QM-W7357, 19 specs, Heron I. (23°27′S, 151°55′E); QM-W7357, 75 specs, Mon Repos (24°53′S, 152°28′E); QM-W7481–6, 51 specs, Mon Repos (24°53′S, 152°28′E), ex *Caretta caretta*, from soft skin of neck and base of front flipper.

Remarks. The first record of this species from Australian waters is from SE Queensland waters (Monroe & Limpus 1979: 203). Specimens in the WAM now extend the distribution of this species to the waters of WA. The species embeds in the mucous membrane of upper end of gullet, soft skin of neck and base of front flippers of turtles.

Distribution. WA, Qld; cosmopolitan.

Habitat. Surface, epizoic on turtles, e.g. *Caretta caretta* (Linnaeus); *Lepidochelys olivacea* (Eschscholtz).

Stomatolepas transversa Nilsson-Cantell, 1930

Stomatolepas transversa Nilsson-Cantell, 1930a: 2; 1930b: 20; Monroe & Limpus, 1979: 205.

Material Examined. QM-W7468–W7471, 4 specs, Wistari Reef (23°29′S, 151°53′E), ex *Chelonia mydas*; QM-W7469–70, 16 specs, Heron I. (23°27′S, 151°55′E), ex *Chelonia mydas*.

Remarks. The species was first recorded in Australian waters by Monroe & Limpus (1979: 205) from SE Queensland. The species is distinguished from other *Stomatolepas* species by its host (*Chelonia mydas*), its attachment position (along the median groove of the plastron) and its elongate proportions.

Distribution. Qld; Aroe Arch., Indonesia.

Habitat. Surface, epizoic on the turtle *Chelonia mydas* (Linnaeus).

Superfamily TETRACLITOIDEA Gruvel, 1903

Family TETRACLITIDAE Gruvel, 1903

Subfamily AUSTROBALANINAE Newman & Ross, 1976

Austrobalanus Ross, 1970

Austrobalanus imperator (Darwin, 1854)

Balanus imperator Darwin, 1854: 288, pl. 8 figs 4a–c.
Balanus (Austrobalanus) imperator — Pope, 1945: 364, pl. 28 fig. 8, 10, pl. 30 figs 11–12.
Austrobalanus imperator — Newman & Ross, 1976: 46.

Material Examined. AM-P20041, Pt Vernon, Hervey Bay (25°15′S, 152°49′E); AM-P20042, Caloundra (26°48′S, 153°08′E); AM-P20043, Slade Pt, nr Mackay (21°04′S, 149°14′E); AM-P20045, Wreck Pt, Cooee Bay, Yeppoon (23°09′S, 150°46′E); AM-P20046, Elliot River Heads (24°55′S, 152°29′E); AM-P20047, Little Woody I., Hervey Bay (25°19′S, 153°01′E); AM-P20048, Rat I., Port Curtis (23°46′S, 151°19′E); AM-P20049, Port Vernon, Hervey Bay (25°15′S, 152°49′E); AM-P20050, Double Heads, Yeppoon (23°10′S, 150 48′E); AM-P23617, Brampton I., Mackay (20°49′S, 149°17′E); QM-W23910, 1 spec., Kings Headland, Caloundra (26°8′S, 153°08′E), 30.07.1997, P. Davie, D. Potter, littoral, rocky shore; SAM-Tc11479, Moreton Bay (27°15′S, 153°15′E); SAM-Tc11483, E Duck I., N of Mary R. (25°21′S, 153°00′E); SAM-Tc11655, Smith's Rock, Moreton Bay (27°15′S, 153°15′E), buoy; SAM-Tc11656, Smith's Rock, Moreton Bay (27°15′S, 153°15′E), attached to *Lepas anatifera*; SAM-Tc11657, Smith's Rock, Moreton Bay (27°15′S, 153°15′E), buoy.

Remarks. The species was first recorded from NSW (Sydney) and Qld (Moreton Bay) by Darwin (1854: 288). Subsequent records of this endemic Australian species are those of Hoek (1883: 32), Gruvel (1905: 246), Pope (1943: 236; 1945: 364), Allen & Wood (1950: 103), Newman & Ross (1976: 46), Underwood (1977: 13), Foster (1979: 100; 1980: 614), Newman (1979: 285), Lewis (1981: 5) and Jones *et al.* 1990: 14 (NSW, Qld). The purple colouration of the internal parietal walls and their rugged external sculpturing are characteristic for this species.

Distribution. NSW (Port Jackson northward); Qld (N to Torres Strait and N coastline; distribution sporadic); Australia (eastern).

Habitat. Littoral, MTL–LWS in sheltered position, attached to hard substrata.

Subfamily NEWMANELLINAE Ross & Perreault, 1999

Yamaguchiella Ross & Perreault, 1999

Neonrosella subgen. nov.

Rosella — Ross & Perreault, 1999: 5.

Remarks. Ross & Perreault (1999) proposed the subgenus *Rosella* in honour of Neon C. Rosell, for his numerous contributions to the knowledge of the cirripedes fauna of the Philippines, especially the tetraclitids. However, the subgenus is preoccupied (Clark, 1980; Jones, 1979). I therefore propose the alternate genus name *Neonrosella*, to perpetuate the recognition of Neon Rosell and his contributions to cirripedology.

Yamaguchiella (Neonrosella) vitiata (Darwin, 1854)

Tetraclita vitiata Darwin, 1854: 340, pl. 11 figs 3a–e.
Newmanella vitiata — Yamaguchi, in Ikeya & Yamaguchi, 1993: 93.

Yamaguchiella (Rosella) vitiata — Ross & Perreault, 1999: 5.

Material Examined. [all as *Newmanella vitiata*]: AM-P12407, W Reef, Heron I. (23°27'S, 151°55'E); AM-P20964, Heron I., Capricorn Gp. (23°27'S, 151°35'E), AM-P21131, Lady Elliot I. (24°07'S, 152°43'E); AM-P21373, Heron I. (23°27'S, 151°55'E); AM-P23730, Heron I. (23°27'S, 151°55'E); AM-P24125, edge of reef, Heron I. (23°27'S, 151°55'E); AM-P24126, Heron I. (23°27'S, 151°55'E); AM-P24133, Heron I. (23°27'S, 151°55'E); AM-P52104, Heron I. (23°27'S, 151°55'E).

Remarks. The species was first recorded from Raines Islet, GBR, by Darwin (1854: 340). Subsequent records are those of Hoek (1883: 33, Raine I., GBR); Gruvel (1905: 290, Australia); Hiro (1936a: 635, GBR); Nilsson-Cantell (1938: 76, Australia and GBR); Endean *et al.* (1956a: 88, 317); Endean *et al.* (1956b: 335, Heron I.); Stephenson *et al.* (1958: 268, Low Isles); Stephenson (1968: 52, Heron I.); Daniel (1972: 186, GBR); Foster (1974; Qld); Newman & Ross (1976: 48, GBR); and Lewis (1981: 6, Nth Barnard I., Qld). The distribution of the species has been extended to north-western WA by Jones (1992a: 52; 2003: 484; 2004: 148), Jones & Hewitt (1996: 51, 53; 1997: 94) and Jones *et al.* (1990: 14). Material held in the WAM collection confirms the presence of the species in the NT.

Distribution. WA (Exmouth Gulf northward), NT, Qld (North Stradbroke Island northward; also GBR); Indo-west Pacific.

Habitat. Intertidal to sublittoral, attached to hard substrata, including coral reefs.

Subfamily TETRACLITELLINAE Newman & Ross, 1976

Tetraclitella Hiro, 1939

Tetraclitella purpurascens (Wood, 1815)

Lepas purpurascens Wood, 1815: 55, pl. 9 fig. 42.
Tetraclita purpurascens — Darwin, 1854: 337 (part.), pl. 9 figs 1a, c–d.
Tetraclitella purpurascens — Newman & Ross, 1976: 47 (part).

Material Examined. AM-P11288, Noosa Heads (26°23'S, 153°06'E); AM-P12390, Heron I. (23°27'S, 151°55'E); AM-P12395 Noosa Heads (26°23'S, 153°06'E); AM-P20938, Pt Lookout, N Stradbroke I. (27°01'S, 153°30'E); AM-P20940, Bargara (24°49'S, 152°28'E); AM-P23842, Noosa Heads (26°23'S, 153°06'E); AM-P52063, Yeppoon (23°07'S, 150°46'E); AM-P52068, Pt Lookout, N Stradbroke I. (27°26'S, 153°32'E); NMV-J39342, Elliot Head, Bundaberg, H.V. Dobinson, Dec. 1963; NMV-J42379 Elliot Head, Bundaberg, H.V. Dobinson, Dec. 1963; NMV-J42379; QM-W4923, Hoffmans Rocks, 4 mls S of Burnett Heads (24°50'S, 152°25'E), July 1975, R. Monroe.

Remarks. This endemic species was first recorded from Australia by Darwin (1854: 337), from WA, Tas., NSW and the GBR, Qld. Subsequent eastern Australian records are those of Hoek 1883: 33 (Australia, Tas.); Weltner 1899: 443 (NSW); Gruvel 1905: 285 (WA, Tas., NSW); Nilsson-Cantell 1931: 115 (Australia); Fischer 1940: 292, 304, 307, 309 (SA, Tas., NSW, Qld); Pope 1943: 231 (NSW); Pope 1945: 367 (NSW); Dakin *et al.* 1948: 176 (NSW); Guiler 1950: 179 (Tas.); 1951b: 60 (Tas.); 1952: 20 (Tas.); Dakin *et al.* 1953: 208 (NSW); Endean *et al.* 1956a: 88 (Qld, but not N of lat. 25°S); Wisely & Blick 1964: 163 (NSW); Anderson 1969: 183 (southern Australia); Foster 1974: 46 (temperate Australia); Underwood 1977: 17, 23 (NSW); Foster 1979: 93 (southern Australian shores to lat. 25°S); Denley & Underwood 1979: 269 (NSW); Foster 1980: 614 (Australia, Lord Howe I.); Wescott *et al.* 1980: 56 (SE Australia); Anderson & Buckle 1983: 645 (NSW); Marine Research Group of Victoria 1984: 106 (WA, Tas., Vic., Qld); Anderson & Anderson 1985: 100 (eastern Australia); Foster & Anderson 1986: 65 (Australia: Qld from 26°S to Tas. and W to about Fremantle, 32°S), and Jones *et al.* (1990: 13) and Jones (1990b: 391) (WA, SA, Tas., Vic., NSW, S Qld).

Distribution. WA (S), GAB, SA, Tas., Bass Str., Vic., NSW, Norfolk I., Lord Howe I., Qld (SE); Australia (southern shores to ~25°S).

Habitat. Littoral, HWS–LWN; in shaded crevices, under overhangs or in sea caves.

Subfamily TETRACLITINAE Gruvel, 1903

Tesseropora Pilsbry, 1916

Tesseropora rosea (Krauss, 1848)

Conia rosea Krauss, 1848: 136, pl. 6 fig. 28.
Tetraclita rosea — Darwin, 1854: 335, pl. 10 figs 3a–d.
Tetraclita (Tesseropora) rosea — Pilsbry, 1916: 260.
Tesseropora rosea — Newman & Ross, 1976: 47.

Material Examined. AM-P12385, Brennan Shoals, off C. Moreton (27°02'S, 153°28'E); AM-P12387, Pt Lookout, N Stradbroke I., Moreton Bay, (27°25'S, 153° 20'E); AM-P12388, Brennan Shoals, off C. Moreton (27°02'S, 153°28'E); AM-P12389, Brennan Shoals, off

C. Moreton (27°02'S, 153°28'E); AM-P21136, Caloundra (26°48'S, 153°08'E); AM-P21141, 24°49'S, 152°28'E; AM-P21142, Double I. Pt (25°56'S, 153°11'E); QM-W23959, 30+ specs, Pt Lookout, N Stradbroke I. (27° 26'S, 153°32'E), 19.08.1997, P. Davie, littoral, rocky shore; QM-W23911, 26 specs, Kings Headland, Caloundra (26°48'S, 153°08'E), 30.07.1997, P. Davie, D. Potter, littoral, rocky shore; QM-W23959, 30+ specs, Pt Lookout, N Stradbroke I. (27°26'S, 153°32'E), 19.08.1997, P. Davie, littoral, rocky shore.

Remarks. Darwin (1854: 335) first recorded this species from NSW and Queensland. Subsequent records are as follows: Hoek 1883: 161 (NSW); Weltner 1897: 227 (NSW); Pilsbry 1916: 260 (Vic.); Barnard 1924: 92 (Australia); Nilsson-Cantell 1927: 788 (Australia); Hiro 1937: 68 (SA); Nilsson-Cantell 1938: 14 (Australia); Fischer 1940: 287, 305 (NSW, Qld); Pope 1943: 236 (NSW); Pope 1945: 366 (NSW); Dakin *et al.* 1948: (NSW); Dakin *et al.* 1953: 208 (NSW); Endean *et al.*, 1956a: 107 (Qld); Wisely & Blick 1964: 166 (NSW); Anderson 1969: 183 (NSW); Ross 1970: 1 (Australia); Daniel 1972: 186 (Australia); Newman & Ross 1976: 47 (Australia); Underwood 1977: 17, 21 (NSW); Foster 1979: 90 (Vic., NSW, Qld, Lord Howe I.); Denley & Underwood 1979: 269 (NSW); Foster 1980: 614 (Australia, Lord Howe I.); Wescott *et al.* 1980: 57 (Qld, NSW, Vic.); Anderson & Buckle 1983: 645 (NSW); Marine Research Group of Victoria 1984: 106 (Vic., NSW, Qld); Anderson & Anderson 1985: 89 (eastern Australia) and Jones *et al.* 1990: 13 (WA (S), Vic., NSW, Qld).

Distribution. ?WA (represented only by 2 specs), Vic., Bass Str., Tas., NSW, Lord Howe I., Qld (SE, to Magnetic I.); Australia, Lord Howe Is, Kermadec Islands. The records of the species from South Africa (Darwin, 1854: 335) need confirmation.

Habitat. Littoral; MLW–11 m.

Tetraclita Schumacher, 1817

Tetraclita squamosa (Bruguière, 1789)

Balanus squamosus Bruguière, 1789: 170, pl. 165 figs 9–10.
Tetraclita squamulosa Schumacher, 1817: 91.
Tetraclita porosa (and var. *viridis*, var. *nigrescens*) Darwin, 1854: 329, pl. 10 fig. 1a–m.
Tetraclita squamosa squamosa — Pilsbry, 1916: 251.

Material Examined. AM G 3290, Fraser I. (25°33'S, 153°07'E); AM-P12403, Rat I., Port Curtis (27°52'S, 153°24'E); AM-P21253, Wreck Pt, Cooee Bay, nr Yeppoon (23°09'S, 150°46'E); AM-P21257, Double Head, Yeppoon (23°10'S, 150°48'E); AM-P21258, Bargara (24°49'S, 152°28'E); AM-P21260, Rat I., off Port Curtis (23°46'S, 151°19'E); AM-P21267, Curtis I. (23°38'S, 151° 10'E); AM-P21751, Lammermoor (23°09'S, 150°46'E); QM-W14252, Sarina Beach headland (21°26'S, 149° 13'E), 12.04.1987, J. Johnson; QM-W14540, W. side of Lindeman I. (20°27'S, 149°02'E), 24.03.1987, P. Davie, J.W. Short, entrance to small creek down from golf course; on rock; SAM-Tc11646, C. Capricorn (23°29'S, 151°14'E).

Remarks. *Tetraclita squamosa* was first collected in 'Nouvelle-Hollande' (Australia) by Péron in 1802 (Gruvel 1903: 161; Lamy & André 1932: 219). Darwin (1854: 330) collected the species from the east coast of Australia and further east coast records are those of Hoek (1883: 33); Broch, 1922: 337 (NSW); Endean *et al.* 1956a: 88 (Qld S to 25°S); Endean *et al.* 1956b: 317 (Qld); Stephenson *et al.* 1958: 261 (Qld); and Lewis 1981: 6 (Qld). Jones *et al.* (1990: 14) recorded the species from WA, NT, Qld and NSW and further records from WA are those of Jones (1990a: 219; 1992a: 52; 1993: 218; 2003: 484; 2004: 148); Jones & Berry (2000: 60); and Jones & Hewitt (1995: 54, 55; 1996: 51, 53; 1997: 94).

Distribution. WA (NW), Cartier Reef, NT, Qld (SE); Indo-west Pacific.

Habitat. Littoral to 5 m.

Superfamily BALANOIDEA Leach, 1817
Family ARCHAEOBALANIDAE Newman & Ross, 1976
Subfamily ACASTINAE Kolbasov, 1993

Neoacasta Kolbasov, 1993

Neoacasta glans Lamarck, 1818

Acasta glans Lamarck, 1818: 398.
Neoacasta glans — Kolbasov, 1993: 407.

Material Examined. AM-P21911, S of Yeppoon (23°08'S, 150°44'E).

Remarks. This species was reported from the eastern and southern coasts of Australia by Darwin (1854: 314, southern Australia) and Gruvel (1905: 261, NSW, southern Australia). Subsequently, Jones *et al.* (1990: 15) have reported *Neoacasta glans* from WA, SA, NSW and southern Queensland waters.

Distribution. WA, SA, NSW, Qld (SE); Indo-west Pacific.

Habitat. LWM–55 m; epizoic (sponges).

Pectinoacasta Kolbasov, 1993

Pectinoacasta pectinipes Pilsbry, 1912

Acasta pectinipes Pilsbry, 1912: 294.
Acasta nitida Hoek, 1913: 237, pl. 24 figs 17–19, pl. 26 figs 1–3.
Pectinoacasta pectinipes — Kolbasov, 1993: 411.

Material Examined. AM-P21912, Dunwich, N Stradbroke I. (27°30'S, 153°24'E).

Remarks. The first Australian record of this species is that of Krüger (1914: 438) from material collected at Shark Bay, WA (as *A. nitida*). Jones *et al.* (1990: 15) and Jones 1993: 222) documented the species from WA, Vic., NSW and southern Queensland.

Distribution. WA, Vic., NSW, Qld (SE); Indo-west Pacific.

Habitat. Depth 0–170 m, epizoic (sponges).

Subfamily ARCHAEOBALANINAE Newman & Ross, 1976

Armatobalanus Hoek, 1913

Armatobalanus quadrivittatus (Darwin, 1854)

Balanus quadrivittatus Darwin, 1854: 284, pl. 8 fig. 1.
Balanus (Armatobalanus) quadrivittatus — Zullo, 1963: 589.
Armatobalanus (Armatobalanus) quadrivittatus — Newman & Ross, 1976: 49.

Material Examined. [as *Armatobalanus* sp.] SAM-Tc11472, Moreton Bay (27°15'S, 153°15'E).

Remarks. The material from Moreton Bay reported upon herein is the first record of *A. quadrivittatus* from Queensland waters. The species was first reported from Australia from the Kimberley in northern WA and Rottnest Island, WA (Jones 1992a: 52; 1993: 122) and thence from various areas of north-western WA (2003: 484; 2004: 149; Jones & Hewitt 1995: 54, 55; 1996: 51). Material in the WAM also confirms the presence of the species in the NT.

Distribution. WA, Qld; Indo-west Pacific.

Habitat. Depth 1–51 m.

Conopea Say, 1822

Conopea calceola (Ellis, 1758)

Balanus calceolus keratophyto involutus Ellis, 1758: 853, pl. 34 fig. 19.
Balanus calceolus — Darwin, 1854: 218, pl. 3 fig 3a–3e.
Balanus (Conopea) calceolus — McLaughlin & Henry, 1972: 25, figs 12–16.
Conopea calceola — Newman & Ross, 1976: 54.

Material Examined. AM-P20029, SW Bribie I., Moreton Bay (26°57'E 153°07'E).

Remarks. The species was reported from WA and Queensland waters (Jones *et al.* 1990: 16). Subsequent records of the species are from WA (Jones, 2003: 484; 2004: 152; Jones & Hewitt, 1996: 51).

Distribution. WA (NW), Qld; cosmopolitan.

Habitat. Epizoic on gorgonians and antipatharians; 16–250 m.

Solidobalanus Hoek, 1913

Solidobalanus ciliatus (Hoek, 1913)

Balanus ciliatus Hoek, 1913: 199, pl. 19 figs 8–16.
Solidobalanus ciliatus — Henry & McLaughlin, 1967: 47.

Material Examined. SAM-Tc11470, Peel I., Moreton Bay (27°30'S, 153°21'E), on antipatharian.

Remarks. The species has been reported from WA and Queensland waters (Jones *et al.* 1990: 15). More recent records have extended the distribution of the species in the waters of north-western WA (Jones 2003: 485; 2004: 150; Jones & Hewitt 1996: 52; 1997: 95).

Distribution. WA, Qld; Indo-west Pacific.

Habitat. 13–220 m.

Striatobalanus Hoek, 1913

Striatobalanus amaryllis (Darwin, 1854)

Balanus amaryllis Darwin, 1854: 279, pl. 7 figs 6a–c.
Balanus (Chirona) amaryllis — Ren & Liu, 1978: 159, fig. 21, pl. 7 figs 1–5.
Chirona (Striatobalanus) amaryllis — Newman & Ross, 1976: 50.
Striatobalanus amaryllis — Newman, 1996: 503.

Material Examined. AM-P6396, 30 specs, Port Curtis (23°24'S, 151 37'E); AM-P19912, Dunwich, N Stradbroke I. (27°30'S, 153°24'E); AM-P19913, E of Peel I., Moreton Bay, (27°30'S, 153°21'E); AM-P19914, S end of Curtis I., (23°38'S, 151°10'E); AM-P21545, Moreton Bay area (27°25'S, 153°20'E); AM-P23873, Gillett Cay, Coral Sea (21°20'S, 152°30'E); AM-P23875, Noosa Beach (26°25'S, 153°07'E); AM-P23876, Moreton Bay (27°25'S, 153°20'E); AM-P23877, 200 m S of Scarborough, Moreton Bay (27°12'S, 153°07'E); QM-W2592, 2 specs, SE Douglas Light (27°30'S, 153°23'E), 7.3 m, 18.12.1961, clean, gritty sand; SAM-Tc11545, 1 specimen (large), Smith's Rock, Moreton Bay (27°15'S, 153°15'E), with *B. trigonus* attached; SAM-Tc11657, 2 specs, Smith's Rock, Moreton Bay (27°15'S, 153°15'E), buoy; SAM-Tc11357, Caloundra (26°48'S, 153°08`E) and Bribie I. (26°57'S, 153°07'E); SAM-Tc11394, Moreton Bay (27°15'S, 153°15'E); SAM-Tc11476, Qld coast;

WAM-C22244, Pots Pt, off Redland Bay, Moreton Bay (27°15'S, 153°15'E), rubble bottom.

Remarks. Darwin (1854: 279) described *Striatobalanus amaryllis* (as *Chirona amaryllis* var. a) from the NE coast of Australia and *Challenger* collected specimens from Moreton Bay, NE coasts of Australia and Torres Strait (Hoek 1883: 153). Subsequent Queensland records are those of Endean *et al.* (1956a: 88) and Stephenson *et al.* (1970: 492), and broader distributions are reported by Wood & Allen (1958: 17; NSW, Qld), Daniel (1972: 184; Australia, northern coast); Lewis (1981b: 6; northern Australia to NSW in the east), and Jones *et al.* (1990: 14) and Jones (1990a: 220) from WA, across northern Australia and south to NSW.

Distribution. Northern WA across northern Australia to NSW; Indo west Pacific.

Habitat. Sublittoral, 0–500 m.

Striatobalanus tenuis (Hoek, 1883)

Balanus tenuis Hoek, 1883: 154, pl. 13 figs 29–33.
Balanus albus Hoek, 1913: 185, pl. 16 figs 12–13, pl. 17 figs 1–6.
Balanus (Chirona) tenuis — Ren & Liu, 1978: 161, fig. 22, pl. 7 figs 6–10.
Chirona (Striatobalanus) tenuis — Newman & Ross, 1976: 50.
Striatobalanus tenuis — Newman, 1996: 503.

Material Examined. SAM-Tc11654, Palmerston (21° 32'S, 149°29'E), on old telegraph cable.

Remarks. *Striatobalanus tenuis* was first reported from Australian waters by Jones *et al.* (1990: 14) and Jones (1990a: 221; 2004: 152) from WA and Qld.

Distribution. Arafura Sea, WA (N), Qld (SE); Indo-west Pacific.

Habitat. Sublittoral, 7–551 m.

Subfamily ELMINIINAE Foster, 1982

Austrominius Buckeridge, 1983

Elminius (Austrominius) Buckeridge, 1983: 354.
†*Austrominius* — Newman, 1996: 503.
Austrominius — Buckeridge & Newman, 2010: 44.

Austrominius covertus (Foster, 1982)

Elminius covertus Foster, 1982: 24, figs 1B, 3, 4A–C.
Elminius modestus — Pope, 1945: 368.
Elminius sp. Foster, 1980: 614, figs 1, 3, 4.
Elminius (Austrominius) covertus — Buckeridge, 1983: 353.

Material Examined. AM-P21306, Dunwich, Stradbroke I., Moreton Bay (153°24'S, 27°30'E); AM-P21313, Myora Springs, Stradbroke I. (153°25'S, 27°29'E).

Remarks. This endemic species was described by Foster (1982: 24) from SE Qld, NSW, Vic., Tas., SA and WA. *Austrominius covertus* has often been mistakenly identified as *Elminius modestus* Darwin (now *Austrominius modestus*) in Australian collections (Foster 1982: 23). Material described as *Elminius modestus* by Pope (1945: 368, NSW), Guiler (1952: 20, Tas.) and Underwood (1977: 23, ?17, NSW) and as *Elminius* sp. (Foster 1980: 614, NSW) is now attributed to *A. covertus*. Further information and records of *A. covertus* are also provided by Buckeridge (1983: 353, eastern Australia), Egan & Anderson (1985: 383, NSW) and Jones (1990b: 401, WA across southern Australia, including Tas, to Qld; as *Elminius (Austrominius) modestus* (part)).

Distribution. Southern Australia: WA (from Bunbury southward), SA, Tas., Vic., NSW, SE Qld.

Habitat. Littoral, towards upper limit of the tidal range; in harbours and estuaries on sheltered shores.

Austrominius modestus (Darwin, 1854)

Elminius modestus Darwin, 1854: 350, pl. 12 figs 1a–e.
Eliminus (Austrominius) modestus — Buckeridge, 1983: 357 .
Austrominius modestus – Buckeridge *et al.*, 2001: 3; Hayward *et al.*, 2001: 55.

Material Examined. AM-P21306, Dunwich, N Stradbroke I. (27°30'S, 153°24'E); AM-P21313, Myora Springs, N Stradbroke I. (27°29'S, 153°25'E); QM-W12220, Dunwich (23°55'S, 153°24'E), 21.07.1951, on mangrove leaves.

Remarks. The record of Darwin (1854: 350) established the presence of this species in Australian waters (NSW and Tas.). Foster (1982: 23) pointed out the confusion between *A. covertus* and *A. modestus* Darwin in Australian collections. Subsequently, Jones (1990b: 404) and Jones *et al.* (1990: 16) have documented *A. modestus* (as *Elminius (Austrominius) modestus* (part)) from the waters of WA, SA, Vic., Tas., NSW and southern Qld. The fouling proclivity of the species has enabled it to overcome oceanic barriers and become established in European waters (Bishop 1947: 501, Sandison 1950: 79, Southward & Crisp 1963: 24).

Distribution. WA, SA, Vic., Bass Str., Tas., NSW, Qld (SE); Australasian.

Habitat. Littoral, MTL to shallow sublittoral (5 m); introduced to Europe as a fouling species.

Hexaminius Foster, 1982

Hexaminius foliorum Anderson, Anderson & Egan, 1988

Hexaminius foliorum Anderson, Anderson & Egan, 1988: 207, figs 2–4; Jones *et al*., 1990: 16.

Material Examined. SAM-Tc11474, Hercules Bank (renamed Bishop I.), Brisbane, (27°22'S, 153°11'E), very abundant between tidemarks.

Remarks. This endemic species has been reported from NSW (Anderson *et al*., 1988: 207; Jones *et al*., 1990: 16). The records reported herein are the first of this species from Queensland.

Distribution. NSW, Qld (SE).

Habitat. Littoral; frequently attached to leaves of mangrove trees (e.g. *Avicennia marina*).

Hexaminius popeiana Foster 1982

Hexaminius popeiana Foster, 1982: 28, figs 4B–D, 5–6.
Solidobalanus sp. Foster, 1980: 614, fig. 3.

Material Examined. WAM-C19260, Cooee Bay (23°08'S, 150°45'E), intermediate barnacle zone, N edge, colour live, pink-orange; WAM-C19261, Cooee Bay (23°08'S, 150°45'E), mid-barnacle zone, on limpet, colour pinkish-orange.

Remarks. This endemic species has been reported from NSW by Foster (1982: 28) and Egan & Anderson (1985: 383), and from NSW and Qld (Jones *et al*. 1990: 16). *H. popeiana* is superficially similar to *Austrominius modestus* Darwin, 1854 and *A. covertus* (Foster, 1982), but has six parietal plates, whereas *Austrominius* species have four.

Distribution. NSW, Qld (SE); Australia (eastern).

Habitat. Littoral.

Family PYRGOMATIDAE Gray, 1825
Subfamily PYRGOMATINAE Gray, 1825
Tribe PYRGOMATINI Ross & Newman, 1995

Cantellius Ross & Newman, 1973

Cantellius acutum (Hiro, 1938)

Creusia spinulosa forma *acuta* Hiro, 1938: 398, figs 6c–f.
Creusia spinulosa var. 6 (subvariety 2) — Darwin, 1854, pl. 14 fig. 6n.
Cantellius acutum — Newman & Ross, 1976: 56.

Material Examined. AM-P40914, North Reef Crest, One Tree I., Capricorn Gp (23°30'S, 152°05'E).

Remarks. The first report of this species in Australian waters was from Queensland by Jones *et al*. (1990: 17), from material held in the AM. Subsequently, Anderson (1992: 281) recorded *C. acutum* from John Brewer Reef, GBR (19°S 145'E), on *Acropora* coral. Material held in the NTM further confirms the presence of the species in the waters of the NT (Trepang Bay, Cobourg Peninsula).

Distribution. NT, Qld; Western Pacific.

Habitat. Depth 0.5–2.0 m, attached to corals (*Acropora* species).

Cantellius secundus (Broch, 1931)

Creusia spinulosa forma *secunda* Broch, 1931: 118.
Cantellius secundus — Newman & Ross, 1976: 57.

Material Examined. Literature record of Anderson, 1992, from One Tree Reef, Capricorn Gp, GBR (23°30'S, 152°05'E).

Remarks. The first report of this species in Australian waters is that of Anderson (1992: 281) who recorded the species from John Brewer Reef (19°S 145'E) and One Tree Reef, GBR, Queensland, on *Acropora*.

Distribution. Qld (GBR); Indo-west Pacific.

Habitat. Depth 0.5–2.0 m, attached to corals (species of *Acropora* and *Pavona*).

Cantellius sumbawae Hoek, 1913

Cantellius sumbawae Hoek, 1913: 265, pl. 17 figs 9–16.

Material Examined. QM-W7807, Wistari Reef, N side (23°29'S, 151°53'E), 22.9 m, 1978, D. Fisk, on *Heteropsammia michelini* Milne Edwards & Haime.

Remarks. Present material from Queensland represents the first record of this species in Australian waters.

Distribution. Qld; Indo-Malayan.

Habitat. Depth 23–36 m.

Creusia Leach, 1817

Creusia spinulosa Leach, 1818

Creusia spinulosa var. 9 Leach, 1818: 171, pl. 57.
Creusia spinulosa var. 9 — Darwin, 1854: 380.

Material Examined. AM G 5271 (dry), Great Barrier Reef, May 1905; AM-P21321, Mud I., Moreton Bay (27°20'S, 153°15'E); AM-P23567, Swain Reefs, GBR (22°05'S, 152°30'E).

Remarks. The first report of this species in Australian waters is that of Jones *et al*. (1990: 17) from material held in the collections of the AM from Queensland. Subsequently, Anderson (1992: 281) recorded *C. spinulosa* from John Brewer Reef, GBR (19°S 145°E), on *Acropora* coral.

Distribution. Qld; Indo-Malayan.

Habitat. Depth 0–11 m; associated with madreporarian corals.

Wanella Anderson, 1993

Wanella milleporum (Darwin, 1854)

Pyrgoma milleporae Darwin, 1854: 367, pl. 13, figs 2a–f.
Savignium milleporum — Jones *et al*., 1990: 17.
Newmania milleporum — Anderson, 1992: 329.
Wanella milleporum — Anderson, 1993: 377.

Material Examined. AM-P40889, One Tree I., Capricorn Gp (23°30'S, 152°05'E).

Remarks. The species was recorded from Queensland waters as *Savignium milleporum* by Jones *et al*. (1990: 17). Anderson (1992: 281) further recorded the species from One Tree Reef and John Brewer Reef, GBR, on *Millepora*, and at the same time transferred *S. milleporum* to a new genus *Newmania* Anderson, 1992. However, the genus was preoccupied and thus the alternative genus, *Wanella*, was later proposed (Anderson, 1993). Material in the WAM now confirms the presence of this species in north-western WA (Kimberley region).

Distribution. WA (N), Qld; Indo-west Pacific.

Habitat. Depth 0–5 m; associated with corals (e.g. *Millepora*).

Family BALANIDAE Leach, 1817
Subfamily AMPHIBALANINAE Pitombo, 2004

Amphibalanus Pitombo, 2004

Amphibalanus amphitrite amphitrite (Darwin, 1854)

Balanus amphitrite var. (1) *communis* Darwin, 1854: 240 (part), pl. 5 figs 2a–d, i–k, m–o.
Balanus amphitrite amphitrite — Newman & Ross, 1976: 62.
Amphibalanus amphitrite amphitrite — Pitombo, 2004: 274.

Material Examined. AM-P11338, Sandgate, nr Brisbane (27°29'S, 153°04'E); AM-P20025, Ross Creek, nr Yeppoon (25°26'S, 150°20'E); AM-P20026 (as var. *malayensis*), SW of Bribie I., Moreton Bay (26°57'S, 153°07'E); AM-P20027 (as var. *malayensis*), SW of Bribie I., Moreton Bay (26°57'S, 153°07'E); AM-P21549 Sandgate, nr Brisbane (27°20'S, 153°04'E); AM-P21554, Bingham (25°24'S, 152°55'E); AM-P23765, Ely Creek, Hervey Bay (25°03'S, 153°05'E); AM-P23854 (as var. *malayensis*), Hope Banks, Moreton Bay (27°25'S, 153°20'E); AM-P52105, Torquat (25°17'S, 152°52'E); QM-W10933, Pine R (27°17'S, 153°01'E), 03.10.1980, Kelvin Grove College Students, estuarine; QM-W23897, 15 specs, Boggy Ck, Myrtletown (27°24'S, 153°08'E), 29.07.1997, P. Davie, J.W. Short, estuarine, littoral.

Remarks. The species was first reported by Darwin (1854: 240) from NSW, as var. *communis*. Jones *et al*. (1990: 18), Jones (1990a: 223; 1990b: 406; 1992b: 90) and Huisman *et al*. (2008: 210) have recorded the species as introduced into the waters of WA, SA, Bass Str., Vic., NSW and Qld. Other Queensland records of this species include Stephenson *et al*. (1970: 492), Allen & Wood (1950: 102; NSW, Qld, as var. *communis*); Allen (1953: 313; Qld, Torres Str., as var. *denticulata*) and Saenger *et al*. (1979: 401, Qld). Material housed in the WA Museum confirms the presence of this species in the NT.

Distribution. WA, SA, Bass Str., Vic., NSW, Qld, NT; cosmopolitan in tropical and warm temperate seas.

Habitat. Littoral to 9 m; fouling species.

Amphibalanus cirratus (Darwin, 1854)

Balanus amphitrite var. (9) *cirratus* Darwin, 1854: 241, pl. 5 fig. 2b.
Balanus cirratus — Lewis, 1985: 129.
Amphibalanus cirratus — Pitombo, 2004: 274.

Material Examined. AM-P20013 (as *Balanus variegatus* var. *cirratus*) nr Myora Springs, Stradbroke I. (27°29'S, 153°25'E); QM-W417, Caloundra (26°48'S, 153°08'E); QM-W1204, Myora (27°29'S, 153°25'E), University Science Students Association; QM-W2471, Brisbane (27°28'S, 153°0'E), M. Stroughan, in rocks and jetty piles; QM-W4778, Bogimbah Ck, Fraser I. (25°19'S, 153°05'E), Dec. 1973, R. Timmins; QM-W5163, Serpentine Ck (27°24'S, 153°07'E), 23.08.1972, B. Campbell *et al*., transect 1, site S; QM-W5226, Serpentine Ck (27°23'S, 153°05'E), Oct. 1972, B. Campbell *et al*, transect 4, site C; QM-W5252, 6 specs, Jacksons Ck (27°23'S, 153°05'E), 12.10.1972, B. Campbell *et al*., transect 2, site D; QM-W5269, Jacksons Ck (27°24'S, 153°07'E), 20.09.1972, B. Campbell *et al*., Transect 11, site B; QM-W7384, Southport (27°58'S, 153°25'E), Aug. 1977, B. Noonan, ex *Tursiops truncates;* QM-W7558, Graham Inlet, Gladstone (23°51'S, 151°1' E), Apr. 1978, P. Saenger, on *Rhizophora* stilt roots; QM-W16046, 1 specimen, Lady Elliot I. (24°07'S, 152°43'E), Nov. 1988, N. Coleman, littoral, rocky shore, on rocks (live), or at tide-line (dead); SAM-Tc11545 (1 spec., smaller) Smith's Rock, Moreton Bay (27°15'S, 153°15'E), with *B. trigonus* attached; WAM-C19916, entrance to causeway, Cooee Bay area (23°08'S, 150° 45'E); WAM-C19917, Corio Bay (22°56'S, 150°46'E), low barnacle zone.

Remarks. Darwin (1854) originally described the species as *Balanus amphitrite* var. (9) *cirratus*, from material collected from 'Mouth of Indus, Australia, Philippine Archipelago'. The first report of *Amphibalanus cirratus* from Australia is that of Jones *et al.* (1990) from north-western and northern coasts. The material reported on herein confirms the presence of the species in Queensland waters and material housed in the WAM extends its presence to the NT. Material described as *B. amphitrite cirratus* by Pope (1945: 362, pl. 28 fig. 6, p1. 29 fig. 6; pl. 30 figs 13–14) and *B. variegatus cirratus* (Pope, 1966: 179) is now referable to *Amphibalanius variegatus*.

Distribution. WA (N), NT, Qld (SE); Indo-west Pacific.

Habitat. Littoral-sublittoral; fouling species.

Amphibalanus reticulatus (Utinomi, 1967)

Balanus reticulatus Utinomi, 1967: 216, figs 9–12, pl. 6 figs 7–8.
Amphibalanus reticulatus — Pitombo, 2004: 274.

Material Examined. Qld port survey material.

Remarks. Lewis (1979, 1981b) first reported the species from north Queensland waters (1979: 11, as *Balanus amphitrite*; 1981: 9, as *B. reticulatus*). Jones *et al.* (1990: 18) extended the distribution of this species to WA, the Gulf of Carpentaria and Qld. Material in the WAM confirms the presence of the species in the territories of the Cocos-Keeling Island and Christmas Island (Indian Ocean) (Huisman *et al.* 2008: 21). Further WA records are those of Jones (1990b: 410; 2003: 485, 487; 2004: 156).

Distribution. Cocos-Keeling Is., Christmas I., WA, NT, Qld; cosmopolitan in tropical waters.

Habitat. Circumtropical fouling species.

Amphibalanus variegatus (Darwin, 1854)

Balanus amphitrite var. (8) *variegatus* Darwin, 1854: 241.
Balanus amphitrite var. *cirratus* — Pope, 1945: 362, pl. 28 fig. 6, pl. 29 figs 13, 14.
Balanus variegatus — Harding, 1962: 291, pl. 10 figs a–k.
Balanus variegatus cirratus — Pope, 1966: 179.
Amphibalanus variegatus — Pitombo, 2004: 274.

Material Examined. AM-P20013, nr Myora Springs, N Stradbroke I., Moreton Bay (27°29'S, 153°25'E); QM-W7377, 4 specs, Mon Repos (24°53'S, 152°28'E), 21.01.1977, C. Limpus, ex *Caretta caretta* (ex 4520); QM-W7380, 27 specs, Mon Repos (24°53'S, 152°28'E), 22.01.1977, C. Limpus, ex *Caretta caretta* (W 4529).

Remarks. The species was first described by Darwin (1854: 241) as *Balanus amphitrite* var. (8) *variegatus*, from material collected from Sydney, Australia, and New Zealand. Subsequently, Jones (1987a: 143; 1987b: 160; 1990a: 224; 1990b: 413) and Jones *et al.* (1990: 18) reported the species from WA, SA, Bass Str., Vic., NSW and Qld. Material housed in the collection of the TMAG confirms the presence of the species in Tasmanian waters.

Distribution. WA, SA, Bass Str., Vic., NSW, Qld (SE); Australasia.

Habitat. Littoral, LWS to sublittoral; fouling species.

Subfamily BALANINAE Leach, 1817

Balanus da Costa, 1778

Balanus trigonus Darwin, 1854

Balanus trigonus Darwin, 1854: 223, pl. 3 fig. 7a–f.

Material Examined. AM-P35, Bowen (20°01'S, 145°15'E); AM-P20076, Myora Beacon, Stradbroke I. (27°29'S, 153°25'E); QM-W6497, Mon Repos (24°53'S, 152° 28'E), 24.12.1968, C. Limpus; QM-W7355, Moreton Bay, nr Tangalooma (27°27'S, 151°26'E), 10.07.1977, fishing trawl, from left human femur; QM-W7376, 4 specs, Mon Repos (24°53'S, 152°28'E), 21.01.1977, C. Limpus, ex *Caretta caretta* (ex 4520); QM-W7475, 5 specs, Mon Repos Beach (24°53'S, 152°28'E), 27.12.1977, C. Limpus *et al.*, ex *Caretta caretta* (ex 8301); QM-W7476, 10 specs, Mon Repos Beach (24°53'S, 152° 28'E), 10.12.1977, C. Limpus *et al.*, ex carapace of *Caretta caretta* (ex 8301); QM-W7477, 3 specs, Mon Repos Beach (24°53'S, 152°28'E), 12.11.1977, C. Limpus *et al.*, ex *Caretta caretta* (ex 8108); QM-W7478, 5 specs, Mon Repos Beach (24°53'S, 152°28'E), 17.11.1977, C. Limpus *et al.*, ex carapace *Caretta caretta* (ex 8226); QM-W7479, 5 specs, Mon Repos Beach (24°53'S, 152°28'E), Dec. 1977, C. Limpus *et al.*, ex carapace of *Caretta caretta* (ex 8377); QM-W7480, 3 specs, Mon Repos Beach (24°53'S, 152°28'E), 10.12.1977, C. Limpus *et al.*, ex *Caretta caretta* (ex 4820); QM-W15599, 9 specs, Fishermen I., Brisbane R. mouth (27°22.5'S, 153°10'E), 07.07.1988, J.W. Short *et al.*, estuarine, on rocks near boat ramp at container terminal, low tide; SAM-Tc11477, E Moreton Bay (27°15'S, 153°15'E); SAM-Tc11478, Moreton Bay (27°15'S, 153°15'E), from buoy; Tc 11545, Smith's Rock, Moreton Bay (27°15'S, 153°15'E), attached to *Striatobalanus amaryllis* and *Amphibalanus amphitrite*; SAM-Tc11656, Smith's Rock, Moreton Bay (27°15'S, 153°15'E), attached to *Lepas anatifera*.

Remarks. The species was described by Darwin (1854) from material collected from Formosa, Java, East Indian Arch., Peru, West Colombia, California, Sydney and New Zealand. Records of the species from Queensland are those of Fischer (1940: 280, 287, 303, 304, 319; tropical Australia, NSW, Qld); Wood & Allen (1958: 18; NSW, Qld); Monroe & Limpus (1979: 199; SE Qld); and Monroe, 1981: 242; SE Qld). Jones (1987a: 143; 1987b: 158; Jones 1990b: 417; 1993: 122) and Jones *et al.* (1990: 18) have reported *B. trigonus* from WA, Bass Str, Tas., Vic., NSW and Queensland.

Distribution. WA, SA, Bass Str, Tas., Vic., NSW, Qld; cosmopolitan in tropical and subtropical seas.

Habitat. Depth 0–150 m; fouling species.

Subfamily MEGABALANINAE Newman, 1979

Austromegabalanus Newman, 1979

Austromegabalanus nigrescens (Lamarck, 1818)

Balanus nigrescens Lamarck, 1818: 391, pl. 4 fig. 16.
Megabalanus nigrescens — Newman & Ross, 1976: 68.
Austromegabalanus nigrescens — Newman, 1979: 287, fig. 4.

Material Examined. AM-P20052, Pt. Lookout, Stradbroke I. (27°01'S, 148°35'E); AM-P20066, Caloundra (26°48'S, 53°08'E); QM-W12217, Caloundra (26°48'S, 153°08'E), 16.06.1951, lower littoral (exposed); QM-W12218, mouth of Pine R., nr Hornibrook Highway (27°17'S, 153°04'E), 28.08.1960, R. Atkinson, estuarine (LWN), on bivalve; QM-W23958, 2 specs, Pt Lookout, N Stradbroke I. (27°26'S, 153°32'E), 19.08.1997, P. Davie, littoral, rocky shore; SAM-Tc11478, Moreton Bay (27°15'S, 153°15'E), from buoy, with *M. volcano*; SAM-Tc11479, Moreton Bay (27°15'S, 153°15'E).

Remarks. Specimens of this endemic species were first collected in NSW (Sydney) by Darwin (1854). Subsequently, Fischer (1940: 305) and Endean *et al.* (1956a: 88) reported the species from Queensland waters. The species has been recorded from WA, GAB, SA, Tas., Bass Str., Vic., NSW and Qld by Jones (1987a: 143; 1987b: 157; 1990b: 421; 1993: 122) and Jones *et al.* (1990: 18).

Distribution. WA, GAB, SA, Tas., Bass Str., Vic., NSW, Qld (SE); Australia (S).

Habitat. Littoral, MLWN to 9 m.

Megabalanus Hoek, 1913

Megabalanus ajax (Darwin, 1854)

Balanus ajax Darwin, 1854: 214, pl. 3 figs 1a–d.
Megabalanus ajax — Newman & Ross, 1976: 67.

Material Examined. AM-P23609, One Tree I., Capricorn Gp (23°30'S, 152°05'); AM-P23879, One Tree I., Capricorn Gp (23°30'S, 152°05').

Remarks. The first records of the species occurring in the waters of Australia are from the Australian Territory of the Cocos-Keeling Is, Indian Ocean (Jones 1989: 89; 1994: 6), Queensland (Jones *et al.* 1990: 19) and WA (Huisman *et al.* 2008: 21).

Distribution. Cocos-Keeling Is, Indian Ocean; WA, Qld (GBR); Indo-west Pacific.

Habitat. Sublittoral, 0–5.0 m; attached to reefs, coral (e.g. *Millepora complanata* Lamarck).

Megabalanus tintinnabulum (Linnaeus, 1758)

Lepas tintinnabulum Linnaeus, 1758: 668.
Balanus tintinnabulum var. *communis* — Darwin, 1854: 195, pl. 1 figs a, b, f supra, pl. 2 figs 1a, 1d, 1e, 1i, 1k.
Balanus tintinnabulum tintinnabulum — Pilsbry, 1916: 55, fig. 9, pl. 10 figs 1–1e.
Megabalanus tintinnabulum — Newman & Ross, 1976: 68.

Material Examined. QM-W1614, Bald Hills, Bowen (20°01'S, 148°15'E), on *Pinna*; QM-W166, Tortilla (22°28'S, 150°03'E).

Remarks. The species was first recorded from Australian waters by Jones (1990b: 425; 1992b: 90, WA) and Jones *et al.* (1990: 19; WA, Vic., NSW and Qld), and subsequently by Jones (1990a: 225; 1990b: 424), Jones & Hewitt (1997: 95, WA), Jones & Berry (2000: 60, WA), Hass & Jones (2000: 39, WA) and Huisman *et al.* (2008: 22; WA, Bass Str., Vic., NSW, Qld and NT).

Distribution. WA, Bass Str. (E), Vic., NSW, Qld, NT; cosmopolitan.

Habitat. Littoral to sublittoral; fouling species.

Megabalanus volcano Pilsbry, 1916

Balanus (Megabalanus) tintinnabulum volcano Pilsbry, 1916: 60, pl. 11 figs 2–2e.

Balanus (Megabalanus) volcano — Yamaguchi, 1973: 133, fig. 18, pl. 6 figs 2a–j, 4, 5, pl. 7 figs 1a–2b, pl. 8 figs 1–26.
Megabalanus volcano — Newman & Ross, 1976: 69.

Material Examined. SAM-Tc11478, Moreton Bay (27° 15'S, 153°15'E), from buoy, with *Austrobalanus nigrescens*.

Remarks. The first report of this species from Australian waters is that of Allen (1953: 310) from the east coast, fouling aircraft carriers and other vessels returning to Australia after service in Japanese and Korean waters. However, the species was not recorded as establishing on the Australian coastline and it is unknown where the ships docked. Jones *et al*. (1990: 19) reported the species from NSW, from two specimens taken from a ship docked at Garden Island, Port Jackson, New South Wales. The material reported on herein represents the first record of this species from Queensland waters.

Distribution. NSW, Qld; Japan, China; elsewhere fouling.

Habitat. Low tidal, upper subtidal and sublittoral fringe; fouling species.

DISCUSSION

Barnacles are conspicuous components of the intertidal rocky shore fauna of south-eastern Queensland. They are also commonly found attached to jetties, pilings and boats, and to the leaves, trunks and prop roots of mangrove trees. Highest intertidal barnacle diversity occurs where complex habitats offer a large variety of substrata for barnacle attachment. Conversely, lowest diversity occurs where there are less complex habitats and fewer suitable attachment sites.

In south-eastern Queensland the shores are dominated by sessile balanomorph species. Chthamalamoids, tetraclitids and balanids are the most widely-distributed intertidal barnacles, occurring throughout the coasts of the mainland as well as the islands. Zonation follows the chthamalid-tetraclitid-balanid trend that is characteristic of tropical and warm temperate Australian shores (Jones 1992a, 2003) and is fairly universal on warm temperate shores (Foster 1979). Ibliforme representation is sparse with *Ibla* species occurring in essentially refugial shore habitats. In the sublittoral, whilst sessile forms dominate, pedunculates become more prominant than in the littoral. Some pedunculate (e.g. *Octolasmis cor*) and sessile (e.g. *Chelonibia patula*) species are epizoic, i.e. attach to living substrata. Sessile commensal barnacles are also associated with sponge, gorgonian and coral hosts.

South-eastern Queensland represents a transitional area for temperate and tropical cirripede species. The Tropic of Capricorn lies at 23° 26'22"S of the equator and latitudes to the south are in the Southern Temperate Zone, those to the north in the Tropics. This transitional position is reflected in the composition of barnacle species. For example, the tropical chthamalids *Caudoeuraphia caudata*, *Microeuraphia withersi* and *Chthamalus malayensis* extend from Point Vernon northward, whilst the southern *Chthamalus antennatus* extends from Double Island Point southward. Similarly, the tropical tetraclitid *Tetraclita squamosa* extends from Point Vernon northward, whilst the southern *Tetraclitella purpurescens* and *Tesseropora rosea* extend from Double Island Point and Bustard Heads southward, respectively. Intertidal iblomorphs occur infrequently on Australian shores in essentially refugial habitats. In south-eastern Queensland, *Ibla cumingii* occurs from Point Vernon northward, whilst its temperate southern counterpart, *Ibla quadrivalvis*, extends from Currumbin southward.

The present paper confirms that the littoral and shallow water barnacle fauna of south-eastern Queensland is comprised of 74 species. The fauna is dominated by species with Indo-west Pacific (25), cosmopolitan (22), and, to a lesser extent, Indo-Japanese (9) affinities (Table 1). Two species show Australasian affinities (i.e. they occur in Australia and New Zealand), two exhibit western Pacific affinities (extending from the east Australian coast to Hawaii) and one has Indo-Australasian affinities (extending from the western Indian Ocean to Australasia). The number of Australian endemic species (12) is relatively high, reflecting the influence of the southern fauna in this transitional zone. Compared to the northern Australian tropical province that has, as well as a high incidence of tropical species, a low species endemicity and high species diversity, the southern Australian warm-temperate province exhibits decreased species diversity, high species endemicity, and a low incidence of tropical species (Jones 2003: 492).

Table 1: Biogeographic affinities of intertidal and shallow-water barnacles of south-eastern Queensland, Australia. **C**, Cosmopolitan species; **IWP**, Indo-west Pacific species (extend from east Africa to Hawaii); **WP**, Western Pacific species (extend from east Australian coast to Hawaii); **IJ**, Indo-Japanese species (extend from Indo-Malayan Archipelago, Australia and New Guinea to Japan); **IA**, Indo-Australasian species (extend from western Indian Ocean to Australasia); **AA**, Australasian species (occurring in Australia and New Zealand); **AE**, Australian endemic species (occurring only in Australia).

Order IBLIFORMES									
Suborder Iblomorpha									
Family	**Genus**	**Species**	**C**	**IWP**	**WP**	**IJ**	**IA**	**AA**	**AE**
Iblidae	*Ibla*	*cumingi*		+					
		quadrivalvis					+		
Order LEPADIFORMES									
Suborder Heteralepadomorpha									
Heteralepadidae	*Heteralepas*	*adiposa*			+				
		cornuta	+						
		japonica		+					
Malacolepadidae	*Arcalepas*	*brucei*							+
Suborder Lepadomorpha									
Lepadidae	*Alepas*	*pacifica*		+					
	Conchoderma	*aurita*	+						
		hunteri		+					
		virgatum	+						
	Lepas	*anatifera*	+						
		anserifera	+						
		hillii	+						
		pectinata	+						
Oxynaspididae	*Oxynaspis*	*celata*	+						
Poecilasmatidae	*Octolasmis*	*angulata*		+					
		cor		+					
		neptuni		+					
		warwickii		+					
	Temnaspis	*tridens asymmetrica*				+			
	Trilasmis	*eburnea*		+					
Order SCALPELLIFORMES									
Suborder Scalpellomorpha									
Calanticidae	*Smilium*	*peronii*							+
Order SESSILIA									
Suborder Balanomorpha									
Catophragmidae	*Catomerus*	*polymerus*							+
Chthamlidae	*Chthamalus*	*antennatus*							+
		malayensis		+					
	Caudoeuraphia	*caudata*				+			
	Microeuraphia	*withersi*		+					
	Octomeris	*brunnea*				+			
Chelonibiidae	*Chelonibia*	*caretta*	+						

Table 1 continued ...

Family	Genus	Species	C	IWP	WP	IJ	IA	AA	AE
	Chelonibia	*patula*	+						
		testudinaria	+						
Coronulidae	*Coronula*	*diadema*	+						
	Tubicinella	*cheloniae*				+			
	Xenobalanus	*globicipitis*	+						
Platylepadidae	*Cylindrolepas*	*darwiniana*	+						
	Platylepas	*coriacea*							+
		decorata		+					
		hexastylos	+						
		ophiophilus		+					
	Stephanolepas	*muricata*				+			
	Stomatolepas	*dermochelys*	+						
		praegustator	+						
		transversa				+			
Tetraclitidae	*Austrobalanus*	*imperator*							+
	Yamaguchiella	*vitiata*		+					
	Tetraclitella	*purpurascens*							+
	Tesseropora	*rosea*							+
	Tetraclita	*squamosa*		+					
Archaeobalanidae	*Neoacasta*	*glans*		+					
	Pectinoacasta	*pectinipes*		+					
	Armatobalanus	*quadrivittatus*		+					
	Conopea	*calceolus*	+						
	Solidobalanus	*cilatus*		+					
	Striatobalanus	*amaryllis*		+					
		tenuis		+					
	Austrominius	*covertus*							+
		modestus						+	
	Hexaminius	*foliorum*							+
		popeiana							+
Pyrgomatidae	*Cantellius*	*acutum*			+				
		secundus		+					
		sumbawae				+			
	Creusia	*spinulosa*				+			
	Wanella	*milleporum*		+					
Balanidae	*Amphibalanus*	*amphitrite*	+						
		cirratus		+					
		reticulatus	+						
		variegatus						+	
	Balanus	*trigonus*	+						
	Austromegabalanus	*nigrescens*							+

continued ...

Table 1 continued ...

Family	Genus	Species	C	IWP	WP	IJ	IA	AA	AE
	Megabalanus	*ajax*		+					
		tintinnabulum	+						
		volcano				+			
16 families	**44 genera**	**74 species**	**22**	**25**	**2**	**9**	**1**	**2**	**12**

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A preliminary checklist of the marine bivalves (Mollusca: Bivalvia) of Moreton Bay, Queensland

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ABSTRACT

A preliminary checklist of the bivalve molluscs of Moreton Bay is presented, based on the holdings of the Queensland Museum, supplemented by material derived from the 2005 Moreton Bay Workshop, the Bivalve Assembling the Tree of Life expedition (2008) to Moreton Bay, and published literature. A total of 350 species are recorded, representing 155 genera and 55 families, and both extant subclasses (Protobranchia, Autobranchia — the latter now embracing the former subclasses Pteriomorphia, Paleoheterodonta, Heterodonta and Anomalodesmata). By far the most diverse divisions of the Autobranchia, both in terms of numbers of species and higher taxa, is the 'clade' Heterodonta with 235 species in 100 genera and 33 families, and the Superorder Pteriomorphia with 103 species in 50 genera and 17 families. Among the heterodonts the Tellinoidea (tellins and allies; 56 species) and Veneroidea (venus clams and allies; 52 species) clearly predominate (46% of total). The bay fauna also contains a wide variety of Mactroidea (trough clams), Galeommatoidea (commensal clams and allies) and Cardioidea (true cockles) (each with 17–19 species). Key groups in the Pteriomorphia are the Pectinoidea (scallops and allies; 22 species), Pterioidea (pearl oysters and allies; 21 species), Mytiloidea (mussels; 15 species), and Arcoidea (ark shells and allies; 21 species). Pteriomorphians form the dominant component of the epibenthic bivalve fauna of the bay whereas heterodonts form the dominant infaunal component. While the ecological importance of bivalves as filtering animals (cleansing of sea water) is apparent, they are also primary sources of food for many predatory invertebrates within the bay system (gastropods, octopods, crabs) and vertebrates (fish, wading birds and gulls). In addition, some species form the basis of important local fisheries (e.g. the rock oyster *Saccostrea glomerata*; the scallops *Amusium balloti, Annachlamys flabellatus*). By virtue of their clumping lifestyle a number of epibenthic groups such as oysters, mussels and ark shells, provide rich settlement opportunities and/or shelter for numerous smaller animals (invertebrate and vertebrate). Clumped pterio-morphians (living or dead) undoubtedly also aid in the stabilisation of fine or moving sediments. ❑ *Bivalvia, species list, molluscan fauna, Moreton Bay, Queensland.*

The molluscan fauna of Moreton Bay is extensive and although lists of species have been generated through ecological surveys (e.g. Davie 1990; Hailstone 1976; Stephenson *et al.* 1970, 1974, 1976) these have covered only a small proportion of bivalves from the region, primarily with emphasis on the larger and more common species. Aside from commercially harvested species such as the rock oyster (*Saccostrea glomerata*) and scallops (*Amusium balloti, Annachlamys flabellatus*), the vast majority of bivalve species from the bay have never been the subject of anatomical or ecological study, and an enormous amount of taxonomic research remains to be carried out. A number of larger species have been, and continue to be, important elements of the diet of local aboriginal people as evidenced by the occurrence of numerous shell middens throughout the bay islands and adjacent areas (Alfredson 1984; Durbridge 1984; Richardson 1984; Hall & Bowen 1989).

A major survey of the benthos of Moreton Bay was conducted during February 2005 and the results of this work (see Davie & Phillips 2008) include studies on new bivalve species and a taxonomic revision of the date clams (Solemyidae) (Morton 2008; Taylor *et al.* 2008). In October 2008 an international team of malacologists (including JH) collected representative species from Moreton Bay for the National Science Foundation funded *Assembling the Bivalve Tree of Life Project* (BivAToL), focussing on the phylogeny and taxonomy of the Bivalvia. The area was chosen specifically because of the known richness of the bivalve fauna, including the fact that all subclasses and a vast array of genera and families occur there. Such independent recognition of the biological diversity of Moreton Bay clearly underscores the importance of documenting the bivalve species inhabiting the bay and the need for continuing controls on human impacts.

The purpose of the present account is to provide a taxonomically-verified list of bivalve species recorded (to date) from Moreton Bay. It is hoped that the list will act as a useful reference point for current and future survey work, not only in the bay but in southeast Queensland in general. As with the Gastropoda list in this volume (see Healy *et al.* 2010) we stress that this is a *preliminary* list of species. It should therefore be viewed not as the 'last word' on the subject but as a step in the direction of truly knowing the bivalve fauna of this biologically rich marine region.

This paper is dedicated to the late Dr Kevin Lamprell, a long-standing Honorary of the Queensland Museum, whose books, research papers, and vast collection experience have contributed so extensively to the study of the Australian bivalve fauna including that of Moreton Bay.

MATERIAL AND METHODS

This study is based primarily on the extensive marine collections held in the Queensland Museum (including the comprehensive Lamprell and Carless collections) and material from the 2005 Moreton Bay Marine Workshop housed in the Queensland Museum and representative material from the BivAToL Project (2008). The list has been supplemented with records from the literature, with emphasis on recent accounts and those that are illustrated. The source of information concerning confirmed locality data for Moreton Bay material is indicated in brackets after each species in the list. We stress that such sources do not constitute an exhaustive catalogue of locality information. For published records (principally Stephenson *et al.* 1970, 1974, 1976; Stephenson & Campbell 1977) we have not included any taxa listed by those authors as 'cf' or 'sp', except in those instances where the record is the only one for a family or genus in the bay.

For the purposes of this study, Moreton Bay is defined as the waters and shores from Caloundra (and immediate offshore reefs as far east as Flinders Reef) south to (and including) the Gold Coast. Although this definition also includes the ocean side of the larger bay islands (Moreton, North and South Stradbroke), any records beyond 50 m depth (i.e. material outside of normal diving range) are not included.

As with the Gastropoda, the classification of the Bivalvia has undergone profound and almost continuous alteration for the last 40 years and it can be safely concluded that more changes are inevitable once molecular analyses and more detailed (and comparative) anatomical and cytological work have been carried out. Perhaps one of the most significant (and accepted) recent changes to the higher level classification of Bivalvia is the incorporation of the former subclass Anomalodesmata within the Heterodonta based on molecular phylogenetic work (see Dreyer *et al.* 2003; Giribet & Distel 2003; Taylor *et al.* 2006). Most recently Bieler *et al.* (2010), in a revised classification of the Bivalvia incorporating all extinct groups, have followed Waller (1978) in placing 'traditional' subclasses Pteriomorphia, Paleoheterodonta and Heterodonta into a single subclass Autobranchia (originally Autolamellibranchiata of Grobben, 1894), though retaining these three groups as valid higher taxa of lesser rank (either superorders or clades). Bieler *et al.* (2010: 114) recognized the tentative and to some extant pragmatic nature of the newest arrangement of the Bivalvia '... the working classification represents current understanding and/or an educated guess to be tested', and the placement of several fossil groups may always remain uncertain. Clearly changes to the higher classification of the Bivalvia are to be expected as more results from collaborative work such as the BivAToL project come to fruition, but in the present list we have followed the arrangement of Bieler *et al.* (2010) as it represents the 'state of the art' on the subject.

In this list, authorship for taxa is limited to genus and species. All authorships for suprageneric taxa can be found in Bieler & Mikkelsen (2006), Bieler *et al.* (2010) and the Academy of Natural Sciences OBIS searchable taxonomic website for Indo-Pacific molluscs (Indo-Pacific Molluscan Database, http://clade.ansp.org/obis/find_mollusk.html). Key synonyms for species (where they exist) can be found in Lamprell & Whitehead (1992), Lamprell & Healy (1998), the OBIS website and individual taxonomic papers or monographs (see References this paper for key works). In a number of cases it has been necessary for us to list the names under which a species has been cited in previously published lists or in the QM (Vernon) database. For detailed biological information and associated literature on any of the families listed in this account we recommend the *Fauna of Australia Volume 5 (Mollusca: The Southern Synthesis)* (Beesley *et al.* 1998).

Data sources are listed at the back of this paper (numbered), with the exception of the following: M = Moreton Bay Workshop Survey (2005) (material housed in QM); B = BivAToL Project Expedition; QM = Queensland Museum Collections (registered and reserve collections).

DISCUSSION

Moreton Bay offers a very wide range of habitats for epifaunal and infaunal molluscs, and this is amply reflected in the diversity of the Bivalvia from the region. The bay's physical position within the East Australian Overlap and strong connections to both oceanic and estuarine influences undoubtedly are key factors in the richness of the bivalve fauna. In total the present study records 350 species, 155 genera and 55 families, mostly from the subclass Autobranchia (339 species) but also a significant number of Protobranchia (11 species).

As shown in Table 1 the bivalve fauna of Moreton Bay is, in terms of species numbers, dominated by the Autobranchia, in particular the Heterodonta (235 out of 350, or 67% of total count) and to a lesser extent the Pteriomorphia (103 or 30% of total count). Given that some major groups of heterodonts such as the Tellinoidea and Galeommatoidea are almost certainly under-represented in the present list — both are only now attracting taxonomic interest — it is almost inevitable that the total heterodont species count will be substantially greater than 235. Interestingly however, the ratio of pteriomorphian to heterodont species in the bay based on the present count (1: 2.3) approximates that calculated from Boss's (1982) estimate of world species for these two groups of autobranchs (1500 pteriomorphians: 4000 heterodonts or 1: 2.6). Pteriomorphians clearly dominate the epifaunal Bivalvia of the bay both in abundance and species diversity, whereas the infaunal bivalves consist largely of heterodonts.

Bivalves play a key role in filtering and cleansing water by removal of particulate material (organic and inorganic) within the gill (ctenidial) complex. In this respect, the abundance of the Bivalvia in Moreton Bay remains critical to the maintenance of water quality within the system. In addition, the clumping habit of certain mytilids (*Modiolus* species, *Trichomya hirsuta*), many oysters (especially *Saccostrea glomerata*), larger Arcidae (*Barbatia foliata, Arca navicularis*) and several Pterioidea (species of *Pteria* and *Isognomon*) provide attachment surfaces for a large range of epibionts (other molluscs, sponges, hydroids, bryozoans, tubiculous polychaetes, barnacles, sea squirts) and valuable refuges for many other invertebrates and some vertebrates (especially small fish). Such clumping bivalves, even after death, must be seen as an important factor in the promotion of benthic biodiversity but also, to some extent, in the stabilisation of soft or moving sediments.

SUBCLASS AUTOBRANCHIA

Superorder Pteriomorphia: The Moreton Bay pteriomorphian bivalve fauna is extensive in terms of recorded species (103), genera (50), and families (17). Cemented rock oysters (Ostreidae) and byssal-attached ark shells (Arcidae) and mussels (Mytilidae) may form extensive intertidal

Table 1. Breakdown of species composition according to superfamilies in Moreton Bay.

Taxon	No. of Species	Species % (approx.)
Subclass PROTOBRANCHIA (11 species)		
Nuculoidea	5	1.4%
Solemyoidea	2	0.6%
Nuculanoidea	4	1.2%
Subclass AUTOBRANCHIA (339) Superorder PTERIOMORPHIA (103 species)		
Mytiloidea	15	4.3%
Arcoidea	21	6.0%
Limopsoidea	2	0.6%
Pterioidea	21	6.0%
Pinnoidea	6	1.7%
Ostreoidea	7	2.0%
Anomioidea	4	1.2%
Pectinoidea	22	6.3%
Plicatuloidea	1	0.3%
Limoidea	4	1.2%
Superorder HETEROCONCHIA (236) PALEOHETERODONTA (1 species)		
Trigonioidea	1	0.3%
HETERODONTA (235 species)		
Lucinoidea	11	3.1%
Carditoidea	7	2.0%
Crassatelloidea	2	0.6%
Hemidonacidae (position uncertain)	2	0.6%
Arcticoidea	2	0.6%
Cardioidea	17	4.8%
Chamoidea	6	1.7%
Cyamioidea	1	0.3%
Cyrenoidea	3	0.9%
Galeommatoidea	18	5.2%
Mactroidea	19	5.5%
Tellinoidea	56	15.8%
Ungulinoidea	1	0.3%
Veneroidea	52	14.9%
Myoidea	10	2.9%
Pholadoidea	9	2.6%
Hiatelloidea	1	0.3%
Solenoidea	5	1.4%
'ANOMALODESMATAN' HETERODONTS		
Myochamoidea	5	1.4%

Table 1. Continued ...

Taxon (Subclasses & superfamilies)	No. of Species	Species % (approx.)
Pandoroidea	1	0.3%
Thracioidea	5	1.4%
Cuspidarioidea	1	0.3%
Poromyoidea	1	0.3%
TOTALS	350	100%

and shallow subtidal beds throughout the bay. Less extensive, but locally important clumping of pearl oysters (Pteriidae and allies) and mangrove oysters (Isognomonidae) can also occur, often in association with oysters and mussels. However, despite the impressive number of pteriomorphian species recorded from the bay, only a few tend to predominate at any one site. The Pterioidea (21 species, dominant genera *Pteria*, *Pinctada*), Mytiloidea (15 species, dominant genera *Modiolus*, *Musculus*) and Pectinoidea (22 species) are expecially well represented within the bay fauna, the latter containing species from 13 genera (no clearly dominant genera).

Species which are routinely found, often together, include *Saccostrea glomerata* (Ostreidae), *Trichomya hirsuta* (Mytilidae) and *Anadara trapezia* (Arcidae), and it is not surprising that such prolific species form major components of local shell middens (Richardson 1984; Hall & Bowen 1989; JH pers. obs.). Pearl oysters (*Pinctada* species, especially *P. maculata* and *P. albina*) are also a favoured food item ('quampi') of native people of North Stradbroke Island (Iselin 2008; JH pers. obs.). Pteriidae, Malleidae and Isognomonidae are sometimes found on the mainland side of the bay but are most abundant around the bay islands. Possibly this is indicative of a preference for less estuarine water and a lower tolerance to sedimentation and perhaps greater exposure to collecting and pollution effects at mainland bay localities. Certainly species of all three of these families contribute to large intertidal shell beds at North Stradbroke Island. The razor clams (or pen shells) (Pinnoidea) include two common species within Moreton Bay — *Pinna bicolor* and *Atrina pectinata* – both encountered in the intertidal and shallow subtidal sandy mud and a notable hazard to bare-foot walkers, especially around Stradbroke and Moreton Islands. Subtidally, down to 30 metres, Pteriidae, Mytilidae, Arcidae, Pectinidae and Glycymerididae are the dominant pteriomorphian families within the bay, each with several species. Representatives of the first four of these families are capable of clumping into beds which support a wealth of attached or sheltering invertebrates.

Aside from the rock oyster (*Saccostrea glomerata*) and the trawled scallops *Amusium balloti* and *Annachlamys flabellatus* (Pectinidae), the pteriomorphian fauna of the bay has not attracted commercial interest although potentially all species could be subject to amateur over-collecting (food, bait, shells etc) and hence are justifiably subject to policed bag limits.

Superorder Heteroconchia. The Heteroconchia (comprising the former subclasses, and now clades, Palaeheterodonta and Heterodonta) are at least in terms of number of species, the major component of the bivalve fauna of the bay (Table 1) with 236 species, 34 families and 100 genera represented.

Clade Palaeoheterodonta: Australian waters are home to the only surviving members of the Mesozoic-dominant order Trigonioida. The six species, all belonging to the genus *Neotrigonia*, are closely related and superficially cardiid-like in external shell morphology, but clearly possess the internal shell features characteristic of the Trigonioida (complex grooved teeth, nacreous shell interior; e.g. see Darragh 1986, 1998). The only species recorded from Moreton Bay, *Neotrigonia lamarcki*, was found living at about 45–50 m depth north of Cape Moreton, and off the south-east passage, east of southern Moreton Island, by the BivAToL project (Oct 2008). Its precise range is uncertain — according to Darragh (1986) it occurs from Wollongong (New South Wales) to Tin Can Bay (Queensland) but Lamprell & Whitehead (1992) suggest it may occur north to Central Queensland.

Clade Heterodonta: Within the largest heterodont superfamily, the Veneroidea (2 families, 52 species), the Veneridae (20 genera, 51 species) are particularly well represented in Moreton Bay with several abundant species. In the Veneridae, species such as *Marcia hiantina* and *Gafrarium australe* are especially common on the mainland side of the bay and at some sites are often the only species of venerid present. On the eastern side of the bay species such as *Tapes dorsatus* and *Circe plicatina* predominate in the shallow subtidal, whereas in deeper water various species of *Dosinia*, *Placamen*, *Paphia* and *Callista* tend to form the major venerid elements of the bivalve fauna. Several venerid species are prey to gastropods (especially Naticidae and Muricidae) as well as stingrays and wader birds (JH pers. obs.). Brewer & Willan (1985) reported that the exposed siphons of glauconomid veneroids form an important component in the diet of the golden-lined whiting (*Sillago analis*) within parts of Moreton Bay.

The true cockles (Cardioidea) are reasonably well represented in Moreton Bay (9 genera, 17 species), but aside from a few mainland localities (e.g. Redcliffe Peninsula), are mainly restriced to the central and eastern side of the bay. This is probably due to the preponderance of mud as a major sediment component on the mainland (western) side of the bay — cardiids preferring a firmer (though not rocky) substrate. *Fragum unedo*, *Lunulicardium hemicardium* and *Trachycardium vertebratum* are the bay's most abundant cardiids, being particularly common in shallow subtidal banks among seagrass and sand. Moreton Bay can also boast at least one species of giant clam, *Tridacna maxima*, but its distribution in the area is limited to waters around coral reefs, especially off North Stradbroke and Moreton Islands.

Worthy of mention is the large number of higher taxa of anomalodesmatans present within the bivalve fauna of the bay (6 families from 5 superfamilies). While only a few of the species are truly common, the breadth of representation of this group (formerly considered a separate subclass) is probably to be expected. Anomalodesmatans are renowned for exploiting a wide range of habitats and Moreton Bay offers many of these (e.g. mangrove muds for Laternulidae, clayey mud for Cuspidariidae and Poromyidae, live bivalve shells for Myochamidae). At some subtidal sites in the eastern bay a large proportion of the *Eucrassatella cumingii* (Crassatelloidea) and *Corbula tunicata* (Myoidea) may bear one or more attached *Myochama anomioides*.

Among the Mactroidea (9 genera, 19 species), the small indigenous species *Spisula trigonella* (Mactridae) ranks as possibly Moreton Bay's most common bivalve and certainly its most common infaunal species. It is especially abundant in muddy intertidal and shallow subtidal localities, and its dead shells contribute greatly to benthic sediment and to on-shore shell heaps (Quinnell 1999; JH pers. obs.). Much larger mactrids such as *Mactra dissimilis* (mainland or western side of bay) and *M. eximia* (eastern side of bay) are commonly encountered but not in the large numbers seen with *S. trigonella*. Mangrove-associated mactrids such as *Lutraria* species are undoubtedly important components of that ecosystem, however due to their deep-burrowing habit, living animals are rarely seen (unless dug out) and usually isolated valves are the only surface evidence of their presence. They and other mactrid species are often preyed on by wader birds (Quinnell 1999) and *S. trigonella* seems to form a staple part of the diet of sand snails (Naticidae) (JH pers. obs.). Of the four species of Mesodesmatidae known from the bay, only *Paphies elongata* (a surf inhabitant) and *P. striata* (an inshore shallow burrower) are reasonably common.

Five of the six species of Chamidae (Chamoidea) in Moreton Bay are common and very widespread in the area. Chamids comprise one of a very few surface dwelling heterodont families and, like oysters, they settle and grow on shells of other molluscs (live or dead), rocks and dead coral chunks. During the Moreton Bay Benthic Survey of 2005, most shallow subtidal mussel and oyster clump samples were found to contain one or more cemented species of *Chama* (especially *C. asperella*, *C. fibula*, *C. limbula*, *C. pulchella*) (JH pers. obs.) sometimes in small clusters. Chamids are not as common in the bay intertidally as they are subtidally, possibly due to intense competition from rock oysters and barnacles for settlement space at suitable sites.

Two other superfamilies of heterodonts also comprise important elements of the bay bivalve fauna — the Tellinoidea (15 genera, 56 species) and Galeommatoidea (8 genera, 18 species) — although discussion of their diversity is hampered by a lack of detailed taxonomic work on many of their constituent families. Aside from Willan's (1993) monograph on the Australian Psammobiidae, the Tellinoidea of Moreton Bay are in need of thorough revision. With the exception of the surf-zone inhabiting *Donax* spp. (especially the indigenous *Donax deltoides* — 'pipi' or 'eugarie'), most tellinioideans are deep burrowing and seldom seen other than as dead specimens (usually isolated valves). *Donax deltoides* is not only valued as a food item (and a very common midden component — see Haglund-Calley & Quinnell 1973; Richardson 1984) but is also widely used as bait for line fishing. On the mainland side of the bay *Tellina australis* (Tellinidae) and *Soletellina alba* (Psammobiidae) form an important part of the diet of predatory sand snails (Naticidae) as evidenced by the abundance of drilled valves of both species. Both species are also consumed by wading birds (see Quinnell 1999). The taxonomic neglect evident in the Tellinoidea is repeated in the Galeommatoidea, with the exception that that latter is attracting more research attention by virtue of their commensal relationships with other invertebrates such as crustaceans and echinoderms (e.g. see Morton 2008) and their often complex reproductive biology (including the production of strongly dimorphic spermatozoa in several species (Lützen *et al*. 2004, 2005)).

CONCLUDING REMARKS

Moreton Bay is home to a large and important bivalve mollusc fauna (350 species), as indeed is also the case with the gastropod molluscs (1023 species: see Healy *et al*. 2010 this volume). We anticipate that many more species and additional genera and families will, in time, be added once suitable taxonomic work and localised collecting (intertidal and subtidal) have been carried out.

This list is an updatable resource for those interested not only in the ecology and biodiversity of Moreton Bay but also the monitoring of environmental health, regional development issues and species conservation. In the light of current threats such as pollution (e.g. the March 2009 oil and fertiliser spill in Moreton Bay) and over-fishing, it is essential that checklists such as these are established. We believe they are of vital importance in the planning and implementation of strategies designed to safeguard the rich marine fauna of this region such as the revised management zonings for Moreton Bay (particularly the increased extent of the green 'no-take' zone).

CLASS BIVALVIA
SUBCLASS PROTOBRANCHIA
ORDER NUCULIDA
SUPERFAMILY NUCULOIDEA
(see Note 1)

FAMILY NUCULIDAE

Leionucula Quenstedt, 1930
L. astricta (Iredale, 1937) [19; 20]
L. cumingii (Hinds, 1843) [B]
L. obliqua (Lamarck, 1819) [M]
L. orekta (Iredale, 1939) [20]
L. superba (Hedley, 1902) [27]

ORDER SOLEMYIDA
SUPERFAMILY SOLEMYOIDEA

FAMILY SOLEMYIDAE (see Note 2)

Solemya Lamarck, 1818
Solemya incertae sedis (see Note 3)
S. moretonensis Taylor, Glover & Williams, 2008 [QM holotype and paratypes; 23]
S. (Solemyarina) Iredale, 1931
S. (S.) velesiana Iredale, 1931 [B; QM; 23]

ORDER NUCULANIDA
SUPERFAMILY NUCULANOIDEA

FAMILY NUCULANIDAE

Nuculana Link, 1807
N. (Scaeoleda) Iredale, 1929
N. (S.) caloundra (Iredale, 1929) [B; QM]
N. (S.) crassa (Hinds, 1843) [QM]
N. (S.) dohrni (Hanley, 1861) [QM]

FAMILY YOLDIIDAE

Yoldia Möller, 1842
Yoldia cf *lata* (Hinds, 1843) [M]

SUBCLASS AUTOBRANCHIA
SUPERORDER PTERIOMORPHIA
ORDER MYTILIDA
SUPERFAMILY MYTILOIDEA

FAMILY MYTILIDAE

Arenifodiens Wilson, 2006 *incertae sedis* (see Note 5)
A. vagina (Lamarck, 1819) [QM, 29 as *Modiolus vagina*]

SUBFAMILY CRENELLINAE

Musculus Bolten, 1798
M. alganus Laseron, 1956 [M]
M. chinensis Bernard, Cai & Morton, 1993 [M]
M. cumingianus Reeve, 1857 [M; QM; 5; 21]
M. nanus (Dunker, 1856) [M]
Trichomya Ihering, 1900
T. hirsuta (Lamarck, 1818) [B; M; QM; 5; 15; 20; 27; 21 as *Branchiodontes* [sic] *hirsutus*]

SUBFAMILY LIMNOPERNINAE

Limnoperna Rochebrune, 1882 (see Note 4)
L. pulex (Lamarck, 1819) [QM; 5 as *Modiolus pulex*]
L. securis (Lamarck, 1819) [QM, 27 as *Xenostrobus securis*]

SUBFAMILY MODIOLINAE

Modiolus Lamarck, 1799
M. hanleyi Dunker, 1882 [QM]
M. micropterus Deshayes, 1836 [QM]
M. peronianus Laseron, 1956 [QM]
M. philippinarum Hanley, 1843 [QM]
M. proclivis Iredale, 1939 [B; QM; 27]
M. victoriae (Pritchard & Gatliff, 1903) [QM]
Amygdalum Megerie, 1811
A. glaberrima (Dunker, 1856) [QM as *Modiolus glaberrima*]

ORDER ARCIDA
SUPERFAMILY ARCOIDEA

FAMILY ARCIDAE

SUBFAMILY ARCINAE

Arca Linnaeus, 1758
A. (Arca) s.s.
A. (A.) navicularis Bruguière, 1789 [B; M; QM; 15; 20, 21]
A. (A.) ventricosa Lamarck, 1819 [QM]
Barbatia Gray, 1842
B. (Barbatia) s.s.
B. (B.) foliata (Forsskål, 1775) [M; QM; 15]
B. (B.) grayana (Dunker, 1858) [21 as *Arca multivillosa*]
B. (B.) parvillosa (Iredale, 1939) [21]
B. (B.) pistachia (Lamarck, 1819) [QM]
Trisidos Röding, 1798
T. semitorta (Lamarck, 1819) [QM]
T. tortuosa (Linnaeus, 1758) [B; M; QM; 5; 15; 21 as *T. yongei*; 27]

SUBFAMILY ANADARINAE

Anadara Gray, 1847
A. (Anadara) s.s.
A. (A.) antiquata (Linnaeus, 1758) [QM, as *Arca antiquata*]
A. (A.) trapezia (Deshayes, 1840) [B; M; QM also as *Arca trapezium*; 15; 18; 27]
A. (Cunearca) Dall, 1898
A. (C.) pilula (Reeve, 1843) [QM]
A. (C.) rotundicostata (Reeve, 1843) [20 as *Scapharca (Cunearca) hubbardi*; 21 as *Imparilarca hubbardi*]
A. (Scapharca) Gray, 1847
A. (S.) crebricostata (Reeve, 1844) [QM]

FAMILY GLYCYMERIDIDAE

SUBFAMILY GLYCYMERIDINAE

Glycymeris Costa, 1778
G. (Glycymeris) s.s
G.(G.) radians (Lamarck, 1819) [M; QM]
G. (G.) striatularis (Lamarck, 1819) [QM]

G. (Veletuceta) Iredale, 1931
G. (V.) grayana (Dunker, 1857) [QM]
G. (V.) hedleyi (Lamy, 1912) [QM; 21]
G. (V.) holosericus (Reeve, 1843) [B; QM; 15; 27]
G. (Tucetilla) Iredale, 1939
G. (T.) crebriliratus (Sowerby, 1889) [B; QM; 15]

FAMILY NOETIIDAE

Arcopsis von Koenen, 1885
A. afra (Gmelin, 1791) [QM]
Sheldonella Maury, 1917
S. repenta (Iredale, 1939) [QM]

SUPERFAMILY LIMOPSOIDEA

FAMILY LIMOPSIDAE

Limopsis Sassi, 1827
L. (Pectunculina) d'Orbigny, 1842
L. (P.) loringi Angas, 1873 [QM]

FAMILY PHILOBRYIDAE

Cosa Finlay, 1927
C. tatei (Hedley, 1901) [QM]

ORDER PTERIIDA
SUPERFAMILY PTERIOIDEA

FAMILY PTERIIDAE

Pteria Scopoli, 1777
P. coturnix (Dunker, 1872) [QM]
P. falcata (Lamarck, 1819) [QM]
P. lata (Gray, 1845) [QM; 5; 15]
P. levitata (Iredale, 1939) [QM]
P. peasei (Dunker, 1872) [QM]
P. penguin (Röding, 1798) [QM]
P. scabriuscula (Reeve, 1857) [QM]
Electroma Stoliczka, 1871
E. (Electroma) s.s.
E. (E.) georgiana (Quoy & Gaimard, 1834) [QM]
E. (E.) ovata (Quoy & Gaimard, 1834) [21 as *E. pygmaea*]
E. (Pterelectroma) Iredale, 1939
E. (P.) physoides (Lamarck, 1819) [QM; 21 as *E. zebra*; 27]
Pinctada Röding, 1798
P. albina albina (Lamarck, 1819) [B; M; QM]
P. albina sugillata (Reeve, 1857) [QM; 5; 20]
P. fucata (Gould, 1850) [QM; 18]
P. maculata (Gould, 1850) [B; M; QM; 27]
P. margaritifera (Linnaeus, 1758) [QM; 21]
P. maxima (Jameson, 1901) [QM; 18]

FAMILY ISOGNOMONIDAE

Isognomon Lightfoot, 1786
I. (Isognomon) s.s.
I. (I.) ephippium (Linnaeus, 1758) [B; QM; 15]
I. (I.) isognomon (Linnaeus, 1758) [B; QM; 15]
I. (I.) nucleus (Lamarck, 1819) [QM]

FAMILY MALLEIDAE

Malleus Lamarck, 1789
M. albus Lamarck, 1819 [B; M; QM; 5; 15; 18: 20, 21; 27]
M. malleus (Linnaeus, 1758) [B; QM; 15]
Vulsella Röding, 1798
V. vulsella (Linnaeus, 1758) [B; M; QM]

SUPERFAMILY PINNOIDEA

FAMILY PINNIDAE

Pinna Linnaeus, 1758
P. bicolor Gmelin, 1791 [B; QM; 1; 15; 18; 27]
P. deltodes Menke, 1843 [QM]
P. muricata Linnaeus, 1758 [M; QM]
Atrina Gray, 1842
A. (Atrina) s.s.
A. (A.) vexillum (Born, 1778) [QM]
A. (Servatrina) Iredale, 1939
A. (S.) pectinata (Linnaeus, 1758) [QM; 15; 20]
Streptopinna von Martens, 1880
S. saccata (Linnaeus, 1758) [18]

ORDER OSTREIDA
SUPERFAMILY OSTREOIDEA

FAMILY OSTREIDAE

SUBFAMILY OSTREINAE

Ostrea Linnaeus, 1758
O. (Eostrea) Ihering, 1907
O. (E.) virescens Angas, 1867 [QM]

SUBFAMILY CRASSOSTREINAE

Saccostrea Dolfuss & Dautzenberg, 1920
S. cucullata (Born, 1778) [QM; 27]
S. glomerata (Gould, 1850) [B; M; QM also as *Saccostrea commercialis*; 5 as *Crassostrea commercialis*; 15; 27] (see Note 6)

SUBFAMILY LOPHINAE

Lopha Röding, 1798
L. cristagalli (Linnaeus, 1758) [QM]
Planostrea Harry, 1985
P. pestigris (Hanley, 1846) [QM]

FAMILY GRYPHAEIDAE

SUBFAMILY PYCNODONTEINAE

Hyotissa Stenzel, 1971
H. hyotis (Linnaeus, 1758) [B; QM; 27]
Parahyotissa Harry, 1985
P. imbricata (Lamarck, 1819) [B; QM]

ORDER PECTINIDA
SUPERFAMILY ANOMIOIDEA

FAMILY ANOMIIDAE

Anomia Linnaeus, 1758
A. trigonopsis Hutton, 1877 [QM also as *A. descripta*; 18; 21 as *A. descripta*]
Monia Gray, 1850

M. timida Iredale, 1939 [QM]
M. zelandica (Gray, 1843) [QM as *Anomia zelandica*; 21 as *M. ione*]

Patro Gray, 1850
P. australis (Gray, 1847) [M; QM; 15; 27]

SUPERFAMILY PECTINOIDEA

FAMILY PECTINIDAE (see Note 7)

SUBFAMILY PECTININAE

Pecten Müller, 1776
P. fumatus Reeve, 1852 [QM; 18; 21]

Amusium Röding, 1798
A. balloti (Bernardi, 1861) [15; 18; 27]

Annachlamys Iredale, 1939
A. flabellata (Lamarck, 1819) [QM, 15, 18, 20, 21, 27; also as *Chlamys or Annachlamys leopardus*]

Decatopecten Rüppell in Sowerby, 1839
D. plica (Linnaeus, 1758) [QM, 18, 20, 21 all as *Decatopecten strangei* or *Chlamys strangei*]

Gloripallium Iredale, 1939
G. pallium (Linnaeus, 1758) [QM; 18]

Minnivola Iredale, 1939
M. isomeres Iredale, 1939 [QM; 18]

SUBFAMILY CHLAMYDINAE

Laevichlamys Waller, 1993
L. irregularis (Sowerby, 1842) [QM, 18 both *as Chlamys irregularis*]
L. mollita (Reeve, 1853) [18 as C. *grossiana*]
L. squamosa (Gmelin, 1791) [QM]

Mimachlamys Iredale, 1929
M. asperrima (Lamarck, 1819) [15]
M. cloacata (Reeve, 1853) [QM as *Mimachlamys curtisiana*]
M.gloriosa (Reeve, 1853) [M; QM also as *Chlamys gloriosa*; 15; 18; 20; 21; 27]

Scaeochlamys Iredale, 1929
S. livida (Lamarck, 1819) [M; QM; 15; 18; 21; 27]

Semipallium Jousseaume in Lamy, 1928
S. aktinos (Petterd, 1886) [QM; 18]
S. coruscans coruscans (Hinds, 1845) [QM; 18]

Volachlamys Iredale, 1939
V. singaporina (Sowerby, 1842) [QM; 5; 27]

SUBFAMILY PALLIOLINAE

Mesopeplum Iredale, 1929
M. fenestratum (Hedley, 1901) [QM, 18]

FAMILY SPONDYLIDAE

Spondylus Linnaeus, 1758
S. multisetosus Reeve, 1856 [18]
S. nicobaricus Schreibers, 1793 [18]
S. squamosus Schreibers, 1793 [18]
S. victoriae Sowerby, 1860 [B; QM also as *S. wrightianus*; 18, 20, 21 and 27 as *S. wrightianus*]
S. violascens Lamarck, 1818 [QM; 8; 27]

SUPERFAMILY PLICATULOIDEA

FAMILY PLICATULIDAE

Plicatula Lamarck, 1801
P. (Plicatula) s.s
P. (P.) australis Lamarck, 1819 [M]

ORDER LIMIDA
SUPERFAMILY LIMOIDEA

FAMILY LIMIDAE

SUBFAMILY LIMINAE

Lima Bruguière, 1797
L. vulgaris (Link, 1807) [QM; 27 as *Lima lima vulgaris*]

Limaria Link, 1807
L. fragilis (Gmelin, 1791) [QM; 5]
L. orientalis (A.Adams & Reeve, 1850) [27]

SUBFAMILY LIMATULINAE

Limatula Wood, 1839
L. strangei (Sowerby, 1872) [QM]

SUPERORDER HETEROCONCHIA
CLADE PALAEOHETERODONTA
ORDER TRIGONIOIDA
SUPERFAMILY TRIGONIOIDEA

FAMILY TRIGONIIDAE

SUBFAMILY TRIGONIINAE

Neotrigonia Cossman, 1912
N. lamarckii (Gray, 1838) [B; QM; 15]

CLADE HETERODONTA
ORDER LUCINIDA
SUPERFAMILY LUCINOIDEA
FAMILY LUCINIDAE

Anodontia Link, 1807
A. (Cryptophysema) Taylor & Glover, 2005
A. (C.) trulla Taylor & Glover, 2005 [QM; 22]
A. (C.) vesicula (Gould, 1850) [27 as *A. edentula*]

A. (Cavatidens) Iredale, 1930
A. (C.) omissa Iredale, 1930 [B; QM; 22]

Cardiolucina Sacco, 1901
C. rugosa (Hedley, 1909) [M; QM]

Codakia Scopoli, 1777
C. paytenorum (Iredale, 1930) [QM]

Ctena Mörch, 1861
C. bella (Conrad, 1834) [15]

Divaricella Von Martens, 1880
D. irplex (E.A. Smith, 1885) [QM as *D. ornata*]

Indoaustriella Glover, Taylor & Williams, 2008
I. lamprelli Glover, Taylor & Williams, 2008 [QM holotype; 4]

Pillucina Pilsbry, 1921
P. pacifica Glover & Taylor, 2001 [3; 15]

P. vietnamica Zorina, 1974 [3; 15]

Prophetilora Iredale, 1930

P. simplex (Reeve, 1850) [QM]

ORDER CARDITIDA

SUPERFAMILY CARDITOIDEA

FAMILY CARDITIDAE

SUBFAMILY CARDITINAE

Cardita Bruguière, 1792

C. crassicosta Lamarck, 1819 [QM; 27]

C. excavata Deshayes, 1854 [QM]

C. incrassata Sowerby, 1825 [QM; 21]

C. marmorea Reeve, 1843 [QM]

C. muricata Sowerby, 1832 [QM; 15]

C. preissii Menke, 1843 [M]

C. variegata Bruguière, 1792 [QM]

SUPERFAMILY CRASSATELLOIDEA

FAMILY CRASSATELLIDAE

Eucrassatella Iredale, 1924

E. cumingii (A.Adams, 1852) [B; QM; 21; 27]

Salaputium Iredale, 1924

S. cf torrei (Smith, 1885) [M]

ORDER VENERIDA

FAMILY HEMIDONACIDAE *incertae sedis* (see Note 9)

Hemidonax Mörch, 1871

H. dactylus Hedley, 1923 [16]

H. pictus (Tryon, 1870) [B; QM; 6; 15; 18; 21; 27]

SUPERFAMILY ARCTICOIDEA

FAMILY TRAPEZIDAE

Trapezium Mühlfeld, 1811

T. (Neotrapezium) Habe, 1951

T. (N.) sublaevigatum (Lamarck, 1819) [QM; 15]

Fluviolanatus Iredale, 1924

F. subtorta (Dunker, 1857) [QM as *F. amarus*]

SUPERFAMILY CARDIOIDEA

FAMILY CARDIIDAE

SUBFAMILY CARDIINAE

Acrosterigma Dall, 1900

A. impolita (Sowerby, 1833) [QM; 15; 25]

A. kerslakae Healy & Lamprell, 1992 [QM; 7; 25]

A. punctolineata Healy & Lamprell, 1992 [QM]

Maoricardium Marwick, 1944

M. setosum (Redfield, 1846) [B; QM; 5; 21 as *Trachycardium setosum*; 26; 27 as *Plagiocardium setosum*]

Vasticardium Iredale, 1927

V. flavum (Linnaeus, 1758) [M; QM also as *Acrosterigma flava*; 20 as *Regozara flava*]

V. vertebratum (Jonas, 1844) [B; QM also as *Acrosterigma reeveanum*; 15; 27 as *Acrosterigma vertebratum*]

Vepricardium Iredale, 1929

V. multispinosum (Sowerby, 1838) [QM, as *V. pulchricostatum*; 15; 21]

SUBFAMILY FRAGINAE

Fragum Röding, 1792

F. fragum (Linnaeus, 1758) [B; QM]

F. unedo (Linnaeus, 1758) [B; QM; 15; 27]

Lunulicardia Gray, 1853

L. hemicardium (Linnaeus, 1758) [QM; 15]

L. retusum (Linnaeus, 1767) [B; 20 as *Lunulicardium subretusum*; 21 as *Opisocardium subretusum*]

SUBFAMILY FULVIINAE

Fulvia Gray, 1853

F. aperta (Bruguière, 1789) [QM]

F. tenuicostata (Lamarck, 1819) [21 as *Trachycardium racketti*]

Fulvia sp. [M]

SUBFAMILY LAEVICARDIINAE

Laevicardium Swainson, 1840

L. attenuatum (Sowerby, 1840) [QM]

L. biradiatum (Bruguière, 1789) [QM]

SUBFAMILY TRIDACNINAE

Tridacna Bruguière, 1792

T. (Chametrachea) Mörch, 1853

T. (C.) maxima (Röding, 1798) [15]

SUPERFAMILY CHAMOIDEA

FAMILY CHAMIDAE

Chama Linnaeus, 1758

C. asperella Lamarck, 1819 [M; 21 as *C. jukesii*]

C. fibula Reeve, 1846 [M; QM; 15; 19]

C. limbula Lamarck, 1819 [M; QM; 15; 27]

C. pacifica Broderip, 1834 [QM]

C. pulchella Reeve, 1846 [M; QM; 20]

C. ruderalis Lamarck, 1819 [M]

SUPERFAMILY CYAMIOIDEA

FAMILY CYAMIIDAE

Cyamiomactra Bernard, 1897

C. mactroides Tate & May, 1900 [QM]

SUPERFAMILY CYRENOIDEA

FAMILY GLAUCONOMIDAE (see Note 8)

Glauconome Gray, 1828

G. cerea Reeve, 1844 [QM]

G. plankta (Iredale, 1936) [QM; 15]

G. virens (Linnaeus, 1758) [QM]

SUPERFAMILY GALEOMMATOIDEA
(see Note 10)

FAMILY GALEOMMATIDAE

Ambuscintilla Iredale, 1936
A. praemium Iredale, 1936 [QM]
Borniola Iredale, 1924
B. cf lepida (Hedley, 1906) [M]
Scintilla Deshayes, 1856
S. cuvieri Deshayes, 1856 [QM]
S. hyalina (Deshayes, 1856) [QM]
S. incerta (Récluz, 1851) [QM]
S. strangei Deshayes, 1856 [QM]
Scintillona Finlay, 1927
S. cryptozoica (Hedley, 1917) [B; QM as *Varotoga cryptozoica*; 16]
S. daviei Morton, 2008 [QM holotype and paratype; 16]

FAMILY LASAEIDAE

Kellia Turton, 1822
K. adamsi (Angas, 1868) [21 as *Marikellia adamsi*]
K. cycladiformis (Deshayes, 1850) [QM]
K. jacksoniana Smith, 1884 [QM]
K. rotunda (Deshayes, 1855) [QM]
K. tumida (Laseron, 1956) [QM]
Lasaea Brown, 1827
L. australis (Lamarck, 1818) [QM]
Montacuta Turton, 1822
Montacuta sp. [M]
Mysella Angas, 1877
M. (Mysella) s.s.
M. (M.) anomala Angas, 1877 [QM]
M. (M.) vitrea Laseron, 1956 [B; QM]
M. (Rochefortia) Velain, 1877
M. (R.) sp. [QM]

SUPERFAMILY MACTROIDEA

FAMILY MACTRIDAE

SUBFAMILY MACTRINAE

'Mactra' pellucida Gmelin, 1791 *incertae sedis* [15]
Mactra Linnaeus, 1767
M. (Mactra) s.s.
M. (M.) abbreviata Lamarck, 1819 [QM; 27]
M. (M.) dissimilis Reeve, 1854 [QM]
M. (M.) eximia Reeve, 1854 [QM; 15; 21]
M. (M.) queenslandica Smith, 1914 [QM]
M. (M.) seriacea Reeve, 1854 [QM]
M. (Austromactra) Iredale, 1930
M. (A.) contraria Reeve, 1854 [QM; 15]
M. (Electomactra) Iredale, 1930
M. (E.) antecedens Iredale, 1930 [QM]
M. (Nannomactra) Iredale, 1930
M. (N.) pusilla (A. Adams, 1855) [QM]
Spisula Gray, 1837
S. (Notospisula) Iredale, 1930
S. (N.) trigonella (Lamarck, 1819) [QM; 15; 21 as *Notospisula parva*; 18; 27]

SUBFAMILY LUTRARINAE

Lutraria Lamarck, 1799
L. (Psammophila) Brown, 1827
L. (P.) australis Reeve, 1854 [QM]
L. (P.) impar Reeve, 1854 [QM; 21]
L. (P.) rhynchaena Jonas, 1844 [QM]
Meropesta Iredale, 1929
M. nicobarica (Gmelin, 1791) [B; QM; 15]

SUBFAMILY KYMATOXINAE

Raeta Gray, 1853
R. (Raetina) Dall, 1898
R. (R.) pellicula (Reeve, 1854) [15]

SUBFAMILY ZENATIINAE

Zenatina Gill & Darragh, 1963
Z. victoriae (Pritchard & Gatliff, 1903) [QM]

FAMILY MESODESMATIDAE

SUBFAMILY MESODESMATINAE

Paphies Lesson, 1830
P. (Atactodea) Dall, 1895
P. (A.) striata (Gmelin, 1791) [QM; 15]
P. (Amesodesma) Iredale, 1930
P. (A.) elongata (Reeve, 1854) [B; QM; 15]

SUBFAMILY DAVILINAE

Davila Gray, 1853
D. plana (Hanley, 1843) [QM as *Atactodea plana*]

SUPERFAMILY TELLINOIDEA
(see Note 11)

FAMILY TELLINIDAE

Tellina Linnaeus, 1758
T. (Arcopaginula) Lamy, 1918
T. (A.) inflata Gmelin, 1791 [21]
T. (Angulus) Mühlfeld, 1811
T. (A.) emarginata Sowerby, 1825 [QM]
T. (Cadella) Dall, Bartsch & Rehder, 1938
T. (C.) diluta Smith, 1885 [QM]
T. (C.) obtusalis Deshayes, 1854 [QM]
T. (Macomona) Finlay, 1927
T. (M.) australis Deshayes, 1854 [QM; 15]
T. (M.) deltoidalis Lamarck, 1818 [QM]
T. (M.) imbellis (Hanley, 1844) [QM]
T. (Moerella) Fischer, 1887
T. (M.) minuta Lischke, 1872 [QM]
T. (Pharaonella) Lamy, 1918
T. (P.) astula Hedley, 1917 [QM]
T. (P.) perna Spengler, 1798 [QM; 27]
T. (P.) rostrata Linnaeus, 1758 [QM]
T. (Pinguitellina) Iredale, 1925
T. (P.) languida Smith, 1885 [QM]
T. (P.) pinguis Hanley, 1844 [QM]
T. (P.) robusta Hanley, 1844 [QM]
T. (Pistris) Thiele, 1934
T. (P.) capsoides Lamarck, 1818 [QM]

T. (Pseudoarcopagia) Bertin, 1878
T. (P.) botanica (Hedley, 1918) [QM]
T. (Scutarcopagia) Pilsbry, 1918
T. (S.) linguafelis Linnaeus, 1758 [QM]
T. (Semelangulus) Iredale, 1924
T. (S.) lilium Hanley, 1844 [QM; 18]
T. (S.) semitorta Sowerby, 1867 [18]
T. (S.) tenuilirata Sowerby, 1867 [21]
Exotica Lamy, 1818
E. (Exotica) s.s.
E. (E.) donaciformis (Deshayes, 1854) [QM; 19 as *Macoma donaciformis*]
Leporimetis Iredale, 1930
L. spectabilis (Hanley, 1844) [QM]
Macoma Leach, 1819
M. (Psammacoma) Dall, 1900
M. (P.) candida (Lamarck, 1818) [QM]
M. (P.) retrorsa (Sowerby, 1867) [QM]
M. (Salmacoma) Iredale, 1929
M. (S.) vappa (Iredale, 1929) [21]
Strigilla Turton, 1822
S. (Aeretica) Dall, 1900
S. (A.) euronia Hedley, 1908 [QM]

FAMILY DONACIDAE

Donax Linnaeus, 1758
D. (Deltachion) Iredale, 1930
D. (D.) brazieri Smith, 1892 [QM; 15]
D. (Plebidonax) Iredale, 1930
D. (P.) deltoides Lamarck, 1818 [B; QM; 15; 27]
D. (Latona) Schumacher, 1817
D. (L.) faba Gmelin, 1791 [21 as *Latona faba*]
D. (Tentidonax) Iredale, 1930
D. (T.) veruinus Hedley, 1913 [B; QM]

FAMILY PSAMMOBIIDAE

Gari Schumacher, 1817
G. (Gari) s.s.
G. (G.) anomala (Deshayes, 1855) [QM; 28]
G. (G.) lessoni (Blainville, 1826) [QM; 28]
G. (G.) maculosa (Lamarck, 1818) [QM; 27; 28]
G. (G.) modesta (Deshayes, 1855) [20 as *Gari venta*; 21 as *Milligaretta modesta*; 28]
G. (G.) pallida (Deshayes, 1855) [M; QM also as *G. weinkauffi*]
G. (Crassulobia) Willan, 1993
G. (C.) crassula (Deshayes, 1855) [QM; 28]
G. (Dysmea) Dall, Bartsch & Rehder, 1939
G. (D.) occidens (Gmelin, 1791) [QM; 28]
G. (Psammobia) Lamarck, 1818
G. (P.) livida (Lamarck, 1818) [M; QM; 28]
G. (Psammotaena) Dall, 1900
G. (P.) togata (Deshayes, 1855) [QM; 15; 28]
Heteroglypta Martens, 1880
H. contraria (Deshayes, 1863) [QM; 28]
Soletellina Blainville, 1824
S. alba (Lamarck, 1818) [QM also as *S. donacioides*; 28]
S. burnupi (Sowerby, 1894) [28]

FAMILY SEMELIDAE

Semele Schumacher, 1817
S. casta A. Adams, 1853 [21]
S. crenulata (Sowerby, 1833) [QM]
S. duplicata (Sowerby, 1833) [QM]
S. jukesii (Reeve, 1853) [QM]
S. lamellosa (Sowerby, 1830) [QM]
Abra Lamarck, 1818
A. (Abra) s.s.
A. (A.) infans (Smith, 1885) [QM as *Timoclea infans*]
A. (Syndosmya) Récluz, 1843
A. (S.) truncata Hedley, 1906 [QM]
Leptomya A.Adams, 1864
L. pura (Angas, 1871) [QM; 19, 20]
Theora H. & A. Adams, 1866
T. fragilis A. Adams, 1855 [QM]
T. lata (Hinds, 1843) [QM; 19]

FAMILY SOLECURTIDAE

Solecurtus Blainville, 1824
S. divaricatus (Lischke, 1869) [QM as *S. leone*; 21]
S. quoyi Reeve, 1874 [QM]
S. sulcatus (Dunker, 1861) [QM]
Azorinus Récluz, 1869
A. coarctatus (Gmelin, 1791) [QM; 20, 21 all as *A. abbreviatus*]

SUPERFAMILY UNGULINOIDEA

FAMILY UNGULINIDAE

Felaniella Dall, 1899
F. (Zemysia) Finlay, 1926
F. (Z.) ethima (Melvill & Standen, 1899) [21 as *Diplodonta ethima*]

SUPERFAMILY VENEROIDEA (See Note 12)

FAMILY VENERIDAE

SUBFAMILY VENERINAE

Antigona Schumacher, 1817
A. (Antigona) s.s.
A. (A.) chemnitzii (Hanley, 1844) [B; M; QM; 5; 15; 20 as *Tigammona chemnitzii*; 21 as *Periglypta chemnitzii*; 27]
A. (A.) lamellaris Schumacher, 1817 [B; QM; 15; 19, 21]
A. (A.) persimilis (Iredale, 1930) [QM]
A. (Periglypta) Jukes-Browne, 1914
A. (P.) reticulata (Linnaeus, 1758) [QM]
A. (P.) clathrata (Deshayes, 1854) [QM]
Globivenus Coen, 1934
G. capricornea (Hedley, 1908) [QM; 15]

G. embrithes (Melvill & Standen, 1899) [B; QM; 15; 21 as *Venus embrithes*]
G. torenma (Gould, 1850) [21 as *Venus toreuma*]

SUBFAMILY CALLOCARDIINAE

Pitar Römer, 1857
P. (Pitarina) Jukes-Browne, 1913
P. (P.) affinis (Gmelin, 1791) [B; QM; 15; 27]
P. (P.) nipponica Kuroda & Habe, 1971 [10]
P. (P.) queenslandica Lamprell & Healy, 1997 [10]
P. (P.) trevori Lamprell & Whitehead, 1990 [B; 15]
Callista Poli, 1791
C. (Striacallista) Marwick, 1938
C. (S.) roseotincta (Smith, 1885) [M; QM]
C. (Notocallista) Iredale, 1924
C. (N.) disrupta (Sowerby, 1853) [B; QM; 15]

SUBFAMILY CHIONINAE

Placamen Iredale, 1925
P. calophyllum (Philippi, 1836) [QM; 15; 27]
P. placidum (Phillipi, 1844) [QM]
P. sidneyense (Menke, 1858) [M; QM; 19; 20; 21]
P. tiara (Dillwyn, 1817) [B; M; QM; 15 also as *P. foliacea*; 20, 21]
Bassina Jukes-Browne, 1914
B. jacksoni (Smith, 1885) [B; QM; 15]

SUBFAMILY CLEMENTIINAE

Clementia Gray, 1842
C. (Clementia) s.s.
C. (C.) papyracea (Gray, 1825) [B; M; QM also as *C. moretonensis*; 20 as *C. strangei*]

SUBFAMILY DOSINIINAE

Dosinia Scopoli, 1777
D. caerulea Reeve, 1850 [QM]
D. juvenilis (Gmelin, 1791) [B; QM; 15]
D. kaspewi Fischer-Piette & Delmas, 1967 [QM; 15]
D. mira Smith, 1885 [QM]
D. nedigna (Iredale, 1930) [B; QM; 15; 21 as *Merodosinia nedigna*]
D. sculpta (Hanley, 1845) [B; M; QM; 15; 27]
D. tumida (Gray, 1838) [QM]
D. victoriae Gatliff & Gabriel, 1914 [QM]

SUBFAMILY GOULDINAE

Circe Schumacher, 1817
C. (Circe) s.s.
C. (C.) plicatina (Lamarck, 1816) [B; QM; 15; 27]
C. (C.) scripta (Linnaeus, 1758) [M; QM; 20, 21 as *C. sugillata*]
Gafrarium Röding, 1798
G. australe (Sowerby, 1851) [QM; 15]
G. dispar (Holten, 1802) [QM]
G. tumidum Röding, 1798 [27]

SUBFAMILY LIOCONCHINAE

Lioconcha Mörch, 1853
L. fastigiata (Sowerby, 1851) [13]

SUBFAMILY PETRICOLINAE

Petricola Lamarck, 1801
P. divergens (Gmelin, 1791) [15]

SUBFAMILY TAPETINAE

Tapes Mühlfeld, 1811
T. (Tapes) s.s.
T. (T.) dorsatus (Lamarck, 1818) [B; M; QM; 15; 19, 20, 21 all as *T. watlingi*; 25]
T. (T.) literatus (Linnaeus, 1758) [QM; 15]
T. (T.) sericeus Matsukuma, 1986 [QM]
T. (Ruditapes) Chiamenti, 1900
T. (R.) variegatus Sowerby, 1852 [B; QM; 15]
Eumarcia Iredale, 1924
E. fumigata (Sowerby, 1853) [QM]
Gomphina Mörch, 1853
G. fulgida Hedley, 1918 [QM]
Granicorium Hedley, 1906
G. indutum Hedley, 1906 [12]
Irus Schmidt, 1818
Irus carditoides (Lamarck, 1818) [15]
Irus crebrelamellatus (Tate, 1887) [QM; 15]
Irus crenatus (Lamarck, 1818) [QM]
Irus cumingii (Deshayes, 1854) [B; QM]
Marcia H & A Adams, 1857
M. (Hemitapes) Römer, 1864
M. (H.) hiantina (Lamarck, 1818) [B; M; QM; 15; 27]
Paphia Röding, 1798
P. (Paphia) s.s.
P. (P.) crassisulca (Lamarck, 1818) [B; M; QM; 21 as *Tapes sulcosa*]
P. (P.) undulata (Born, 1780) [B; M; QM; 19; 20; 21 as *Paratapes scordalus*; 27]
P. (Protapes) Dall, 1902
P. (P.) gallus (Gmelin, 1791) [M; QM; 20; 21]
Timoclea Brown, 1827
T. (Chioneryx) Iredale, 1924
T. (C.) scabra (Hanley, 1844) [B; QM]
Venerupis Lamarck, 1818
V. (V.) anomala (Lamarck, 1818) [M; QM]

ORDER MYIDA

SUPERFAMILY MYOIDEA

FAMILY MYIDAE

SUBFAMILY CRYPTOMYINAE

Cryptomya Conrad, 1848
C. (Venatomya) Iredale, 1930
C. (V.) elliptica (A. Adams, 1853) [14]

FAMILY CORBULIDAE

SUBFAMILY CORBULINAE

Corbula Bruguière, 1797
C. (Anisocorbula) Iredale, 1930

C. (A.) moretonensis Lamprell & Healy, 1997 [QM including holotype; 9]

C. (Notocorbula) Iredale, 1930

C. (N.) fortisulcata Smith, 1878 [QM]

C. (N.) hydropica (Iredale, 1930) [QM; 15; 20, 21; 27]

C. (N.) monilis Hinds, 1843 [M]

C. (N.) smithiana Brazier, 1879 [QM]

C. (N.) stephensoni Lamprell & Healy, 1997 [QM including holotype; 9]

C. (N.) tunicata Hinds, 1843 [B; QM also as *Notocorbula vicaria*]

C. (Serracorbula) Olsson, 1961

C. (S.) coxi Pilsbry, 1897 [QM]

C. (S.) crassa Reeve, 1843 [M; QM]

SUPERFAMILY PHOLADOIDEA

FAMILY PHOLADIDAE

SUBFAMILY PHOLADINAE

Pholas Linnaeus, 1758

P. (Monothyra) Tryon, 1862

P. (M.) australasiae Sowerby, 1849 [QM]

P. (M.) orientalis (Gmelin, 1790) [QM]

SUBFAMILY JOUANNETIINAE

Jouannetia Des Moulins, 1828

J. cumingi (Sowerby, 1850) [QM]

SUBFAMILY MARTESIINAE

Martesia Sowerby, 1824

M. striata (Linnaeus, 1758) [B; QM]

FAMILY TEREDINIDAE

SUBFAMILY TEREDININAE

Teredo Linnaeus, 1758

T. poculifer Iredale, 1936 [24]

Dicyathifer Iredale, 1932

D. manni (Wright, 1866) [24]

SUBFAMILY BANKIINAE

Bankia Gray, 1842

B. australis (Calman, 1920) [11; 24]

B. rochi Moll [24]

Nausitora Wright, 1864

N. dunlopei Wright, 1864 [24]

CLADE HETERODONTA *INCERTAE SEDIS*

SUPERFAMILY HIATELLOIDEA

FAMILY HIATELLIDAE

Hiatella Daudin 1801

H. australis (Lamarck, 1818) [B; M; QM]

SUPERFAMILY SOLENOIDEA

FAMILY SOLENIDAE

Solen Linnaeus, 1758

S. fonesi Dunker, 1862 [QM; 15]

S. vaginoides Lamarck, 1818 [B; M; QM; 20, 21 as *Neosolen correctus* or *N. vaginoides*; 27]

FAMILY PHARIDAE

SUBFAMILY CULTELLINAE

Cultellus Schumacher, 1817

C. attenuatus Dunker, 1861 [QM; 27]

Ensiculus H. Adams, 1860

E. cultellus (Linnaeus, 1758) [B; M; QM as *Cultellus cultellus* and *Cultellus hiliaris*; 20, 21 as *Ensiculus hilaris*]

SUBFAMILY SILIQUINAE

Siliqua Mergerie von Mühlfeld, 1811

Siliqua sp. [M]

ORDER PHOLADOMYIDA ('ANOMALODESMATA')

SUPERFAMILY MYOCHAMOIDEA

FAMILY MYOCHAMIDAE

Myochama Stutchbury, 1830

M. anomioides Stutchbury, 1830 [B; QM; 15; 21]

M. strangei Adams, 1852 [QM]

Myadora Gray, 1840

M. brevis Sowerby, 1829 [B; QM; 15]

M. ovata Reeve, 1844 [QM]

M. pandoriformis (Stutchbury, 1830) [B; QM]

SUPERFAMILY PANDOROIDEA

FAMILY PANDORIDAE

Pandora Bruguière, 1797

P. (Frenamya) Iredale, 1930

P. (F.) elongatus (Carpenter, 1846) [B; QM]

SUPERFAMILY THRACIOIDEA

FAMILY LATERNULIDAE

Laternula Röding, 1798

L. anatina (Linnaeus, 1758) [27]

L. attenuata Reeve, 1860 [M]

L. faba (Reeve, 1860) [11]

L. marilina (Reeve, 1860) [B; QM]

FAMILY PERIPLOMATIDAE

Periploma Schumacher, 1817

P. (Offadesma) Iredale, 1930

P. (O.) angasi Crosse & Fischer, 1868 [QM]

SUPERFAMILY CUSPIDARIOIDEA

FAMILY CUSPIDARIIDAE

Cuspidaria Nardo, 1840

C. latesulcata Tension-Woods, 1878 [B]

SUPERFAMILY POROMYOIDEA

FAMILY POROMYIDAE

Poromya Forbes, 1844

P. illevis Hedley, 1913 [B; QM]

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NOTES ON THE LIST

Note 1. The Nuculida of Moreton Bay are not well known and it is likely that new species will emerge when adequate sampling of the bay is carried out. Taxonomic revision is needed.

Note 2. Taylor *et al*. (2008) have indicated that a further species of *Solemya* occurs in Moreton Bay but awaits description when additional material becomes available.

Note 3. Taylor *et al*. (2008) could not determine the subgeneric placement of their new species but noted it showed some shell and ligament similarities to the New Zealand species *S. (Zesolemya) parkinsoni* E.A. Smith, 1874.

Note 4. The species listed here have usually been allocated to *Xenostrobus* Wilson, 1966, but Beu (2006) has recently placed this name into the synonymy of *Limnoperna*.

Note 5. Wilson (2006) has recently erected this new genus for *Modiolus vagina*, on the basis of major anatomical differences from other *Modiolus* spp. and unique features (complex siphonal structures).

Note 6. Based on molecular evidence, Lam & Morton (2006) regard this species as part of the *S. cucullata* superspecies (consisting of *S. cucullata* s.s, *S. glomerata* and *S. kegaki*). Possibly it is better to consider it a subspecies of *S. cucullata*.

Note 7. Taxonomy of Pectinidae follows that of Raines & Poppe (2006) as this is the most recent comprehensive treatment of the whole family. It is anticipated however that molecular work will have a significant impact on the defining and recognition of genera and species once sufficient data has accumulated.

Note 8. The Glauconomidae was formerly located within the Veneroidea, but recently has been moved to a position basal to veneroids (Bieler *et al*. 2010) based on molecular and morphological evidence. Brewer & Willan (1985) report that the exposed siphons of glauconomids form an important component in the diet of the golden-lined whiting (*Sillago analis*) within parts of Moreton Bay.

Note 9. The affinities and systematic position of the Hemidonacidae remain uncertain and cases for their inclusion in the Cardioidea, Tellinoidea and the Veneroidea have been made (Ponder *et al*. 1981). Even sperm ultrastructure (of *Hemidonax pictus*) has not provided any definitive evidence of immediate affinity other than to suggest general cardioid-veneroid affiliations (see Healy *et al*. 2007).

Note 10. The Galeommatoidea of Moreton Bay are poorly known. It is likely that several additional species to those listed here occur in the region.

Note 11. The small-sized tellinoideans of Moreton Bay are poorly known. Many subgenera used for Tellinidae have been used as full genera. However the validity of these taxa remains to be tested using molecular data. Bieler *et al*. (2010) do not recognise any subfamilies and we have followed this.

Note 12. The classification used here and understanding of phylogenetic relations within the Veneroidea owes much to the recent work of Mikkelsen *et al*. (2006).

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A preliminary checklist of the marine gastropods (Mollusca: Gastropoda) of Moreton Bay, Queensland

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ABSTRACT

A preliminary checklist of the marine gastropod molluscs of Moreton Bay is presented, based on the collections of the Queensland Museum, supplemented by records from the Moreton Bay Workshop (2005), published literature and unpublished field records. 1023 species have to date been recorded from the bay area (Caloundra to the Gold Coast including bay islands, to 50 metres depth) representing 138 families and 446 genera. Dominating, in terms of species numbers, are caenogastropod 'prosobranchs' with 672 species (65% of the faunal total) most of which are carnivorous. In contrast, patellogastropods (true limpets), vetigastropods (trochids, turbinids and allies) and neritimorphs, despite containing some of the most abundant species of bay gastropods, constituent less than 8.0% of the total species count. The larger groups of caenogastropods are the Muricoidea (murex shells and allies, 100 species or 9.8% of faunal total), Conoidea (cones, terebrids and turrids: 122 species or 11.9%), Cypraeoidea (cowries and allies), Triphoroidea (triphorids plus cerithiopsids) and Buccinoidea (true whelks) – these three groups each with just over 70 species (each approximately 7.0% of the faunal total). Next in size to the Caenogastropoda is the Heterobranchia (opisthobranchs *sensu lato* plus pulmonates) with 273 recorded species (approximately 26% of faunal total), dominated by a large nudibranch component (145 species, almost half of which are doridoideans). The number of gastropod species that actually occur within Moreton Bay is unknown and likely to remain so until the appropriate taxonomic work and supplementary collecting are carried out. Certain families, such as the Cypraeidae (cowries), Ovulidae (allied cowries), Strombidae (strombs), Mitridae (mitres), Ranellidae (tritons) and Conidae (specifically subfamily Coninae — cone shells) are very well documented thanks largely to their popularity with collectors and/or specialists. Other groups, notably the small-shelled 'turrids', the various rissooidean families and pyramidellid heterobranchs almost certainly have significant numbers of unrecorded or undescribed species living in the bay, and hence such groups should be targeted in future studies. The impressive diversity of the bay gastropod fauna undoubtedly reflects the physical complexity of the region and the wide range of available habitats (sandflats, mudflats, seagrass areas, mangroves, rocky reefs, coral reefs). ❑ *Gastropoda, species list, molluscan fauna, Moreton Bay, Queensland.*

Within Moreton Bay the dominant molluscan components of the marine fauna are gastropods and bivalves, with the former clearly predominating in terms of the number of species (Stephenson *et al.* 1970, 1974; Carless *et al.* in Davie 1998). Ranging in size from the 30 cm baler shells

(Volutidae) down to a multitude of small to micro-taxa, the diversity of gastropod species found within the bay ranks among the most impressive anywhere along the Australian coastline. The richness of the gastropod fauna in Moreton Bay has long been known (e.g. Brazier 1879), and certainly there have been attempts to document some of the more conspicuous species from various localities (e.g. Bramble Bay: Stephenson *et al.* 1976; Serpentine Creek (Cribb Island): Stephenson *et al.* 1977; Wellington Point: Morgan & Hailstone 1986; Brisbane River: Hailstone 1976; Davie 1990) or of some popular families (e.g. Carless 1995–2006). The reasons for this richness lie not just in the large range of available habitats within the bay but also in the fact that the region forms part of an eastern Australian marine overlap zone. Within this zone, widespread northern tropical species extend south into New South Wales, and southern temperate forms extend north into south-eastern Queensland (see Ponder & Wells 1998). Tropical forms become less common moving southwards, and temperate species less common moving northwards. Endemic species are also found within this zone (Short & Potter 1987).

Moreton Bay is one of the most intensively utilised marine areas in Australia, directly impacted by rapid population growth and the attendent pressures from pollution, commercial and recreational activity and environmental factors such as water run-off, sedimentation and presumably even climate change (Neil 1998; Skilleter 1998; Tibbetts *et al.* 1998; Davie & Phillips 2008). It therefore seems timely that a working checklist of the marine Gastropoda occurring in the bay should be produced, if only to provide a faunal snapshot of this numerically and ecologically dominant group of invertebrates.

In May 1996 the members of the Queensland Branch of the Malacological Society of Australasia (MSA) formally recognised the need for a taxonomically-verified checklist of the marine molluscs of south-east Queensland, with the ultimate goal being a photographically illustrated guide based on published accounts, museum sources and member's own records (see Note 1). The late Terry Carless, prominent member of the MSA and Honorary Research Associate of the Queensland Museum was, up until his passing in 2006, compiling a list of the marine Gastropoda of south-east Queensland for the society. He also produced illustrated accounts of families such as the Columbellidae, Cypraeidae, Ovulidae, and Triphoridae with special emphasis on the bay fauna (Carless 2006). However, for many families occuring within the bay, no recent lists or taxonomic revisions have been published, and for several, the need for assessment of suprageneric groups is clearly evident. Current knowledge of most small--shelled families (i.e. shell length <10mm) known to occur in Moreton Bay is fragmentary, and the number of species here listed for these groups will inevitably increase once detailed work and fresh collecting are carried out. Nevertheless the purpose of the list is to fill an immediate need of researchers in south-east Queensland, and hopefully stimulate and assist the work needed to generate a more definitive list.

This paper is dedicated to the late Terry Carless, a dedicated amateur malacologist with an exceptional knowledge of, and experience in collecting, marine molluscs of Queensland and especially of Moreton Bay. He is greatly missed.

MATERIAL AND METHODS

The locality 'Moreton Bay' has often been used in a loose or erroneous context especially in connection with pre-1970 literature and as it refers to some of the older specimen lots held in the Queensland Museum (and undoubtedly in other museums). Even in recent literature 'Moreton Bay' is sometimes cited in relation to species known only from the outer continental shelf, well outside the bay and its direct area of influence (e.g. Wilson 1994: cone shells *Conus howelli*, *C. sculletti*, *C. minnamurra*, and muricids *Siphonochelus erythrostigma* and *S. pavlova*). While it is true that some gastropods can show a considerable depth range, most species tend to fall into a 'shallow water' or 'mid-deep water' category, a fact well known to commercial trawlers operating in south-east Queensland during the 1960s and 1970s (e.g. Evans 2000–2001). For the purposes of this checklist, 'Moreton Bay' is here defined as the waters and shores from Caloundra south to the Gold Coast (to the QLD/NSW border). It includes waters around Bribie, Moreton, North and South Stradbroke

Islands and the many inner-bay islands, as well as the shallow reefs off Cape Moreton (including Flinders Reef area). Gastropod species characteristic of deeper water (> 50m, ie beyond normal dive-collecting range) and normally only encountered by dredging, are therefore excluded.

This list is based on the marine gastropod collections held in the Queensland Museum, and material from the Moreton Bay Marine Workshop (February 2005), supplemented with records from the literature (with emphasis on recent accounts and those that are illustrated, including pertinent websites such as the *Sea Slug Forum*, and *Nudibranchs of the Sunshine Coast*) and collection records of the Malacological Society of Australasia. The source of information concerning confirmed locality data for Moreton Bay material is indicated in [square brackets] after each species in the list. We would like to emphasise that such sources are not an exhaustive catalogue of locality information and for some of the older literature (1960 and earlier) it has been necessary to interpret the use of names now considered invalid or synonyms (and where appropriate, we have indicated some of these after species names). Species with several confirmed locality records can generally be regarded as 'core' elements of the bay's gastropod fauna although for families such as the Conidae (Coninae only; cone shells), Strombidae (strombs), and Cypraeidae (cowries), Ranellidae (tritons) and Mitridae (mitres) there is an admitted 'collector' and/or taxonomic specialist bias. We have included some undetermined species in the list (e.g. *Metaxia* sp., *Janolus* sp.) primarily to establish the existence of a genus and/or family otherwise not represented, or to highlight known diversity in genera awaiting taxonomic attention. Where specific numbers are quoted in relation to undetermined species (e.g. *Retusa* sp. 1, *Retusa* sp. 2) these relate to the source document of the record (s). In general we have avoided inclusion of 'cf' species or subspecies except where these species or higher taxa are of current taxonomic interest. For brevity, and in order to keep the list as uncluttered for the user as possible, we have elected not to include species' synonymies. Such information can generally be found either in the literature (e.g. Wilson 1993, 1994; see references listed at the end of this account) or on taxonomically monitored websites such as the *Sea Slug Forum* (Rudman 2010); *OBIS Molluscan Database of the Academy of Natural Sciences*; and *Nudibranchs of the Sunshine Coast* (Cobb & Mullins 2010). There is currently much interest in nudibranchs and affiliated groups by divers, and species are constantly being added to local lists often as unidentified species (e.g. *Chromodoris* sp. 5, sp. 6 etc). This again underscores the provisional nature of the list presented herein. Partly for ease of reference, species' records taken from the Sea Slug Forum are credited to that website (i.e. Rudman 2010) and not to each individual contributor.

Gastropod classification has undergone major changes over the last three decades. Such changes have been driven by various factors including the fundamental (often radical) alternatives offered by Soviet workers during the 1970s (e.g. Golikov & Starobogatov 1975) and the wealth of new data from comparative anatomy and ultrastructure (of organs and spermatozoa), fossils and from detailed molecular analyses (see Colgan *et al.* 2003; Haszprunar 1988; Ponder & Lindberg 1997, 2008, for summaries and further literature). Recently, Fryda, Hausdorf, Ponder, Valdés & Warén (in Bouchet & Rocroi 2005) have proposed a new classification for the Gastropoda, this time encompassing all known supra-generic taxa, both living and fossil and it is largely this system we have employed herein (see Note 2). For all taxa above the level of superfamily, Fryda *et al.* (2005) have used the terms 'clade' and 'subclade' (i.e. non-Linnean hierarchy) to reflect current consensus, based on cladistic analyses, that such groups are monophyletic. However in order to preserve some degree of hierarchical signposting at higher classificatory levels we have, in this list, found it necessary to use the rank of 'Subclass' in place of 'Clade' for major subdivisions of the Gastropoda. Hence the clades Patellogastropoda, Vetigastropoda, Neritimorpha, Caenogastropoda and Heterobranchia, as used by Fryda *et al.* (2005), are each given the rank of subclass. Fryda *et al.* (2005) also used 'Tribes' within certain families, but in a list such as this we do not feel this extra level of complexity is warranted. In our list (which should not be considered a 'classification' but a working checklist), authorship for taxa is limited to genus and species; all authorships for suprageneric taxa up to and including superfamily level, can be found in Fryda *et al.* (2005) and references cited therein. We would emphasise that recent taxonomic reviews of the Australian fauna do not exist for many families and genera of gastropods included herein, although wherever advances have been made, such works are identified and their salient features incorporated.

Data sources are listed at the back of this paper (numbered), with the exception of the following: M = Moreton Bay Workshop Survey (2005) material (housed in QM); QM = Queensland Museum Collection.

DISCUSSION

This study has recorded a total of 1023 species of Gastropoda from Moreton Bay and group numbers are summarised in Table 1. Notable is the dominance of the Caenogastropoda both in terms of species numbers (672) and higher taxa represented (65 families, 260 genera). Given that caenogastropods are now considered the largest division of the Gastropoda (Ponder *et al.* 2008), this result was perhaps to be expected, but the breadth of representation of families and genera remains impressive. Caenogastropods account for over two thirds of all gastropod species from the bay, mostly belonging to the Conoidea, Muricoidea, Buccinoidea, Cypraeoidea and Triphoroidea — these five groups comprising 438 of the 672 species, or about 65% of all caenogastropod species (see Table 1). It should not, however, be assumed that the most abundant and/or widespread gastropods within the bay necessarily belong to these groups. The cerithioidean family Batillariidae for example is represented by only two species (the mudwhelks *Pyrazus ebeninus* and *Battilaria australis*), but these are among the most prolific macrogastropods intertidally and clearly are of major ecological importance (as surface detritivore/grazers). Similarly the Littorinidae (12 species) feature heavily at many localities often with a pair of predominating species. Neverthless, species-rich superfamilies such as the Muricoidea and Buccinoidea have also produced locally dominant species (e.g. muricids *Morula marginalba, Lepsiella hanleyi* — both pests of oyster farms; nassariids — extremely important as predators and/or scavengers) and subtidally, small-shelled groups such as the Columbellidae are frequently well represented in grab samples by one or more species. Probably the most overlooked of the caenogastropod groups, because of their minute size, is the Rissooidea. The 48 species recorded in the present list is probably only a fraction of the rissooidean fauna of Moreton Bay and certainly much more research is warranted on these numerically abundant and ecologically important gastropods.

Regarding the 'archaeogastropod' groups, Moreton Bay does contain a wide variety of families and genera, but only the Fissurellidae, Trochidae and Neritidae are to any extent well represented within the core portion of the bay in terms of species. Collectively these groups account for less than 8% of the bay gastropod fauna (78 species). Nevertheless some species such as *Austrocochlea porcata* (Trochidae) and *Nerita squamulata* (Neritidae) are dominant intertidal species at several sites both on the mainland and bay island sides. The Haliotidae (abalones) are notable by their absence throughout most of the bay – the few species that have been recorded essentially limited to the northern portion of the bay, especially the seaward sides of the islands and are rarely encountered dead or alive. The status of all four of these species is still uncertain (see Geiger 1998; Note 3 herein).

Among the Heterobranchia occurring in Moreton Bay (273 species, representing 62 families and 144 genera), by far the most species-rich group is the Nudibranchia, with a total of 145 recorded species from 29 families and 69 genera. About one third of these come from the large and diverse doridoidean family Chromodorididae (50 species, mostly from the genera *Chromodoris, Hypselodoris* and *Ceratosoma*). A number of undetermined species of several nudibranch genera are also recorded by Cobb & Mullins (2010) from Moreton Bay (as here defined) but these are not included in the current list. Coleman (2001, 2008), Cobb & Willan (2006) and Cobb & Mullins (2010) record many additional species of nudibranchs and other heterobranchs from the Sunshine Coast north of Caloundra, and for this reason, these are also not listed here. Although many of these species may eventually be found in Moreton Bay it also possible that they have low tolerance to

Table 1. Breakdown of species composition according to superfamilies in Moreton Bay.

Taxon	**No. of Species**	**Species % (approx.)**
Subclass PATELLOGASTROPODA (12 species)		
Patelloidea	6	0.6%
Lottioidea	6	0.6%
Subclass VETIGASTROPODA (51 species)		
Fissurelloidea	13	1.3%
Haliotoidea	4	0.4%
Trochoidea	34	3.3%
Subclass NERITIMORPHA (15)		
Neritoidea	15	1.5%
Subclass CAENOGASTROPODA (672 species)		
Cerithioidea	35	3.4%
Littorinoidea	12	1.2%
Calyptraeoidea	1	0.1%
Capuloidea	2	0.2%
Cypraeoidea	71	6.9%
Cingulopsoidea	6	0.6%
Ficoidea	1	0.1%
Naticoidea	22	2.2%
Pterotracheoidea	1	0.1%
Rissooidea	48	4.7%
Stromboidea	13	1.3%
Tonnoidea	36	3.5%
Vanikoroidea	4	0.4%
Velutinoidea	12	1.2%
Vermetoidea	1	0.1%
Xenophoroidea	1	0.1%
Epitonioidea	21	2.1%
Eulimoidea	5	0.5%
Triphoroidea	72	7.0%
Buccinoidea	73	7.1%
Cancellarioidea	9	0.9%
Conoidea	122	11.9%
Muricoidea	100	9.8%
Olivoidea	4	0.4%
Subclass HETEROBRANCHIA (273 species)		
Acteonoidea	8	0.8%
Architectonicoidea	11	1.1%
Omalogyroidea	1	0.1%
Pyramidelloidea	21	2.1%
Ringiculoidea	2	0.2%

Table 1. Continued ...

Taxon	**No. of Species**	**Species % (approx.)**
Rissoelloidea	1	0.1%
Bulloidea	4	0.4%
Haminoeoidea	4	0.4%
Philinoidea	16	1.6%
Cavolinioidea	7	0.7%
Aplysioidea	10	1.0%
Oxynooidea	2	0.2%
Plakobranchoidea	10	1.0%
Limapontioidea	6	0.6%
Umbraculoidea	2	0.2%
Pleurobranchoidea	6	0.6%
'NUDIBRANCHIA'		
Doridoidea	67	6.5%
Phyllidioidea	13	1.3%
Onchidoridoidea	3	0.3%
Polyceroidea	15	1.5%
Protonotidae (Unassigned Family)	2	0.2%
Arminoidea	2	0.2%
Tritonioidea	11	1.1%
Aeolidoidea	22	2.2%
Fionoidea	6	0.6%
Flabellinoidea	4	0.4%
'PULMONATA'		
Amphiboloidea	2	0.2%
Siphonaroidea	3	0.3%
Ellobioidea	7	0.7%
Onchidoidea	5	0.5%
Totals	1023	100%

salinity/water quality fluctuations to which the region is periodically subject (storm run-off, sedimentation). Rudman & Bergquist (2007) have presented a detailed list of sponge species consumed by the Chromodorididae and Actinocyclidae and their work indicates a high degree of prey-predator specificity. Indeed food availability combined with the short lifespan of nudibranchs (generally one year, often much less) led Willan & Coleman (1984) to comment that 'seldom will one be able to visit a location with the intention of finding a particular species and locate it successfully'. For this reason the long list of nudibranch species recorded herein for Moreton Bay should not be misconstrued as a list of permanent nudibranch components of the fauna.

Pyramidelloidean heterobranchs formed a significant proportion of the gastropods recovered from numerous grab-sample sites during the 2005 Moreton Bay Workshop survey although the number of species encountered was not particularly large (approximately 10 species). The small numbers of species for most heterobranch families occurring in Moreton Bay, especially the shelled groups (e.g. bullomorphs) probably reflects a combination of low collection effort to date combined with on-going difficulties in accurate identification of material (sometimes difficult even to genus or family level). Nevertheless the diversity of heterobranch families (62) and genera (144) represented in the bay fauna remains an impressive tally.

The question as to exactly how many gastropod species live within Moreton Bay (as defined in this account) remains a challenging and presently unanswerable one. While it is true that certain taxa, such as the Cypraeidae, Muricidae, Conidae and Strombidae are very well documented (a reflection both of popularity and research effort), a number of groups, especially those of small physical size (<1cm), are either poorly known or virtually unstudied (e.g. Rissooidea). This situation arises from a combination of factors, not the least being a lack of available (or recent) taxonomic literature dealing with such groups, a lack of adequate material from many sites within the bay and an on-going shortage of specialists capable of dealing with this material. Groups such as the Triphoroidea, 'Turridae' (*sensu lato*) and Pyramidelloidea are known to be extremely species-rich (Marshall 1983; Wells 1991; Schander *et al*. 1999), and hence the number listed in this account for each of these taxa may represent only a small proportion of the total occurring in Moreton Bay. For example, the Carless Collection (now in QM) contains many species of Triphoroidea collected within relatively small areas of the central-east and northern regions of the bay (Amity Point and Bongaree/Sandstone Point) suggesting that there may be many more species to add to the record once detailed collecting in other areas is carried out. According to Davie & Hooper (1998) the number of molluscan species occurring in Moreton Bay, based on estimates provided by T. Carless and K. Lamprell was 1345. This figure is close to the combined total of the gastropod and bivalve checklists presented by us in the current volume (1023 gastropods + 350 bivalves = 1373) but excluding the Polyplacophora, Cephalopoda and Scaphopoda (for Bivalvia list, see Healy & Potter 2010). The numbers of cephalopod and polyplacophoran (chiton) species from the bay are not known, although based on available QM records, their totals are unlikely to exceed 100 each, whereas the number of scaphopod species from the bay is very low — presently only five known (Lamprell & Healy 1998; JH pers. obs.).

Undoubtedly the physical complexity of the bay (geology, hydrology, interplay of oceanic currents, especially the East Australian Current and associated eddying) has been a major contributing factor to the development of a wide variety of habitats (estuarine, mangrove, coral reef, ocean beach, rocky shore and rocky reef, seagrass pasture) and the high species diversity (Neil 1998). Within the bay, the differences in benthic substratum type encountered between relatively closely placed dredge-sampling stations are often dramatic – sometimes passing from sand to clayey mud to gravel or coarse shell pieces within a single kilometre and with major changes in faunal composition through each substratum transition (JH pers. obs.). The rich diversity of gastropods (and other molluscs) within Moreton Bay appears to be paralleled in other major groups of invertebrates (e.g. Crustacea and Porifera – see Davie & Hooper 1998), further indicating the biological importance of the area and the need to preserve its integrity. The recent sighting of living tropical mudwhelks (*Telescopium telescopium* of the cerithioidean family Potamididae) at Nudgee Beach (J. Singfield and S. Quinnell, pers. com. to JH) has raised the issue of northern invasives and the possible reasons for sporadic appearances of such species (this species is not listed herein). It is tempting to suggest that such events may be linked to global weather and oceanic temperature changes but more work is required to test these ideas. Certainly it would appear wise to have regular monitoring of molluscan fauna in selected bay localities, if only to ensure the early detection of invasives.

Finally, it is interesting to reflect on the diets of gastropods occurring in Moreton Bay as inferred from taxa which have been examined to date. Of the 1023 species, approximately 72% are either active predators (Conoidea, Naticoidea; Tonnoidea, Muricoidea, many Cypraeoidea, most nudibranchs), scavengers (several Buccinoidea, some Muricoidea) or parasitic/semi-parasitic (Pyramidelloidea, Eulimoidea). The remaining 28% are mostly algal grazers (e.g. patellogastropods, vetigastropods, Littorinoidea, some cowries, some Cerithioidea) and/or detritivores (most Cerithioidea, Rissooidea) with a few mucous-trap/ciliary feeders (e.g. Capuloidea, Vermetoidea, some Cerithioidea). Of the active predators: approximately 36% feed on polychaetes or sipunculids (most Conoidea and many Buccinoidea and Muricoidea); 25% feed on sponges (Triphoroidea, many nudibranchs, some cowries); 16 % feed on other molluscs (Naticoidea, many Muricoidea, some Conoidea, mostly preying on bivalves or other gastropods); 16% feed on solitary or colonial cnidarians (ovulid cypraeoideans, Epitonioidea, Architectonicoidea, aeolid nudibranchs) and 7% feed on other prey (echinoderms, ascidians, bryozoans, fish etc) (several Tonnoidea, some nudibranchs, some Muricoidea, some Conoidea). Such figures underscore the trophic importance of all of these prey groups to the bay's gastropod fauna, as in turn gastropods themselves form a significant dietary component of other animals such as crabs, fish, and other molluscs (gastropods, cephalopods).

CLASS GASTROPODA

SUBCLASS PATELLOGASTROPODA
SUPERFAMILY PATELLOIDEA

FAMILY PATELLIDAE

Cellana H. Adams, 1869
- *C. conciliata* Iredale, 1940 [QM]
- *C. radiata* (Born, 1778) [QM]
- *C. testudinaria* (Linnaeus, 1758) [QM]
- *C. tramoserica* (Holten, 1802) [QM; 32; 44; 56]
- *C. turbator* Iredale, 1940 [QM; 56]

Patella Linnaeus, 1758
P. (*Scutellastra*) H. & A. Adams, 1854
- *P.* (*S.*) *chapmani* Tenison Woods, 1876 [QM; 44]

SUPERFAMILY LOTTIOIDEA
FAMILY LOTTIIDAE

SUBFAMILY LOTTIINAE

Notoacmea Iredale, 1915
- *N. flammea* (Quoy & Gaimard, 1834) [QM]
- *N. petterdi* (Tenison Woods, 1876) [QM; 56]

SUBFAMILY PATELLOIDIINAE

Patelloida Quoy & Gaimard, 1834
- *P. cryptalirata* (Macpherson, 1955) [56]
- *P. heteromorpha* (Oliver, 1926) [QM]
- *P. mimula* (Iredale, 1924) [QM]
- *P. saccharina* (Linnaeus, 1758) [QM]

SUBCLASS VETIGASTROPODA
SUPERFAMILY FISSURELLOIDEA

FAMILY FISSURELLIDAE

SUBFAMILY FISSURELLINAE

Amblychilepas Pilsbry, 1890
- *A. nigrita* (Sowerby, 1834) [QM]

SUBFAMILY EMARGINULINAE

Emarginula Lamarck, 1801
- *E. dilecta* (A. Adams, 1851) [QM]
- *E. incisura* (A. Adams, 1853) [QM]

Diodora Gray, 1821
- *D. jukesii* (Reeve, 1850) [M; QM; 32; 56]
- *D. lineata* (Sowerby, 1835) [QM]
- *D. singaporensis* (Reeve, 1850) [44]
- *D. ticaonica* (Reeve, 1850) [QM]

Hemitoma Swainson, 1840
H. (*Montfortista*) Iredale, 1929
- *H.* (*M.*) *excentrica* (Iredale, 1929) [QM]

Montfortula Iredale, 1915
- *M. pulchra* (A. Adams, 1852) [QM]
- *M. rugosa* (Quoy & Gaimard, 1834) [QM]

Scutus Montfort, 1810
- *S. antipodes* Montfort, 1810 [QM; 32; 44; 56]
- *S. unguis* (Linnaeus, 1758) [M; QM; 19; 32; 44]

Tugali Gray, 1843
- *T. parmophoidea* (Quoy & Gaimard, 1834) [QM; 1]

SUPERFAMILY HALIOTOIDEA
FAMILY HALIOTIDAE (see Note 3)

Haliotis Linnaeus, 1758
- *H. brazieri* Angas, 1869 [QM]
- *H. ethalogus* (Iredale, 1927) [QM]
- *H. hargravesi* Cox, 1869 [QM; 56]
- *H. melculus* (Iredale, 1927) [QM]

SUPERFAMILY TROCHOIDEA (see Note 4)
FAMILY TROCHIDAE

SUBFAMILY TROCHINAE

Austrocochlea Fischer, 1855
- *A. porcata* (A. Adams, 1853) [QM; 32; 34; 56 (also as *A. constricta*)]

Calthalotia Iredale, 1929
C. arruensis (Watson, 1880) [61]
C. indistincta (Wood, 1828) [M; QM; 32; 56]

Clanculus Montfort, 1810
C. atropurpureus (Gould, 1849) [QM]
C. johnstoni Hedley, 1917 [QM]

Eurytrochus Fischer, 1880
E. strangei (A. Adams, 1853) [QM]

Notogibbula Iredale, 1924
N. bicarinata (A. Adams, 1854) [QM, as *N. coxi*]

Phasianotrochus Fischer, 1885
P. eximius (Perry, 1811) [QM; 1]

SUBFAMILY EUCYCLINAE

Euchelus Philippi, 1847
E. (Vaceuchelus) Iredale, 1929
E. (V.) ampullus Tate, 1893 [QM]

Herpetopoma Pilsbry, 1894
H. atrata (Gmelin, 1791) [M; QM; 19; 32; 53, 56 (also as *Euchelus atratus*)]
H. rubra (A. Adams, 1853) [QM]

SUBFAMILY HALISTYLINAE

Botelloides Strand, 1928
B. glomerosus (Hedley, 1907) [37]

SUBFAMILY SOLARIELLINAE

Spectamen Iredale, 1924
S. bellulus (Angas, 1869) [QM]

SUBFAMILY STOMATELLINAE

Stomatia Helbling, 1779
S. phymotis Helbling, 1779 [QM; 32; 56]

SUBFAMILY UMBONIINAE

Bankivia Krauss, 1848
B. fasciata (Menke, 1830) [QM]

Conotalopia Iredale, 1929)
C. tropicalis (Hedley, 1907) [QM]

Leiopyrga H. & A. Adams, 1863
L. cingulata (Adams, 1863) [QM]

Monilea Swainson, 1840
M. callifera (Lamarck, 1822) [QM; 32; 56]
M. morti Iredale, 1919 [52, 53 also as *Talopia morti*]

FAMILY CALLIOSTOMATIDAE

Calliostoma Swainson, 1840
C. comptum (A. Adams, 1854) [QM]

Astele Swainson, 1855
A. (Astele) s.s.
A. (A.) speciosum (A. Adams, 1854) [QM; 32; 53; 56; 61]

FAMILY SKENEIDAE

Chunula Thiele, 1925
C. johnstoni (Beddome, 1883) [QM]

Lodderia Tate, 1899
L. lodderae (Petterd, 1884) [QM]

FAMILY TURBINIDAE

SUBFAMILY TURBININAE

Turbo Linnaeus, 1758
T. (Turbo) s.s.
T. (T.) petholatus Linnaeus, 1758 [QM]
T. (Dinassovica) Iredale, 1937
T. (D.) militaris Reeve, 1848 [QM; 32; 44; 56 as *T. imperialis*]
T. (Marmarostoma) Swainson, 1829
T. (M.) haynesi Preston, 1914 [QM; 32; 44; 56]
T. (Subninella) Thiele, 1929
T. (S.) undulatus Lightfoot, 1786 [QM; 32]

Astralium Link, 1807
A. tentoriiformis (Jonas, 1845) [QM; 44; 56]

Bolma Risso, 1826
B. aureola (Hedley, 1907) [56]

SUBFAMILY ANGARIINAE

Angaria Röding, 1798
A. delphinus (Linnaeus, 1758) [32]

FAMILY LIOTIDAE

Austroliotia Cotton, 1948
A. botanica (Hedley, 1915) [QM]

FAMILY PHASIANELLIDAE

SUBFAMILY PHASIANELLINAE

Phasianella Lamarck, 1804
P. solida (Born, 1778) [QM]
P. variegata Lamarck, 1822 [QM; 56]

SUBFAMILY TRICOLIINAE

Tricolia Risso, 1826
T. fordiana (Pilsbry, 1888) [QM; 61]

SUBCLASS NERITIMORPHA
SUPERFAMILY NERITOIDEA

FAMILY NERITIDAE

SUBFAMILY NERITINAE

Nerita Linnaeus, 1758
N. albicilla Linnaeus, 1758 [QM; 32; 56]
N. balteata Reeve, 1855 [QM; 32; 34 as *N. lineata*]
N. chamaeleon Linnaeus, 1758 [QM; 32; 34]
N. costata Gmelin, 1791 [QM; 32]
N. melanotragus (E.A. Smith, 1884) [QM; 32; 56 also as *N. atramentosa*] (see Note 5)
N. planospira Anton, 1839 [QM; 1; 34; 56]
N. plicata Linnaeus, 1758 [QM; 1; 32; 56]
N. polita Linnaeus, 1758 [QM; 1; 32; 56]
N. reticulata Karsten, 1789 [QM]
N. squamulata Le Guillou, 1841 [QM; 32; 56]
N. undata Linnaeus, 1758 [QM; 32]

Clithon Montfort, 1810
C. oualaniensis (Lesson, 1831) [M] (see Note 6)

FAMILY PHENACOLEPADIDAE

Phenacolepas Pilsbry, 1891
P. crenulata (Broderip, 1834) [QM]

Plesiothyreus Cossman, 1888
P. cytherae (Lesson, 1831) [56]
Cinnalepeta Iredale, 1929
C. cinnamomea (Gould, 1846) [QM; 1]

SUBCLASS CAENOGASTROPODA
CLADE SORBEOCONCHA
SUPERFAMILY CERITHIOIDEA

FAMILY CERITHIIDAE

SUBFAMILY CERITHIINAE

Cerithium Bruguière, 1789
C. atromarginatum Dautzenberg & Bouge, 1933 [24]
C. citrinum Sowerby, 1855 [QM; 44]
C. coralium Kiener, 1841 [24]
C. egenum Gould, 1849 [24]
C. nesioticum Pilsbry & Vanatta, 1906 [QM; 24; 32]
C. novaehollandiae A. Adams in Sowerby, 1855 [QM; 24; 44; 56]
C. punctatum Bruguière, 1792 [QM]
C. rostratum Sowerby, 1855 [24]
C. torresi E.A. Smith, 1884 [24]
Clypeomorus Jousseaume, 1888
C. batillariaeformis Habe & Kosuge, 1966 [23]
C. bifasciata (Sowerby, 1855) [QM; 32]
C. pellucida (Hombron & Jacquinot, 1852) [QM; 23]
C. petrosa (Wood, 1828) [QM; 23; 32; 56]
Rhinoclavis Swainson, 1840
R. aspera (Linnaeus, 1758) [32]
R. brettinghami Cernohorsky, 1974 [QM; 32]
R. vertagus (Linnaeus, 1758) [QM]

SUBFAMILY ALABININAE

Alaba H. & A. Adams, 1853
A. difformis (Laseron, 1956) [QM, as *Australaba difformis*); 32]
A. opiniosa (Iredale, 1936) [QM]

SUBFAMILY BITTININAE

Bittium Leach in Gray, 1847
B. (Cacozeliana) Strand, 1928
B. (C.) lacertinum (Gould, 1861) [QM]

FAMILY BATILLARIIDAE

Pyrazus Montfort, 1810
P. ebeninus (Bruguière, 1792) [QM; 19; 32; 34; 56]
Batillaria Benson, 1842
B. australis (Quoy & Gaimard, 1834) [QM; 19; 32; 34; 53; 56; also as *Velacumantus australis*]

FAMILY DIALIDAE

Diala A. Adams, 1861
D. albugo (Watson, 1886) [39]
D. semistriata (Philippi, 1849) [QM as *D. varia*; 39]

FAMILY PLANAXIDAE

SUBFAMILY PLANAXINAE

Planaxis Lamarck, 1822
P. sulcatus (Born, 1780) [QM; 32; 56]
Hinea Gray, 1847
H. brasiliana (Lamarck, 1822) [QM; 32; 56]

FAMILY POTAMIDIDAE

Cerithidea Swainson, 1840
C. anticipata Iredale, 1929 [QM; 32; 34 as *Cerithidea obtusa*]
C. largillierti (Philippi, 1849) [QM; 32; 34]

FAMILY SCALIOLIDAE

Finella A. Adams, 1860
F. fabrica (Laseron, 1956) [32]

FAMILY SILIQUARIIDAE

Pyxipoma Mörch, 1860
P. weldii (Tenison Woods, 1875) [1]
Tenagodus Guettard, 1770
T. australis (Quoy & Gaimard, 1834) [QM]

FAMILY TURRITELLIDAE

SUBFAMILY TURRITELLINAE

Colpospira Donald, 1900
C. aquamarina Garrard, 1972 [61]
C. cordisme (Watson, 1881) [1]
C. wollumbi Garrard, 1972 [1]
Gazameda Iredale, 1924
G. gunnii (Reeve, 1848) [QM; 1]
Haustator Montfort, 1810
H. (Kurosioia) Ida, 1952
H. (K.) cingulifera (Sowerby, 1825) [QM]

SUBCLADE HYPSOGASTROPODA
GROUP LITTORINIMORPHA
SUPERFAMILY LITTORINOIDEA

FAMILY LITTORINIDAE

SUBFAMILY LITTORININAE

Afrolittorina Williams, Reid & Littlewood, 2003
A. acutispira (E.A.Smith, 1892) [QM]
Austrolittorina Rosewater, 1970
A. unifasciata (Gray, 1826) [QM; 32; 56; also as *Nodilittorina unifasciata*]
Littoraria Griffith & Pidgeon, 1834
L. (Littoraria) s.s.
L. (L.) undulata (Gray, 1839) [QM]
L. (L.) Mörch, 1876
L. (L.) filosa (Sowerby, 1832) [QM]
L. (L.) luteola (Quoy & Gaimard, 1833) [QM; 45; 56]
L. (L.) philippiana (Reeve, 1857) [45; 61]
L. (L.) scabra (Linnaeus, 1758) [QM; 34; 45; 61]
L. (Palustorina) Reid, 1986
L. (P.) articulata (Philippi, 1846) [QM; 32; 45; 61]
Echinolittorina Habe, 1956
E. (Granulittorina) Habe & Kosuge, 1966
E. (G.) vidua (Gould, 1859) [QM as *E. millegrana*; 32; 46]

Nodilittorina von Martens, 1897
N. pyramidalis (Quoy & Gaimard, 1833) [QM; 32; 56]

SUBFAMILY LACUNINAE

Bembicium Philippi, 1846
B. auratum (Quoy & Gaimard, 1834) [QM; 32; 34; 56]
B. nanum (Lamarck, 1822) [QM; 32; 56]

SUPERFAMILY CALYPTRAEOIDEA

FAMILY CALYPTRAEIDAE

Crepidula Lamarck, 1799
C. aculeata (Gmelin, 1791) [QM]

SUPERFAMILY CAPULOIDEA

FAMILY CAPULIDAE

Capulus Montfort, 1810
C. devotus Hedley, 1904 [QM]

Icuncula Iredale, 1924
I. torcularis (Tenison Woods, 1878) [1]

SUPERFAMILY CYPRAEOIDEA

FAMILY CYPRAEIDAE (see Note 7)

SUBFAMILY CYPRAEINAE

Cypraea Linnaeus, 1758
C. tigris Linnaeus, 1758 [QM; 6; 15; 32; 33; 44; 56]

Mauritia Troschel, 1863
M. arabica (Linnaeus, 1758) [QM; 6; 32; 33; 44; 56]
M. eglantina (Duclos, 1833) [QM; 6; 32; 33; 44]

SUBFAMILY ERRONEINAE

Erronea Troschel, 1863
E. caurica (Linnaeus, 1758) [QM; 6; 32; 33; 44]
E. cylindrica (Born, 1778) [QM; 6; 32]
E. errones (Linnaeus, 1758) [QM; 6; 32; 33; 44; 56]
E. listeri (Gray, 1824) [QM; 6; 32; 33 all as *Erronea felina* or *Cypraea felina*]
E. xanthodon (Sowerby, 1822) [QM; 6; 32; 33; 44; 56]

Adusta Jousseaume, 1884
A. subviridis (Reeve, 1835) [QM; 6; 32; 33; 44; 56]

Bistolida Cossmann, 1920
B. hirundo (Linnaeus, 1758) [QM; 6; 44]
B. kieneri (Hidalgo, 1906) [44]
B. stolida (Linnaeus, 1758) [QM; 6; 32]
B. ursellus (Gmelin, 1791) [6]

Contradusta Meyer, 2003
C. walkeri (Sowerby, 1832) [QM; 6; 33]

Cribrarula Strand, 1929
C. cribraria (Linnaeus, 1758) [6; 32; 44]

Notadusta Schilder, 1935
N. punctata (Linnaeus, 1771) [6]

Ovatipsa Iredale, 1931
O. chinensis (Gmelin, 1791) [QM; 6; 32; 44; 56]

Palmadusta Iredale, 1930
P. asellus (Linnaeus, 1758) [6; 32]
P. clandestina (Linnaeus, 1758) [QM; 6; 32; 33; 44]
P. contaminata (Sowerby, 1832) [6]
P. humphreysii (Gray, 1825) [QM; 6; 32; 33; 44; 56]
P. ziczac (Linnaeus, 1758) [QM; 6]

Purpuradusta Schilder, 1935
P. fimbriata (Gmelin, 1791) [6]
P. gracilis (Gaskoin, 1849) [QM; 6; 32; 33; 44; 56]
P. hammondae Iredale, 1939 [QM; 6; 32; 44; 56]
P. microdon (Gray, 1825) [6]
P. minoridens (Melvill, 1901) [QM; 6; 32; 44]

Talostolida Iredale, 1930
T. teres (Gmelin, 1791) [QM; 6; 32; 44]

SUBFAMILY EROSARIINAE

Erosaria Troschel, 1863
E. cernica Sowerby, 1870 [QM; 6; 32; 44]
E. erosa (Linnaeus, 1758) [QM; 6; 15; 32; 33; 44; 53; 56]
E. flaveola (Linnaeus, 1758) [QM; 32; 33; 44; 56 also as *C. labrolineata*)]
E. helvola (Linnaeus, 1758) [QM; 6; 32; 44]
E. miliaris (Gmelin, 1791) [6; 32; 44]
E. poraria (Linnaeus, 1758) [QM; 6; 44]

Monetaria Troschel, 1863
M. annulus (Linnaeus, 1758) [QM; 6; 32; 33; 44; 56]
M. caputserpentis (Linnaeus, 1758) [QM; 6; 32; 33; 44; 56]
M. moneta (Linnaeus, 1758) [QM; 6; 32; 33; 44]

Nucleolaria Oyama, 1959
N. nucleus (Linnaeus, 1758) [6]

Staphylaea Jousseaume, 1884
S. limacina (Lamarck, 1810) [QM; 6; 32; 33; 44]
S. staphylaea (Linnaeus, 1758) [QM; 6; 32; 33; 44; 56]

SUBFAMILY LURIINAE

Luria Jousseaume, 1884
L. isabella (Linnaeus, 1758) [6; 32; 44]

Lyncina Troschel, 1863
L. carneola (Linnaeus, 1758) [QM; 6; 32; 33; 44; 56]
L. lynx (Linnaeus, 1758) [QM; 6; 32; 33; 44; 56]
L. vitellus (Linnaeus, 1758) [QM; 6; 32; 33; 44; 56]

Talparia Troschel, 1863
T. talpa (Linnaeus, 1758) [6]

SUBFAMILY UNCERTAIN

Pustularia Swainson, 1840
P. cicercula (Linnaeus, 1758) [6]
P. globulus (Linnaeus, 1758) [6]

FAMILY OVULIDAE (see Note 8)

SUBFAMILY OVULINAE

Ovula Bruguière, 1789
O. costellata Lamarck, 1810 [QM; 9; 32; 44]
O. ovum (Linnaeus, 1758) [QM; 9; 32; 44; 56]

Calpurnus Montfort, 1810
C. (*Calpurnus*) s.s.
C. (*C.*) *verrucosus* (Linnaeus, 1758) [QM; 9; 44; 56]
C. (*Procalpurnus*) Thiele, 1939
C. (*P.*) *lacteus* (Lamarck, 1810) [QM; 9]

Crenovula Cate, 1973
C. striatula striatula (Sowerby, 1828) [QM; 9]
C. striatula traillii (A.Adams, 1856) [9]
C. striatula tinctura (Garrard, 1963) [QM; 9; 15 as *Primovula tinctura*; 44]

Habuprionovula Azuma, 1970
H. hervieri (Hedley, 1899) [9]

Primovula Thiele, 1925
P. (*Adamantia*) Cate, 1973
P. (*A.*) *dubia* Cate, 1973 [QM; 9]
P. (*A.*) *uvula* Cate, 1973 [QM; 9; 44]

Prionovolva Iredale, 1930
P. brevis (Sowerby, 1828) [QM; 9]
P. cavanaghi (Iredale, 1931) [QM; 9; 44]
P. pulchella (H. Adams, 1873) [QM; 9]
P. pudica (A. Adams, 1854) [44]
P. wilsoniana Cate, 1973 [QM; 9]

Prosimnia Schilder, 1927
P. semperi (Weinkauff, 1881) [QM; 9]

Pseudosimnia Schilder, 1927
P. (*Diminovula*) Iredale, 1930
P. (*D.*) *alabaster* (Reeve, 1865) [9; 61]
P. (*D.*) *punctata* (Duclos, 1831) [QM; 9]
P. (*D.*) *incisa* Azuma & Cate, 1971 [QM; 9]
P. (*D.*) *whitworthi* Cate, 1973 [QM; 9]
P. (*Inflatovula*) Cate, 1973
P. (*I.*) *culmen* Cate, 1973 [9; 44]
P. (*Labiovolva*) Cate, 1973
P. (*L.*) *nubila* Cate & Azuma, 1973 [9]

SUBFAMILY VOLVINAE

Volva Röding, 1798
V. volva (Linnaeus, 1758) [QM; 9]

Cymbovula Cate, 1974
C. queenslandica Cate, 1974 [QM; 9]

Phenacovolva Iredale, 1930
P. (*Phenacovolva*) s.s.
P. (*P.*) *rosea rosea* (A. Adams, 1854) [QM; 32]
P. (*P.*) *rosea schmidi* Fehse & Wiese, 1993 [15 as *P. schmidi*]
P. (*Pellasimnia*) Iredale, 1931
P. (*P.*) *subreflexa* (A. Adams & Reeve, 1848) [9]

SUPERFAMILY CINGULOPSOIDEA

FAMILY CINGULOPSIDAE

Eatonina Thiele, 1912
E. hutchingsae Ponder & Yoo, 1980 [43]

Eatoniopsis Thiele, 1912
E. (*Rufodardanula*) Ponder, 1965
E. (*R.*) *castanea* (Laseron, 1950) [43]

Pseudopisinna Ponder & Yoo, 1980
P. gregaria gregaria (Laseron, 1950) [43]
P. gregaria rugifera Ponder & Yoo, 1980 [43]

Tubbreva Ponder, 1965
T. parva Ponder & Yoo, 1980 [43]

FAMILY EATONIELLIDAE

Eatoniella Dall, 1876
E. (*Eatoniella*) s.s.
E. (*E.*) *atropurpurea* (Frauenfeld, 1867) [42]

Crassitoniella Ponder, 1965
C. flammea (Frauenfeld, 1867) [42]

SUPERFAMILY FICOIDEA

FAMILY FICIDAE

Ficus Röding, 1798
F. subintermedia (Orbigny, 1852) [QM]

SUPERFAMILY NATICOIDEA (see Note 9)

FAMILY NATICIDAE

SUBFAMILY NATICINAE

Natica Scopoli, 1777
N. stellata (Hedley, 1913) [QM]
N. vitellus (Linnaeus, 1758) [M; QM; 44; 56]

Naticarius Dumeril, 1806
N. alapapilionis (Röding, 1798) [QM]
N. colliei Récluz, 1844 [QM; 56; 61]
N. onca (Röding, 1798) [QM]

Notocochlis Powell, 1933
N. gualtieriana (Récluz, 1844) [QM; 44 as *Natica gualtieriana*]

SUBFAMILY POLINICINAE

Polinices Montfort, 1810
P. cumingianus (Récluz, 1844) [QM; 44 both as *Polinices powisiana*]
P. jukesii Reeve, 1855 [QM]
P. mammilla (Linnaeus, 1758) [QM also as *Polinices pyriformis*; 56]

Conuber Finlay & Marwick, 1937
C. conicus (Lamarck, 1822) [QM; 15; 19; 32; 53]
C. incei (Philippi, 1851) [QM; 32; 56]

C. melastomus (Swainson, 1822) [44; 56]
C. sordidus (Swainson, 1821) [QM; 32; 56]

Glossaulax Pilsbry, 1929
G. didyma (Röding, 1798) [QM]

Mammilla Schumacher, 1817
M. melanostoma (Gmelin, 1791) [32; 44]
M. sebae (Récluz, 1844) [QM]
M. simiae (Deshayes, 1838) [QM]

Neverita Risso, 1826
N. aulacoglossa (Pilsbry & Vanatta, 1908) [QM as *Polinices didyma*]
N. peselephanti (Link, 1807) [QM as *Polinices peselephanti*]

SUBFAMILY SININAE

Sinum Röding, 1798
S. haliotoideum (Linnaeus, 1758) [QM]

Eunaticina Fischer, 1885
E. linneana (Récluz, 1843) [QM]
E. papilla (Gmelin, 1791) [QM]

SUPERFAMILY PTEROTRACHEOIDEA (see Note 10)

FAMILY ATLANTIDAE

Atlanta Lesueur, 1817
A. peronii Lesueur, 1817 [QM]

SUPERFAMILY RISSOOIDEA (see Note 11)

FAMILY RISSOIDAE

SUBFAMILY RISSOINAE

Alvania Risso, 1826
A. (*Alvania*) s.s.
A. (A.) firma (Laseron, 1956) [QM]
A. (A.) novarensis Frauenfeld, 1867 [QM]
A. (*Linemera*) Finlay, 1924
A. (L.) suprasculpta May, 1915 [QM]

Lucidestea Laseron, 1956
L. nitens (Frauenfeld, 1867) [QM, as *Rissoa nitens*]

Merelina Iredale, 1915
M. queenslandica Laseron, 1956 [QM]

SUBFAMILY RISSOININAE

Rissoina Orbigny, 1840
R. (*Rissoina*) s.s.
R. (R.) ambigua (Gould, 1849) [QM]
R. (R.) crassa Angas, 1871 [QM]
R. (R.) heronensis (Laseron, 1956) [QM]
R. (*Phosinella*) Mörch, 1876
R. (P.) allanae Laseron, 1950 [QM]

FAMILY ANABATHRONIDAE (ANABATHRIDAE)

Anabathron Frauenfeld, 1867
A. ascensum Hedley, 1907 [QM]
A. contabulatum Frauenfeld, 1867 [QM]
A. lene (Hedley, 1915) [QM]

Amphithalamus Carpenter, 1865
A. (*Amphithalamus*) s.s.
A. (A.) incidatus (Frauenfeld, 1867) [QM]
A. (A.) fulcira (Laseron, 1956) [QM]
A. (A.) jacksoni (Brazier, 1894) [QM]

Badepigrus Iredale, 1955
B. improrsa (Laseron, 1956) [QM]
B. protractus (Hedley, 1904) [QM]

FAMILY ASSIMINEIDAE

Assiminea Fleming, 1828
A. (*Metassiminea*) Thiele, 1927
A. (M.) brazieri Tenison Woods, 1876 [QM]
A. (M.) buccinoides (Quoy & Gaimard, 1834) [QM; 34 as *Hydrobia buccinoides*]
A. (M.) relata Cotton, 1942 [34]

FAMILY BARLEEIDAE

Pisinna Monterosato, 1878
P. castella (Laseron, 1950) [40]
P. frauenfeldi (Frauenfeld, 1867) [40]
P. kershawi (Tenison Woods, 1878) [40]
P. nitida Ponder & Yoo, 1976 [40]
P. salebrosa (Frauenfeld, 1867) [40]
P. tasmanica (Tennison-Woods, 1876) [40]
P. tumida simplicosta Ponder & Yoo, 1976 [40]
P. vincula (Laseron, 1950) [40]
P. perdigna (Laseron, 1956) [QM]

FAMILY CAECIDAE

Caecum Fleming, 1813
C. amputatum Hedley, 1893 [QM]
C. lilianum Hedley, 1903 [QM]
Caecum sp. [QM as *C. septimentum*]

Parastrophia de Folin, 1869
P. cygnicollis (Hedley, 1904) [QM]

FAMILY CALOPIIDAE

Calopia Ponder, 1999
C. imitata Ponder, 1999 [38]

FAMILY EMBLANDIDAE

Emblanda Iredale, 1955
E. emblematica (Hedley, 1906) [QM]

FAMILY EPIGRIDAE

Epigrus Hedley, 1903
E. cylindracea (Tenison Woods, 1878) [QM]
E. dissimilis (Watson, 1886) [QM]

FAMILY IRAVADIIDAE

Iravadia Blandford, 1867
I. (*Iravadia*) s.s.
I. (I.) quadrasi (Boettger, 1893) [QM]
I. (*Pseudonoba*) Boettger, 1902
I. (P.) delicata (Philippi, 1849) [QM]
I. (P.) sublevis (Laseron, 1956) [QM]

Nozeba Iredale, 1915
N. topaziaca (Hedley, 1908) [QM]

FAMILY STENOTHYRIDAE

Stenothyra Benson, 1856
S. australis Hedley, 1901 [QM; 34]

FAMILY TRUNCATELLIDAE

Truncatella Risso, 1826
T. scalarina Cox, 1867 [QM]

FAMILY TORNIDAE

SUBFAMILY VITRINELLINAE

Callomphala A. Adams & Angas, 1864
C. lucida A. Adams & Angas, 1864 [QM]

Liotropia Laseron, 1958
L. introspecta (Hedley, 1907) [QM; 8]

Pseudoliotia Tate, 1898
P. axialis Laseron, 1958 [QM; 7]
P. gowllandi (Brazier, 1874) [7]
P. micans (A.Adams, 1850) [QM; 7]
P. speciosa (Angas, 1877) [QM; 7]

SUPERFAMILY STROMBOIDEA

FAMILY STROMBIDAE

Lambis Röding, 1798
L. lambis (Linnaeus, 1758) [44]
L. truncata (Humphrey, 1786) [32; 44]

Strombus Linnaeus, 1758
S. (Canarium) Schumacher, 1817
S. (C.) erythrinus Dillwyn, 1817 [QM; 44]
S. (C.) labiatus (Röding, 1798) [QM; 32; 44; 56]
S. (C.) microurceus (Kira, 1959) [QM; 32; 44]
S. (C.) mutabilis Swainson, 1821 [QM; 44; 56]
S. (Conomurex) Fischer, 1884
S. (C.) luhuanus Linnaeus, 1758 [QM; 32; 44; 56]
S. (Dolomena) Iredale, 1931
S. (D.) dilatatus Swainson, 1821 [44]
S. (Doxander) Iredale, 1931
S. (D.) campbelli Griffith & Pidgeon, 1834 [QM; 32; 44; 53; 56]
S. (D.) vittatus Linnaeus, 1758 [53]
S. (Euprotomus) Gill, 1870
S. (E.) aurisdianae Linnaeus, 1758 [56]
S. (E.) uratrum (Röding, 1798) [56]
S. (Gibberulus) Jousseaume, 1888
S. (G.) gibberulus Linnaeus, 1758 [QM; 32]

SUPERFAMILY TONNOIDEA

FAMILY TONNIDAE

SUBFAMILY TONNINAE

Tonna Brunnich, 1772
T. chinensis (Dillwyn, 1817) [QM]
T. perdix (Linnaeus, 1758) [QM]
T. tetracotula Hedley, 1919 [QM]
T. variegata (Lamarck, 1822) [QM; 32; 56]

SUBFAMILY CASSINAE

Casmaria H. & A. Adams, 1853
C. ponderosa (Gmelin, 1791) [QM]

SUBFAMILY PHALINAE

Phalium Link, 1807
P. areola (Linnaeus, 1758) [QM; 32; 44; 56]
P. bandatum (Perry, 1811) [QM; 32; 56]

Semicassis (Mörch, 1852)
S. bisulcata (Schubert & Wagner, 1820) [QM]
S. labiata (Perry, 1811) [QM; 1]
S. sophia (Brazier, 1872) [QM]

FAMILY BURSIDAE

Bursa Röding, 1798
B. granularis (Röding, 1798) [QM; 44; 56]
B. rhodostoma (Beck in Sowerby, 1835) [44]

Bufonaria Schumacher, 1817
B. margaritula (Deshayes, 1832) [61]

Tutufa Jousseaume, 1881
T. (Tutufa) s.s.
T. (T.) bubo (Linnaeus, 1758) [61]

FAMILY PERSONIDAE

Distorsio Röding, 1798
D. reticularis (Linnaeus, 1758) [QM]

FAMILY RANELLIDAE

SUBFAMILY RANELLINAE

Gyrineum Link, 1807
G. lacunatum (Mighels, 1845) [QM; 32; 44; 56]

SUBFAMILY CYMATIINAE

Cymatium Röding, 1798
C. (Gelagna) Schaufuss, 1869
C. (G.) succinctum (Linnaeus, 1771) [QM; 32]
C. (Gutturnium) Mörch, 1852
C. (G.) muricinum (Röding, 1798) [QM]
C. (Lotoria) Emerson & Old, 1963
C. (L.) lotorium (Linnaeus, 1758) [QM]
C. (Monoplex) Perry, 1811
C. (M.) aquatile (Reeve, 1844) [QM]
C. (M.) exaratum (Reeve, 1844) [QM; 44]
C. (M.) mundum (Gould, 1849) [QM]
C. (M.) nicobaricum (Röding, 1798) [QM]
C. (M.) parthenopeum (von Salis, 1793) [QM; 32; 44; 56]
C. (M.) pileare (Linnaeus, 1758) [QM; 32; 44; 56]
C. (M.) vespaceum (Lamarck, 1822) [QM]
C. (Ranularia) Schumacher, 1817
C. (R.) caudatum (Gmelin, 1791) [QM]
C. (R.) gutturnium (Röding, 1798) [QM]
C. (R.) sarcostomum (Reeve, 1844) [QM; 44]
C. (Septa) Perry, 1810
C. (S.) hepaticum (Röding, 1798) [QM]
C. (S.) occidentale (Mörch, 1877) [QM; 32]
C. (S.) rubeculum (Linnaeus, 1758) [QM]
C. (Turritriton) Dall, 1904
C. (T.) labiosum (Wood, 1828) [QM; 32]

Cabestana Röding, 1798
C. spengleri Perry, 1811 [QM; 32; 44; 56]

Charonia Gistel, 1848

C. lampas (Linnaeus, 1758) [QM; 1; 32]
C. tritonis (Linnaeus, 1758) [32; 44]

SUPERFAMILY VANIKOROIDEA

FAMILY VANIKORIDAE

Vanikoro Quoy & Gaimard, 1832
V. cancellata (Lamarck, 1822) [QM; 15]
V. helicoidea Le Guillou, 1842 [QM]

Couthouyia A. Adams, 1860
C. cf *gracilis* (Henn & Brazier, 1894) [QM]

FAMILY HIPPONICIDAE

Hipponix Defrance, 1819
H. conicus (Schumacher, 1817) [QM]

SUPERFAMILY VELUTINOIDEA

FAMILY LAMELLARIIDAE

Lamellaria Montagu, 1815
'*Lamellaria* sp.' [see Note 12]

FAMILY TRIVIIDAE

SUBFAMILY TRIVIINAE

Trivia Gray, 1832
T. (*Cleotrivia*) Iredale, 1930
T. (*C.*) *globosa* (Sowerby, 1832) [QM]
T. (*Ellatrivia*) Iredale, 1931
T. (*E.*) *merces* (Iredale, 1924) [QM]
T. (*Trivirostra*) Jousseaume, 1884
T. (*T.*) *edgari* Shaw, 1909 [QM]
T. (*T.*) *hordacea* (Kiener, 1843) [QM]
T. (*T.*) *oryza* (Lamarck, 1810) [QM; 56]
T. (*T.*) *pellucidula* (Reeve, 1846) [QM]

SUBFAMILY ERATOINAE

Proterato Schilder, 1927
P. (*Cypraeerato*) Schilder, 1932
P. (*C.*) *angistoma* (Sowerby, 1832) [QM; 61]
P. (*C.*) *gemma* (Bavay, 1917) [QM]
P. (*Eratoena*) Iredale, 1935
P. (*E.*) *sulcifera* (Sowerby, 1832) [QM]
P. (*Sulcerato*) Finlay, 1930
P. (*S.*) *lachryma* (Sowerby, 1832) [QM]
P. (*S.*) *recondita* (Melvill & Standen, 1903) [QM]

SUPERFAMILY VERMETOIDEA

FAMILY VERMETIDAE (see Note 13)

Serpulorbis Sassi, 1827
Serpulorbis sp. (Lamarck, 1818) [QM]

SUPERFAMILY XENOPHOROIDEA

FAMILY XENOPHORIDAE

Xenophora Fischer, 1887
Xenophora sp. [32]

GROUP PTENOGLOSSA

SUPERFAMILY EPITONIOIDEA

FAMILY EPITONIIDAE (see Note 14)

Epitonium Röding, 1798
E. barissum (Iredale, 1936) [44]
E. christyi (Iredale, 1936) [QM]
E. imperialis (Sowerby, 1844) [32; 44; 56]
E. irregulare (Sowerby, 1844) [QM]
E. jukesianum (Forbes, 1852) [44, as *E. ampacta*]
E. lyrum (Sowerby, 1844) [44]
E. millecostatum (Pease, 1861) [QM]
E. minorum (Iredale, 1936) [QM]
E. perplexum Pease, 1867 [QM also as *E. perplicatum*; 44]
E. replicatum (Sowerby, 1844) [QM; 44]
E. sexcostum Jousseaume, 1912 [61]
E. tacitum Iredale, 1936 [QM]
E. tenellum (Hutton, 1885) [32; 56 as *E. helicornuum*]

Cirsotrema Mörch, 1852
C. morchi (Angas, 1871) [QM]

Acrilla H. & A. Adams, 1860
A. acuminata (Sowerby, 1844) [32]

Eglisia Gray, 1847
E. tricarinata A. Adams & Reeve, 1850 [56]

Opalia H. & A. Adams, 1853
O. ballinensis (E.A. Smith, 1891) [32]

FAMILY JANTHINIDAE

Janthina Röding, 1798
J. exigua Lamarck, 1816 [32; 44; 56]
J. janthina (Linnaeus, 1758) [QM; 32; 44; 56]
J. pallida (Thompson, 1840) [44 as *J. globosa*]

Recluzia Petit, 1853
R. hargravesi Cox, 1870 [QM; 44; 61]

SUPERFAMILY EULIMOIDEA (see Note 15)

FAMILY EULIMIDAE

Eulima Risso, 1826
Eulima sp. [M]

Hypermastus Pilsbry, 1918
Hypermastus sp. [M]

Mucronalia A. Adams, 1860
Mucronalia sp. [M]

Pictobalcis Laseron; 1955
Pictobalcis sp. [M]

Sticteulima Laseron, 1955
S. lentiginosus (A. Adams, 1861) [QM as *Lentigobalcis lentiginosa*]

SUPERFAMILY TRIPHOROIDEA (see Note 16)

FAMILY TRIPHORIDAE

SUBFAMILY TRIPHORINAE

Triphora Blainville, 1828
T. granulata (A. Adams & Reeve, 1850) [QM; 11]
T. tesselata (Kosuge, 1963) [QM; 11]
T. truncis (Laseron, 1958) [QM; 11]

Aclophora Laseron, 1958

A. alveata Laseron, 1958 [QM; 11]
A. kerslakei Laseron, 1958 [30]
A. robusta Laseron, 1958 [QM; 11; 30; 61]
A. xystica (Jousseaume, 1884) [11 as *A. grandiosa*]

Aclophoropsis Marshall, 1983
A. maculosa (Hedley, 1908) [QM; 11]

Bouchetriphora Marshall, 1983
B. aspergata (Laseron, 1958) [QM; 11; 30 as *Coriophora nigrogranosa*]
B. pallida (Pease, 1870) [QM; 11]

Cautor Finlay, 1927
C. intermissa (Laseron, 1958) [QM; 11]
C. similis (Pease, 1871) [M; QM; 11]

Euthymella Thiele, 1929
E. elegans (Hinds, 1843) [QM; 11]
E. elongata (Laseron, 1958) [QM; 11]
E. kosugei Marshall, 1983 [11]

Inella Bayle, 1879
I. acicula Laseron, 1958 [QM; 11]
I. hervieri (Kosuge, 1963) [QM; 11]
I. pavimenta (Laseron, 1958) [QM; 11]

Iniforis Jousseaume, 1884
I. violaceus (Quoy & Gaimard, 1843) [QM; 11]

Latitriphora Marshall, 1983
L. conferta (Laseron, 1958) [30 as *Aclophora conferta*]

Mastonia Hinds, 1843
M. rubra (Hinds, 1843) [QM; 11]
M. ustulata (Hervier, 1897) [QM; 11]

Mesophora Laseron, 1958
M. fulva (Laseron, 1958) [QM]
M. fusca (Dunker, 1860) [QM; 11; 30 as *M. bowenensis*]
M. inconspicua (Laseron, 1958) [QM; 11]
M. mistura (Laseron, 1958) [QM; 11]
M. pallenta (Laseron, 1958) [QM; 11]
M. rufosutura Laseron, 1958 [QM; 11]
M. tigris (Laseron, 1958) [30 as *Coriophora tigris*]

Monophorus Grillo, 1877
M. constricta (Laseron, 1958) [QM; 11]
M. diminuta (Laseron, 1958) [QM; 11]
M. subora (Laseron, 1958) [QM]

Nanaphora Laseron, 1958
N. caloundra Laseron, 1958 [QM; 30]
N. tricolor Laseron, 1958 [QM; 30]

Obesula Jousseaume, 1898
O. tribulationis (Hedley, 1909) [QM; 11]

Opimaphora Laseron, 1958
O. albogemmata Laseron, 1958 [QM]
O. litorea Laseron, 1958 [QM]
O. sarcira Laseron, 1958 [QM; 11]

Sagenotriphora Marshall, 1983
S. ampulla (Hedley, 1903) [QM; 11]

Subulophora Laseron, 1958
S. rutilans (Hervier, 1897) [QM; 11]

Talophora Gründel, 1975
T. subulata (Laseron, 1958) [QM]

Tetraphora Laseron, 1958
T. iniqua (Jousseaume, 1898) [QM; 11]
T. mapoonensis Laseron, 1958 [QM; 11]

Viriola Jousseaume, 1884
V. cancellata (Hinds, 1843) [QM]
V. elegans (Hinds, 1843) [QM]
V. incisa (Pease, 1861) [QM]
V. truncata Marshall, 1983 [QM]

SUBFAMILY METAXIINAE

Metaxia Monterosato, 1884
Metaxia sp. [QM; 11]

Seilarex Iredale, 1924
S. turritelliformis (Angas, 1877) [QM; 11]
S. verconis Cotton, 1951 [11]

FAMILY CERITHIOPSIDAE

Clathropsis Laseron, 1956
C. maritima Laseron, 1956 [QM; 28]
C. mellita Laseron, 1956 [QM]

Conciliopsis Laseron, 1956
C. carrota Laseron, 1956 [QM]

Horologica Laseron, 1956
H. bicolor Laseron, 1956 [QM]
H. bipartita Laseron, 1956 [QM]
H. minareta Laseron, 1956 [QM]
H. telegraphica (Hedley, 1909) [QM]

Joculator Hedley, 1909
J. albordina Laseron, 1956 [QM]
J. columna Laseron, 1956 [QM]
J. continens Laseron, 1956 [QM]
J. melania Laseron, 1956 [QM]
J. minima Laseron, 1956 [QM]
J. semiplica Laseron, 1956 [QM]
J. subula Laseron, 1956 [QM]
J. tomacula tomacula Laseron, 1956 [QM]
J. tomacula negrita Laseron, 1956 [QM]
J. tribulationis (Hedley, 1909) [QM]
J. varians Laseron, 1956 [QM]

Seila A.Adams, 1861
S. crocea (Angas, 1871) [QM; 52 as *Cerithiopsis (Notoseila) crocea*]

Synthopsis Laseron, 1956
S. columna Laseron, 1956 [QM]

Tubercliopsis Laseron, 1956
T. bowenensis Laseron, 1956 [QM]
T. capricornia Laseron, 1956 [QM]
T. elongata Laseron, 1956 [QM]

GROUP NEOGASTROPODA
SUPERFAMILY BUCCINOIDEA

FAMILY BUCCINIDAE

SUBFAMILY BUCCININAE

Phos Watson, 1882

P. sculptilis Watson, 1886 [QM; 53]
P. senticosus (Linnaeus, 1758) [QM; 56]

SUBFAMILY PISANIINAE

Cantharus Röding, 1798
C. (*Clivipollia*) Iredale, 1929
C. (C.) pulcher (Reeve, 1846) [QM]
C. (*Pollia*) Gray in Sowerby, 1834
C. (P.) fumosus (Dillwyn, 1817) [QM]
C. (P.) undosus (Linnaeus, 1758) [QM; 56]
C. (*Prodotia*) Dall, 1924
C. (P.) iostomus (Gray in Griffith & Pidgeon, 1834) [QM]

Engina Gray, 1839
E. armillata (Reeve, 1846) [QM; 44]
E. concinna (Reeve, 1846) [QM]
E. incarnata (Deshayes, 1834) [QM]
E. lineata (Reeve, 1846) [QM]
E. siderea (Reeve, 1846) [QM]
E. zonalis (Lamarck, 1822) [QM; 44; 56]

Pisania Bivona, 1832
P. crenilabrum A. Adams, 1855 [QM]
P. luctuosa Tapperone-Canefri, 1875 [QM]

FAMILY COLUBRARIIDAE

Colubraria Schumacher, 1817
C. brazieri (Angas, 1869) [QM; 62 as *Fusus brazieri*]
C. castanea Kuroda & Habe, 1952 [QM]
C. nitidula (Sowerby, 1833) [QM]

FAMILY COLUMBELLIDAE (see Note 17)

SUBFAMILY COLUMBELLINAE

Euplica Dall, 1889
E. scripta (Lamarck, 1822) [QM; 56 both as *Pyrene scripta*]
E. turturina (Lamarck, 1822) [QM; 44 both as *Pyrene turturina*]
E. varians (Sowerby, 1832) [QM as *Pyrene varians* and *Zafra varians*]

SUBFAMILY PYRENINAE

Aesopus Gould, 1860
A. spiculum (Duclos in Chenu, 1846) [QM]

Anachis H. & A. Adams, 1853
A. atkinsoni Tenison Woods, 1875 [M; QM]
A. lurida (Hedley, 1907) [QM]
A. marquesa (Gaskoin, 1852) [M]
A. miser (Sowerby, 1844) [M]
A. smithi (Angas, 1877) [QM]
A. spiculum (Duclos in Chenu, 1846) [QM]

Graphicomassa Iredale, 1929
G. albina (Kiener, 1841) [QM; 56]

Indomitrella Oostingh, 1940
I. puella (Sowerby, 1844) [QM]

Mitrella Risso, 1826
M. abyssicola (Brazier, 1877) [QM]
M. intexta (Gaskoin, 1852) [QM]
M. moleculina (Duclos, 1840) [QM
M. peroniana (Hedley, 1913) [QM]
M. semiconvexa (Lamarck, 1822) [QM]
M. tayloriana (Reeve, 1859) [QM]
M. venulata (Sowerby, 1894) [QM]

Pardalinops deMaintenon, 2008
P. testudinaria (Link, 1807) [QM; 32; 56 as *Pyrene testudinaria*]

Parviterebra Pilsbry, 1904
P. brazieri (Angas, 1875) [QM]
P. trilineata (A. Adams & Angas, 1864) [QM]

Pyrene Röding, 1798
P. flava (Bruguière, 1789) [QM]
P. punctata (Bruguière, 1789) [QM; 56]

Zafra A. Adams, 1860
Z. darwini Angas, 1877 [M]
Z. pumila (Dunker, 1860) [QM]
Z. troglodytes (Souverbie, 1866) [QM]

FAMILY FASCIOLARIIDAE

Fusinus Rafinesque, 1815
F. colus (Linnaeus, 1758) [QM; 32; 53; 56]
F. nicobaricus (Röding, 1798) [32]

Latirolagena Harris, 1897
L. smaragdula (Linnaeus, 1758) [QM]

Latirus Montfort, 1810
L. turritus (Gmelin, 1791) [QM]

Nodopelagia Hedley, 1915
N. brazieri (Angas, 1877) [62]

Peristernia Mörch,1852
P. incarnata (Kiener, 1830) [QM]
P. nassatula (Lamarck, 1822) [QM; 44]
P. ustulata (Reeve, 1847) [QM]

Saginafusus Iredale, 1931
S. pricei (E.A. Smith, 1887) [QM]

FAMILY NASSARIIDAE

SUBFAMILY NASSARIINAE

Nassarius Dumeril, 1806
N. (*Nassarius*) s.s.
N. (N.) coronatus (Bruguière, 1789) [QM; 32; 56]
N. (*Alectrion*) Montfort, 1810
N. (A.) glans (Linnaeus, 1758) [QM]
N. (A.) particeps (Hedley, 1915) [QM]
N. (*Hima*) Leach in Gray, 1852
N. (H.) pauperus (Gould, 1850) [QM; 32; 51; 52; also as *Reticunassa paupera*]
N. (*Niotha*) H. & A. Adams, 1853
N. (N.) albescens (Dunker, 1846) [QM]
N. (N.) conoidalis (Deshayes, 1832) [QM; 53 as *Niotha gemmulata*]
N. (N.) echinatus (A. Adams, 1852) [QM]
N. (N.) pauperatus (Lamarck, 1822) [QM; 32]
N. (*Plicarcularia*) Thiele, 1929
N. (P.) burchardi (Dunker in Philippi, 1849) [QM; 32; 34]
N. (P.) globosus (Quoy & Gaimard, 1833) [62]

N. (P.) jonasii (Dunker, 1846) [QM; 19; 32; 56]
N. (P.) pullus (Linnaeus, 1758) [QM; 15; 56; 62]
N. (Telasco) H. & A. Adams, 1853
N. (T.) gaudiosus (Hinds, 1844) [QM]
N. (T.) luridus (Gould, 1850) [QM; 62]
N. (Zeuxis) H. & A. Adams, 1853
N. (Z.) algidus (Reeve, 1853) [QM]
N. (Z.) celebensis (Schepman, 1907) [62]
N. (Z.) comptus (A. Adams, 1852) [QM]
N. (Z.) dorsatus (Röding, 1798) [QM; 15; 19; 32; 56]
N. (Z.) melanoides (Reeve, 1853) [QM; 62]
N. (Z.) olivaceus (Bruguière, 1789) [QM; 32; 62]

SUPERFAMILY CANCELLARIOIDEA

FAMILY CANCELLARIIDAE

SUBFAMILY CANCELLARIINAE

Cancellaria Lamarck, 1799
C. (Merica) H. & A. Adams, 1854
C. (M.) elegans Sowerby, 1822 [QM]
C. (Nevia) Jousseaume, 1887
C. (N.) spirata Lamarck, 1822 [QM]
C. (Sydaphera) Iredale, 1929
C. (S.) granosa Sowerby, 1832 [QM *as Trigonostoma granosa*]
C. (S.) spengleriana Deshayes, 1830 [QM]
Trigonostoma Blainville, 1827
T. amasia (Iredale, 1930) [QM; 56]
T. obliquata (Lamarck, 1822) [QM]
T. scalariformis (Lamarck, 1822) [62]
T. scalarina (Lamarck, 1822) [QM]

SUBFAMILY PLESIOTRITONINAE

Tritonoharpa Dall, 1908
T. angasi (Brazier, 1877) [QM; 62]

SUPERFAMILY CONOIDEA (see Note 18)

FAMILY CONIDAE

SUBFAMILY CONINAE

Conus Linnaeus, 1758
C. ammiralis Linnaeus, 1758 [QM; 32; 44]
C. arenatus Hwass in Bruguière, 1792 [QM; 32; 44]
C. canonicus Hwass in Bruguière, 1792 [44]
C. capitaneus Linnaeus, 1758 [QM; 32; 44; 56]
C. catus Hwass in Bruguière, 1792 [QM; 32]
C. chaldaeus (Röding, 1798) [QM]
C. coronatus Gmelin, 1791 [QM; 32]
C. cyanostoma A. Adams, 1854 [QM; 32; 44]
C. distans Hwass in Bruguière, 1792 [32]
C. ebraeus Linnaeus, 1758 [QM; 32; 56]
C. eburneus Hwass in Bruguière, 1792 [QM]
C. emaciatus Reeve, 1849 [QM]
C. episcopatus daMotta, 1982 [QM; 44]
C. ferrugineus Hwass in Bruguière, 1792 [QM; 32; as *C. planorbis*]
C. flavidus Lamarck, 1810 [QM; 32; 44]
C. geographus Linnaeus, 1758 [QM; 32; 56]
C. imperialis Linnaeus, 1758 [44]
C. leopardus (Röding, 1798) [QM; 56]
C. lischkeanus Weinkauff 1875 [QM; 56]
C. litoglyphus Hwass in Bruguière, 1792 [QM]
C. litteratus Linnaeus, 1758 [QM; 32; 44]
C. lividus Hwass in Bruguière, 1792 [QM; 32; 44]
C. miles Linnaeus, 1758 [QM; 32; 44]
C. miliaris Hwass in Bruguière, 1792 [QM]
C. moreleti Crosse, 1858 [62]
C. muriculatus Sowerby, 1833 [QM; 44; 56]
C. musicus Hwass in Bruguière, 1792 [QM; 32; 44; 56]
C. mustelinus Hwass in Bruguière, 1792 [QM]
C. obscurus Sowerby, 1833 [QM; 44]
C. omaria Hwass in Bruguière, 1792 [QM; 32; 44; 56]
C. planorbis Born, 1778 [QM; 44; 56; 62; also as *C. vitulinus*]
C. pulicarius Hwass in Bruguière, 1792 [QM]
C. quercinus Lightfoot, 1786 [QM; 44; 56]
C. rattus Hwass in Bruguière, 1792 [QM]
C. rufimaculosus Macpherson, 1959 [QM; 32; 44]
C. sanguinolentus Quoy & Gaimard, 1834 [QM]
C. sponsalis Hwass in Bruguière, 1792 [QM]
C. striatus Linnaeus, 1758 [QM; 32; 44; 56; 61]
C. suturatus Reeve, 1844 [62]
C. terebra Born, 1778 [QM; 32; 44]
C. tessulatus Born, 1778 [QM; 56; 62]
C. textile Linnaeus, 1758 [QM; 32; 44; 56]
C. varius Linnaeus, 1758 [32; 44]
C. vexillum Gmelin, 1791 [QM; 32; 44]
C. virgo Linnaeus, 1758 [QM; 32; 44]

SUBFAMILY CLATHURELLINAE

Etrema Hedley, 1918
E. alliterata (Hedley, 1916) [QM; 22]
E. capillata Hedley, 1922 [QM]
E. catapasta Hedley, 1922 [52]
E. crassilabrum (Reeve, 1843) [QM]
E. curtisiana Hedley, 1922 [QM]
E. firma Hedley, 1922 [QM]
E. orirufa Hedley, 1922 [QM]
E. scalarina (Deshayes, 1863) [QM]
E. spurca (Hinds, 1843) [QM; 52]
E. tortilabra Hedley, 1922 [QM]
Eucithara Fischer, 1883
E. arenivaga Hedley, 1922 [QM; 32]
E. crassilabrum (Reeve, 1846) [QM]
E. cylindrica (Reeve, 1846) [QM]
E. phyllidis Hedley, 1922 [QM]
Lienardia Jousseaume, 1884
L. lischkeana (Pilsbry, 1904) [QM]
L. malleti (Reeve, 1852) [QM]
L. punctilla Hedley, 1922 [QM]
Pulsarella Laseron, 1954
P. cognata (E.A. Smith, 1877) [22 as *Asthenotoma cognata*)

SUBFAMILY MANGELIINAE

Antiguraleus Powell, 1939
A. serpentis (Laseron, 1954) [QM]

A. tepidus (Laseron, 1954) [QM]
Apispiralia Laseron, 1954
A. catena Laseron, 1954 [QM]
Filodrillia Hedley, 1922
F. haswelli (Hedley, 1907) [QM]
F. stadialis Hedley, 1922 [QM]
Guraleus Hedley, 1918
G. fascinus Hedley, 1922 [QM]
G. mitralis (A. Adams & Angas, 1869) [QM]
G. pictus (A. Adams & Angas, 1864) [QM; 22]
G. tasmantis Laseron, 1954 [QM]
Heterocithara Hedley, 1922
H. bilineata (Angas, 1871) [QM]
H. erismata Hedley, 1922 [QM]
Marita Hedley, 1922
M. bella A. Adams & Angas, 1864 [QM]
Paramontana Laseron, 1954
P. fusca Laseron, 1954 [QM]
P. modesta (Angas, 1877) [QM]
Turrella Laseron, 1954
T. asperrima Laseron, 1954 [QM]
T. tenuilirata (Angas, 1871) [QM]

FAMILY DRILLIIDAE

Epidirona Iredale, 1931
E. cosifera Laseron, 1954 [QM]
Inquisitor Hedley, 1918
I. flindersianus Hedley, 1922 [QM; 53; 55]
I. lassulus Hedley, 1922 [QM]
I. spicata (Hinds, 1843) [QM]
I. sterrhus (Watson, 1881) [QM also as *I. formidabilis*; 55; 56]
Ptychobela Thiele, 1925
P. flavidula (Lamarck, 1822) [QM; 55]
Splendrillia Hedley, 1922
S. nenia (Hedley, 1903) [QM]
Tomopleura Casey, 1904
T. carrota Laseron, 1954 [QM]
T. foliacea Laseron, 1954 [QM]
T. thola Laseron, 1954 [QM]

FAMILY TEREBRIDAE

SUBFAMILY TEREBRINAE

Duplicaria, Dall, 1908
D. bernardii (Deshayes, 1857) [QM; 44]
Terenolla Iredale, 1929
T. pygmaea (Hinds, 1844) [M]
Terebra Bruguière, 1789
T. amanda Hinds, 1844 [QM]
T. areolata (Link, 1807) [QM; 32; 44]
T. ballina (Hedley, 1915) [QM; 32; 44; 56]
T. dimidiata (Linnaeus, 1758) [QM; 44]
T. laevigata Gray, 1834 [QM]
T. paucistriata (E.A. Smith, 1873) [QM]
T. subulata (Linnaeus, 1767) [QM; 32; 44]
T. triseriata Gray, 1834 [QM; 44; 56]

FAMILY TURRIDAE

SUBFAMILY TURRINAE

Turridrupa Hedley, 1922
T. albofasciata (E.A. Smith, 1877) [QM]
T. bijubata (Reeve, 1843) [QM]
T. cerithina (Anton, 1839) [QM]
T. cincta (Lamarck, 1822) [QM]
Xenuroturris Iredale, 1929
X. millepunctata (Sowerby, 1908) [QM]

SUBFAMILY DAPHNELLINAE

Daphnella Hinds, 1844
D. botanica Hedley, 1918 [QM]
D. cheverti Hedley, 1922 [52]
D. souverbiei (E.A. Smith, 1882) [22 as *Hemidaphne souverbiei*)
Asperdaphne Hedley, 1922
A. hayesiana (Angas, 1871) [QM]
A. moretonica (E.A. Smith, 1882) [22]
Exomilus Hedley, 1918
E. anxius (Hedley, 1909) [QM]
Kermia Oliver, 1915
K. barnardi (Brazier, 1876) [QM]
K. canistra (Hedley, 1922) [QM]
K. daedalea (Garrett, 1873) [QM]
Neopotilla Hedley, 1918
N. tropicalis Hedley, 1922 [QM]
Philbertia Monterosato, 1864
P. attenuata (Hedley, 1922) [QM]
P. canistra (Hedley, 1922) [QM]
P. pustulata (Angas, 1877) [QM]
P. ramsayi (Brazier, 1876) [QM]
Tasmadaphne Laseron, 1954
T. aculeola (Hedley, 1915) [QM]

SUBFAMILY MITROMORPHINAE

Mitromorpha Bucquoy, Dautzenberg & Dollfus, 1883
M. atramentosa (Reeve, 1849) [QM]

SUBFAMILY TURRICULINAE

Vexitomina Powell, 1942
V. coxi (Angas, 1867) [62]
V. metcalfei (Angas, 1867) [52 as *Inquisitor metcalfei*]

SUPERFAMILY MURICOIDEA

FAMILY MURICIDAE

SUBFAMILY MURICINAE

Aspella Mörch, 1877
A. producta (Pease, 1861) [QM]
Aspella sp. [32]
Chicoreus Montfort, 1810
C. denudatus (Perry, 1811) [56]
C. microphyllus (Lamarck, 1816) [32]
C. ramosus (Linnaeus, 1758) [15; 32; 44; 56]
Pterynotus Swainson, 1833

P. (*Pterochelus*) Jousseaume, 1880
P. (*P.*) *duffusi* (Iredale, 1936) [62]

SUBFAMILY CORALLIOPHILINAE

Coralliophila H. & A. Adams, 1853
C. bulbiformis (Conrad, 1833) [QM]
C. erosa (Röding, 1798) [QM]
C. radula (A. Adams, 1855) [QM]
C. squamosissima (E.A. Smith, 1876) [QM]

Mipus de Gregorio, 1885
M. nodosus (A. Adams, 1854) [QM]

Quoyula Iredale, 1912
Q. madreporarum (Sowerby, 1832) [QM]

SUBFAMILY ERGALATAXINAE

Cronia H. & A. Adams, 1853
C. (*Cronia*) s.s.
C. (*C.*) *aurantiaca* (Hombron & Jaquinot, 1835) [QM; 32; 44]
C. (*Ergalatax*) Iredale, 1931
C. (*E.*) *contracta* (Reeve, 1846) [QM]
C. (*E.*) *margariticola* (Broderip, 1833) [QM]

Lataxiena Jousseaume, 1883
L. (*Lataxiena*) s.s.
L. (*L.*) *blosvillei* (Deshayes, 1832) [62]
L. (*L.*) *fimbriata* (Hinds, 1844) [QM; 44]
L. (*Orania*) Pallary, 1900
L. (*O.*) *ficula* (Reeve, 1848) [M]

Maculotriton Dall, 1904
M. serriale (Deshayes, 1830) [QM; 32]

Muricodrupa Iredale, 1918
M. fiscella (Gmelin, 1791) [QM]

Pascula Dall, 1908
P. ochrostoma (Blainville, 1832) [QM as *Drupella ochrostoma* or *Cronia ochrostoma*]

SUBFAMILY HAUSTRINAE

Lepsiella Iredale, 1912
L. (*Bedeva*) Iredale, 1924
L. (*B.*) *hanleyi* (Angas, 1867) [QM; 32; 44; 51; 54; 56; also as *B. hanleyi*]

SUBFAMILY MURICOPSINAE

Favartia Jousseaume, 1880
F. confusa (Brazier, 1877) [35; 62]

Homalocantha Mörch, 1852
H. anatomica (Perry, 1811) [QM]

Murexiella Clench & Perez Farfante, 1945
M. brazieri (Angas, 1877) [1; 35; 62]

Muricopsis Bucquoy, Dautzenberg & Dollfus, 1882
M. purpurcrispina Ponder, 1972 [62]

SUBFAMILY RAPANINAE

Agnewia Tenison Woods, 1879
A. tritoniformis (Blainville, 1832) [54]

Dicathais Iredale, 1936
D. orbita (Gmelin, 1791) [QM; 32; 44; 54; 56]

Drupa Röding, 1798
D. (*Drupa*) s.s.
D. (*D.*) *morum* Röding, 1798 [QM; 32]
D. (*D.*) *ricinus* (Linnaeus, 1758) [QM; 44]
D. (*Ricinella*) Schumacher, 1817
D. (*R.*) *rubusidaeus* Röding, 1798 [QM]

Drupella Thiele, 1925
D. cornus (Röding, 1798) [QM; 17]
D. rugosa (Born, 1778) [QM; 17; 56]

Drupina Dall, 1923
D. grossularia (Röding, 1798) [QM]

Mancinella Link, 1807
M. alouina Röding, 1798 [QM; 56]
M. ambustulatus Hedley, 1912 [QM; 44; 62]
M. echinata (Blainville, 1832) [44]

Morula Schumacher, 1817
M. (*Morula*) s.s.
M. (*M.*) *granulata* (Duclos, 1832) [QM]
M. (*M.*) *marginalba* Blainville, 1832 [QM; 32; 56]
M. (*M.*) *uva* (Röding, 1798) [QM; 44]
M. (*Spinidrupa*) Habe & Kosuge, 1966
M. (*S.*) *biconica* (Blainville, 1832) [QM]
M. (*S.*) *dumosa* (Conrad, 1837) [QM]
M. (*S.*) *spinosa* (H. & A. Adams, 1853) [QM]

Nassa Röding, 1798
N. serta (Bruguière, 1789) [QM]

Phycothais Tan, 2003
P. botanica (Hedley, 1918) [54]

Vexilla Swainson, 1840
V. vexillum (Gmelin, 1791) [QM]

SUBFAMILY TYPHINAE

Typhis Montfort, 1810
T. philippensis Watson, 1883 [1]

FAMILY COSTELLARIIDAE (see Note 19)

Vexillum Röding, 1798
V. (*Vexillum*) s.s.
V. (*V.*) *plicarium* (Linnaeus, 1758) [QM]
V. (*V.*) *takakuwai* Cernohorsky & Azuma, 1974 [62]
V. (*Costellaria*) Swainson, 1840
V. (*C.*) *acromiale* (Hedley 1915) [62]
V. (*C.*) *amanda* (Reeve, 1845) [QM]
V. (*C.*) *collinsoni* (A. Adams, 1864) [QM]
V. (*C.*) *daedalum* (Reeve, 1845) [QM]
V. (*C.*) *exasperatum* (Gmelin, 1791) [QM; 56]
V. (*C.*) *festum* (Reeve, 1845) [QM]
V. (*C.*) *obeliscus* (Reeve, 1844) [QM; 62]
V. (*C.*) *pacificum* (Reeve, 1845) [QM]
V. (*C.*) *semifasciata* (Lamarck, 1811) [QM]
V. (*Pusia*) Swainson, 1840
V. (*P.*) *aureolineatum* Turner, 1988 [QM]
V. (*P.*) *cancellarioides* (Anton, 1839) [62]
V. (*P.*) *consanguineum* (Reeve, 1845) [QM]
V. (*P.*) *microzonias* (Lamarck, 1811) [QM]
V. (*P.*) *pardalis* (Küster, 1841) [QM]
V. (*P.*) *patriarchalis* (Gmelin, 1791) [QM]

FAMILY CYSTISCIDAE

SUBFAMILY CYSTISCINAE Stimpson, 1965

Cystiscus Stimpson, 1865
C. angasi (Crosse, 1870) [QM]

FAMILY HARPIDAE

Morum Röding, 1798
M. (Herculea) H. & A. Adams 1858
M. (H.) ponderosum (Hanley, 1858) [44]

FAMILY MARGINELLIDAE

SUBFAMILY MARGINELLINAE

Austroginella Laseron, 1957
A. queenslandica Laseron, 1957 [QM; 29]

Balanetta Jousseaume, 1875
B. baylei (Jousseaume, 1875) [QM]

Mesoginella Laseron, 1957
M. strangei (Angas, 1877) [QM]

FAMILY MITRIDAE (see Note 20)

SUBFAMILY MITRINAE

Mitra Lamarck, 1798
M. (Mitra) s.s.
M. (M.) ambigua Swainson, 1829 [QM]
M. (M.) cooki Sowerby, 1874 [QM]
M. (M.) mitra (Linnaeus, 1758) [32; 44; 56]
M. (M.) solida Reeve, 1844 [QM]
M. (M.) stictica Link, 1807 [QM]
M. (M.) variabilis Reeve, 1844 [QM; 32; 56]
M. (Nebularia) Swainson, 1840
M. (N.) amaura Hervier, 1898 [QM]
M. (N.) aurantia (Gmelin, 1791) [QM]
M. (N.) coronata Lamarck, 1811 [QM; 44]
M. (N.) cucumerina Lamarck, 1811 [62]
M. (N.) luctuosa A. Adams, 1853 [QM; 44; 56; 62]
M. (N.) lugubris Swainson, 1822 [QM; 56]
M. (N.) procissa Reeve, 1844 [QM]
M. (Strigatella) Swainson, 1840
M. (S.) assimilis Pease, 1868 [QM]
M. (S.) litterata Lamarck, 1811) [QM]
M. (S.) retusa Lamarck, 1811 [QM]
M. (S.) scutulata (Gmelin, 1791) [QM]

SUBFAMILY CYLINDROMITRINAE

Pterygia Röding, 1798
P. crenulata (Gmelin, 1791) [QM; 32; 44]
P. nucea (Gmelin, 1791) [QM]

SUBFAMILY IMBRICARIINAE

Imbricaria Schumacher, 1817
I. conularis (Lamarck, 1811) [QM]
I. punctata (Swainson, 1821) [QM; 62]

Scabricola Swainson, 1840
S. eximia A. Adams, 1853 [62]

Cancilla Swainson, 1840
C. (Domiporta) Cernohorsky, 1970
C. (D.) filiaris (Linnaeus, 1771) [QM]
C. (D.) granatina (Lamarck, 1811) [QM; 62]
C. (D.) praestantissima (Röding, 1798) [QM; 44; 62]

FAMILY TURBINELLIDAE

SUBFAMILY VASINAE

Tudivasum Rosenberg & Petit, 1987
T. armigera (A. Adams, 1855) [QM; 32; 62]
T. spinosa (H. & A. Adams, 1863) [62]

FAMILY VOLUTIDAE

SUBFAMILY AMORIINAE

Amoria Gray, 1855
A. (Amoria) s.s.
A. (A.) zebra (Leach, 1814) [QM; 32; 44]
A. (Cymbiolista) Iredale, 1929
A. (C.) hunteri (Iredale, 1931) [QM; 32; 44]

SUBFAMILY CYMBIINAE

Cymbiola Swainson, 1831
C. magnifica (Gebauer, 1802) [32]
Melo Broderip in Sowerby, 1826
M. (Melocorona) Pilsbry & Olsson, 1954
M. (M.) amphora (Lightfoot, 1786) [QM; 32]

SUPERFAMILY OLIVOIDEA

FAMILY OLIVIDAE

SUBFAMILY OLIVINAE

Oliva Bruguière, 1789
O. (Oliva) s.s.
O. (O.) oliva (Linnaeus, 1758) [QM]
O. (Annulatoliva) Petuch & Sargent, 1986
O. (A.) amethystina (Röding, 1798) [QM; 32]

SUBFAMILY ANCILLARINAE

Ancillista Iredale, 1936
A. velesiana Iredale, 1936 [QM]

FAMILY OLIVELLIDAE

Belloliva Peile, 1922
B. leucozona (A. Adams & Angas, 1864) [62]

SUBCLASS HETEROBRANCHIA

[INFORMAL GROUP 'LOWER HETEROSTROPHA']

SUPERFAMILY ACTEONOIDEA

FAMILY ACTEONIDAE

Japonacteon Taki, 1956
J. suturalis (A. Adams, 1855) [12]
Pupa Röding, 1792
P. cf *strigosa* (Gould, 1859) [M; 12 as *P. fumata, P.* cf *nivea*]
P. sulcata (Gmelin, 1791) [12; 56]

FAMILY BULLINIDAE

Bullina Férussac, 1822
B. lineata (Gray, 1825) [10; 12; 44; 56]

FAMILY APLUSTRIDAE

Hydatina Schumacher, 1817
H. albocincta (Van der Hoeven, 1839) [10]
H. amplustre (Linnaeus, 1758) [10]

H. physis (Linnaeus, 1758) [QM; 10; 12; 13; 32; 44; 50; 56]
Micromelo Pilsbry, 1895
M. undata (Bruguière, 1792) [12; 13]

SUPERFAMILY ARCHITECTONICOIDEA

FAMILY ARCHITECTONICIDAE

Architectonica
A. grandiosa Iredale, 1931 [32; 56]
A. perspectiva (Linnaeus, 1758) [QM; 32; 56]
Philippia J.E. Gray, 1847
P. lutea (Lamarck, 1822) [56]
Psilaxis
P. oxytropis (A. Adams, 1855) [32]
P. radiatus (Röding, 1798) [QM]

SUBFAMILY HELIACINAE

Heliacus Orbigny in Sagra, 1842
H. (*Heliacus*) s.s.
H. (*H.*) *variegatus* (Gmelin, 1791) [QM; 56]
H. (*Grandeliacus*) Iredale, 1957
H. (*G.*) *stramineus* (Gmelin, 1791) [56]
H. (*Torinista*) Iredale, 1936
H. (*T.*) *hyperionis* Bieler, 1993 [18 as *Heliacus* (*Torinista*) *delectabilis*]
H. (*T.*) *implexus* (Mighels, 1845) [32]
H. (*T.*) *infundibuliformis* Gmelin, 1791 [QM]
Pseudotorinia Sacco, 1892
P. laseronorum (Iredale, 1936) [32]

SUPERFAMILY OMALOGYROIDEA

FAMILY AMMONICERIDAE

Ammonicera Vayssiére, 1893
Ammonicera sp. [32]

SUPERFAMILY PYRAMIDELLOIDEA
(see Note 21)

FAMILY PYRAMIDELLIDAE

Cossmannica Dall & Bartsch, 1904 *incertae sedis*
C. subcarina Laseron, 1959 [31]

SUBFAMILY PYRAMIDELLINAE

Pyramidella Lamarck, 1799
P. (*Pyramidella*) s.s.
P. (*P.*) *acus* (Gmelin, 1791) [QM]
Longchaeus Mörch, 1875
L. obtusa (Laseron, 1959) [31 as *Wingenella obtusa*]

FAMILY ODOSTOMIIDAE

SUBFAMILY CHRYSALLIDINAE

Odostomia Fleming, 1817
O. (*Odostomia*) s.s.
O. (*O.*) *occultidens* May, 1915 [QM]
O. (*Linopyrga*) Laws, 1941
O. (*L.*) *delicatula* Laseron, 1959 [31]
O. (*L.*) *pascoei* Angas, 1867 [QM]

Parthenina Bucquoy, Dautzenberg & Dollfus, 1883
P. fasciata (Laseron, 1959) [31 as *Elodiamea fasciata*]

SUBFAMILY CYCLOSTREMELLINAE

Pseudoskenella Ponder, 1973
P. depressa Ponder, 1973 [36]
Chrysallida Carpenter, 1857
C. (*Pyrgulina*) A. Adams, 1863
C. (*P.*) *pupaeformis* (Souverbie, 1865) [QM]
Miralda A. Adams, 1864
Miralda sp. [M]
Syrnola A. Adams, 1860
S. tincta Angas, 1871 *incertae sedis* [QM]
S. (*Agatha*) A.Adams, 1860
S. (*A.*) *laevis* (Angas, 1867) [QM]
S. (*A.*) *simplex* (Angas, 1871) [QM]

FAMILY TURBONILLIDAE

SUBFAMILY CINGULININAE

Cingulina A. Adams, 1860
C. austrina Laseron, 1959 [31]
C. imperita Laseron, 1959 [31]
C. spina (Crosse & Fischer, 1864) [QM]

SUBFAMILY EULIMELLINAE

Koloonella Laseron, 1959
K. capricornia Laseron, 1959 [31]
K. moniliformis (Hedley & Musson, 1894) [QM]
Turbonilla Risso, 1826
T. (*Turbonilla*) s.s.
T. (*T.*) *mariae* Angas, 1877 [QM]
T. (*Chemnitzia*) Orbigny, 1839
T. (*C.*) *fusca* (A. Adams, 1855) [QM]

FAMILY AMATHINIDAE

Amathina J.E. Gray, 1842
A. tricarinata (Linnaeus, 1767) [QM; M]

SUPERFAMILY RINGICULOIDEA

FAMILY RINGICULIDAE

Ringicula Deshayes, 1838
R. doliaris Gould, 1860 [QM; 12 as *Ringicula* sp. 3]
Ringicula sp. 1 [12]

SUPERFAMILY RISSOELLOIDEA

FAMILY RISSOELLIDAE

Rissoella Gray, 1847
R. (*Jeffreysiella*) Thiele, 1912
R. (*Jeffreysiella*) *colleenae pacifica* Ponder & Yoo, 1977 [41]

[INFORMAL GROUP OPISTHOBRANCHIA]
(see Note 22)

CLADE CEPHALASPIDEA

SUPERFAMILY BULLOIDEA

FAMILY BULLIDAE

Bulla Linnaeus, 1758
B. ampulla Linnaeus, 1758 [QM]
B. angasi (Pilsbry, 1893) [13]
B. punctulata A. Adams, 1850 [13]
B. vernicosa Gould, 1859 [QM; 13; 32; 56; 57]

SUPERFAMILY HAMINOEOIDEA

FAMILY HAMINOEIDAE

Haminoea Turton & Kingston in Carrington, 1830
H. wallisi Gray, 1825 [12, 16 (as *H. fusca*); 32; 56]

Atys Montfort, 1810
Atys sp. 1 [12]
Atys sp. 2 [12]

Nipponatys Kuroda & Habe, 1952
N. tumida Burn, 1978 [4]

SUPERFAMILY PHILINOIDEA

FAMILY PHILINIDAE

Philine Ascanius, 1772
P. angasi (Crosse & Fischer, 1865) [32; 52; 53]
P. cf *elegans* Bergh, 1905 [12]
P. trapezia Hedley, 1902 [12]

Melanochlamys Cheesman, 1881
Melanochlamys sp. 1 [12]

FAMILY AGLAJIDAE

Chelidonura A. Adams, 1850
C. varians Eliot, 1903 [50]
C. fulvipunctata Baba, 1938 [12]
C. inornata Baba, 1949 [12]

Philinopsis Pease, 1860
P. lineolata (H & A Adams, 1854) [12]

FAMILY CYLICHNIDAE

Cylichna Lovén, 1846
Cylichna sp. [M]

Adamnestia Iredale, 1936
A. thetidis Hedley, 1903 [52; 53]

Austrocylichna Burn, 1974
A. leucampyx Burn, 1978 [4]

Retusa Brown, 1827
Retusa sp. 1 [12]
Retusa sp. 2 [12]

Rhizorus Montfort, 1810
Rhizorus sp. [M]

Tornatina A.Adams, 1850
Tornatina sp. 3 [M; 12]

FAMILY GASTROPTERIDAE

Sagaminopteron Tokioka & Baba, 1964
S. ornata Tokioka & Baba, 1964 [56]

CLADE THECOSOMATA [PTEROPODA](see Note 23)

SUPERFAMILY CAVOLINIOIDEA

FAMILY CAVOLINIIDAE

Cavolinia Abildgaard, 1791
C. globulosa Gray, 1850 [QM]
C. inflexa (Lesueur, 1813) [QM]
C. tridentata (Forsk l in Niebuhr, 1775) [QM]

Clio Linnaeus, 1767
C. pyramidata Linnaeus, 1767 [QM]

Creseis Rang, 1828
C. acicula (Rang, 1828) [QM]
C. virgula (Rang, 1828) [QM]

Diacria J.E. Gray, 1842
D. trispinosa (Blainville, 1821) [QM]

CLADE APLYSIOMORPHA

SUPERFAMILY APLYSIOIDEA

FAMILY APLYSIIDAE

SUBFAMILY APLYSIINAE

Aplysia Linnaeus, 1767
A. dactylomela Rang, 1828 [QM; 12; 13; 16; 32; 56]
A. extraordinaria (Allan, 1932) [3]
A. c.f. *kurodai* (Baba, 1937) [12]
A. parvula Guilding in Mörch, 1863 [12]
A. sowerbyi Pilsbry, 1895 [12; 32; 56]

SUBFAMILY DOLABELLINAE

Dolabella Lamarck, 1801
D. auricularia (Lightfoot, 1736) [QM also as *D. scapula*; 44]

SUBFAMILY DOLABRIFERINAE

Dolabrifera Gray, 1847
D. brazieri Sowerby, 1870 [12]
D. dolabrifera (Cuvier, 1817) [12]

SUBFAMILY BURSATELLINAE

Bursatella Blainville, 1817
B. leachii Blainville, 1817 [QM; 5; 16; 32; 50]

SUBFAMILY NOTARCHINAE

Stylocheilus Gould, 1852
S. striatus (Quoy & Gaimard, 1832) [5]

CLADE SACOGLOSSA

SUBCLADE OXYNOACEA

SUPERFAMILY OXYNOOIDEA

FAMILY JULIIDAE

Julia Gould, 1862
J. exquisita (Gould, 1862) [12; 13]

FAMILY VOLVATELLIDAE

Volvatella Pease, 1860
V. cf *pyriformis* Pease, 1860 [M; QM]

SUBCLADE PLAKOBRANCHAEA

SUPERFAMILY PLAKOBRANCHOIDEA

FAMILY PLAKOBRANCHIDAE

Elysia Risso, 1818
- *E. australis* (Quoy & Gaimard, 1832) [12; 13]
- *E. bangtawaensis* Swennen, 1997 [16]
- *E. coodgeensis* (Angas, 1864) [12; 56 as *E. australis*]
- *E.* cf *furvacauda* Burn, 1958 [12]
- *E. ornata* (Swainson, 1840) [50]
- *E.* cf *tomentosa* Jensen, 1997 [50]
- *E. verrucosa* Jensen, 1985 [12]

Thuridilla Bergh, 1872
- *T. gracilis* (Risbec, 1928) [12]
- *T. neona* Gosliner, 1995 [12; 13]
- *T. vatae* (Risbec, 1928) [16]

SUPERFAMILY LIMAPONTIOIDEA

FAMILY LIMAPONTIIDAE

Ercolania Trinchese, 1872
- *Ercolania* sp. 1 [12]

FAMILY CALIPHYLLIDAE

Cyerce Bergh, 1871
- *C. nigra* Bergh, 1871 [12]
- *C. nigricans* Pease, 1866 [12; 50]

Polybranchia Pease, 1860
- *P. orientalis* (Kelaart, 1858) [13]

FAMILY HERMAEIDAE

Hermaea Loven, 1844 (see Note 24)
- *Hermaea* sp. 2 [12]
- *Hermaea* sp. 3 [12]

CLADE UMBRACULIDA (see Note 25)

SUPERFAMILY UMBRACULOIDEA

FAMILY UMBRACULIDAE

Umbraculum Schumacher, 1817
- *U. umbraculum* (Lightfoot, 1786) [QM; 20; 32; 50]

FAMILY TYLODINIDAE

Tylodina Rafinesque, 1819
- *T. corticalis* (Tate, 1889) [14]

CLADE NUDIPLEURA

SUBCLADE PLEUROBRANCHOMORPHA

SUPERFAMILY PLEUROBRANCHOIDEA

FAMILY PLEUROBRANCHIDAE

SUBFAMILY PLEUROBRANCHINAE

Berthella Blainville, 1825
- *B. martensi* (Pilsbry, 1896) [50]

Berthellina Gardiner, 1936
- *B. citrina* (Rüppell & Leuckart, 1828) [QM; 12; 20; 56]

Pleurobranchus Cuvier, 1804
- *P. albiguttatus* (Bergh, 1905) [12]
- *P. grandis* Pease, 1868 [50]
- *P. peroni* Cuvier, 1804 [QM; 12; 14; 16; 20; 56]

SUBFAMILY PLEUROBRANCHAEINAE

Pleurobranchaea Leue, 1813
- *P. maculata* (Quoy & Gaimard, 1832) [3]

CLADE EUCTENIDIACEA (see Note 26)

SUBCLADE DORIDACEA

SUPERFAMILY DORIDOIDEA

FAMILY DORIDIDAE

Doris Linnaeus, 1758
- *Doris* sp. [13]

Hoplodoris Bergh, 1880
- *H. nodulosa* (Angas, 1864) [QM; 13; 60]

Siraius Marcus, 1955
- *S. immonda* (Risbec, 1928) [50]

FAMILY ACTINOCYCLIDAE

Actinocyclus Ehrenberg, 1831
- *A. japonicus* (Eliot, 1913) [27]

FAMILY CHROMODORIDIDAE

Chromodoris Alder & Hancock, 1855
- *C. albopunctata* (Garratt, 1879) [12; 13]
- *C. aspersa* Gould, 1852 [12; 14; 16]
- *C. aureopurpurea* Collingwood, 1881 [12; 13; 14; 16; 50; 56]
- *C. burni* Rudman, 1982 [12; 13; 50]
- *C. collingwoodi* Rudman, 1987 [16; 50; 59]
- *C. daphne* (Angas, 1864) [14; 16; 47; 56]
- *C. decora* (Pease, 1860) [12; 13]
- *C. elisabethina* Bergh, 1877 [QM; 12; 13; 14; 16; 50; 60]
- *C. kuiteri* Rudman, 1982 [QM; 12; 13; 32; 56]
- *C. leopardus* Rudman, 1987 [49; 50]
- *C. lochi* Rudman, 1982 [12]
- *C. splendida* (Angas, 1864) [QM; 12; 13; 14; 32; 50; 56]
- *C. strigata* Rudman, 1982 [12; 13; 14; 16; 50]
- *C. tinctoria* (Ruppell & Leuckart, 1828) [12; 50; 60]

Ceratosoma J.E. GRAY 1850
- *C. amoenum* (Cheeseman, 1886) [50; 60 as *Chromodoris amoena*]
- *C. flavicostatum* (Baba, 1940) [16]
- *C. magnificum* (Eliot, 1910) [14]
- *C. moloch* Rudman, 1988 [16; 50]
- *C. tenue* Abraham, 1876 [QM; 12; 13; 14; 32; 50]
- *C. trilobatum* (J.E. Gray, 1827) [12; 13; 50; 56]

Diversidoris Rudman, 1987
- *D. aurantionodulosa* Rudman, 1987 [49]

Glossodoris Ehrenberg, 1831
- *G. atromarginata* (Cuvier, 1804) [QM; 12; 13; 21; 27; 32; 50; 56; also as *Casella atromarginata*]
- *G. cincta* (Bergh, 1888) [12; 13; 50]
- *G. electra* Rudman, 1990 [12]

G. rubroannulata Rudman, 1986 [12; 13; 59]
G. rufomarginata Rudman, 1986 [12; 14]

Hypselodoris Stimpson, 1855
H. bennetti (Angas, 1864) [13; 27 as *Glossodoris bennetti*; 60]
H. bullocki (Collingwood, 1881) [12; 13; 50]
H. emmae Rudman, 1977 [12; 13]
H. ? infucata (Rüppell & Leukart, 1828) [50]
H. jackousoni Wilson & Willan, 2007 [50; 63]
H. kaname Baba, 1994 [50]
H. maculosa Risbec, 1928 [56; 59]
H. maritima (Baba, 1949) [13]
H. obscura (Stimpson, 1855) [QM; 12; 13; 14; 32; 56]
H. whitei (A. Adams & Reeve, 1850) [12]
H. zephyra Gosliner & Johnson, 1999 [50]

Mexichromis Bertsch, 1977
M. festiva (Angas, 1864) [12; 13; 50; 56; 59]
M. macropus Rudman, 1983 [32; 56; 59]

Miamira Bergh, 1874
M. flavicostata Baba, 1949 [27]

Noumea Risbec, 1928
N. alboannulata Rudman, 1988 [12; 13; 59]
N. crocea Rudman, 1985 [16; 48; 50]
N. flava (Eliot, 1904) [12]

Pectenodoris Rudman, 1984
P. trilineata (A. Adams & Reeve, 1850) [50]

Risbecia Odhner, 1934
R. godeffroyana Bergh, 1877 [12]
R. tryoni (Garrett, 1873) [50; 59]

Thorunna Bergh, 1878
T. australis (Risbec, 1928) [13]
T. daniellae (Kay & Young, 1969) [12]
T. ? florens (Baba, 1949) [50]
T. montrouzieri Rudman, 1995 [12]

FAMILY DISCODORIDIDAE

Discodoris Bergh, 1877
D. fragilis (Alder & Hancock, 1864) [13; 56; 59]
D. lilacina (Gould, 1852) [16]
D. palma Allan, 1933 [12; 13; 56; 60]

Atagema Gray, 1850
A. ornata (Ehrenbergh, 1831) [60 as *Trippa intecta*]
A. spongiosa (Kelaart, 1858) [56]

Halgerda Bergh, 1880
H. aurantiomaculata (Allan, 1932) [12; 13]
H. willeyi Eliot, 1903 [56]

Jorunna Bergh, 1876
J. funebris (Kelaart, 1858) [56]
J. pantherina (Angas, 1864) [60]
Jorunna sp. 3 [12]

Platydoris Bergh, 1877
P. formosa (Alder & Hancock, 1864) [13]

Rostanga Bergh, 1879
R. bifurcata Rudman & Avern, 1989 [13]

Sclerodoris Eliot, 1904
S. tarka Burn, 1969 [12; 13]

Thordisa Bergh, 1877
T. verrucosa (Angas, 1864) [12; 13]

SUPERFAMILY PHYLLIDIOIDEA

FAMILY PHYLLIDIIDAE

Phyllidia Cuvier, 1797
P. elegans Bergh, 1869 [2]
P. ocellata Cuvier, 1804 [2; 12; 14; 16; 56]
P. picta Provot-Fol, 1957 [16]
P. varicosa Lamarck, 1801 [QM; 2; 14; 32; 56]

Fryeria J.E. Gray, 1853
F. marindica (Yonow & Hayward, 1991) [59]

Phyllidiella Bergh, 1869
P. lizae Brunckhorst, 1993 [2]
P. pustulosa (Cuvier, 1804) [2; 12; 13; 21 (as *Phyllidea nobilis*), 56]

Phyllidiopsis Bergh, 1875
P. fissurata Brunckhorst, 1993 [QM; 2; 12; 13; 14; 16; 32]

FAMILY DENDRODORIDIDAE

Dendrodoris Ehrenberg, 1831
D. albobrunnea Allan, 1933 [56; 60]
D. denisoni (Angas, 1864) [QM; 12; 50]
D. fumata (Ruppell & Leuckart, 1831) [12; 13; 56]
D. nigra (Stimpson, 1855) [12; 19; 27; 32; 56]
D. rainfordi Allan, 1932 [50]

SUPERFAMILY ONCHIDORIDOIDEA

FAMILY GONIODORIDIDAE

Okenia Leuckart & Bronn in Menke, 1830
O. brunneomaculata Gosliner, 2004 [12]
O. pellucida Burn, 1967 [14, 16]
O. plana Baba, 1960 [13]

SUPERFAMILY POLYCEROIDEA

FAMILY POLYCERIDAE

SUBFAMILY POLYCERINAE

Polycera Cuvier, 1817
P. melanosticta Miller, 1996 [12]

SUBFAMILY KALINGINAE

Kalinga Alder & Hancock, 1864
K. ornata Alder & Hancock, 1864 [16; 27; 50]

SUBFAMILY NEMBROTHINAE

Nembrotha Bergh, 1877
N. livingstonei Allan, 1933 [12]

Tambja Burn, 1962
T. morosa (Bergh, 1877) [50]
T. tenuilineata Miller & Haagh, 205 [12; 13]
T. cf verconis (Basedow & Hedley, 1905) [50]

SUBFAMILY TRIOPHINAE

Kaloplocamus Bergh, 1893
K. acutus Baba, 1949 [12]

Plocamopherus Leucart, 1828
P. ceylonicus (Kelaart, 1858) [12; 13]
P. imperialis (Angas, 1864) [13]

FAMILY AEGIRETIDAE

Aegires Lovén, 1844
A. flores Fahey & Gosliner, 2004 [50]
A. gardineri (Eliot, 1906) [12; 13]

FAMILY GYMNODORIDIDAE

Gymnodoris Stimpson, 1855
G. aurita (Gould, 1852) [14, 16; 50]
G. cf *nigricolor* Baba, 1960 [12]

FAMILY HEXABRANCHIDAE

Hexabranchus Ehrenberg, 1831
H. sanguineus (Rüppell & Leuckart, 1828) [QM; 12; 13; 21; 32]

FAMILY OKADAIIDAE

Vayssierea Risbec, 1928
V. caledonica (Risbec, 1928) [12; 13]

CLADE CLADOBRANCHIA
UNASSIGNED FAMILIES

FAMILY MADRELLIDAE

Madrella Alder & Hancock, 1864
M. ferruginosa Alder & Hancock, 1864 [12]

FAMILY PROTONOTIDAE

Janolus Bergh, 1884
Janolus sp. 1 [50]

SUBCLADE EUARMINIDA
SUPERFAMILY ARMINOIDEA

FAMILY ARMINIDAE

Armina Raphinesque, 1814
A. cygnea (Bergh, 1876) [56]
Dermatobranchus Hasselt, 1924
Dermatobranchus sp. 2 [12]

SUBCLADE DENDRONOTIDA
SUPERFAMILY TRITONIOIDEA

FAMILY TRITONIIDAE

Marianina Pruvot-Fol., 1931
M. rosea (Pruvot-Fol, 1930) [12]
Marionia Vayssi re, 1877
M. cyanobranchiata (Rüppell & Leuckart, 1831)[13]
M. cf *distincta* Bergh, 1905 [12; 13]
M. pustulosa Odhner, 1936 [12; 13]

FAMILY BORNELLIDAE

Bornella A. Adams & Reeve, 1848
B. anquilla Johnson, 1984 [12; 13; 32; 50]
B. stellifer (A. Adams & Reeve, 1848) [12; 13; 14; 50]

FAMILY HANCOCKIIDAE

Hancockia Gosse, 1877
H. burni Thompson, 1972 [12]

FAMILY LOMANOTOIDAE

Lomanotus Verany, 1844
L. vermiformis Eliot, 1908 [12; 13; 16; 21; 56]

FAMILY PHYLLIROIDAE

Tritonopsis Eliot, 1905
T. alba (Baba, 1949) [27 as *Tritoniopsilla alba*; 53; 56]

FAMILY SCYLLAEIDAE

Notobryon Odhner, 1936
N. bijecurum Baba, 1949 [27]

FAMILY TETHYDIDAE

Melibe Rang, 1829
M. japonica Eliot, 1910 [QM also as *M. mirifica*; 12] (see Note 27)

SUBCLADE AEOLIDIDA
SUPERFAMILY AEOLIDOIDEA

FAMILY AEOLIDIIDAE

Anteaeolidiella Miller, 2001
A. indica (Bergh, 1888) [12]
Baeolidia Bergh, 1888
B. major (Eliot, 1903) [12]
Cerberilla Bergh, 1873
C. affinis Bergh, 1888 [50]
C. asamusiensis Baba, 1940 [12]
Spurilla Bergh, 1864
S. alba (Risbec, 1928) [3 as *Aeolidiella alba*; 60]
S. major (Eliot, 1903) [50]
S. neapolitana (Delle Chiaje, 1823) [12]

FAMILY FACELINIDAE

SUBFAMILY FACELININAE

Mordilla Bergh, 1888
M. brockii Bergh, 1888 [12]

SUBFAMILY CRATENINAE

Cratena Bergh, 1864
C. lineata (Eliot, 1904) [12; 60]
C. simba Edmunds, 1970 [13]

SUBFAMILY FAVORININAE

Favorinus M.E. Gray, 1850
F. tsuruganus Baba & Abe, 1964 [13; 58; 60]
Austraeolis Burn, 1962
A. ornata (Angas, 1864) [3; 12; 13; 56; 60]
Godiva Macnae, 1954
G. quadricolor (Barnard, 1927) [12; 13; 16]
G. ? rachelae Rudman, 1980 [50]
Phyllodesmium Ehrenberg, 1831
P. crypticum Rudman, 1981 [13; 50]
P. longicirrum (Bergh, 1905) [14]
P. poindimiei (Angas, 1864) [12; 13]

SUBFAMILY HERVIELLINAE

Herviella Baba, 1949

H. albida Baba, 1966 [13]
H. claror Burn, 1963 [13]

SUBFAMILY PTERAEOLIDINAE

Pteraeolidia Bergh, 1875
P. ianthina (Angas, 1864) [13; 50; 56]

FAMILY GLAUCIDAE

Glaucus Forster, 1777
Glaucus atlanticus Forster, 1777 [32; 50]
G. marginatus (Bergh, 1860) [QM; 32]

SUPERFAMILY FIONOIDEA

FAMILY FIONIDAE

Fiona Alder & Hancock, 1855
F. pinnata (Eschscholtz, 1831) [QM]

FAMILY EUBRANCHIDAE

Eubranchus Forbs, 1838
E. ? echizenicus Baba, 1975 [50]
Eubranchus sp. [12]

FAMILY TERGIPEDIDAE

SUBFAMILY CUTHONINAE

Phestilla Bergh, 1874
P. melanobrachia Bergh, 1874 [12]
Trinchesia Ihering, 1879 (see Note 28)
T. sibogae (Bergh, 1905) [12; 56]
T. yamasui (Hamatani, 1993) [12; 13]

SUPERFAMILY FLABELLINOIDEA

FAMILY FLABELLINIDAE

Flabellina Voigt, 1834
F. bicolor (Kelaart, 1858) [12; 13; 59]
F. bilas Gosliner & Willan, 1991 [12; 13]
F. ornata (Risbec, 1928) [27; 60]
F. rubrolineata (O'Donoghue, 1929) [14; 16; 32; 50; 56]

[INFORMAL GROUP PULMONATA]
[INFORMAL SUBGROUP BASOMMATOPHORA]

SUPERFAMILY AMPHIBOLOIDEA (see Note 29)

FAMILY AMPHIBOLIDAE

Salinator Hedley, 1900
S. fragilis (Lamarck, 1822) [QM; 34]

FAMILY PHALLOMEDUSIDAE

Phallomedusa Golding, Ponder & Byrne, 2007
P. solida (von Martens, 1878) [QM; 34; 56 all as *Salinator solida*]

SUPERFAMILY SIPHONARIOIDEA

FAMILY SIPHONARIIDAE

Siphonaria Sowerby, 1824
S. denticulata Quoy & Gaimard, 1833 [QM; 56]
S. funiculata Reeve, 1856 [QM; 25]
S. zelandica Quoy & Gaimard, 1833 [26]

CLADE EUPULMONATA
SUPERFAMILY ELLOBIOIDEA

FAMILY ELLOBIIDAE

Cassidula Gray, 1847
C. nucleus (Gmelin, 1791) [34]
C. zonata H. & A. Adams, 1854 [34]
Laemodonta Philippi, 1846
L. typica (H & A Adams, 1854) [QM]
Marinula King & Broderip, 1831
M. xanthostoma H. & A. Adams, 1855 [QM]
Pleuroloba Hyman, Rouse & Ponder, 2005 (see Note 30)
P. quoyi (H. & A. Adams, 1855) [QM; 32; 34; 56; all as *Ophicardelus quoyi*]
Ophicardelus Beck, 1837
O. ornatus (Férussac, 1821) [QM; 32; 34]
O. sulcatus (H. & A. Adams, 1855) [QM; 32; 34]

CLADE SYSTELLOMMATOPHORA
SUPERFAMILY ONCHIDOIDEA (see Note 31)

FAMILY ONCHIDIIDAE

Onchidella Gray, 1850
O. patelloides Quoy & Gaimard, 1832 [QM]
Onchidina Semper, 1885
O. australis (Gray, 1882) [QM; 56]
Onchidium Buchannan, 1800
O. damelii [QM; 32]
Peronia Fleming, 1822
P. verruculata (Cuvier, 1830) [QM; 15; 56]
Uncertain
Onchidiidae sp. [QM] (see Note 32)

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NOTES ON THE TEXT

Note 1. In the early 1980s MSA member Jim Whittle produced a useful, privately distributed list of molluscs from South East Queensland. Although valuable for subsequent checklist development, its taxonomic content was based on older literature and many names cited in that list have now been relegated to the ranks of synonomy.

Note 2. Like Fryda *et al.* (2005) we have listed the name-stem taxon for each taxonomic level, followed alphabetically by other constituent taxa. In some instances Fryda *et al.* (2005) do not adhere to alphabetic arrangement for superfamilies listed after the nominate taxon, and in this respect our list (which is not intended as a 'classification') differs from theirs.

Note 3. Geiger (1998) reviewed the Recent Haliotidae and concluded that *Haliotis melculus* Iredale, 1927, and *H. ethologus* Iredale, 1927, were synonyms of *H. brazieri* and *H. hargravesi* respectively. While he draws attention to suspected *H. hargravesi-H. brazeri* hybrids (and illustrates examples) he also refers to a *H. hargravesi-H. brazieri* 'continuum' suggesting the possibility that all four nominal taxa may be variants of a single species. The status of Iredale's taxa will only be settled when animals become available for anatomical and molecular study.

Note 4. Williams *et al.* (2008) have recently concluded, on the basis of molecular evidence, that families allocated by Fryda *et al.* (2005) to a superfamily Turbinoidea (Turbinidae Liotiidae and Phasianellidae) should be returned to the Trochoidea (their 'traditional' position). This departure from the Fryda *et al.* classification is adopted here. Aside from the larger-sized (>1cm) species, the Trochoidea of Moreton Bay are poorly known and clearly in need of taxonomic review.

Note 5. This is the name that must be used for Moreton Bay black nerites. The often cited name *Nerita atramentosa* Reeve, 1855 applies to a similar species occurring in southern Australia (for figures and discussion see Spencer *et al.* 2007).

Note 6. This species is sometimes placed in *Theodoxus*, but Haynes (2005) has upheld its inclusion in *Clithon* (and the validity of that genus).

Note 7. The arrangement of the Cypraeidae follows that of Meyer (2003) based on extensive molecular work, although we have, for consistency reasons, not utilised the category of 'tribe'. Many authors consider all extant cypraeids as belonging to *Cypraea* (e.g. Burgess 1970, 1985; Liltved 1989) and probably for reasons of simplicity, this is often applied in faunal lists (e.g. Slack-Smith & Bryce 2004). However, Meyer's study, combined with the extensive fossil history of the Cypraeidae (for literature, see Meyer 2003), supports the recognition of many genera within the family (e.g. Allan 1956; Lorenz & Hubert 1993).

Note 8. The arrangement of Ovulidae essentially follows that of Higo *et al.* (1999) (see Carless 2005a).

Note 9. The classification and identifications of naticid material held by QM follows that of T. Huelsken (Huelsken 2008).

Note 10. The Pterotracheoidea (= 'Heteropoda') of Moreton Bay are very poorly known: our QM *Atlanta* record consists of beachdrift material.

Note 11. Taxonomic work relevant to the Australian marine Rissooidea has largely focussed on issues at the level of genus and above. To date species-level reviews are limited to the Barleeidae and some smaller families (Ponder & Yoo 1976) and Laseron's (1956b) early work continues to be important. We list here only those species with confirmed records from Moreton Bay rather than species with published inferred ranges that include this region. Given their small physical size, it seems likely that the Moreton Bay rissooidean fauna contains many more species than cited here.

Note 12. Allan (1958) records a '*Lamellaria* sp. D' from Kirra (Gold Coast) but stated that its generic placement was provisional. This record is included simply to establish the presence of the Lamellariidae in Moreton Bay (as defined herein).

Note 13. The Vermetoidea of Moreton Bay essentially remain unstudied. At present only the genus *Serpulorbis* has been confirmed from the area (R. Bieler, pers. com. to JH) but in all likelihood other genera such as *Dendropoma* have representatives among the fauna.

Note 14. Although several subgenera of *Epitonium* have been proposed little consensus exists as to their application and hence we here follow Wilson (1993) in using the name in a wider sense. Four undetermined species of Epitoniidae were also obtained from Moreton Bay Workshop (2005) benthic samples (central bay).

Note 15. The Eulimoidea from Moreton Bay are very poorly known and the few taxa listed here are included merely to establish the presence of various genera in the bay fauna.

Note 16. Carless (2005), using Laseron's early account (1958) and Marshall's (1983) revision, has provided a very useful summary of the Triphoridae from the north and central-eastern portion of the bay. At the time of his death TC had organised his own Cerithiopsidae collection (Moreton Bay well represented) based on Laseron's (1956a) work. Aside from Marshall's (1978) account, no recent anatomy and/or molecular based revisions of this family have been attempted and hence the validity of many of Laseron's species has yet to be tested.

Note 17. Carless (2004a) lists a further three species of Columbellidae from SE Queensland some of which may eventually be shown to occur in Moreton Bay (as defined herein). The

FIG 1. *Melibe japonica* Eliot, 1910 (Nudibranchia, Tethyiidae) photographed alive and intact in a canal at Wellington Point, Moreton Bay in early February 1994. The entire animal measures approximately 450 mm in length. The right hand side of the photograph shows the fully extended oral veil, while on the left hand side the large colourful cerata are observed. Large numbers of these impressive nudibranchs have been seen in Moreton Bay in recent years, most commonly in commercial trawling nets. For further discussion see Note 27. Photo: courtesy Rod Foster.

generic placement of some species is modified according to deMaintenon (2008).

Note 18. All Coninae are here treated as belonging to *Conus* until molecular and anatomical work can establish the validity of the numerous nominal genera/subgenera (for a recent discussion see Duda *et al.* 2001). The classification of Fryda *et al.* (2005) expanded the Conidae to include some groups formerly allocated to the Turridae. Other than the Coninae (which are reasonably well known), all other groups of Conoidea from southern Queensland waters have remained largely ignored for more than 50 years, hence the listing here is very provisional. Undoubtedly the Moreton Bay fauna of this group contains many as yet undescribed or unrecorded conoideans.

Note 19. Strong *et al.* (1996) record a further 12 species of Costellariidae fom SE Queensland, some of which may eventually be shown to occur in Moreton Bay (as defined herein).

Note 20. Strong *et al.* (1996) record a further 17 species of Mitridae fom SE Queensland, some of which may eventually be shown to occur in Moreton Bay (as defined herein).

Note 21. Pyramidelloideans are arranged according to the recent revision (based on shell features) by Schander *et al.* (1999), who admit that their arrangement is a very provisional one (in the absence of sufficient comparative anatomy and molecular data). Aside from the work of Laseron (1959), the Pyramidelloidea of Moreton Bay essentially remain unstudied. The species listed here from our records and published literature possibly represent only a small proportion of the total pyramidelloidean fauna from the region.

Note 22. Many more opisthobranch species (including numerous nudibranchs) are recorded from the northern section of the Sunshine Coast (e.g. see Coleman 2001, 2008; Cobb & Willan 2006; Cobb & Mullins 2010) and may eventually be found within Moreton Bay (as defined herein). The shelled bullomorph families (e.g. Haminoeidae, Cylichnidae) are clearly in need of taxonomic revision and the names applied to some Indo-Pacific species must be considered as provisional only.

Note 23. The pteropod records of Moreton Bay are all derived from beach drift shells.

Note 24. Cobb & Mullins (2010) place this genus within Styligeridae; however we have followed Fryda *et al*. (2005) who recognise the H. & A. Adams family Hermaeidae.

Note 25. Although long regarded as pleurobranchs the umbraculidans are now considered a distinct though still pleurobranch-allied group (see Wagele & Willan 2000; Fryda *et al*. 2005).

Note 26. It is important to bear in mind that a collecting record for a nudibranch species does not imply that it is a constant faunal component. The occurrence of many species of opisthobranchs (and especially many nudibranch species) in southeast Queensland can be very sporadic (see Willan & Coleman 1984).

Note 27. The presence of this large and spectacular species in Moreton Bay has only recently been established. A damaged 30cm specimen (minus cerata) now in the QM collection was found washed ashore at Myora, North Stradbroke Island in August 2008 and tentatively identified by Dr K. Townsend (Moreton Bay Marine Station) as *Melibe japonica*, a view with which we concur. An even larger (approximately 50cm) intact swimming specimen (which appears to be this species) was photographed at the Moreton Bay Yacht Club Marina at Redcliffe in December 2007 (for images see Sea Slug Forum website). The QM Malacology section files have a photographic record of this species (also intact, length approximately 45cm) observed alive in the canals at Wellington Point (1994) (see Fig. 1). Dr W.B. Rudman initially suggested the Moreton Bay species might be *M. viridis* Kelaart, 1858, but he has subsequately confirmed the identification as *M. japonica* (see *Sea Slug Forum* Oct 22, 2008, item #21985). In addition he has proposed that *M. mirifica* Allan 1932 (long known from Australian waters, including Moreton Bay, see Kenny 1970) should now be regarded as a synonym of *M. japonica*. Willan & Colman (1984) had previously suggested that this might prove to be the case. *Melibe japonica* gives off an unappealling (but distinctive) citrus-like odour which helps to discriminate it in the field. Large numbers of these enormous animals were caught by trawlers in Moreton Bay in late 2008, and first brought to the attention of the QM at that time, however discussions between JH and local trawler operators indicates that *M. japonica* has been common in a number of areas of the bay at least since the mid-1970s, and probably earlier. It seems likely that this species is a normal component of the bay's gastropod fauna but not in the large numbers recently recorded.

Note 28. These species are often placed in the genus *Cuthona* Alder & Hancock, 1855, but are here included in *Trinchesia* following Miller (2004). However this placement should be regarded as provisional in the light of the apparent phylogenetic complexity of '*Cuthona*' (see also Rudman's comments on the *Sea Slug Forum* item #21285, '*Cuthona* or *Trinchesia* ?').

Note 29. Golding *et al*. (2007) have recently established the genus *Phallomedusa* and the family Phallomedusidae for *Salinator solida* (and a related species) based on important differences of the reproductive system.

Note 30. Hyman *et al*. (2005) established *Pleuroloba* to accommodate two species formerly placed in *Ophicardelus* (*O. quoyi*, *O. costellaris*)

Note 31. The Onchidiidae of Queensland have never been rigorously assessed from the taxonomic perspective and in some cases uncertainty exists as to species identity and generic assignment (also see Note 32).

Note 32. In November 2008 an unusual (and locally common) onchidiid was found at Macleay Island, southern Moreton Bay, characterised by raised papillae and two dorsal reddish-brown stripes. Although its identification and even generic placement are undetermined it is here included as part of the known bay onchidiid fauna.

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A review of the Ascidiacea (Tunicata) of Moreton Bay, Queensland

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ABSTRACT

A review of the 95 species of the Ascidiacea recorded from Moreton Bay, Queensland shows that solitary species of Phlebobranchia and Stolidobranchia (53 species) dominate the fauna, there being few colonial species of either suborder and only 30 species of the almost exclusively colonial Aplousobranchia, eight being species of the Didemnidae recorded only from locations immediately to the north of the Bay rather than in its semi-enclosed waters. However, it is emphasised that much of the sampling within the Bay has been from muddy and sandy rather than hard substrates and this may have caused a bias in the material taken. An assessment of the geographic range of each of the species shows Moreton Bay to be the southern and northern limit for a number of species with, respectively, tropical and temperate affinities. This supports other studies indicating that Moreton Bay is at the centre of the eastern Australian tropical to temperate faunal transition zone. ❑ *Ascidiacea, Tunicata, Aplousobranchia, Phlebobranchia, Stolidobranchia, intertidal, subtidal, reef, taxonomy, checklist, biogeography.*

This study is based on the 4000 specimen lots of the Ascidiacea from Moreton Bay, and regions immediately to the north, registered in the collections of the Queensland Museum. Some hard surfaces are provided by several shipwrecks on Moreton I. and off the Gold Coast, reefs on the eastern side of the islands facing the Pacific Ocean, and rocky headlands such as Kings Beach (in the northern part of the Bay). Only a few locations are described as 'rocky reef' or 'Acropora reef'. However most ascidians were taken from habitats where sediments such as sand, mud and shell grit, and various mixtures of these, prevail. This may reflect a collecting bias that favours the large solitary species that dominate this species list. Many of the records are from dredge, grab and trawl collecting in connection with the late Prof. W. Stephenson's surveys of the benthic fauna (e.g. Stephenson *et al.* 1970, 1974, 1976). Colonial species that closely adhere to hard, clean substrates are not well sampled by these collecting methods; and usually settle on upper surfaces where fine sediments could smother small colonial zooids with exposed branchial apertures opening on the upper surface of the colony.

TAXONOMIC NOTES

Ninety-five species of the Class Ascidiacea are represented in the collections from Moreton Bay, Caloundra and Flinders Reef (see Table 1). Their taxonomy is discussed in Kott (1972–2006).

Colonial species are known in the three subdivisions (suborders) of the Ascidiacea. In one, Aplousobranchia, the colonial habit is almost universal, solitary species occurring only in rare and exceptional cases. In the Stolidobranchia about half of the higher level taxa (families and subfamilies) are colonial. In the Phlebobranchia, most species are large and solitary, only a couple of families being colonial. Colonies are formed by vegetative replication (budding or fission) that interrupts the growth of individuals and results in progressively smaller, more numerous, and more simplified zooids united by test. The parallel evolution of the colonial habit in each suborder reflects a striking degree of convergence, all colonial taxa tending toward larger and more integrated colonial systems, and simplified body organs, especially reductions in the size of the ovary relative to the testis. This last condition, possibly associated with internal fertilisation and the liberation of embryos (brooded in the adult colony as free-swimming tailed larvae) is a strategy likely to contribute to population maintenance. It is one of the most significant aspects of the colonial habit in all suborders.

On the other hand, irrespective of suborder, most solitary species are externally fertilised and the adult body organs (branchial sac, gut and liver diverticulae and especially the gonads) tend to be larger and more elaborate, presumably to accommodate the needs of the large, solitary, externally fertilised individuals. However, although the colonial taxa present in Moreton Bay are in the minority, they can be placed in the same geographic groups (based on their known range) as the solitary taxa (see below). There are ecological reasons such as substrate and the range of habitats available that can explain the dominance of large solitary species in these waters, however there are no obvious biological reasons. Apart from the massive colonies of the stolidobranch *Polyandrocarpa colemani*, the colonial species most conspicuous in Moreton Bay are similar thin, sheet-like investing colonies irrespective of the suborders to which they belong, *viz*, Polyzoinae and Botryllinae (Stolidobranchia) and Didemnidae (Aplousobranchia). The characteristics of the suborders are summarised below and a Key to the families represented in Moreton Bay is given.

APLOUSOBRANCHIA

Twenty-nine species represent this exclusively colonial group. They have relatively small zooids with small branchial sacs, the gut loop in an abdomen behind the pharynx and a gonad of each sex either enclosed in the gut loop or stretched out behind it. Although they tend to have colony forms similar to some colonial Stolidobranchia, replication is even more prolific, usually resulting from segmentation of the zooids, the replicates developing from endodermal tissue in each segment. Only Clavelinidae are exceptional, their replicates being generated from mesodermal tissue in the terminal ampullae of the test vessels.

PHLEBOBRANCHIA

Thirteen of the species of Phlebobranchia are listed, characterised by their flat branchial sacs and single male and female gonads associated with the large gut loop embedded in the pallial body wall to the left of the branchial sac. Eleven species are large, soltary individuals with a firm, characteristically translucent gelatinous test; although in this collection there is an unusually large number of species (*Adagnesia opaca, Agnezia glaciata. Microgastra granosa and Ascidia scaevola*) with a thin test brittle with embedded sand that resembles the test of some *Polycarpa* and *Molgula* species (Stolidobranchia) and suggests that habitat requirements may be the principal environmental pressure selecting some components of the ascidian fauna of Moreton Bay. These species appear to be adapted for a benthic habitat on the sea floor, and the body muscles are modified to operate the closure of the apertures, rather than the general contraction of the body

Two species are colonial (family Perophoridae), the small, replicated zooids joined by ectodermal stolons from which they develop, as they are added to the growing colony. Embryos generated from the ovaries in the gut loop in the left side of the atrial cavity are released into a brood pouch on the right. These are eventually liberated from the colony as free-swimming tailed larvae. This viviparous habit is characteristic of colonial ascidians in contrast to the oviparous externally fertilised habit of solitary species.

STOLIDOBRANCHIA

Stolidobranch species have the gut loop bent up into the pallial wall on either the right or the left side of the pharynx. One or more gonads are embedded in the pallial wall on both sides of the body. Branchial sacs are folded thus increasing the filtering area — a factor that is especially important in large solitary individuals.

Species usually have rough, leathery test, although in some, the body wall is closely adherent to the thin test which has sand embedded, making it rigid, brittle and non-contractile. Body muscles in these species tend to be adapted to the opening and closing of apertures rather than the contraction of the whole body wall. These adaptations are similar in a number of phlebobranch species, suggesting that these components of the ascidian fauna may be responding to the same environmental pressures. The majority (41) of Stolidobranchia reported from Moreton Bay are solitary.

Colonial species of the Stolidobranchia (Styelidae) bud prolifically from ectodermal tissue of the pallial body wall or from vessels in the test in which they are embedded. These replicated zooids are small and simplified, the branchial sacs usually being reduced in size and in the number of folds (often being smooth), although they have gonads embedded in the body wall on each side of the pharynx as in solitary forms. In the present collection there are 10 colonial stolidobranch species, the majority being in the subfamily Botryllinae, which has similar encrusting colonies to the majority of the Aplousobranchia (Didemnidae) in this collection.

KEY TO FAMILIES OF ASCIDIACEA IN MORETON BAY

1. Gut in abdomen behind pharynx . . . . (Aplousobranchia) 2
– Gut in body wall at the side of the pharynx. 8
2. Zooids develop from terminal ampullae of test vessels . . . . Clavelinidae
– Zooids develop from horizontal subdivision of posterior abdomen and/or abdomen. . 3
3. Gonads in posterior end of long gut loop. . . . . Polycitoridae
– Gonads not in posterior end of long gut loop. 4
4. Testis in longitudinal series in posterior abdomen behind gut loop 5
– Testis not in longitudinal series in posterior abdomen behind gut loop 7
5. Excurrent openings of zooids exposed directly to exterior 6
– Excurrent openings of zooids exposed to intracolonial spaces . . . . . . Polyclinidae
6. Larvae in brood pouch connected to anterior part of abdomen by narrow neck.. . . . . Pseudodistomidae
– Larvae develop in atrial cavity of zooids. . . . . Ritterellidae
7. Replicates develop as buds from oesophageal region of zooids. Didemnidae
– Replicates develop by horizontal division of a posterior abdominal vegetative stolon. Holozoidae
8. Gonads on one side of body; branchial sac without folds . . . . . . (Phlebobranchia) 9
– Gonads on both sides of body; branchial sac folded . . . . (Stolidobranchia) 12
9. Gonads enclosed in gut loop. 10
– Gonads not enclosed in gut loop. . . . . Plurellidae
10. Small colonial zooids joined by external stolons from which they bud, and which fix them to the substrate; internally fertilised eggs develop in brood pouch on right side of pallial wall. . . . . Perophoridae
– Large solitary externally fertilised individuals. 11
11. Stigmata coiled. . . . . Agneziidae
– Stigmata rectangular. . . . . . . Ascidiidae
12. Branchial folds not more than four per side; branchial tentacles simple. . . . . Styelidae 13
– Branchial folds more than four per side; branchial tentacles branched. 15
13. Solitary. . . . . Styelinae
– Colonial. 14
14. Zooids not always completely embedded; excurrent apertures open separately to the exterior. . . . . Polyzoinae
– Zooids always completely embedded; excurrent apertures open to an internal cavity. Botryllinae
15. Stigmata rectangular. . . . . Pyuridae
– Stigmata coiled. . . . . Molgulidae

BIOGEOGRAPHY

Based on their known geographic range, the species presently recorded from Moreton Bay can be divided into five groups.

1. Cosmopolitan Species. These include in their geographic range the tropical Pacific, Atlantic and Indian Oceans, sometimes also the Mediterranean, and down the eastern and western coasts of Australia. Some (*Perophora multiclathrata* and *Styela canopus*) extend only to Moreton Bay or northern NSW on the eastern Australian coast, and Cockburn Sound or Bunbury on the Western Australian coast. *Trididemnum savignyi* is reported from the western and eastern coasts of Australia, and although pan-tropical is not known from north of the equator. *Microcosmus exasperatus* extends to Port Phillip Bay in the east and several species (*Botrylloides leachii*, *Botryllus schlosseri* and *Diplosoma listerianum*) are recorded from all around the continent. *Molgula manhattensis* reported only for a limited time from the Brisbane River appears to have been introduced but never colonised in Australian waters (Kott 1972).

2. Indo-West Pacific Tropical Species. In Australian waters these have similar distribution patterns to cosmopolitan species, although *Phallusia arabica* has been recorded only from the Arafura Sea, the Great Barrier Reef and Moreton Bay. *Ritterella dispar* is known from the west Indian Ocean as well as the eastern Australian coast from Mackay to northern NSW. Otherwise it is not recorded from the Western Pacific nor from the western coast of Australia. The majority of species in this group have a known range extending south to Moreton Bay or northern New South Wales on the eastern coast and to Port Hedland, Shark Bay or Cockburn Sound on the western coast (*Polyclinum vasculosum, Didemnum moseleyi. D. sordidum, D. membranaceum, Lissoclinum bistratum, Phallusia julinea, Eusynstyela latericius, Microcosmus madagascariensis* and *M. squamiger*) although some have been recorded from all around the continent, including the southern coast (*Ascidia sydneyensis, Cnemidocarpa areolata, Polycarpa papillata, Polycarpa procera, Pyura gangelion, P. sacciformis,* and *Botrylloides perspicuum*).

Lissoclinum bistratum is of particular interest, being one of the characteristically tropical *Didemnum/Prochloron* symbioses (Kott 1980) which are autotrophic, the chlorophyll-containing Blue/Green algal symbionts photosynthesising carbohydrate to nourish the ascidians. The species is one of the tropical ascidians that extends furthest to the south, having been recorded also from Hastings Point (northern NSW).

3. Western Pacific Tropical Species. These occur in waters to the north of Australia, and many have a range extending down the eastern coast to Moreton Bay (*Distaplia dubia, Leptoclinides rufus, Polysyncraton meandratum, Ascidia empheres, Herdmania momus, Molgula diversa*) or to more southerly locations (*Eudistoma laysani, Ascidia scaevola, Microgastra granosa*). Also in this group *Microcosmus australis* extends south to Bass Strait on the eastern coast and Cockburn Sound on the west and *Molgula sphaera* to Moreton Bay and Albany on the eastern and western coasts, respectively; several species (*Polycarpa aurita, P. chinensis, P. obscura, Botryllus tuberatus*) extend south to Moreton Bay and Cockburn Sound on the east and west, respectively); and some species have a range around the whole continent, including the southern coast (*Aplidium altarium, Cnemidocarpa pedata, Polycarpa argentata* and *Herdmania grandis*).

4. Australian Species. These possibly indigenous species have not been recorded from outside Australian waters. They are either circum-Australian (*Ascidia latesiphonica, Phallusia obesa, Polycarpa pedunculata*); or known only from the northeastern and northwestern coasts (*Sigillina cyanea, Sycozoa pulchra, Synoicum macroglossum* and *Eugyra molguloides*). Also, the largest group of species reported from Moreton Bay are a group of 27 indigenous species known only from the eastern coast of the continent that are perhaps the best indicators of its biogeographic affinities. Some of these species are not recorded south of Moreton Bay and could be regarded as tropical species (*Didemnum scopi, Lissoclinum conchylium, Phallusia barbarica Cnemidocarpa floccosa, C.stolonifera, Polycarpa fungiformis, P. nota, P. ovata, Pyura confragosa*). Some not recorded north of Moreton Bay may very likely have temperate affinities (*Clavelina australis, Pseudodistoma inflatum, Aplidium directum, Dumus areniferus, Adagnesia opaca, Stolonica australis, Microcosmus propinquus, Pareugyrioides exigua*). *Trididemnum cerebriforme*, known from the central coast of Western Australia, the southern coast of the continent and north to Moreton Bay and also may have temperate affinities. Five species (*Aplidium incubatum, Leptoclinides longicollis, Polysyncraton flammeum, Perophora sabulosa* and *Molgula rima*) have been recorded only from the immediate vicinity of Moreton Bay.

Only seven species, *Leptoclinides placidus* (Noosa to northern NSW), *Eudistoma elongatum* (Hervey Bay to Port Jackson), *Synoicum prunum* (Cape Tribulation to NSW), *Ascidia decepta* (Townsville to South Australia), *Ascidia glabra* (Townsville to NSW), *Hartmeyeria formosa* (Torrres Strait to Bass Strait) and *Microcosmus stoloniferus* (Innisfail to South Australia) do not have a boundary at Moreton Bay and there is no indication of biogeographic affinity from the data presently available.

5. Southern Ocean Species. These form only a relatively small component, and include: *Agnesia glaciata* (reported from subantarctic locations, extending up the South American and Australian (to Double Island Point, SE Qld) continents, and *Pyura stolonifera* (which may be a Gondwanaland relict, having populations on the coasts of Africa, the south-eastern coast of Australia and in Peru, Ecuador and Chile); *Botryllus stewartensis* and *Dumus areniferus* (extending across the southern Australian coast); and *Sigillina cyanea* (reported from south eastern and western Australia) are known from New Zealand and appear to have a Trans-Tasman connection (Kott 2007a).

CONCLUSION

The semi-enclosed embayment that is Moreton Bay, appears to be a transition zone between the tropical and temperate species of the eastern coast of Australia. Thirty two species with tropical affinities and with the southern limits of their range at Moreton Bay dominate the fauna. The majority of these are large, solitary species. Another (albeit smaller but well-defined) group of 14 species are judged to be temperate, having the northern limits of their range in Moreton Bay. Seven species appear to be indigenous to the central eastern coast of Australia, and there are five species known only from Moreton Bay and its immediate vicinity. Other species recorded from the area have a wide pan-tropical, tropical Indo-West Pacific, western Pacific and circum-Australian range that include Moreton Bay and extend into temperate waters down the eastern and western coasts of Australia.

Relatively few colonial species are known from the area and these are most often similar thin sheet-like colony forms. The composition of the ascidian fauna may be the result of the lack of habitats favouring a colonial habit while large solitary phlebobranch and stolidobranch species are well adapted for the mud, shell and sand substrates that abound in the area.

Table 1. List of species of the Class Ascidiacea reported from Moreton Bay, Queensland. Each family heading includes a citation to a recent account of species-level taxa for that family (see also Kott 2005).

Species	Locality	Depth/Collecting method/ Substrate
	APLOUSOBRANCHIA	
Family Clavelinidae [see Kott 1990a]		
Clavelina australis (Herdman, 1899)	North Stradbroke I. (Amity Point 18.2 km W of Myora); Peel I.	to 9m dredge sides of rocky reef
Family Polycitoridae [see Kott 1990a, 1992b]		
Eudistoma elongatum (Herdman, 1886)	Gold Coast Seaway (piles outside Seaworld); North Stradbroke I. (Dunwich, intertidal flats, Amity Point, Myora); Myora Light (c. 2.4 km N); Moreton I.; Bribie I. (Pumice Stone Passage); Redland Bay (in landing strip area, c. 1.6 km offshore); Jacobs Well Jetty; Biggera Creek (1 km from mouth of creek. L.W.M.); Caloundra (Kings Beach)	intertidal trawl dredge mud flats with *Zostera* sp.; sea grass meadows; dolorite rock, behind ridge, deep ledge; boat jetty pile; rocky substrate
Eudistoma laysani (Sluiter, 1900)	North Stradbroke I. (Dunwich; Myora Banks); Caloundra (Moffat Beach)	3–30 m common under rocks
Family Holozoidae [see Kott 1990a]		
Sycozoa pulchra (Herdman, 1886)	Coochiemudlo I. (1.6 km NE.); 0.8–1.6 km S of Peel I. (Southwest Rocks); 2 km N of Hope Beacon; Redland Bay (between mainland & Garden I.)	2–10 m trawl, dredge mud through to sand and shell grit
Family Pseudistomidae [see Kott 1992a, 2007a]		
Pseudodistoma inflatum Kott, 1992a	Mooloolaba (Gneering Shoals)	
Sigillina cyanea (Herdman, 1899)	Moreton I. (Tangalooma wrecks)	

Species	Locality	Depth/Collecting method/ Substrate
Family Ritterellidae [see Kott 1992a]		
Dumus areniferus Brewin, 1952	North Stradbroke I. (Dunwich); Moreton I.	10 m dredge; rocky substrate
Ritterella dispar Kott, 1957	Moreton I.; Caloundra; Flinders Reef	
Family Polyclinidae [see Kott 1992a]		
Aplidium altarium (Sluiter, 1909)	North Stradbroke I . (Myora Banks)	
Aplidium directum Kott, 1972	North Stradbroke I. (Dunwich); Cape Moreton	6--140 m dredge; coral rubble
Aplidium incubatum Kott, 1992a	Cape Moreton, Point Lookout, Smith's Rock	intertidal to 10 m; coral rubble; crevices in rocky platforms
Aplidium sp.	North Stradbroke I. (Dunwich); Moreton I. (Smith's Reef)	15 m dredge
Polyclinum vasculosum Pizon, 1908	North Stradbroke I. (Myora Banks); Bribie I. (Pumicestone Passage)	Deep ledge, behind ridge
Synoicum macroglossum (Hartmeyer, 1919)	Gold Coast (Scottish Prince)	13 m wreck dive
Synoicum prunum (Herdman, 1899)	Bribie I. (Ocean Beach)	
Family Didemnidae [see Kott 2001]		
Didemnum jedanense Sluiter, 1909	Cowan Cowan Wrecks	1.8 m coral rubble
Didemnum membranaceum Sluiter, 1909	Moreton I.; Caloundra	5 m under ledge
Didemnum moseleyi (Herdman,1886)	Caloundra	1 m under buoy
Didemnum scopi Kott, 2001	Caloundra (Kings Beach)	intertidal rocky substrate
Didemnum sordidum Kott, 2001	Moreton I.	5 m under ledge
Diplosoma listerianum (Milne Edwards, 1841)	North Stradbroke I. (Myora Banks); Woody Point	on back of crab
Leptoclinides longicollis Kott, 2001	Moreton Bay	
Leptoclinides placidus Kott, 2001	Moreton I. (Smith Rock)	15 m
Leptoclinides rufus (Sluiter, 1909)	Caloundra (King's Beach)	intertidal rocky substrate
Lissoclinum bistratum (Sluiter, 1905)	off Moreton Island (Smith Rock); Flinders Reef	15 m coral reef
Lissoclinum conchylium Kott, 2001	Moreton I.	6 m under rock
Polysyncraton flammeum Kott, 2001	Caloundra (King's Beach)	
Polysyncraton meandratum Monniot, 1993	Caloundra (King's Beach)	intertidal rocky substrate

Species	Locality	Depth/Collecting method/ Substrate
Trididemnum nobile Kott, 2001	N Stradbroke I. (W of Myora, coral bay); Caloundra (King's Beach)	13–15 m, intertidal reef, rocky substrate
Trididemnum savignyi (Herdman, 1886)	Moreton I. (Smith's Rock)	15 m reef
PHLEBOBRANCHIA		
Family Agneziidae [see Kott 1985]		
Adagnesia opaca Kott, 1963	Toorbul Point (0.8 SE Red Beacon); Peel I. (Southwest Rocks); Rous Channel	5–10 m sand, shell, grit
Agnezia glaciata (Michaelsen, 1898)	North Stradbroke I. (Dunwich); Peel I. (Southwest Rocks)	2–17 m sand and mud
Family Ascidiidae [see Kott 1985, 2003]		
Ascidia decepta Kott, 1985	North Stradbroke I. (Dunwich); Biggera Ck (1 km from mouth of creek); Cleveland Point; Redcliffe (Woody Point)	intertidal
Ascidia empheres Sluiter, 1895	North Stradbroke I. (Dunwich): Victoria Point	
Ascidia glabra Hartmeyer, 1922	North Stradbroke I. (Myora Banks); Peel I.	
Ascidia latesiphonica Hartmeyer, 1922	Moreton I (The Wrecks); Victoria Point	10 m
Ascidia scaevola (Sluiter, 1904)	Peel I; 08- 1.6 km S of Peel I. (Southwest Rocks); 2.4 km SE St Helena; Green I. (S beacon on N tip); W of Hope Banks; Cleveland (N pt of Green I. on Nazereth House	2–9 m grab, dredge sand, shell, grit, mud, sandy mud
Ascidia sydneyensis Stimpson, 1885	North Stradbroke I. (Dunwich, Myora Banks); Peel I. (between two beacons, Southwest Rocks); 0.8- 1.6 km S of Peel I. (Southwest Rocks); St. Helena I. (2.4 km E); Wellington Point (3.2 km E); Redcliffe: Otter Rock (1.6 km E)	intertidal, 2–8 m trawl, grab, dredge various mixtures of sand, shell, grit, mud; coral; mud flats with *Zostera* sp.
Phallusia arabica Savigny, 1816	North Stradbroke I. (Dunwich)	intertidal
Phallusia barbarica Kott, 1985	Cleveland Point	rocks and mud
Phallusia julinea Sluiter, 1915	North Stradbroke I. (Myora Banks, Dunwich); Moreton I. (Cowan Cowan)	to 20 m
Phallusia obesa (Herdman, 1880)	Moreton I. (Cowan Cowan Wrecks)	20 m
Family Perophoridae [Kott 1985, 1990b, 1992b]		
Perophora multiclathrata (Sluiter, 1904)	Redcliffe (Woody Point)	
Perophora sabulosa Kott, 1990	North Stradbroke I. (Pt Lookout, Dunwich); Peel I.	intertidal, 6 m dredge, rock crevices
Family Plurellidae [Kott 1985, 1990b]		
Microgastra granosa (Sluiter, 1904)	North Stradbroke I. (Dunwich); Peel I.	dredge
STOLIDOBRANCHIA		
Family Styelidae (Styelinae) [Kott 1985, 1992b, 2003]		
Cnemidocarpa areolata (Heller, 1878)	off Moreton I. (Smiths Rock); Caloundra (Shelly Beach)	15 m muddy sand

Species	Locality	Depth/Collecting method/ Substrate
Cnemidocarpa floccosa (Sluiter, 1904)	0.8–1.6 km S of Peel I. (Southwest Rocks); Bramble Bay (5 km NE Cabbage tree); Brisbane River mouth	2–9 m
Cnemidocarpa lobata (Kott, 1952)	Gold Coast (wreck of Scottish Prince)	13 m wreck dive
Cnemidocarpa pedata (Herdman, 1881)	Trawled with *Pyura spinifera*	trawl
Cnemidocarpa stolonifera (Herdman, 1899)	North Stradbroke I. (Rainbow Channel, Dunwich, Amity Point, Myora Light); 0.8-1.6 km S of Peel I. (Southwest Rocks); Peel I.; Moreton I. (Smith Rock, Cowan Cowan wreck); off Moreton Island; St Helena I. (S); Redcliffe Jetty (1.6 km SE); Redcliffe Water Tower (E, 1.6 km offshore; southern Moreton Bay (W side)	4-15 m trawl, dredge, grab mud, shell, grit, sandy mud; sand slope out from boat ramp, mud flats, fringing reef; *Acropora* reef
Polycarpa argentata (Sluiter, 1890)	Moreton I. (Smith Rock)	15 m
Polycarpa aurita (Sluiter. 1890)	North Stradbroke I. (Dunwich); 0.8-1.6 km S of Peel I. (Southwest Rocks); Raby Bay	intertidal to 9 m; grab sand, shell grit, shelly sand, sandy mud
Polycarpa chinensis (Tokioka, 1967)	Moreton I. (Tangalooma, 8 km W, nr M3 beacon; S edge Dring Banks; 0.8–1.6 km S of Peel I. (Southwest Rocks); 6.4 km off North Stradbroke I.; W of Hope Banks,Scarborough (8.7 km E of Reef Pt; 12.8 km E); Scarborough	7–12 m on rising shallowing banks grab. trawl, dredge mud, sand, shell, grit;
Polycarpa fungiformis Herdman,1899	North Stradbroke I. (Dunwich); Southern Moreton Bay, W side); 0.8-1.6 km S of Peel I. (Southwest Rocks)	5–8 m grab, trawl, dredge muddy, gritty mud, sand, shell grit
Polycarpa nota Kott, 1985	North Stradbroke I. (Myora Banks)	
Polycarpa obscura Heller, 1878	Moreton I. (Cowan Cowan wrecks)	20 m
Polycarpa ovata Pizon, 1908	Myora Light (45.7 m W); Mud I.; Peel I.; Redcliffe Water Tower (1.6 km E)	intertidal–10 m; dredge, grab mud to sand and shell grit
Polycarpa papillata (Sluiter, 1885)	Gold Coast (Scottish Prince, Bait Reef); N. Stradbroke I. (Myora Light, Dunwich); Peel I.; Hope Banks (1.6 km E); Moreton I. (Cowan Cowan); 2.1 km SW Wellington Point (3.2 km E); St Helena I. (0.8 km E and S beacon off Green I. 2.4 km E); Mud I. Redcliffe Jetty (1.6 km SE); Flinders Reef; Hutchison Shoals	10–20 m trawl, dredge, SCUBA amongst reef corals, sponges, mussels, sand to mud and shell-grit substrates; sides of rocky reef, *Acropora* reef
Polycarpa pedunculata Heller, 1878	Moreton I. (Cowan Cowan); Scarborough (183 m off blinker)	3–20 m dredge, wreck dives
Polycarpa procera (Sluiter, 1885)	Moreton I.	sides of rocky reef
Styela canopus (Savigny, 1816)	North Stradbroke I. (Dunwich); Peel I. east (Hanlon Light); Pearl Channel (6.4 km NE of Pearl Channel buoy); Wellington Point)	3-7m dredge gritty sand with mud
Styela plicata (Lesueur, 1823)	Peel I. (Southwest Rocks); Manly Boat Harbour; Wellington Point; Biggera Ck (1 km from mouth of creek on large boulders)	3–7 m intertidal grab sand, shell, grit; sandy mud;

Species	Locality	Depth/Collecting method/ Substrate
Family Styelidae (Polyzoinae) [Kott 1985, 1990b, 1992b]		
Ensynstycla latericius (Sluiter, 1904)	Moreton I.; Biggera Creek (1 km from mouth of creek)	under rock
Polyandrocarpa colemani Kott, 1992	Gold Coast (Scottish Prince)	13 m wreck dive
Stolonica australis Michaelsen, 1927	North Stradbroke I. (Dunwich); Peel I.	dredge
Symplegma brakenhielmi (Michaelsen, 1904)	North Stradbroke I. (Dunwich, Myora Banks); Moreton I. (Cowan Cowan); Cleveland Point (3.2 km NNE); Hutchinson Shoals	20 m under rock, on wreck, mud flats with *Zostera*, gritty mud
Metandrocarpa miniscula Kott, 1985	North Stradbroke I. (Point Lookout)	sand-adapted in crevices and epibiotic; intertidal
Family Styelidae (Botryllinae) [Kott 1985, 1990b, 1992b]		
Botrylloides leachii (Savigny, 1816)	Pearl Channel (6.4 km NE of Pearl I.)	1.9 m; grab, wreck dive; sand, shell, grit, gritty mud, intertidal pools in mud flats
Botrylloides perspicuum Herdman, 1886	Moreton I. (The Pines); Coffee Rock	14 m sides of rocky reef
Botrylloides violaceus Oka, 1927	Gold Coast (Scottish Prince); Moreton I.	13 m; on wreck; mud flats, sandy mud and fringing reef
Botryllus schlosseri (Pallas, 1766)	North Stradbroke I. (Myora Light, Myora Banks); Peel I (S)	dredge
Botryllus stewartensis Brewin, 1858	North Stradbroke I. (Point Lookout)	intertidal to 10 m coral rubble, low tide crevices
Botryllus tuberatus Ritter & Forsyth, 1917	North Stradbroke I. (Myora Banks)	
Family Pyuridae [Kott 1985, 1990b, 2002]		
Hartmeyeria formosa Herdman, 1881	Peel I. (Southwest Rocks); Bramble Bay (5 km NE Cabbage Tree); Hope Banks (3.2 km W)	5–12 m; grab, dredge sand, shell grit, mud, sandy mud, muddy sand
Herdmania grandis (Heller, 1878)	North Stradbroke I. (6.4 km off); Moreton I. (Smith Rock); Cleveland Light; halfway between Cleveland and Peel I. jetties; Redcliffe Water Tower (1.6 km offshore)	5–15 m trawl muddy grit, gritty sandy mud, shelly, mud and shell
Herdmania momus (Savigny, 1816)	Flinders Reef	5.4–9 m gritty mud, coral reef
Microcosmus australis Herdman, 1899	North Stradbroke I. (Myora Banks); Moreton I. ('The Wrecks'); 0.8 km south of Peel I. (Southwest Rocks); Scarborough to Bribie I.; Otter Rock (1.6 km E); Biggera Ck (1 km from mouth of ck, on large boulders); Bramble Bay (5 km NE Cabbage Tree)	1.8–8.3 m; low tide dredge, grab mud with shell; shell, grit; shelly; gritty mud, clean and hard sand
Microcosmus exasperatus Heller, 1878	North Stradbroke I. (Dunwich, Myora Banks); Southwest Rocks, 0.8 km S of Peel I.; Peel I.; Brisbane River mouth; Cleveland (Raby Bay)	6.5 m; grab, dredge; mud flats and rubble with hard and soft corals; mud flats and *Zostera*
Microcosmus madagascariensis Michaelsen, 1918	Moreton Bay	6 m dredged
Microcosmus propinquus Herdman, 1881	1.6 km S of Peel I. (Southwest Rocks)	5.4 m grab; sandy mud

Species	Locality	Depth/Collecting method/ Substrate
Microcosmus squamiger Michaelsen, 1927	North Stradbroke I. (Dunwich, Myora Banks); 0.8 km S of Peel I. (Southwest Rocks); Brisbane River mouth; Biggera Ck (1 km from mouth of ck on large boulders); Cleveland Point; Redcliffe Peninsula (Woody Point)	intertidal, 7.6 m grab, dredge sand, shell, grit; on rocky shore; from Mussel clumps, under rocks LWM
Microcosmus stoloniferus Kott, 1952	Peel I.; 0.8–1.6 km S of Peel I. (Southwest Rocks)	5..4–7.9 m; grab, dredge; mud to sand, shell and grit
Pyura confragosa Kott, 1985	off Moreton I. (Smith Rock)	15 m rocky reef
Pyura elongata Tokioka, 1952	North Stradbroke I. (Dunwich); Peel I.; Cleveland Point, Wellington Point Jetty	intertidal dredge; on rocks
Pyura gangelion (Savigny,1816)	Moreton I. (Tangalooma); Peel I. (S end between 2 beacons; W end: 1.6 km S Southwest Rocks); Peel I. (S of Myora Banks)	2.1–5.4 m dredge, grab; muddy grit, shell grit sandy mud, wrecks
Pyura navicula Kott, 1985	Moreton I. (Cowan Cowan)	20 m
Pyura sacciformis (Drasche, 1884)	Moreton I. (Cowan Cowan Wrecks)	18 m encrusting epifauna off wreck
Pyura stolonifera (Heller, 1878)	Gold Coast Seaway; North Stradbroke I. (Amity Point); Moreton I. (Cowan Cowan, Smith Rock); Caloundra (Shelly Beach)	1–20 m on piles, rock wall
Family Molgulidae [Kott 1985]		
Eugyra molguloides Sluiter, 1904	Peel I.; 0.8–1.6 km S of Peel I. (Southwest Rocks); Bramble Bay (5 km NE Cabbage Tree)	3.5–8 m dredge, grab sandy mud; gritty mud
Molgula diversa Kott, 1972	1.6 km S of Peel I. (Southwest Rocks)	6–10 m sand, shell, grit, sandy mud;
Molgula ficus (Macdonald, 1859)	North Stradbroke I. (Dunwich); Redland Bay (landing strip area); Sandgate Jetty; Naval Reserve (4.8 km N); Bramble Bay (5 km NE Cabbage Tree); Brisbane River mouth; Biggera Creek (1 km from mouth of creek); Scarborough (8.7 km E of Reef Point); Cleveland Point; Woody Point	LWM to 10 m grab, dredge, trawl sand, shell, mud, grit, gritty mud, sandy mud
Molgula manhattensis (de Kay, 1843)	Brisbane River (Mobray Park, mouth of Norman Creek, Bulimba Corner, City Reach)	mid-channel
Molgula mollis Herdman, 1899	Brisbane River mouth	
Molgula rima Kott, 1972	Peel I. (Southwest Rocks)	6–10 m; grab, dredge sand to mud, and shell grit
Molgula sphaera Kott, 1972	Peel I. (Southwest Rocks)	3–7 m; grab sand to mud, and shell grit
Pareugyrioides exigua (Kott, 1972)	1.6 km S of Peel I. (Southwest Rocks)	6–10 m sand, sandy mud, shell, grit

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The 2005 Workshop provided the opportunity to review the state of knowledge of a number of groups in Moreton Bay and I thank the convenors of that meeting, and especially Peter Davie, for the invitation to contribute the present short review and checklist, to the workshop proceedings. It is the first such review for these benthic, filter-feeding organisms in this important biogeographic region where they are so conspicuous.

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Fishes of the Moreton Bay Marine Park and adjacent continental shelf waters, Queensland, Australia

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ABSTRACT

The fish fauna of Moreton Bay Marine Park and adjacent continental shelf waters up to 200 m depth is shown to comprise at least 1,190 species. Fishes were mainly identified from specimens collected and lodged in the Queensland Museum, but records were also compiled from underwater photographs and visual surveys. Species are separately listed for five locally significant areas in the region: coastal Moreton Bay, Flinders Reef, Flat Rock, Southport Seaway, and offshore in 40–200 m depth. Overall abundance levels are provided for each species, and species at the known northern or southern limit of their continental eastern Australian distribution are indicated. Almost one-third of the fauna reaches the extremity of its known latitudinal range in the area, with 64 species (5.4%) at their northern range limit and 310 (26.1%) at their southern range limit. Three new Australian records, four new records for the east coast of Australia, and three undescribed species known only from the area are listed. Additional information is given on some rare and limital species, and species of uncertain taxonomy. ❑ Moreton Bay, Queensland, Flinders Reef, Flat Rock, Southport, fish, checklist, distribution, biogeography

The Moreton Bay Marine Park (MBMP) was first declared in 1993, in recognition of the significance of its biodiversity and the social, cultural, environmental, fisheries and conservation value of the area. The park covers almost 350,000 hectares and stretches about 125 km along the mainland between Caloundra and Southport. The offshore boundary is generally about three nautical miles east of Moreton and Stradbroke Islands. The fish fauna of the area has long been exploited by commercial and recreational fishers, and until recently efforts to document species diversity were mainly directed at these elements of the fauna and its bycatch. Johnson (1999) produced an annotated checklist of fishes from the coastal area inside Moreton and Stradbroke Islands, however information on fishes of the portion of the marine park outside the sheltered waters of Moreton Bay remained sparse. This paper is intended to provide a detailed inventory of fishes from the entire MBMP and adjacent continental shelf waters recorded to date, and to indicate separately the composition of fish communities at five locally significant areas within the region.

COASTAL MORETON BAY

Coastal Moreton Bay is modified from the area of Moreton Bay treated by Johnson (1999), mainly to include the area of the MBMP from Comboyuro Point north to Cape Moreton and west to Caloundra Head, including Pumicestone Passage (Fig. 1). The new area at the north mostly includes broad expanses of fine sandy substrates in depths up to 28 m, however Caloundra Head is a prominent rocky headland with a rock platform that is exposed to ocean swells and significant wave action. Southport Seaway is here excluded from the area defined as coastal Moreton Bay, as its fauna is listed separately in this study. Coastal Moreton Bay has a few limited holes and channels with maximum depths of up to about 30 m, but predominantly comprises depths of less than 20 m. Habitat descriptions

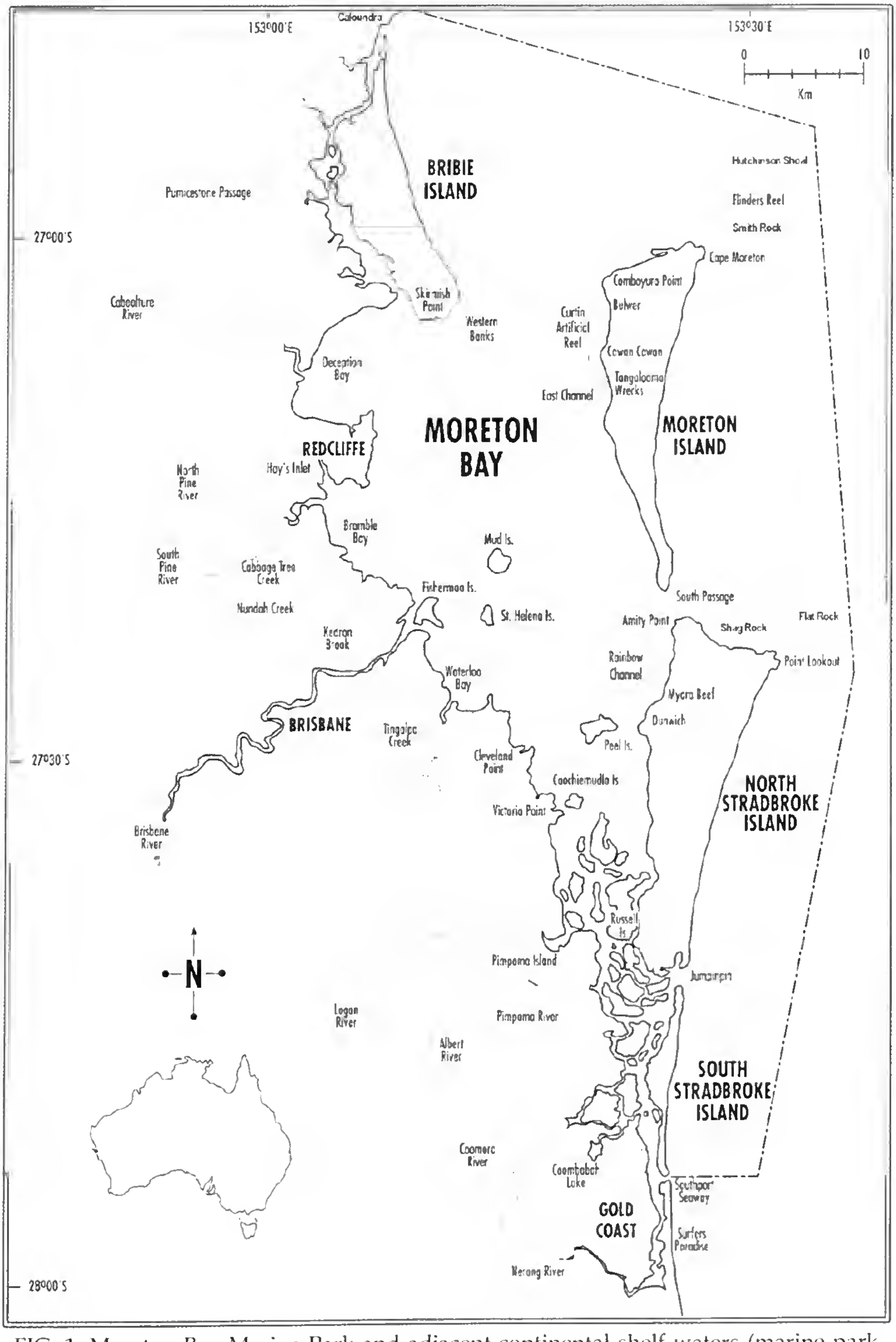

FIG. 1. Moreton Bay Marine Park and adjacent continental shelf waters (marine park boundary is delineated by the broken line; shaded area is defined as coastal Moreton Bay; 200 m depth contour approximately follows the right hand border of the map).

and other background information on Moreton Bay were detailed in Johnson (1999).

FLINDERS REEF

Flinders Reef and the adjacent reefs off Cape Moreton, including Hutchinson Shoal and Smith Rock (Figs 1, 2), were surveyed to a depth of 30 m. These reefs are largely composed of rocky outcrops, the most significant of which is partially exposed at all stages of the tide. The more sheltered north-western side of Flinders Reef, in depths of about 5–12 m, has well established coral communities that support many fish species infrequently found in other areas of the MBMP. The northern end has numerous large boulders, caves, underhangs and fissures between large rocky plates. Hutchinson Shoal has a small pinnacle rising to a depth of 6 m, but consists most notably of a north–south aligned ridge with variously inclined sides that fall away steeply to about 35 m. There are some vertical walls, overhangs, and large caves near the foot of the reef, some of which contain large growths of gorgonians. A wide variety of pelagic fishes congregate around these features. Smith Rock is similar to the south-eastern end of Flinders Reef. Both have undulating shallow rocky bottom and are heavily exposed to ocean swells and current.

FLAT ROCK

Flat Rock and adjacent reefs, including Shag Rock, Boat Rock, Middle Reef and Manta Ray Bommie, as well as the rocky headlands of Point Lookout (Figs 1, 3A–C) were surveyed to depths of 30 m. Most reefs in this area (Flat, Boat and Shag) are partially exposed at all stages of the tide. There are some stands of hard corals throughout the area, especially on the

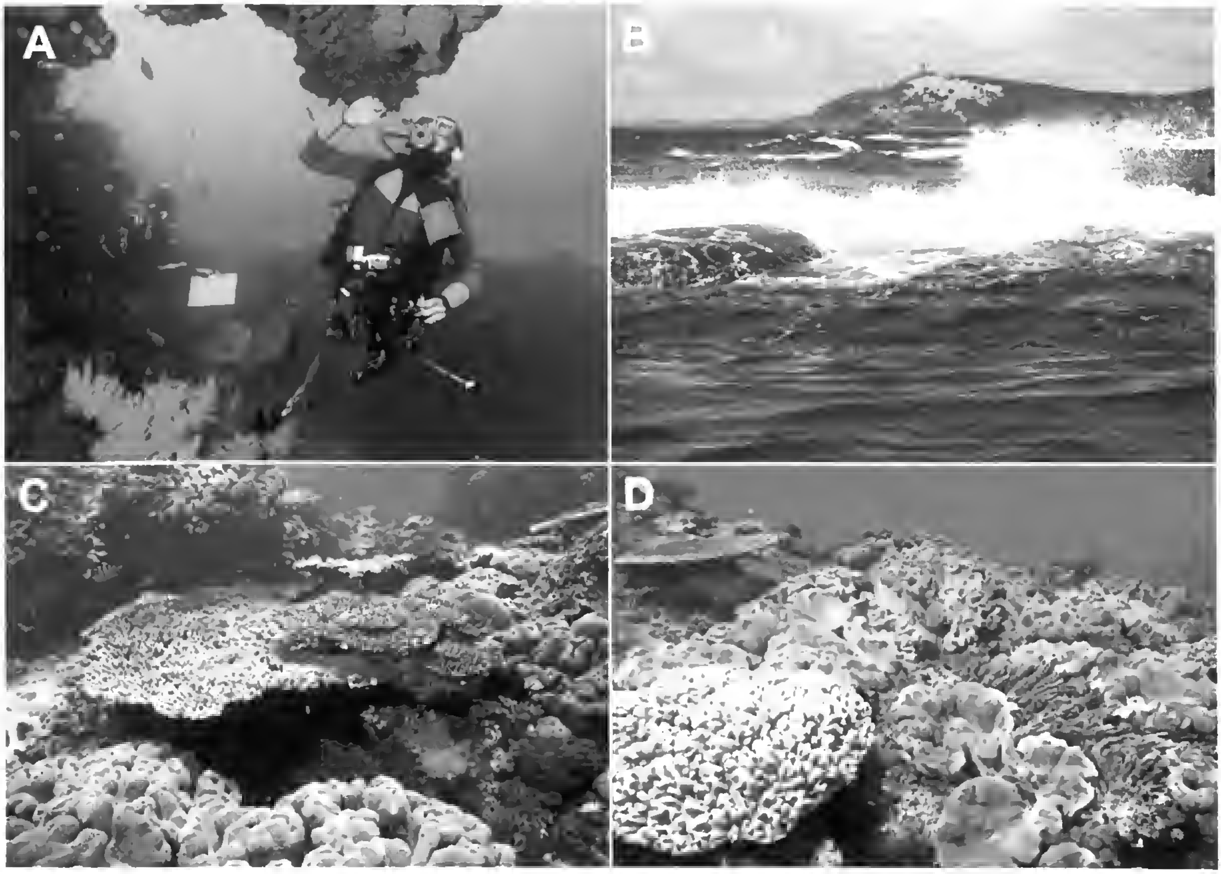

FIG. 2. A. Photographing and visually recording fishes at the base of Hutchinson Shoal at a depth of 28 m. **B.** Crest of Flinders Reef, showing tidal rock pools, with Cape Moreton in the background. **C.** Hard and soft corals among rock ledges at the northwest edge of Flinders Reef. **D.** Soft coral and red algae at the northern end of Flinders Reef. Photos: A, C, D by I. Banks; B by J. Wright.

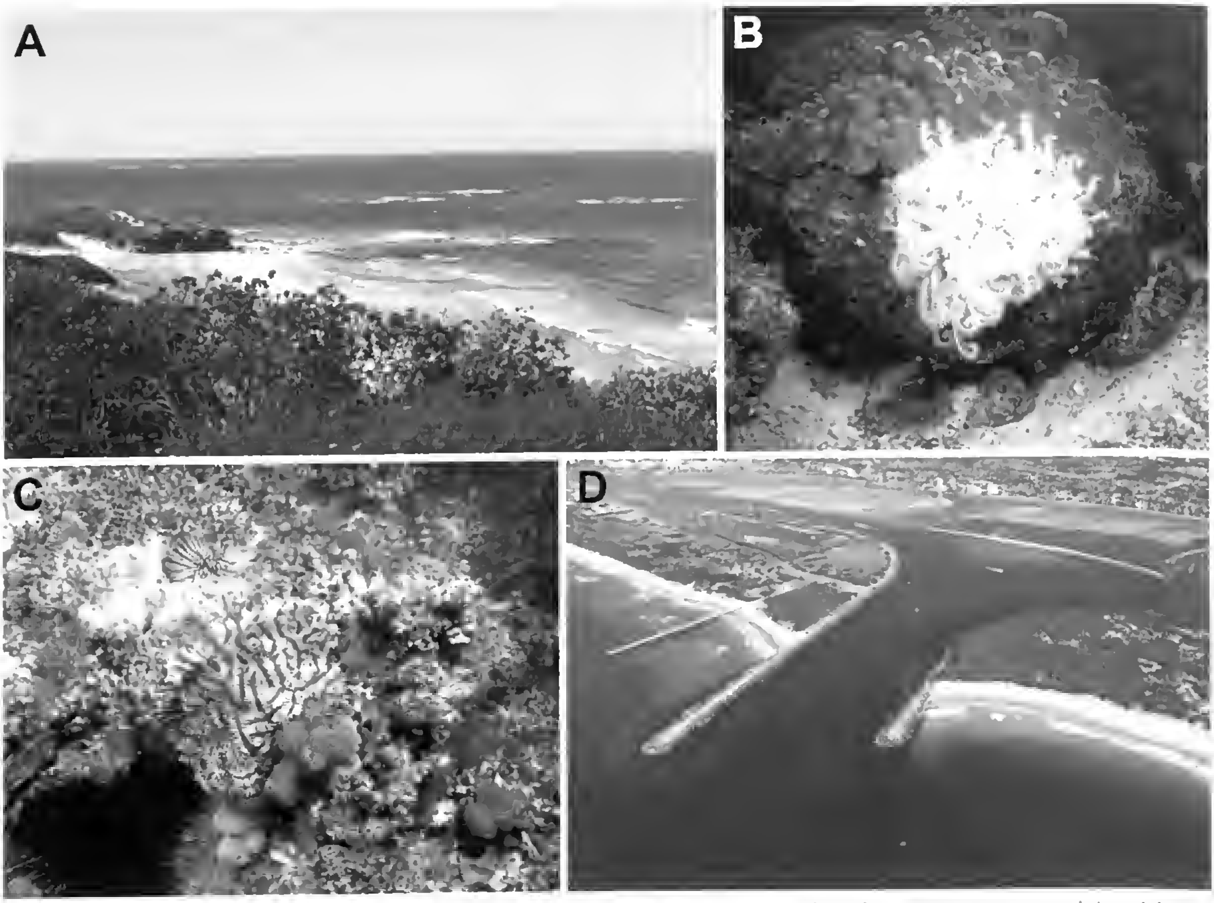

FIG. 3. **A.** View north from headland near Point Lookout, over exposed rocky outcrops comprising Manta Ray Bommie, with Flat Rock further out to sea in the centre left. **B.** Large boulders with hard coral and crinoids, off the southeast end of Flat Rock. **C.** Reef encrusted with various crinoids, soft corals and algae near the southern end of Flat Rock. **D.** Aerial view of Southport Seaway, with Wavebreak Island in the right hand background. Photos: A by C. Wallace; B–D by I. Banks.

leeward side of Flat Rock, but the predominant habitat consists of large rock formations with some soft corals and a profusion of hydroids and other encrusting invertebrate and algal growth. Flat Rock features a series of steep gutters, a gradual dropoff, and several stepped rocky platforms. It is exposed to heavy surf and strong currents depending on wind, swell and tidal conditions. Boat Rock is most notable for its vertical rock faces that extend from the seafloor in about 27 m to just above the surface. Manta Ray Bommie has a number of large isolated rocky outcrops in a sandy channel subject to moderate to strong currents. Shag Rock is a large rocky outcrop partially split by a narrow wedge-shaped channel. It is largely sheltered from the prevailing south-east winds and swell that affect other reefs in the area. Crinoids are particularly common around Shag Rock. The various rocky headlands of Point Lookout are proximal to the offshore reefs, especially to Manta Ray Bommie. Also surveyed for this area were rock pools at the bottom of the tidal plane and non-enclosed rock faces at the foot of several of the headlands of Point Lookout.

SOUTHPORT SEAWAY

The Southport Seaway was surveyed between the eastern entrance and the eastern side of Wavebreak Island (Figs 1, 3D). This area mainly consists of current swept clean sandy substrate to a maximum depth of 20 m, bordered by steep rock walls constructed of large boulders. There are some relatively sparse seagrass beds in the western portion. The area also features several extensive submerged pipelines (Fig. 8B) which consistently attract large aggregations of fishes. While much of the habit in the seaway is comprised of man-made structures, the area was included separately as a site for this study as it supports very significant fish communities, elements of which are rarely found elsewhere in the region, e.g. aggregations of Whitespotted Guitarfish (*Rhynchobatus laevis*), whiprays (Himantura *fai* and *H. uarnak*), ghost pipefishes (*Solenostomus cyanopterus* and *S. paradoxus*) pipefish (*Stigmatophora nigra* and *Trachyrhamphus bicoarctatus*), Highcrown Seahorse *(Hippocampus procerus)* and Queensland Groper (*Epinephelus lanceolatus*).

OFFSHORE WATERS

Offshore waters are categorised here as the open sea to the east of Caloundra and the major Moreton Bay Islands, in depths of 40–200 m (Fig. 1). While this area mostly consists of sandy or silty bottom able to be sampled by demersal trawls, there are also significant areas of low relief rocky reef and shoals composed of rubble and shell. Some of these reefs and shoals are known to support well developed stands of gorgonians, bryzoans and macroalgae, including kelp, *Ecklonia radiata*, in some very limited areas. The reefal zones are scattered, but variously occur throughout this depth range. The soft bottom areas are trawled for the Eastern King Prawn (*Penaeus plebejus*) fishery, while the reefal areas are subject to commercial and recreational line fisheries, especially for Snapper (*Pagrus auratus*) and Pearl Perch (*Glaucosoma scapulare*).

MATERIALS AND METHODS

The fishes listed are those recorded from Caloundra Head (26°48'S), east to the 200 m depth contour, and south to the Southport Seaway (27°57'S) (Fig. 1). This region encompasses the Moreton Bay Marine Park (MBMP), but is expanded slightly in that it extends due east from Caloundra Head (rather than obliquely southeast), extends to the south bank of the Southport Seaway (instead of the north bank) and uses the 200 m depth contour as the eastern boundary (instead of a line variably approximating three nautical miles east of Moreton and Stradbroke Islands). Maximum depth within the MBMP is about 110 m in a limited area northeast of Cape Moreton. The 200 m depth contour was substituted as the eastern boundary for this study to produce greater consistency of results, and due to difficulties in directing and effectively limiting appropriate sampling efforts to within the MBMP boundary. The diversity of fishes from depths in excess of 40 m was largely determined by trawling carried out by third parties whose objectives were to determine catch composition in a broader area than that of the MBMP. Consequently, there was limited opportunity to collect detailed information in deeper areas of the MBMP, and restricting this study to that area was deemed impractical. Information gathered using a fixed maximum depth determinant coinciding with the edge of the continental shelf was also considered to be more biogeographically informative than data determined by an arbitrary distance-from-shore limitation, as the latter encompassed a wide variation of maximum depths from north to south. Despite the difference in depth profiles between the study area and the actual MBMP, it is envisaged that the fishes listed here are also an accurate representation of those likely to be found in the MBMP. The results of trawling throughout this area (Qld Dept. of Primary Industries & Fisheries, unpublished data; this study) indicate most species that were sampled in depths of 110–200 m also occurred at least as stragglers in depths of 40–110 m.

The basis of all records is individually identified. Where species were recorded by multiple means, it is indicated only once and according to the following order of priority: voucher specimen (S), photograph (P), visual (V), or literature (L). Most records are based on specimens held in the collection of the Queensland Museum, however several are from specimens in the Australian Museum (Sydney), or the Australian National Fish Collection (CSIRO Marine Research, Hobart). Methods of sampling, acquiring specimens and validating museum specimens were similar to that outlined in Johnson (1999). Demersal trawl samples from the 40–200 m depth range were obtained from both commercial catches and research trawls, but most were sourced from Qld Dept. of Primary Industries and Fisheries Eastern King Prawn, Bycatch Reduction and Long Term Monitoring Program surveys from 2001–2010. Photographs of trawled specimens were also accessed from fisheries surveys in the area, and in many cases the photographed specimen was also lodged at QM. Handlining with baited hooks and multi-hooked jigs of various sizes was used to sample pelagic fishes in open water and demersal fishes on reef habitats in depths of 40–120 m. Larval fishes were not sampled as part of this study and do not form the basis of any of the records. Collectors of species that constitute additional records to this list are encouraged to lodge voucher specimens in the collection of the Queensland Museum.

In the coastal and reef areas up to depths of 30 m (areas 1–4, Table 1) numerous scuba dives were undertaken for underwater visual surveys, photography, and collection by hand net, spear and ichthyocide. For underwater visual surveys, fish species were identified and recorded solely by the author, using visual census techniques modified from Hutchins (2001). Sheets of waterproof paper printed with pre-prepared lists of the most common fish species known from the area were mounted on a clipboard. Swimming transects of approximately 45 minutes were conducted throughout various prospective habitats at each dive site, all species were recorded, and their abundance noted. Numbers and additional species were updated during the dive as additional fishes were observed. On many dives a second diver photographed as many species as possible along the same transect (Fig. 2A) and these images were later identified in the laboratory and used to help confirm species identifications and abundance levels. Many additional underwater photographs, taken by Ian Banks (*Diving the Gold Coast*), were also used to validate records. These images were all supplied with detailed date and locality descriptions. Footage from baited underwater video taken near Flinders Reef, Henderson Rock and Flat Rock during 2008–09 by CSIRO Marine Research was examined by the author. This provided further confirmation of a number of species previously classified in this study as rare, however only one species was recorded solely by this method.

Relative abundance presented in the table of results was based on a combination of indicators, including numbers of specimen lots in the QM collection, frequency a species was collected or observed in the field by the author, frequency a species was recorded in trawl samples, and number of times a species was photographed underwater. It is presented according to the following criteria: rare – 1 to 4 records; uncommon – 5 to 10 records; common – 11 to 100 records; and abundant – more than 100 records. In general, an observation of a shoal of schooling fish was regarded as a single rather than multiple record of the species, so as to avoid overstating the abundance of species based on one-off sightings of shoals.

The Australian distribution of species in the list was generally sourced from Hoese *et al.* (2006), except where more recent revisions were available, or where validated QM records indicated a more expansive range. Where species recorded herein are at the northern or southern limit of their known range throughout the continental east coast of Australia, they are indicated in the range column of Table 1 as 'North' or 'South' respectively. Species known from Western Australia, but not previously recorded from the east coast are indicated by 'East'. New records for Australia are indicated by 'NAR'. Where no indication of range is given, MBMP falls wholly within the broader known range of the species. In the notes column, symbols indicate whether photographs of species taken in the MBMP are reproduced as figures, or other information is provided in endnotes (eg museum registration numbers for species regarded as rare, undescribed or indeterminate, and for specimens representing extensions of previously known range).

The checklist follows the classification of Hoese *et al.* (2006).

RESULTS

The fish fauna of five areas of the MBMP and adjacent continental shelf waters up to 200 m depth (Fig. 1) is listed in Table 1. A total of 1,190 species is recorded, mainly from specimens collected. Of the 167 species where no voucher specimen is held, 122 are recorded primarily from photographs identified by the author, 39 are from the author's underwater visual observations, and six are based solely on reports in the literature that were deemed reliable (references for the latter are provided in the endnotes). 753 species are recorded from coastal

Moreton Bay, 477 from Flinders Reef area, 420 from Flat Rock area, 404 from Southport Seaway, and 297 from the offshore zone in 40–200 m depth. Almost a third of the fauna reaches the extremity of its latitudinal range in the area. Sixty-four species (5.4%) are at their northern range limit and 310 (26.1%) are at their southern range limit in MBMP. There are three new Australian records and four new records for the east coast of Australia.

Table 1. Fishes of the Moreton Bay Marine Park. Abbreviations: **1** = coastal Moreton Bay; **2** = Flinders Reef and adjacent reefs off Cape Moreton; **3** = Flat Rock, adjacent reefs and rocky headlands off Point Lookout; **4** = Southport Seaway; **5** = Offshore (40–200 m depth). Abund. = abundance; S = voucher specimen/s in QM; P = photograph; P in 'Note' column indicates a photograph reproduced in Figs 4–9); V = visual record; L = literature record. Abundance: A = abundant, C = common, U = uncommon, R = rare. 'North' or 'South' in the Range column indicates a species is at the northern or southern limit of their known range along eastern Australia. Species known from Western Australia, but not previously recorded from the east coast are indicated by 'East'. New records for Australia are indicated by 'NAR'. Numbers in 'Notes' column refer to endnotes following the table.

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Chimaeridae								
Hydrolagus lemures (Whitley, 1939)					S	C		
Hydrolagus marmoratus Didier, 2008					S	U		1
Heterodontidae								
Heterodontus galeatus (Günther, 1870)					S	U	North	2
Odontaspididae								
Carcharias taurus Rafinesque, 1810	S	P	P			U		
Alopiidae								
Alopias vulpinus (Bonnaterre, 1788)	L				L	R		3
Lamnidae								
Carcharodon carcharias (Linnaeus, 1758)	S		P		V	U		
Isurus oxyrinchus Rafinesque, 1810	S		P			U		
Isurus paucus Guitart Manday, 1966			P			R	North	4
Scyliorhinidae								
Asymbolus analis (Ogilby, 1885)					S	U		5
Asymbolus rubriginosus Last, Gomon & Gledhill, 1999					S	U	North	
Figaro boardmani (Whitley, 1928)					S	U	North	6
Triakidae								
Mustelus walkeri White & Last, 2008	S				S	C	South	7
Hemigaleidae								
Hemigaleus australiensis White, Last & Compagno, 2005	S				P	C		8
Hemipristis elongata (Klunzinger, 1871)	S					R	South	9
Carcharhinidae								
Carcharhinus amboinensis (Müller & Henle, 1839)	S					C	South	10
Carcharhinus brachyurus (Günther, 1870)	S					R	North	11
Carcharhinus brevipinna (Müller & Henle, 1839)	S			S		C		
Carcharhinus cautus (Whitley, 1945)	S					U		
Carcharhinus leucas (Valenciennes, 1839)	S			P		C		
Carcharhinus limbatus (Valenciennes, 1839)	S					C		
Carcharhinus obscurus (Lesueur, 1818)	S	V				C		
Carcharhinus plumbeus (Nardo, 1827)	S			P		C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Carcharhinus sorrah (Valenciennes, 1839)	S					A	South	12
Galeocerdo cuvier (Pèron & Lesueur, 1822)	S	V	V			C		
Loxodon macrorhinus Müller & Henle, 1839	S					R	South	13
Negaprion acutidens (Rüppell, 1837)	S			S		U	South	
Rhizoprionodon acutus (Rüppell, 1837)	S					C	South	14
Rhizoprionodon taylori (Ogilby, 1915)	S					U	South	15
Triaenodon obesus (Rüppell, 1837)			V			R	South	16
Sphyrnidae								
Sphyrna lewini (Griffith & Smith, 1834)	S	S			S	C		
Sphyrna mokarran (Rüppell, 1837)	P					U		
Parascylliidae								
Parascyllium collare Ramsay & Ogilby, 1888					S	U	North	
Brachaeluridae								
Brachaelurus colcloughi Ogilby, 1908	S				P	U		
Brachaelurus waddi Bloch & Schneider, 1801	S		S			U		
Orectolobidae								
Orectolobus halei Whitley, 1940		P	V	S		U	North	
Orectolobus maculatus (Bonnaterre, 1788)	S	V	P	S	S	C		
Orectolobus ornatus (De Vis, 1883)	S	S	V	S		C		
Hemiscylliidae								
Chiloscyllium punctatum Müller & Henle, 1838	S	V	V	P		A		
Stegostomatidae								
Stegostoma fasciatum (Hermann, 1783)	S	V	V	P		C		
Rhincodontidae								
Rhincodon typus (Smith, 1828)			P		P	R		
Hexanchidae								
Hexanchus nakamurai Teng, 1962					S	R		
Squalidae								
Squalus grahami White, Last & Stevens, 2007					S	C		
Squalus megalops (Macleay, 1881)					S	C		
Squatinidae								
Squatina albipunctata Last & White, 2008					S	U		
Torpedinidae								
Hypnos monopterygium (Shaw & Nodder, 1795)	S	P			S	C		
Pristidae								
Pristis zijsron Bleeker, 1851	S					R		17
Rhinidae								
Rhina anclyostoma Bloch & Schneider, 1801	S	V				U		
Rhynchobatus laevis (Bloch & Schneider, 1801)	S	V	V	P		C		P; 18
Rhinobatidae								
Aptychotrema rostrata (Shaw & Nodder, 1794)	S			S	S	C		
Rhinobatos typus Bennett, 1830	S					C		
Trygonorrhina fasciata (Müller & Henle, 1841)					S	U	North	

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Rajidae								
Dipturus australis (Macleay, 1884)					S	U		
Dipturus endeavouri Last, 2008					S	C		
Dasyatidae								
Dasyatis fluviorum Ogilby, 1908	S			P		C		
Dasyatis thetidis Ogilby, 1899					S	R	North	19
Himantura astra Last, Manjaji-Matsumoto & Pogonoski, 2008	S					U	South	
Himantura fai Jordan & Seale, 1906	P		P	P		C	South	20
Himantura toshi Whitley, 1939	S					U		
Himantura uarnak (Forsskål, 1775)	S			P		C		
Neotrygon kuhlii (Müller & Henle, 1841)	S	P	V	P	S	A		
Pastinachus atrus (Macleay, 1883)	S			P		U		21
Taeniura meyeni Müller & Henle, 1841	V		V	P		U		
Urolophidae								
Trygonoptera testacea (Müller & Henle, 1841)	S		V	P	S	C		
Urolophus kapalensis Yearsley & Last, 2006					S	R	North	
Urolophus sufflavus Whitley, 1929					S	R	North	
Gymnuridae								
Gymnura australis (Ramsay & Ogilby, 1886)	S			P		C		
Myliobatidae								
Aetobatus ocellatus (Kuhl, 1823)	S	P	V	P		A		22
Manta alfredi (Krefft, 1868)	V		P			C		23
Mobula japanica (Müller & Henle, 1841)			S	P		U		
Mobula eregoodootenkee (Cuvier, 1829)	S					R		
Myliobatis australis Macleay, 1881	L					R	North	24
Myliobatis hamlyni Ogilby, 1911	S				S	R	South	25
Rhinoptera neglecta Ogilby, 1912	S			P		C		P
Elopidae								
Elops hawaiensis Regan, 1909	S					U		
Megalopidae								
Megalops cyprinoides (Broussonet, 1782)	S			P		C		
Albulidae								
Albula oligolepis Hidaka, Iwatsuki & Randall, 2008	S	S	S	S		C		26
Anguillidae								
Anguilla australis Richardson, 1841	S					C		
Anguilla reinhardtii Steindachner, 1867	S					C		
Muraenidae								
Anarchias seychellensis Smith, 1962		S	S			U	South	27
Echidna nebulosa (Ahl, 1789)	S			P		U		
Echidna polyzona (Richardson, 1845)	S		S	S		C	South	28
Gymnothorax buroensis (Bleeker, 1857)			S			C	South	29
Gymnothorax chilospilus Bleeker, 1865		S	S			C		
Gymnothorax cribroris Whitley, 1932	S	S		S		C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Gymnothorax eurostus (Abbott, 1860)	S	S	S	S		A		
Gymnothorax favagineus Bloch & Schneider, 1801	S			P		U		
Gymnothorax fimbriatus (Bennett, 1832)	V					R	South	
Gymnothorax flavimarginatus (Rüppell, 1830)		S				R	South	30
Gymnothorax kidako (Temminck & Schlegel, 1847)	S	S				R		31
Gymnothorax margaritophorus Bleeker, 1864			S			R	South	32
Gymnothorax meleagris (Shaw & Nodder, 1795)			S			R		33
Gymnothorax monochrous (Bleeker, 1856)	S	P				R	South	34
Gymnothorax nudivomer (Günther, 1867)		S				R	South	35
Gymnothorax prasinus (Richardson, 1848)			S	S		U	North	36
Gymnothorax prionodon Ogilby, 1895					S	U		37
Gymnothorax pseudoherrei Bohlke, 2000			S			U	South	38
Gymnothorax pseudothyrsoideus (Bleeker, 1852)	S	S		P		A		
Gymnothorax rueppellii (McClelland, 1844)		S				R	South	39
Gymnothorax thyrsoideus (Richardson, 1845)	S		S	P		C		
Gymnothorax undulatus (Lacepède, 1803)	S					R		40
Strophidon sathete (Hamilton, 1822)	S					R	South	41
Synaphobranchidae								
Dysomma anguillare Barnard, 1923					S	R	NAR	42
Ophichthidae								
Echelus uropterus (Temminck & Schlegel, 1847)					S	U	North	43
Malvoliophis pinguis (Günther, 1872)	S	S		S		C		
Myrichthys colubrinus (Boddaert, 1781)			V			R		
Ophichthus bonaparti (Kaup, 1856)	L					R		44
Ophichthus sp. 1	S				S	R		45
Ophisurus serpens (Linnaeus, 1758)	S			S		R		
Scolecenchelys godeffroyi (Regan, 1909)	S					U	South	46
Scolecenchelys macropterus Bleeker, 1857	S					R	South	47
Muraenesocidae								
Muraenesox bagio (Hamilton, 1822)	S				P	C		
Congridae								
Ariosoma anago (Temminck & Schlegel, 1847)	S					U	South	
Ariosoma howensis (McCulloch & Waite, 1916)					S	U		
Bathycongrus cf *guttulatus* (Günther, 1887)					S	R		48
Conger cinereus Rüppell, 1830	S					U	South	
Conger wilsoni (Bloch and Schneider, 1801)	S			P	S	U		
Gnathophis grahami Karmovskaya & Paxton, 2000					S	C		49
Nettastomatidae								
Saurenchelys finitimus (Whitley, 1935)	S					R	South	
Engraulididae								
Engraulis australis (White, 1790)	S		S		P	C		
Stolephorus carpentariae (De Vis, 1883)	S					C	South	
Thryssa aestuaria (Ogilby, 1910)	S					A		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Thryssa hamiltonii (Gray, 1835)	S					R	South	
Chirocentridae								
Chirocentrus dorab (Forsskål, 1775)	S					R	South	
Clupeidae								
Etrumeus teres (DeKay, 1842)					S	U		50
Herklotsichthys castelnaui (Ogilby, 1897)	S			S		A		
Herklotsichthys koningsbergeri (Weber & de Beaufort, 1912)	S					R	South	51
Hyperlophus translucidus McCulloch, 1917	S			S		A	North	
Hyperlophus vittatus (Castelnau, 1875)	S			S		U	North	
Nematalosa erebi (Günther, 1868)	S					C		
Sardinella gibbosa (Bleeker, 1849)	S			S		C		
Sardinops sagax neopilchardus (Steindachner, 1879)	S				S	C		
Spratelloides delicatulus (Bennett, 1832)	S		S			C	South	
Spratelloides robustus Ogilby, 1897	S		S	S		C	North	
Chanidae								
Chanos chanos (Forsskål, 1775)	S					U		
Gonorynchidae								
Gonorynchus greyi (Richardson, 1845)	S				S	C		
Ariidae								
Neoarius graeffei (Kner & Steindachner, 1867)	S					A		
Netuma proxima (Ogilby, 1898)	S					C		
Plicofollis argyropleuron (Valenciennes, 1840)	S					U	South	52
Plotosidae								
Cnidoglanis macrocephalus (Valenciennes, 1840)				S		C	North	53
Euristhmus lepturus (Günther, 1864)	S					A		
Euristhmus nudiceps (Günther, 1880)	L					R	South	54
Paraplotosus albilabris (Valenciennes, 1840)	S					R	South	55
Plotosus lineatus (Thunberg, 1791)	S	V	S	P	P	A		
Argentinidae								
Glossanodon australis Kobyliansky, 1998					S	C		
Galaxiidae								
Galaxias maculatus (Jenyns, 1842)	S					U		
Ateleopodidae								
Ateleopus japonicus Bleeker, 1853					S	U		
Aulopidae								
Hime curtirostris (Thomson, 1967)					S	C		
Hime purpurissata (Richardson ,1843)					S	C		
Synodontidae								
Harpadon translucens Saville-Kent, 1889	S					R	South	
Saurida argentea Macleay, 1881	S					R	South	56
Saurida filamentosa Ogilby, 1910					S	C		
Saurida gracilis Quoy & Gaimard, 1824	S		S	S		U	South	
Saurida macrolepis Tanaka, 1917	S				S	A	?	57

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Saurida tumbil (Bloch, 1795)	S					C		
Saurida undosquamis (Richardson, 1848)	S				S	A		
Synodus binotatus Schultz, 1953		S				R	South	58
Synodus dermatogenys Fowler, 1912	S	S		P		C		
Synodus hoshinonis Tanaka, 1917					P	C		59
Synodus macrops Tanaka, 1917					P	U	South	P; 60
Synodus variegatus (Lacepède, 1803)	S	S	S	P		C		
Trachinocephalus myops (Forster, 1801)	S				S	C		
Myctophidae								
Diaphus kapalae Nafpaktitis, Robertson & Paxton, 1995					S	U	North	61
Trachipteridae								
Trachipterus jacksonensis (Ramsay, 1881)					S	R	North	62
Regalecidae								
Regalecus glesne Ascanius, 1772	S		S		S	R	North	63
Ophidiidae								
Neobythites nigriventris Nielsen, 2002					S	C		
Ophidion muraenolepis (Günther, 1880)					S	C		
Sirembo metachroma Cohen & Robins, 1986					S	C		
Bythitidae								
Brosmophyciops sp.		S				R		64
Diancistrus longifilis Ogilby, 1899			S			U	South	
Dinematichthys sp.	S	S	S			C		65
Moridae								
Physiculus luminosa Paulin, 1983					S	U		
Pseudophycis breviuscula (Richardson, 1846)					S	U	North	66
Batrachoididae								
Batrachomoeus dubius (White, 1790)	S				S	C		
Halophryne queenslandiae (De Vis, 1882)	S		S		S	U		
Lophiidae								
Lophiomus setigerus (Vahl, 1797)					S	C		
Antennariidae								
Antennarius coccineus (Lesson, 1830)	S	S	S	S		U		
Antennarius commerson (Latreille, 1804)				P		R		
Antennarius nummifer (Cuvier, 1817)			S			R		67
Antennarius pictus (Shaw & Nodder, 1794)	S					R		68
Antennarius striatus (Shaw, 1794)	S		S	P	S	C		
Histiophryne bougainvilli (Valenciennes, 1837)			S			R		69
Histrio histrio (Linnaeus, 1758)	S			S	S	U		
Brachionichthyidae								
Brachionichthys australis Last, Gledhill & Holmes, 2007					S	U	North	70
Chaunacidae								
Chaunax cf *endeavouri* Whitley, 1929					S	U		71
Ogcocephalidae								

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Halieutaea brevicauda Ogilby, 1910					S	C		
Halieutaea cf *stellata* (Vahl, 1797)					S	C		72
Mugilidae								
Crenimugil crenilabis (Forsskål, 1775)	S	S				R		
Liza argentea (Quoy & Gaimard, 1825)	S			S		C		
Liza subviridis (Valenciennes, 1836)	S					A		
Liza vaigiensis (Quoy & Gaimard, 1824)	S					R		
Mugil cephalus Linnaeus, 1758	S		V	P		A		
Myxus elongatus Günther, 1861	S		S	P		A		
Paramugil georgii (Ogilby, 1897)	S			S		A		
Valamugil seheli (Forsskål, 1775)	S					R	South	73
Notocheiridae								
Iso rhothophilus (Ogilby, 1895)			S			U		
Pseudomugilidae								
Pseudomugil signifer Kner, 1867	S					A		
Atherinidae								
Atherinomorus vaigiensis (Quoy & Gaimard, 1825)	S			S		A		74
Craterocephalus honoriae (Ogilby, 1912)	S					R	North	75
Craterocephalus mugiloides (McCulloch, 1912)	S					U	South	76
Hypoatherina tropicalis (Whitley, 1948)	S					C		
Belonidae								
Ablennes hians (Valenciennes, 1846)	S	V	S			C		
Strongylura leiura (Bleeker, 1851)	S					C		
Tylosurus acus (Lacepède, 1803)	S	S				U		
Tylosurus crocodilus (Pèron & Lesueur, 1821)	L					R	South	77
Tylosurus gavialoides (Castelnau, 1873)	S	V	V	V		A		
Scomberesocidae								
Scomberesox saurus (Walbaum, 1792)					S	U	North	78
Exocoetidae								
Cheilopogon pinnatibarbatus melanocercus (Ogilby, 1885)	S	S			S	C		
Hirundichthys oxycephalus (Bleeker, 1852)	S				S	U		
Parexocoetus brachypterus (Richardson, 1846)	S					U	South	
Hemiramphidae								
Arrhamphus sclerolepis krefftii (Steindachner, 1867)	S					A		
Euleptorhamphus viridis (Hasselt, 1823)					V	U		79
Hemiramphus robustus Günther, 1866	S					C		
Hyporhamphus australis (Steindachner, 1866)	S					U	North	
Hyporhamphus quoyi (Valenciennes, 1847)	S	S				C		
Hyporhamphus regularis ardelio (Whitley, 1931)	S			S		A		
Monocentrididae								
Cleidopus gloriamaris De Vis, 1882	S	P	S	P	S	C		80
Trachichthyidae								
Aulotrachichthys novaezelandicus (Kotlyar, 1980)					S	C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Optivus agastos Gomon, 2004					S	C		81
Trachichthys australis Shaw, 1799	S			P	S	R	North	
Berycidae								
Centroberyx affinis (Günther, 1859)					S	C		82
Holocentridae								
Myripristis berndti Jordan & Evermann, 1903	S	S	S			C		
Myripristis kuntee Valenciennes, 1831		S	P			C	South	83
Myripristis murdjan (Forsskål, 1775)	S	S	S			C		
Neoniphon sammara (Forsskål, 1775)		V				R	South	
Ostichthys japonicus (Cuvier, 1829)					S	R		
Pristilepis oligolepis (Whitley, 1941)					S	R		
Sargocentron caudimaculatum (Rüppell, 1838)		S				R		
Sargocentron diadema (Lacepède, 1802)	S	S	S			C		
Sargocentron rubrum (Forsskål, 1775)	S	S	S			C		
Zeidae								
Zenopsis nebulosus (Temminck & Schlegel, 1845)					P	U	North	P
Zeus faber Linnaeus, 1758	S		S			R		
Caproidae								
Antigonia malayana Weber, 1913					S	U		84
Antigonia rubicunda Ogilby, 1910					S	C		
Pegasidae								
Pegasus volitans Linnaeus, 1758	S			P	S	A		
Solenostomidae								
Solenostomus cyanopterus Bleeker, 1855				P		U		
Solenostomus paradoxus (Pallas, 1770)	P			S		U		P
Syngnathidae								
Campichthys tryoni (Ogilby, 1890)	S					C	South	
Choeroichthys brachysoma (Bleeker, 1855)	S					R	South	85
Choeroichthys suillus (Whitley, 1951)	S					R	South	86
Cosmocampus howensis (Whitley, 1948)			S	S		U	North	87
Filicampus tigris (Castelnau, 1879)	S		S	S		C		
Hippichthys cyanospilus (Bleeker, 1854)	S					C	South	
Hippichthys penicillus (Cantor, 1849)	S					C		
Hippocampus dahli Ogilby, 1908	S					U	South	88
Hippocampus procerus Kuiter, 2001	S			S		C	South	89
Hippocampus queenslandicus Horne, 2001					S	U	South	
Hippocampus tristis Castelnau, 1872				P	S	U		
Maroubra perserrata Whitley, 1948		S	S			U		
Micrognathus andersonii (Bleeker, 1858)	S					R	South	90
Phoxocampus diacanthus (Schultz, 1943)			S			R	South	91
Solegnathus dunckeri Whitley, 1927					S	C		
Stigmatopora nigra Kaup, 1856	S			P		C		
Syngnathoides biaculeatus (Bloch, 1785)	S					C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Trachyrhamphus bicoarctatus (Bleeker, 1857)			S	S		C		
Urocampus carinirostris Castelnau, 1872	S			P		A		
Vanacampus margaritifer (Peters, 1869)	S					R	North	92
Aulostomidae								
Aulostomus chinensis (Linnaeus, 1766)	S	P	V	P		C		
Fistulariidae								
Fistularia commersonii Rüppell, 1838	S				S	C		
Fistularia petimba Lacepède, 1803	S	V	V	P	S	C		
Macroramphosidae								
Macroramphosus gracilis (Lowe, 1839)					S	C		93
Macroramphosus scolopax (Linnaeus, 1758)					S	C		94
Centriscidae								
Centriscus scutatus Linnaeus, 1758	S					C		
Dactylopteridae								
Dactyloptena orientalis (Cuvier, 1829)	S			P	S	C		
Dactyloptena papilio Ogilby, 1910	S		S		S	C		
Dactyloptena peterseni (Nyström, 1887)					S	R	East	95
Neosebastidae								
Maxillicosta whitleyi Eschmeyer & Poss, 1976					S	C		
Neosebastes incipinnis Ogilby, 1910					S	C		
Neosebastes johnsoni Motomura, 2004					S	C	South	
Scorpaenidae								
Dendrochirus brachypterus (Cuvier, 1829)				S	S	U		
Dendrochirus zebra (Cuvier, 1829)	S		S	S		C		
Ebosia bleekeri (Döderlein, 1884)					S	R		
Parascorpaena aurita (Rüppell, 1838)		S	S	S		U	South	96
Parascorpaena mcadamsi (Fowler, 1938)			S			R	South	97
Parascorpaena mossambica (Peters, 1855)	S	S	S	S		C	South	98
Parascorpaena picta Kuhl & van Hasselt, 1829	S					R	South	99
Pterois antennata (Bloch, 1787)		S	S			U		
Pterois volitans (Linnaeus, 1758)	S	P	S	S	S	C		
Scorpaena cardinalis Richardson, 1842	S	S	S	P	S	C		
Scorpaena neglecta Temminck & Schlegel, 1843					S	R		100
Scorpaena sp. 1	S	S	S	S		C		101
Scorpaena sp. 2		S				R	?	102
Scorpaenodes guamensis Quoy & Gaimard, 1824	S	S	S	S		C		
Scorpaenodes littoralis (Tanaka, 1917)	S	S	S	S		A	North	103
Scorpaenopsis cotticeps Fowler, 1938			S			R	South	104
Scorpaenopsis diabolus Heckel, 1837	S	S		S		R		105
Scorpaenopsis eschmeyeri Randall & Greenfield, 2004			S	P		R	South	106
Scorpaenopsis macrochir Ogilby, 1910	S		S	S		U		
Scorpaenopsis venosa (Cuvier, 1829)	S		S	S		U	South	
Sebastapistes cyanostigma (Bleeker, 1856)		V	S			C	South	107

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Sebastapistes tinkhami (Fowler, 1946)		S	S			C	South	108
Taenianotus triacanthus Lacepède, 1802	S		S	S		C		
Apistidae								
Apistops caloundra (De Vis, 1886)	S				S	U	South	
Apistus carinatus (Bloch & Schneider, 1801)	S				S	U		
Tetrarogidae								
Ablabys taenianotus (Cuvier, 1829)		S		S		U		
Centropogon australis (White, 1790)	S		S	S	S	A		
Centropogon marmoratus Günther, 1862	S					C		
Liocranium praepositum Ogilby, 1903	S					C	South	
Neocentropogon aeglefinus (Weber, 1913)					S	U	South	109
Notesthes robusta (Günther, 1860)	S					C		
Ocosia cf *apia* Poss & Eschmeyer, 1975					S	U	?	110
Paracentropogon vespa Ogilby, 1910	S					R	South	111
Paracentropogon sp. 1		S				R	?	112
Synanceiidae								
Erosa erosa (Langsdorf, 1829)	S				S	C		
Inimicus caledonicus (Sauvage, 1878)	S			P		C		
Minous versicolor Ogilby, 1910	S				P	C		
Synanceia horrida (Linnaeus, 1766)	S			P		C		
Aploactinidae								
Adventor elongatus (Whitley, 1952)	S					U	South	
Aploactis aspera (Richardson, 1844)					S	R		
Bathyaploactis ornatissimus Whitley, 1933	S					C	South	113
Cocotropus microps Johnson, 2004				S		R	North	114
Erisphex aniarus (Thomson, 1967)					S	U	South	
Kanekonia queenslandica Whitley, 1952					S	R	South	115
Paraploactis trachyderma Bleeker, 1865)	S			P		C		
Peristrominous dolosus Whitley, 1952	S					U	South	
Pataecidae								
Pataecus fronto Richardson, 1844	S				S	U		
Triglidae								
Chelidonichthys kumu (Lesson, 1826)	S				S	C		
Lepidotrigla argus Ogilby, 1910	S				S	A		
Lepidotrigla grandis Ogilby, 1910					S	C		
Lepidotrigla papilio (Cuvier, 1829)					S	U	North	P; 116
Lepidotrigla umbrosa Ogilby, 1910					S	C		
Pterygotrigla andertoni Waite, 1910					S	U		
Satyrichthys lingi (Whitley, 1933)					S	U		
Bembridae								
Bembras macrolepis Imamura, 1998					S	U		
Platycephalidae								
Ambiserrula jugosa (McCulloch, 1914)	S			S	S	C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Cymbacephalus bosschei (Bleeker, 1860)	S					R	South	
Cymbacephalus nematophthalmus (Günther, 1860)	S			P		C		
Inegocia japonica (Cuvier, 1829)	S				P	C	South	
Platycephalus caeruleopunctatus McCulloch, 1922	S				S	C		
Platycephalus endrachtensis Quoy & Gaimard, 1824	S		S		S	A		117
Platycephalus fuscus Cuvier, 1829	S	P	V	P		A		
Platycephalus indicus (Linnaeus, 1758)	S					C		
Platycephalus longispinis Macleay, 1884	S				S	C		
Platycephalus marmoratus Stead, 1908		S			S	C		
Platycephalus westraliae (Whitley, 1938)	S					C		118
Ratabulus diversidens (McCulloch, 1914)					S	A		
Rogadius mcgroutheri Imamura, 2007					S	R	South	119
Sorsogona tuberculata (Cuvier, 1829)	S					R	South	
Sunagocia arenicola (Schultz, 1966)			S			U	South	120
Thysanophrys celebica (Bleeker, 1854)	S			S		U	South	121
Thysanophrys chiltonae Schultz, 1966			S			R	South	122
Thysanophrys cirronasa (Richardson, 1848)	S					R	North	123
Hoplichthyidae								
Hoplichthys ogilbyi McCulloch, 1914					S	C		
Latidae								
Psammoperca waigiensis (Cuvier, 1828)	S					R	South	124
Ambassidae								
Ambassis jacksoniensis Macleay, 1881	S			S		A		
Ambassis marianus Günther, 1880	S			S		A		
Acropomatidae								
Apogonops anomalus Ogilby, 1896					S	C		
Synagrops japonicus (Döderlein, 1883)					S	C		
Serranidae: Anthiinae								
Caprodon krasyukovae Kharin, 1983					S	C	North	125
Hypoplectrodes annulatus (Günther, 1859)					S	U		126
Hypoplectrodes jamiesoni Ogilby, 1908	S					C		
Hypoplectrodes maccullochi (Whitley, 1929)	S			S		U		127
Lepidoperca brochata Katayama & Fujii, 1982					S	C		
Lepidoperca caesiopercula (Whitley, 1951)					S	C	North	
Odontanthias grahami Randall & Heemstra, 2006					S	R	North	128
Plectranthias longimanus (Weber, 1913)			S			R	South	129
Pseudanthias fasciata (Kamohara, 1954)		P	V			C	South	P
Pseudanthias pictilis (Randall & Allen, 1978)		V				U		
Pseudanthias pleurotaenia (Bleeker, 1857)		P	V			U	South	
Pseudanthias rubrizonatus (Randall, 1983)		P				U	South	
Pseudanthias squamipinnis (Peters, 1855)		S	P	P		A		
Pseudanthias sp. 1					S	U	?	130
Serranidae: Epinephelinae								

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Cephalopholis argus (Bloch & Schneider, 1801)		S		P		U	South	131
Cephalopholis boenak (Bloch, 1790)	S					R	South	132
Cephalopholis miniata (Forsskål, 1775)		V		V		R	South	
Cephalopholis sonnerati (Valenciennes, 1828)		S				U	South	133
Cephalopholis urodeta (Bloch & Schneider, 1801)		S	S			C	South	134
Chromileptes altivelis (Valenciennes, 1828)	S	S		P		R	South	
Diploprion bifasciatum Kuhl & van Hasselt, 1828	S	S	P	P		C		
Epinephelus coioides (Hamilton, 1822)	S	P	P	P		A		
Epinephelus cyanopodus (Richardson, 1846)	S	V	S	S		C		
Epinephelus daemelii (Günther, 1876)	S	S	P		P	U		
Epinephelus fasciatus (Forsskål, 1775)	S	S	S	P		C		
Epinephelus howlandi (Günther, 1873)		V				R	South	
Epinephelus lanceolatus (Bloch, 1790)	S	V	S	P		U		P
Epinephelus macrospilos (Bleeker, 1855)		S				R	South	135
Epinephelus maculatus (Bloch, 1790)		S		P		C		
Epinephelus malabaricus (Bloch & Schneider, 1801)	S	P	S	P		C		
Epinephelus morrhua (Valenciennes, 1833)					S	U		
Epinephelus octofasciatus Griffin, 1926					S	C		
Epinephelus quoyanus (Valenciennes, 1830)	S	S	V	P		U		
Epinephelus rivulatus (Valenciennes, 1830)	L	S		P		U	North	136
Epinephelus sexfasciatus (Kuhl & van Hasselt, 1828)	S					R	South	
Epinephelus tauvina (Forsskål, 1775)		S	S			U		
Epinephelus tukula Morgans, 1959		V				R	South	
Epinephelus undulostriatus (Peters, 1867)	S	S	V	P		C		
Grammistes sexlineatus (Thunberg, 1792)	S			P		U		
Plectropomus laevis (Lacepède, 1801)		V				R	South	
Plectropomus leopardus (Lacepède, 1802)	V	V		P		U	South	
Plectropomus maculatus (Bloch, 1790)	V					R	South	
Rainfordia opercularis McCulloch, 1923	S	P				U	South	
Triso dermopterus (Temminck & Schlegel, 1843)		S	P		S	C		
Variola louti (Forsskål, 1775)		S				R	South	
Serranidae: Serraninae								
Acanthistius cinctus (Günther, 1859)			S			R	North	137
Acanthistius ocellatus (Günther, 1859)	S					R		
Callanthiidae								
Callanthias australis Ogilby, 1899					S	R		138
Centrogeniidae								
Centrogenys vaigiensis (Quoy & Gaimard, 1824)	S			P		C		
Percichthyidae								
Macquaria novemaculeata (Steindachner, 1866)	S					C		
Plesiopidae								
Belonepterygion fasciolatum (Ogilby, 1889)	S	S				U		
Fraudella carassiops Whitley, 1935					S	R	South	139

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Paraplesiops poweri Ogilby, 1908	S					C		
Plesiops genaricus Mooi & Randall, 1991	S			S		R	South	140
Trachinops taeniatus Günther, 1861	V		V			U		
Pseudochromidae								
Ogilbyina novaehollandiae (Steindachner, 1880)	S					U	South	141
Pseudochromis cyanotaenia Bleeker, 1857	S	S	S			U		
Pseudochromis fuscus Müller & Troschel, 1849	S					R	South	142
Pseudoplesiops immaculatus Gill & Edwards, 2002		S				R	South	143
Opistognathidae								
Opistognathus eximius (Ogilby, 1908)	S	S				U	South	144
Opistognathus jacksoniensis (Macleay, 1881)	S					U		
Apogonidae								
Apogon aureus (Lacepède, 1802)	P	P	S	P		U		
Apogon capricornis Allen & Randall, 1993	S					C		
Apogon cavitiensis (Jordan & Seale, 1907)	S			P		C		
Apogon cookii Macleay, 1881	S			P		U		145
Apogon crassiceps Garman, 1903	S	S	S	S		C		
Apogon cyanosoma (Bleeker, 1853)		V				U		
Apogon doederleini Jordan & Snyder, 1901	S	V	S	P		C		
Apogon doryssa (Jordan & Seale, 1906)		S				R	South	146
Apogon fasciatus (White, 1790)	S			P		A		
Apogon fraenatus Valenciennes, 1832	V		V			U		
Apogon kallopterus Bleeker, 1856		P	S			R	South	147
Apogon limenus Randall & Hoese, 1988	S	S	S	S		A		
Apogon nigrofasciatus Lachner, 1953		S	V			U	South	148
Apogon novemfasciatus Cuvier, 1828		V	S			C	South	149
Apogon pallidofasciatus Allen, 1987	S			P		C	South	150
Apogon poecilopterus Cuvier, 1828	S					C	South	
Apogon properuptus (Whitley, 1964)	P	V	P	P		C		
Apogon semilineatus Temminck & Schlegel, 1843					S	U	South	151
Apogon seminigracaudus Greenfield, 2007	S					U	NAR	152
Apogon semiornatus Peters, 1876	S	V	S	S		U		
Apogon taeniophorus Regan, 1908			S			R		153
Apogon sp. 1	S					R	?	154
Apogonichthyoides atripes (Ogilby, 1916)	S			P		C		
Apogonichthyoides timorensis (Bleeker, 1854)				S		R	South	
Apogonichthys ocellatus Weber, 1913				S		R		
Archamia leai Waite, 1916		P				R	South	P
Cheilodipterus macrodon (Lacepède, 1802)		V	P			U	South	
Cheilodipterus quinquelineatus Cuvier, 1828				P		R		
Foa fo Jordan & Seale, 1905	S			S		C	South	155
Fowleria variegata (Valenciennes, 1832)	S					U	South	156
Nectamia viria Fraser, 2008		P	S			R	South	157

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Siphamia cuneiceps Whitley, 1941	S					U	South	158
Siphamia rosiegaster (Ogilby, 1886)	S					A		
Siphamia zaribae Whitley, 1959		S				U	South	159
Priacanthidae								
Cookeolus japonicus (Cuvier, 1829)					S	U		
Heteropriacanthus cruentatus (Lacepède, 1801)		P				R		
Priacanthus hamrur (Forsskål, 1775)	S	P	V			C		
Priacanthus macracanthus Cuvier, 1829	S	S	S		S	A		
Pristigenys niphonia (Cuvier, 1829)					S	U	East	160
Sillaginidae								
Sillago analis Whitley, 1943	S					C	South	
Sillago ciliata Cuvier, 1829	S			S		A		
Sillago flindersi McKay, 1985					S	C		
Sillago ingenuua McKay, 1985	S					U	South	161
Sillago maculata Quoy & Gaimard, 1824	S				P	A		
Sillago robusta Stead, 1908	S				S	A		
Malacanthidae								
Branchiostegus serratus Dooley & Paxton, 1975					S	U		
Malacanthus brevirostris Guichenot, 1848	V	S				U		
Pomatomidae								
Pomatomus saltatrix (Linnaeus, 1766)	S		V	P		A		
Echeneididae								
Echeneis naucrates Linnaeus, 1758	S	V	S	P		C		
Remora remora Linnaeus, 1758	S					U		
Glaucosomatidae								
Glaucosoma scapulare Ramsay, 1881	S	S	S	P	S	C		
Kuhliidae								
Kuhlia mugil (Forster, 1801)	V		S			U		
Rachycentridae								
Rachycentron canadus (Linnaeus, 1766)	S	V	V	S		C		
Coryphaenidae								
Coryphaena hippurus Linnaeus, 1758					S	C		
Carangidae								
Alectis ciliaris (Bloch, 1787)	S			S		C		
Alectis indica (Rüppell, 1830)	S	S		S		C		
Alepes apercna Grant, 1987	S		V	P		A		
Atule mate (Cuvier, 1833)	S	P				U		
Carangoides caeruleopinnatus (Rüppell, 1830)	S			P		U		
Carangoides chrysophrys (Cuvier, 1833)	S	S	V	S		C		
Carangoides dinema Bleeker, 1851	S			S		R	South	162
Carangoides equula (Temminck & Schlegel, 1844)					S	C	South	163
Carangoides ferdau (Forsskål, 1775)	V			P		U	South	
Carangoides fulvoguttatus (Forsskål, 1775)	V	S				C	South	164

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Carangoides gymnostethus (Cuvier, 1833)		P				U	South	
Carangoides humerosus (McCulloch, 1915)	S					U		
Carangoides malabaricus (Bloch & Schneider, 1831)	S					C		
Carangoides oblongus (Cuvier, 1833)	S					R	South	165
Carangoides orthogrammus (Jordan & Gilbert, 1882)		S				U		
Caranx ignobilis (Forsskål, 1775)	S	S		P		C		
Caranx melampygus Cuvier, 1833	S	P		P		C		
Caranx papuensis Alleyne & Macleay, 1877		S	S			C	South	166
Caranx sexfasciatus Quoy & Gaimard, 1825	S	S		S		A		
Decapterus macrellus (Cuvier, 1833)			S			R	North	167
Decapterus russelli (Rüppell, 1830)	S	V	V	P		A	South	168
Elagatis bipinnulatus (Quoy & Gaimard, 1825)		V	S			C		
Gnathanodon speciosus (Forsskål, 1775)	S	V		S		C	South	
Megalaspis cordyla (Linnaeus, 1758)	S					U		
Naucrates ductor (Linnaeus, 1758)	S					U		
Parastromateus niger (Bloch, 1795)	S				P	R	South	169
Pseudocaranx cf *dentex* (Bloch & Schneider, 1801)	S	S	V	P		C		170
Scomberoides commersonnianus Lacepède, 1801	S					R	South	171
Scomberoides lysan (Forsskål, 1775)	S	V		P		C		
Scomberoides tol (Cuvier, 1832)	S			P		U		
Selaroides leptolepis (Kuhl & van Hasselt, 1833)	S	P				C		
Seriola dumerili (Risso, 1810)	S	S		P	P	C		
Seriola hippos Günther, 1876	S	S			P	U	North	172
Seriola lalandi Valenciennes, 1833	S	S	P	P	P	C		
Seriola rivoliana Valenciennes, 1833		S				C	North	
Seriolina nigrofasciata (Rüppell, 1829)	S					U	South	
Trachinotus anak Ogilby, 1909	S					U	South	
Trachinotus blochii (Lacepède, 1801)	S					U		
Trachinotus coppingeri (Günther, 1884)	S	P	S	P		A		
Trachurus declivis Jenyns, 1841	S					C		
Trachurus novaezelandiae Richardson, 1843	S				S	C		
Ulua mentalis (Cuvier, 1833)				P		U	South	P
Uraspis uraspis (Gunther, 1860)	S					R	South	173
Leiognathidae								
Leiognathus fasciatus (Lacepède, 1803)				P		C	South	P
Nuchequula gerreoides (Bleeker, 1851)	S					C	South	174
Equulites moretoniensis (Ogilby, 1912)	S					A		
Bramidae								
Pteraclis aesticola (Jordan & Snyder, 1901)			S			R	North	175
Emmelichthyidae								
Emmelichthys struhsakeri Heemstra & Randall, 1977					S	C	North	176
Lutjanidae								
Aprion virescens Valenciennes, 1830		S				U		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Caesio caerulaurea Lacepède, 1801	S	P	V			C		
Caesio cuning (Bloch, 1791)		P	V			C		
Caesio lunaris Cuvier, 1830		V				R	South	
Etelis coruscans Valenciennes, 1862					S	U		177
Lutjanus adetii (Castelnau, 1873)	S	S				U		
Lutjanus argentimaculatus (Forsskål, 1775)	S	V		P		C		
Lutjanus bohar (Forsskål, 1775)		S	V	P		U	South	
Lutjanus carponotatus (Richardson, 1842)	S	P				U	South	
Lutjanus fulviflamma (Forsskål, 1775)	V	S	S	V		C		
Lutjanus fulvus (Bloch & Schneider, 1801)		V				R		
Lutjanus gibbus (Forsskål, 1775)	S	S		P		U		
Lutjanus kasmira (Forsskål, 1775)	S	S	S			C		
Lutjanus malabaricus Schneider, 1801	S			P		U		
Lutjanus quinquelineatus (Bloch, 1790)	S		V	P		C		
Lutjanus russelli (Bleeker, 1849)	S	S	V	P		A		
Lutjanus sebae (Cuvier, 1828)	S	S				C		
Lutjanus vitta (Quoy & Gaimard, 1824)	S	V				U	South	178
Paracaesio sordida Abe & Shinohara, 1962					S	R	South	179
Paracaesio xanthura (Bleeker, 1869)	S	S	P		S	A		
Pristipomoides argyrogrammicus (Valenciennes, 1831)					S	U		
Pristipomoides filamentosus (Valenciennes, 1830)					S	C		
Pristipomoides sieboldii (Bleeker, 1857)					S	C		180
Pterocaesio chrysozona (Cuvier, 1830)	L	V	V			C		181
Pterocaesio digramma (Bleeker, 1865)	S	V	V	P		A		
Pterocaesio tile (Cuvier, 1830)		S	V			U	South	182
Symphorus nematophorus (Bleeker, 1860)	S	V	V	P		C	South	
Lobotidae								
Lobotes surinamensis (Bloch, 1790)	S				S	U		
Gerreidae								
Gerres filamentosus Cuvier, 1829	S					R	South	183
Gerres oyena (Forsskål, 1775)	S					C	South	184
Gerres subfasciatus (Cuvier, 1830)	S			S		A		
Haemulidae								
Diagramma pictum labiosum Macleay, 1883	S	V	V	P		C		
Plectorhinchus flavomaculatus (Ehrenberg, 1830)	S	S	P	P		A		
Plectorinchus gibbosus (Lacepède, 1802)	S	P	S	P		C		
Plectorhinchus lessonii (Cuvier, 1830)	V	S				U	South	185
Plectorhinchus picus (Cuvier, 1830)	V	S	V			C		
Plectorhinchus schotaf (Forsskål, 1775)	S	S				C		186
Pomadasys argenteus (Forsskål, 1775)	S					U		
Pomadasys kaakan (Cuvier, 1830)	S					U		
Pomadasys maculatus (Bloch, 1797)	S					U	South	
Sparidae								

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Acanthopagrus australis (Günther, 1859)	S	V	V	P		A		
Argyrops spinifer (Forsskål, 1775)	S					U		
Dentex spariformis Ogilby, 1910					S	C		
Pagrus auratus Schneider, 1801	S	S	V	P	S	A		
Rhabdosargus sarba (Forsskål, 1775)	S	V	V	P		A		
Lethrinidae								
Gnathodentex aurolineatus (Lacepède, 1802)		S	V			C		
Gymnocranius audleyi Ogilby, 1916	S	S	P		S	C	South	
Gymnocranius euanus (Günther, 1879)		S				U		
Lethrinus atkinsoni Seale, 1910		S				R	South	187
Lethrinus genivittatus Valenciennes, 1830	S	V	P	P	P	A		
Lethrinus laticaudis Alleyne & Macleay, 1877	S	V	V	P		C		
Lethrinus miniatus (Schneider, 1801)		S	S		S	C		
Lethrinus nebulosus (Forsskål, 1775)	S	V	V	P		A		
Lethrinus rubrioperculatus Sato, 1978		S	V			C		
Monotaxis grandoculis (Forsskål, 1775)		P	S			C	South	188
Nemipteridae								
Nemipterus aurifilum (Ogilby, 1910)					S	C		
Nemipterus hexodon (Quoy & Gaimard, 1824)	S	S				U	South	189
Nemipterus peronii (Valenciennes, 1830)	S					U	South	190
Nemipterus theodorei Ogilby, 1916					S	A		
Pentapodus aureofasciatus Russell, 2001		S				C		
Pentapodus paradiseus (Günther, 1859)	S	V	V	P	S	A		
Scolopsis bilineatus (Bloch, 1793)	S	P	P	P		C		
Scolopsis monogramma (Kuhl & Van Hasselt, 1830)	S	S	V	P		C		
Polynemidae								
Polydactylus macrochir (Günther, 1867)	S					C	South	191
Polydactylus multiradiatus (Günther, 1860)	S					A		
Sciaenidae								
Argyrosomus japonicus (Temminck & Schlegel, 1843)	S			P	P	C		
Atractoscion aequidens (Cuvier, 1830)		P			P	C		
Johnius australis (Günther, 1880)	S					U	South	192
Johnius borneensis (Bleeker, 1850)	S					A		193
Nibea soldado (Lacepède, 1802)	S					R	South	194
Mullidae								
Mulloidichthys flavolineatus (Lacepède, 1801)	S	S	V			C		
Mulloidichthys vanicolensis (Valenciennes, 1831)		S	P			C		
Parupeneus barberinoides (Bleeker, 1852)				P		R		195
Parupeneus barberinus (Lacepède, 1801)				P		R		196
Parupeneus ciliatus (Lacepède, 1802)	S	S	S	S		C		
Parupeneus cyclostomus (Lacepède, 1801)		S				R		
Parupeneus heptacanthus (Lacepède, 1802)	S					R	South	197
Parupeneus indicus (Shaw, 1803)	V			P		R	South	

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Parupeneus multifasciatus (Quoy & Gaimard, 1825)	S	V	V	P		C		
Parupeneus pleurostigma (Bennett, 1831)		S	P			U		
Parupeneus spilurus (Bleeker, 1854)	S	S	S	P	S	A		
Upeneichthys lineatus (Bloch & Schneider, 1801)				P	S	C		
Upeneus australiae Kim & Nakaya, 2002	S					A		198
Upeneus filifer (Ogilby, 1910)					S	U		
Upeneus tragula Richardson, 1846	S		V	P	S	A		
Pempheridae								
Parapriacanthus ransonneti Steindachner, 1870	V					U		199
Pempheris affinis McCulloch, 1911	V	S	S	P		C		
Pempheris oualensis Cuvier, 1831		S				C	South	200
Pempheris schwenkii Bleeker, 1855	S	V	V	S		C	South	201
Pempheris ypsilychnus Mooi & Jubb, 1996	S	V				C	South	202
Leptobramidae								
Leptobrama muelleri Steindachner, 1879	S					R	South	203
Monodactylidae								
Monodactylus argenteus (Linnaeus, 1758)	S	P	V	P		A		
Schuetta scalaripinnis Steindachner, 1866	S	P	V	P		A		
Chaetodontidae								
Amphichaetodon howensis (Waite, 1903)					S	R	North	204
Chaetodon aureofasciatus Macleay, 1878	S		V			U		
Chaetodon auriga Forsskål, 1775	S	V	V	P		C		
Chaetodon baronessa Cuvier, 1831		P				R		P
Chaetodon bennetti Cuvier, 1831	S					R		205
Chaetodon citrinellus Cuvier, 1831	S	P	V	P		C		
Chaetodon ephippium Cuvier, 1831	S			P		U		
Chaetodon flavirostris Günther, 1873	S	S	S	S		A		
Chaetodon guentheri Ahl, 1913	S	V	V	P	S	A		
Chaetodon kleinii Bloch, 1790	S	V	S	P		C		
Chaetodon lineolatus Cuvier, 1831	V	P		P		U		
Chaetodon lunula (Lacepède, 1803)	S	V		P		C		
Chaetodon lunulatus Quoy & Gaimard, 1825	S	P				U		206
Chaetodon melannotus Bloch & Schneider, 1801	S	P	V	P		C		
Chaetodon mertensii Cuvier, 1831	S	S	P	P		U		
Chaetodon ocellicaudus Cuvier, 1831				P		U	South	P; 207
Chaetodon ornatissimus Cuvier, 1831		P				R	South	
Chaetodon pelewensis Kner, 1868	V	P	V	P		U		
Chaetodon plebeius Cuvier,1831	S	P	P			C		
Chaetodon rafflesi Bennett, 1830	V					R	South	208
Chaetodon rainfordi McCulloch, 1923	S	P	V			C		
Chaetodon reticulatus Cuvier, 1831		S				R	South	209
Chaetodon speculum Cuvier, 1831	S	P	V			U		
Chaetodon trifascialis (Quoy & Gaimard, 1824)	P	P	S			C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Chaetodon ulietensis Cuvier, 1831	S					R		210
Chaetodon unimaculatus Bloch, 1787		P	P			U		
Chaetodon vagabundus Linnaeus, 1758	S	S	V	P		C		
Chelmon rostratus (Linnaeus, 1758)	S	S	P	P		C		
Chelmonops truncatus (Kner, 1859)	S		V	P		C		
Coradion altivelis McCulloch, 1916	S					C		
Forcipiger flavissimus Jordan & McGregor, 1898	S	S	S			C		
Hemitaurichthys polylepis (Bleeker, 1857)		P	S			C		
Heniochus acuminatus (Linnaeus, 1758)	S	P	P	P		A		
Heniochus chrysostomus Cuvier, 1831		V	V	V		U		
Heniochus diphreutes Jordan, 1903		P	V			C		
Heniochus monoceros Cuvier, 1831	S	V	S	P		C		
Parachaetodon ocellatus (Cuvier, 1831)	S			P		C		
Pomacanthidae								
Centropyge bicolor (Bloch, 1787)	S	P	S			U		
Centropyge bispinosa (Günther, 1860)	V	S		P		U		
Centropyge flavissima (Cuvier, 1831)		S		P		R	South	211
Centropyge tibicen (Cuvier, 1831)	S	S	S	P		C		
Centropyge vroliki (Bleeker, 1853)	V	S	S	P		U		
Chaetodontoplus conspicillatus (Waite, 1900)	V			P		R		
Chaetodontoplus duboulayi (Günther, 1867)	V					R	South	212
Chaetodontoplus meredithi Kuiter, 1990	S	P	V			C		
Pomacanthus imperator (Bloch, 1787)	S	S	S			C		
Pomacanthus semicirculatus (Cuvier, 1831)	V	S	S	P		C		
Pomacanthus xanthometapon (Bleeker, 1853)		S				R	South	213
Pygoplites diacanthus (Boddaert, 1772)	V					R		
Enoplosidae								
Enoplosus armatus (White, 1790)	S	S		P		U		
Pentacerotidae								
Paristiopterus labiosus (Günther, 1871)	S	S				U		
Zanclistius elevatus (Ramsay & Ogilby, 1888)					S	R		214
Kyphosidae								
Atypichthys strigatus (Günther, 1860)	S	S	S	P		A		
Girella cyanea Macleay, 1881		S				R	North	215
Girella elevata Macleay, 1881	S		S			R		
Girella tricuspidata (Quoy & Gaimard, 1824)	S			P		A		P
Kyphosus bigibbus (Lacepède, 1803)	S	P	S	P		C		
Kyphosus cinerasceus (Forsskål, 1775)	S	S				C		
Kyphosus pacificus Sakai & Nakabo, 2004		S	S			U	South	216
Kyphosus sydneyanus (Günther, 1866)	S	S		P		C		
Kyphosus vaigiensis (Quoy & Gaimard, 1825)	S	V				C		
Microcanthus strigatus (Langsdorff, 1831)	S	V	S	S	S	A		
Scorpis lineolata Kner, 1865	S	S	S	P	S	A		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Arripidae								
Arripis trutta (Forster, 1801)			V			U	North	217
Terapontidae								
Helotes sexlineatus (Quoy & Gaimard, 1825)	S					U	South	218
Pelates sexlineatus (Quoy & Gaimard, 1824)	S			P		A		219
Pelates quadrilineatus (Bloch, 1790)	S					R	South	219
Terapon jarbua (Forsskål, 1775)	S					C		
Terapon theraps Cuvier, 1829	S					R	South	220
Cirrhitidae								
Amblycirrhitus bimacula Jenkins, 1903			S			R	South	221
Cirrhitichthys aprinus (Cuvier, 1829)	S	S	P	P		C		
Cirrhitichthys falco Randall, 1963	S	P	S	S		C		
Cirrhitichthys oxycephalus (Bleeker, 1855)			P			R		
Cyprinocirrhites polyactis (Bleeker, 1874)		V	P			U		
Paracirrhites arcatus (Cuvier, 1829)		P	V			C	South	P
Paracirrhites forsteri (Bloch & Schneider, 1801)		P	P			C		
Chironemidae								
Chironemus marmoratus Günther, 1860	V		S	V		C		
Aplodactylidae								
Aplodactylus lophodon (Günther, 1859)	S			P		U		222
Cheilodactylidae								
Cheilodactylus fuscus Castelnau, 1879	V	S	P	P		C		
Cheilodactylus vestitus (Castelnau, 1878)	S	S	S	P		A		
Nemadactylus douglasii (Hector 1875)					S	U	North	223
Cepolidae								
Acanthocepola krusensternii Schlegel, 1850	S					C	South	
Labridae								
Achoerodus viridis (Steindachner, 1866)	V	V	V	P		U		
Anampses caeruleopunctatus Rüppell, 1829	V	S	P	V		C		
Anampses femininus Randall, 1972		P				U	North	P
Anampses geographicus Valenciennes, 1840	S	V	V	S		C		
Anampses neoguinaicus Bleeker, 1878		S	P			C		
Austrolabrus maculatus (Macleay, 1881)			S			U		
Bodianus axillaris (Bennett, 1832)		S	V	P		C		
Bodianus bilunulatus (Lacepède, 1802)		S				R	East	224
Bodianus dictynna Gomon, 2006		P	P			R	South	
Bodianus frenchii (Klunzinger, 1880)		V				U		225
Bodianus perditio (Quoy & Gaimard, 1835)	S	S	P	P	P	C		
Bodianus unimaculatus (Günther, 1862)					S	C		226
Bodianus sp. 1		P				R	?	227
Cheilinus chlorourus (Bloch, 1791)	S		V	P		U	South	228
Cheilinus trilobatus Lacepède, 1801	V	S				C	South	229
Cheilinus undulatus Rüppell, 1835			V			R	South	230

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Cheilio inermis (Forsskål, 1775)	S		V	S		C		
Choerodon cephalotes (Castelnau, 1875)	S		P	S		C		
Choerodon fasciatus (Günther, 1867)	S	S	S			C		
Choerodon frenatus Ogilby, 1910					S	C		
Choerodon graphicus (De Vis, 1885)	S	V	V	S		C		
Choerodon jordani (Snyder, 1908)		P	P			R	South	231
Choerodon schoenleinii (Valenciennes, 1839)	S	V	V	P		C		
Choerodon venustus (De Vis, 1884)	S	S	P		P	C		
Cirrhilabrus punctatus Randall & Kuiter, 1989	S	S	S	P		A		
Coris aurilineata Randall & Kuiter, 1982	S					C		
Coris aygula (Lacepède, 1801)		P		V		U		
Coris batuensis (Bleeker, 1856)	S	P	S			C		
Coris dorsomacula Fowler, 1908		S	P			C		
Coris gaimard (Quoy & Gaimard, 1824)			S			R		232
Coris picta (Bloch & Schneider, 1801)	S	S	S			C		
Coris pictoides Randall & Kuiter, 1982	P					U		
Epibulus insidiator (Pallas, 1770)		V				R	South	233
Gomphosus varius Lacepède, 1801		S	V			C	South	P
Halichoeres biocellatus Schultz, 1960		V				R		
Halichoeres chrysurus Randall, 1981			V			R		
Halichoeres hartzfeldii (Bleeker, 1852)	S	V		P		U		
Halichoeres hortulanus (Lacepède, 1801)		V	S			C		
Halichoeres margaritaceus (Valenciennes, 1839)	V	S	S	P		C		
Halichoeres marginatus Rüppell, 1835	S	S	V	P		C		
Halichoeres melanurus (Bleeker, 1851)	V	P				U	South	P
Halichoeres nebulosus (Valenciennes, 1839)	V	S	P			C		
Halichoeres trimaculatus (Quoy & Gaimard, 1834)	V	V		P		C	South	P
Hemigymnus fasciatus (Bloch, 1792)	S	P	V			C		
Hemigymnus melapterus (Bloch, 1791)	S	P	P			C		
Hologymnosus annulatus (Lacepède, 1801)		S	V			C		
Hologymnosus longipes (Günther, 1862)		S				U	South	234
Iniistius jacksonensis (Ramsay, 1881)	S			V		U		
Iniistius pavo (Valenciennes, 1840)		S				R		235
Labrichthys unilineatus (Guichenot, 1847)		P				U	South	
Labroides bicolor Fowler & Bean, 1928		V				U	South	
Labroides dimidiatus (Valenciennes, 1839)	S	S	S	S		A		
Labropsis australis Randall, 1981		P				U	South	
Labropsis xanthonota Randall, 1981	V					R	South	236
Leptojulis cyanopleura (Bleeker, 1853)				P		U		
Macropharyngodon choati Randall, 1978		P				U		
Macropharyngodon meleagris (Valenciennes, 1839)		P	V			C		
Macropharyngodon negrosensis Herre, 1932		P	V			C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Notolabrus gymnogenis (Günther, 1862)	S	V	S	S		C		
Novaculichthys taeniourus (Lacepède, 1801)		P				U		
Novaculoides macrolepidotus (Bloch, 1791)				P		R		
Ophthalmolepis lineolatus (Valenciennes, 1839)					S	R	North	237
Oxycheilinus bimaculatus (Valenciennes, 1840)	S		P	P		C		
Oxycheilinus diagrammus (Lacepède, 1801)		P				R	South	
Pseudocheilinus hexataenia (Bleeker, 1857)		V	S			U	South	238
Pseudojuloides elongatus Ayling & Russell, 1977		P				U	North	
Pseudolabrus guentheri Bleeker, 1862	S	S	S	S		A		
Pteragogus enneacanthus (Bleeker, 1853)	S	P	P	S		C		
Pteragogus flagellifer (Valenciennes, 1839)	S			S		C	South	
Stethojulis bandanensis (Bleeker, 1851)	V	S	S	P		C		
Stethojulis interrupta (Bleeker, 1851)	S		S	P		C		
Stethojulis strigiventer (Bennett, 1832)	S			P		C		
Suezichthys arquatus Russell, 1985		V	S			U		
Suezichthys devisi (Whitley, 1941)	V			P		C		
Thalassoma amblycephalum (Bleeker, 1856)	V	S	S	P		C		
Thalassoma hardwicke (Bennett, 1828)	S	P				C		
Thalassoma lunare (Linnaeus, 1758)	S	S	S	S		A		
Thalassoma lutescens (Lay & Bennett, 1839)	S	S	S	S		A		
Thalassoma nigrofasciatum Randall, 2003	S	S	V	P		C		239
Thalassoma purpureum (Forsskål, 1775)	S	S	S	S		C		
Thalassoma trilobatum (Lacepède, 1801)	V	S	S	P		C		
Scaridae								
Calotomus carolinus (Valenciennes, 1840)	V	S		V		U		240
Cetoscarus bicolor (Rüppell, 1829)		V				R	South	
Chlorurus microrhinos (Bleeker, 1854)	V	S	S			C		
Chlorurus sordidus Forsskål, 1775		P				C	South	P
Leptoscarus vaigiensis (Quoy & Gaimard, 1824)	S			S		C		
Scarus altipinnis (Steindachner, 1879)		S				U		241
Scarus chameleon Choat & Randall, 1986		S	P			C		
Scarus forsteni (Bleeker, 1861)		P				R		242
Scarus frenatus Lacepède, 1802		S		P		C	South	243
Scarus ghobban Forsskål, 1775	S	V	V	P		A		
Scarus niger Forsskål, 1775		P				R	South	244
Scarus rivulatus Valenciennes, 1840	V	V				C	South	
Scarus rubroviolaceus Bleeker, 1847		P				C		245
Cichlidae								
Oreochromis mossambica (Peters, 1852)	S					C	South	246
Pomacentridae								
Abudefduf bengalensis (Bloch, 1787)	S	V	V	P		A		
Abudefduf sexfasciatus (Lacepède, 1801)	S	V	V	P		C		
Abudefduf sordidus (Forsskål, 1775)	V	V	S	P		C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Abudefduf vaigiensis (Quoy & Gaimard, 1825)	S	S	S	P		C		
Abudefduf whitleyi Allen & Robertson, 1974	S			P		C		
Amblyglyphidodon curacao (Bloch, 1787)		P				C	South	P
Amphiprion akindynos Allen, 1972	S	P	S	P		C		
Amphiprion latezonatus Waite, 1900	S		P			R		P; 247
Chromis abyssicola Allen & Randall, 1985					S	C		
Chromis atripectoralis Welander & Schultz, 1951	V	P				C	South	P
Chromis chrysura (Bliss, 1883)	P					U		
Chromis flavomaculata Kamohara, 1960			P			U		
Chromis hypsilepis (Günther, 1876)	V		V	V		U	North	
Chromis margaritifer Fowler, 1946	V	S	S	S		C		
Chromis nitida (Whitley, 1928)	V	V	V	P		A		
Chromis vanderbilti (Fowler, 1941)		S	S			C		
Chromis weberi Fowler & Bean, 1928		P	V			C		
Chrysiptera brownriggii (Bennett, 1828)		S				U		248
Chrysiptera cyanea (Quoy & Gaimard, 1824)	S					U		
Chrysiptera flavipinnis (Allen & Robertson, 1974)	S	S	S	P		C		
Chrysiptera glauca (Cuvier, 1830)	S					U		249
Chrysiptera taupou (Jordan & Seale, 1906)	V					R	South	
Dascyllus aruanus (Linnaeus, 1758)	P	V	V			C		
Dascyllus melanurus Bleeker, 1854	S					R	South	250
Dascyllus reticulatus (Richardson, 1846)	V	S	S			C	South	251
Dascyllus trimaculatus (Rüppell, 1828)	S	S	S	P		C		
Mecaenichthys immaculatus (Ogilby, 1885)	V	S				U		252
Neopomacentrus azysron (Bleeker, 1877)		P		P		U		
Neopomacentrus bankieri (Richardson, 1845)	S			P		C		
Neopomacentrus cyanomos (Bleeker, 1856)	S			P		U		
Parma oligolepis Whitley, 1929	S	S	S	P		A		
Parma polylepis Günther, 1862	V	S	V	P		C		
Parma unifasciata (Steindachner, 1867)	V	P	P	V		C		
Plectroglyphidodon dickii (Liénard, 1839)	P	S	S			C	South	
Plectroglyphidodon johnstonianus Fowler & Ball, 1924		S	V			C		
Plectroglyphidodon lacrymatus (Quoy & Gaimard, 1825)		P	V			C		
Plectroglyphidodon leucozonus (Bleeker, 1859)	S	S	S	S		A		
Pomacentrus amboinensis Bleeker, 1868	S	P	V	P		C		
Pomacentrus australis Allen & Robertson, 1973	S	V	S	P		C		
Pomacentrus bankanensis Bleeker, 1853	V	S	S	P		C		
Pomacentrus brachialis Cuvier, 1830	S		S			U	South	253
Pomacentrus chrysurus Cuvier, 1830		S				U		
Pomacentrus coelestis Jordan & Starks, 1901	S	P	S	P		C		
Pomacentrus lepidogenys Fowler & Ball, 1928		S	S			C	South	254
Pomacentrus moluccensis Bleeker, 1853	S	S	S			C	South	255

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Pomacentrus nagasakiensis Tanaka, 1909	S	V	S	P		C		
Pomacentrus pavo (Bloch, 1787)		P				U?		256
Pomacentrus vaiulu Jordan & Seale, 1906		S				U	South	257
Pomacentrus wardi Whitley, 1927	S	S	S	V		C		
Pristotis obtusirostris (Günther, 1862)			V	P	P	C		
Stegastes apicalis (De Vis, 1885)	V	V	S	S		C		
Stegastes fasciolatus (Ogilby, 1899)		V				U		
Stegastes gascoynei (Whitley, 1964)	S	S	S	S		A		
Champsodontidae								
Champsodon nudivittis (Ogilby, 1895)					S	C		
Pinguipedidae								
Parapercis australis Randall, 2003	S	P	S	P		C		
Parapercis binivirgata (Waite, 1904)					S	U		
Parapercis clathrata Ogilby, 1911		P				R	South	P
Parapercis diplospilus Gomon, 1981	S					U		
Parapercis millepunctata (Günther, 1860)		P				R	South	P
Parapercis nebulosa (Quoy & Gaimard, 1825)	S			S	S	A		
Parapercis queenslandica Imamura & Yoshino, 2007		S	S	P		C		
Parapercis sexlorata Johnson, 2006					S	R	North	258
Parapercis stricticeps (De Vis, 1884)	S	S	V	P		C		
Parapercis sp. 1					S	C		259
Simipercis trispinosa Johnson, 2006					P	U		260
Trichonotidae								
Trichonotus setiger Bloch & Schneider, 1801		S		P		U	South	P; 261
Creediidae								
Limnichthys nitidus Smith, 1958			S			R		
Schizochirus insolens Waite, 1904	S					C		
Percophidae								
Acanthaphritis barbata (Okamura & Kishida, 1963)					S	R		
Matsubaraea fusiforme (Fowler, 1943)	S					U	South	
Leptoscopidae								
Lesueurina platycephala Fowler, 1907	S		S			C		
Ammodytidae								
Ammodytoides vagus (McCulloch & Waite, 1916)	S					U		
Uranoscopidae								
Ichthyscopus sannio Whitley, 1936	S			S		C		
Ichthyscopus nigripinnis Gomon & Johnson, 1999	S				S	C		
Uranoscopus terraereginae Ogilby, 1910					S	C		262
Uranoscopus sp. 1					S	C		263
Tripterygiidae								
Ceratobregma helenae Holleman, 1987			S			R	South	264
Enneapterygius atrogulare (Günther, 1873)	S	S	S	S		A		
Enneapterygius nanus (Schultz, 1960)		S				U	South	265

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Eneapterygius similis Fricke, 1997		S	S	S		A		266
Eneapterygius tutuilae Jordan & Seale, 1906	S					U	South	267
Eneapterygius sp. 1		S				R	South?	P; 268
Helcogramma sp. 1		S				U	South?	P; 269
Lepidoblennius haplodactylus Steindachner, 1867	S					R	North	270
Norfolkia squamiceps (McCulloch & Waite, 1916)	S	S	S	S		A		271
Norfolkia thomasi Whitley, 1964			S			R		272
Ucla xenogrammus Holleman, 1993	S					R	South	273
Clinidae								
Cristiceps aurantiacus Castelnau, 1879				S		R	North	274
Heteroclinus whiteleggii (Ogilby, 1894)			S			U		
Heteroclinus sp. 1	S					R	North	275
Blennidae								
Aspidontus dussumieri (Valenciennes, 1836)		P				U		
Blenniella chrysospilos (Bleeker, 1857)		S				R	South	276
Blenniella paula (Bryan & Herre, 1903)		S				R	South	277
Cirripectes castaneus (Valenciennes, 1836)			S			U		
Cirripectes stigmaticus Strasburg & Schultz, 1953			S			U	South	278
Ecsenius bicolor (Day, 1888)			S			U	South	279
Ecsenius stictus Springer, 1988			S			U	South	280
Entomacrodus striatus (Valenciennes, 1836)			S			R	South	281
Exallias brevis (Kner, 1868)		S	P			U		
Istiblennius edentulus (Schneider, 1801)	S	S	S	P		C		
Istiblennius meleagris (Valenciennes, 1836)	S	V	S	S		A		
Laiphognathus multimaculatus Smith, 1955	S		S	S		C		
Meiacanthus atrodorsalis (Günther, 1877)				P		R		
Meiacanthus lineatus (De Vis, 1884)	S					C		
Omobranchus anolius (Valenciennes, 1836)	S					C		
Omobranchus punctatus (Valenciennes, 1836)	S					C	South	
Omobranchus rotundiceps rotundiceps (Macleay, 1881)	S					A		
Omobranchus verticalis Springer & Gomon, 1975	S					R	South	282
Parablennius intermedius (Ogilby, 1915)	S	S	S	S		A		
Petroscirtes fallax Smith-Vaniz, 1976	S			P		C		
Petroscirtes lupus (De Vis, 1886)	S			P		A		
Petroscirtes mitratus Rüppell, 1830				P		R	South	P
Plagiotremus rhinorhynchos (Bleeker, 1852)	S		S	P		C		
Plagiotremus tapeinosoma (Bleeker, 1857)	S	P	S	P		C		
Xiphasia setifer Swainson, 1839	S		S			U		
Gobiesocidae								
Lepadichthys caritus Briggs, 1969			S			R		
Lepadichthys frenatus Waite, 1904	S		S			U		
Callionymidae								
Bathycallionymus moretonensis (Johnson, 1971)					S	A		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Calliurichthys cf *australis* (Fricke, 1983)					S	U		283
Calliurichthys grossi (Ogilby, 1910)	S				S	C	South	
Calliurichthys ogilbyi (Fricke, 2002)					S	A		
Dactylopus dactylopus (Valenciennes, 1837)	S			P	S	C		
Eocallionymus papilio (Günther, 1864)				S		R		284
Foetorepus calauropomus (Richardson, 1844)					S	A	North	
Neosynchiropus ocellatus (Pallas, 1770)	S		S			U		
Repomucenus belcheri (Richardson, 1844)	S					C	South	
Repomucenus calcaratus (Macleay, 1881)	S			P	S	A		
Repomucenus limiceps (Ogilby, 1908)	S				S	A		
Repomucenus macdonaldi (Ogilby, 1911)	S			S		C		
Repomucenus russelli (Johnson, 1976)	S			S		C		
Repomucenus sublaevis (McCulloch, 1926)	S					C		
Orbonymus rameus (McCulloch, 1926)					S	U		
Spinicapitichthys draconis (Nakabo, 1977)					S	C	East	285
Eleotridae								
Butis butis (Hamilton-Buchanan, 1822)	S					C		
Butis koilomatodon (Bleeker, 1849)	S					R	South	286
Eleotris melanosoma Bleeker, 1852	S					R	South	287
Ophiocara porocephala (Valenciennes, 1837)	P					R	South	288
Prionobutis microps (Weber, 1908)	S					U	South	
Gobiidae								
Acentrogobius caninus (Cuvier & Valenciennes, 1837)	S					U	South	289
Afurcagobius tamarensis (Johnston, 1883)	L					R		290
Amblyeleotris callopareia Polunin & Lubbock, 1979	S					R	South	291
Amblyeleotris wheeleri (Polunin & Lubbock, 1977)		P				R	South	P
Amblygobius phalaena (Valenciennes, 1837)	S			P		U		
Amoya sp. 1	S					U	South?	292
Arenigobius frenatus (Günther, 1861)	S					C		
Arenigobius leftwichi (Ogilby, 1910)	S					C		
Asterropteryx semipunctatus Rüppell, 1830				P		U		P
Austrolethops wardi Whitley, 1935	S					R	South	
Bathygobius cocosensis (Bleeker, 1854)	S	S	S	S		A		
Bathygobius kreftii (Steindachner, 1866)	S			P		A		
Bathygobius laddi (Fowler, 1931)	S		S	S		C		
Callogobius depressus (Ramsay & Ogilby, 1886)	S					U	North	
Callogobius sclateri (Steindachner, 1879)			S			R	South	293
Callogobius sp. 1	S			S		C		294
Caragobius urolepis (Bleeker, 1852)	S					U	South	295
Caragobius sp. 1	S					C	South	296
Cryptocentroides gobioides (Ogilby, 1886)	S			S		C		
Cryptocentrus sp. 1	S					R		297

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Drombus triangularis (Weber, 1911)	S					C	South	
Eugnathogobius polylepis (Wu & Ni, 1985)	S					U	South	298
Eviota guttata Lachner & Karnella, 1978		S	S	S		C		299
Eviota nebulosa Smith, 1958			S			C	South	300
Eviota prasina (Klunzinger, 1871)		S	S			C	South	301
Favonigobius exquisitus Whitley, 1950	S			P		A		
Favonigobius lentiginosus (Richardson, 1844)	S			P		A		
Flabelligobius sp. 1	S					U		302
Fusigobius inframaculatus (Randall, 1994)			S			R	South	303
Fusigobius neophytus (Günther, 1877)	S			P		C		
Gnatholepis cauerensis (Bleeker, 1853)			S	P		C		
Gnatholepis gymnocara Randall & Greenfield, 2001	S					C	South	304
Gobiodon citrinus (Rüppell, 1838)		V				R	South	
Gobiodon quinquestrigatus (Valenciennes, 1837)	S		S			U	South	305
Gobiodon rivulatus (Rüppell, 1830)			S			R	South	306
Gobiopterus semivestita (Munro, 1949)	S					C		
Istigobius decoratus (Herre, 1927)	S	P	S	P		C		307
Istigobius nigroocellatus (Günther, 1874)	S			S		C		
Lubricogobius ornatus Fourmanoir, 1966					S	R		308
Mugilogobius platynotus (Günther, 1861)	S					U	North	
Mugilogobius stigmaticus (De Vis, 1884)	S					A		
Oxyurichthys cornutus McCulloch & Waite, 1918	S					R	South	309
Pandaka lidwilli (McCulloch, 1917)	S					C		
Parachaeturichthys polynema (Bleeker, 1853)	S					U	South	
Paratrypauchen microcephalus (Bleeker, 1860)	S					C	South	310
Parkraemeria ornata Whitley, 1951	S					U		
Periophthalmus argentilineatus Valenciennes, 1837	S					R	South	311
Pleurosicya mossambica Smith, 1959		S				R		312
Priolepis cincta (Regan, 1908)	S	S	S			C		
Priolepis fallacincta Winterbottom & Burridge, 1992	S					R	South	313
Priolepis nuchifasciata (Günther, 1873)	S		S			C		
Priolepis sp. 1			S			R		314
Psammogobius biocellatus (Valenciennes, 1837)	S			P		U		
Pseudogobius sp. 1	S					A		
Redigobius bikolanus (Herre, 1927)	S					C		
Redigobius macrostoma (Günther, 1861)	S					C		
Redigobius nanus Larson, 2010	S					U	South	
Scartelaos histiophorus (Valenciennes, 1837)	S					U	South	
Silhouettea evanida Larson & Miller, 1985	S					R	South	315
Taenioides purpurascens (De Vis, 1884)	S					U		
Trimma necopina Whitley, 1959	S	S	S			U		
Valenciennea immaculata (Ni, 1981)	S					C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Valenciennea strigata (Broussonet, 1782)		P				U		
Vanderhorstia ornatissima Smith, 1959				P		R	South	P
Microdesmidae								
Ptereleotris heteroptera (Bleeker, 1855)	S					R		316
Ptereleotris microlepis (Bleeker, 1856)	S					R		317
Ephippididae								
Drepane punctata (Linnaeus, 1758)	S					R	South	318
Platax batavianus Cuvier, 1831	P					R	South	P
Platax orbicularis (Forsskål, 1775)	S					R	South	319
Platax teira (Forsskål, 1775)	S	S	P	P		C		
Zabidius novemaculeatus (McCulloch, 1916)		S				R	South	320
Scatophagidae								
Scatophagus argus (Linnaeus, 1766)	S			P		C		
Selenotoca multifasciata (Richardson, 1846)	S			P		A		
Siganidae								
Siganus argenteus (Quoy & Gaimard, 1825)		S				U	South	321
Siganus doliatus Cuvier, 1830	V					R	South	
Siganus fuscescens (Houttuyn, 1782)	S	P	V	P		A		
Siganus lineatus (Valenciennes, 1835)	S	V				U	South	322
Siganus spinus (Linnaeus, 1758)	V	V	V	P		C	South	
Zanclidae								
Zanclus cornutus (Linnaeus, 1758)	V	S	P	V		C		
Acanthuridae								
Acanthurus blochii Valenciennes, 1835		P	P			U		
Acanthurus dussumieri Valenciennes, 1835	S	V	P	S		A		
Acanthurus grammoptilus Richardson, 1843	S			V		C	South	323
Acanthurus lineatus (Linnaeus, 1758)		P		P		U		
Acanthurus mata Cuvier, 1829		S	P	P		C		
Acanthurus nigricans (Linnaeus, 1758)		S				R	South	324
Acanthurus nigrofuscus (Forsskål, 1775)	S	P	S	S		C		
Acanthurus olivaceus Bloch & Schneider, 1801		P	P	P		U		
Acanthurus pyroferus Kittlitz, 1834		V		P		R		
Acanthurus triostegus (Linnaeus, 1758)	S	S	S	P		C		
Acanthurus xanthopterus Valenciennes, 1835	S	V	V	S		C		
Ctenochaetus striatus (Quoy & Gaimard, 1825)		V		S		U	South	325
Naso annulatus (Quoy & Gaimard, 1825)	S	V	V	P		C	South	326
Naso brevirostris (Cuvier, 1829)		P				R		
Naso hexacanthus Bleeker, 1855		S				R	South	327
Naso lituratus (Bloch & Schneider, 1801)		P	P			R	South	
Naso maculatus Randall & Struhsaker, 1981			S			U	South	328
Naso mcdadei Johnson, 2002			S			U	South	
Naso tonganus (Valenciennes, 1835)		V	S			C		
Naso unicornis (Forsskål, 1775)	S	S	V	S		C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Naso vlamingii (Valenciennes, 1835)		S				R	South	329
Paracanthurus hepatus (Linnaeus, 1766)		S	P			C		
Prionurus maculatus Ogilby, 1887	S	S	S	P		A		
Prionurus microlepidotus Lacepède, 1804	S	S	V	P		A		
Zebrasoma scopas (Cuvier, 1829)		P	V	P		C	South	P
Zebrasoma veliferum (Bloch, 1797)	S	V	V			U		
Sphyraenidae								
Sphyraena acutipinnis Day, 1876					S	U		
Sphyraena barracuda Walbaum, 1792	S			P		C		
Sphyraena helleri Jenkins, 1901		S				R	South	330
Sphyraena jello Cuvier, 1829	S	V		P		C		
Sphyraena obtusata Cuvier, 1829	S	P	V	P		A		
Sphyraena pinguis Günther, 1874	S					U		
Sphyraena putnamae Jordan & Seale, 1905	S	V	V			C	South	331
Sphyraena qenie Klunzinger, 1870		S				U	South	332
Trichiuridae								
Trichiurus lepturus Linnaeus, 1758	S			S	S	C		
Scombridae								
Acanthocybium solandri (Cuvier, 1831)	S	P	P			C		
Auxis thazard (Lacepède, 1800)		S			S	C		
Cybiosarda elegans (Whitley, 1935)	S	V			S	A		
Euthynnus affinis (Cantor, 1849)		P	S		S	C		
Gasterochisma melampygus Richardson, 1845					S	R		333
Grammatorcynus bicarinatus (Quoy & Gaimard, 1824)	V	V	S			C		
Gymnosarda unicolor (Rüppell, 1836)		S				R	South	334
Katsuwonus pelamis (Linnaeus, 1775)					P	C		
Rastrelliger kanagurta (Cuvier, 1817)	S				P	U	South	335
Sarda australis (Macleay, 1881)	P	S	S	P	S	C		
Scomber australasicus Cuvier, 1831	S			P	S	C		
Scomberomorus commerson (Lacepède, 1800)	S	P	P	S	P	C		
Scomberomorus munroi Collette & Russo, 1980	S				P	C		
Scomberomorus queenslandicus Munro, 1943	S	V				A		
Scomberomorus semifasciatus (Macleay, 1884)	S					U		
Thunnus albacares (Bonnaterre, 1788)		S				C		
Thunnus maccoyii (Castelnau, 1872)					S	U		
Thunnus tonggol (Bleeker, 1851)	S					A		
Istiophoridae								
Istiophorus platypterus (Shaw, 1792)	S	S	P		S	C		
Makaira indica (Cuvier, 1832)	S				P	C		
Makaira nigricans Lacepède, 1802					P	C		
Tetrapturus angustirostris Tanaka, 1915					P	U		
Tetrapturus audax (Philippi, 1887)					P	U		
Xiphiidae								

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Xiphias gladius Linnaeus, 1758					P	R		336
Centrolophidae								
Schedophilus maculatus Günther, 1860	S					R		
Nomeidae								
Cubiceps whiteleggii (Waite, 1894)	S		S		P	U		337
Nomeus gronovii (Gmelin, 1788)	S					U		
Psenes hillii Ogilby, 1915	S		S			U		
Ariommatidae								
Ariomma lurida Jordan & Snyder, 1904					S	C		
Bothidae								
Arnoglossus fisoni Ogilby, 1898	S				S	C		
Arnoglossus dalgleishi (Von Bonde, 1922)					S	U	NAR	338
Arnoglossus waitei Norman, 1926	S				S	C	South	
Asterorhombus intermedius (Bleeker, 1866)					P	R	South	
Bothus mancus (Broussonet, 1782)				P		R		
Bothus myriaster Temminck & Schlegel, 1846					S	R		339
Bothus pantherinus (Rüppell, 1830)				P		R		
Crossorhombus valderostratus (Alcock, 1890)					S	C		
Engyprosopon grandisquama (Schlegel, 1846)	S				P	C		
Engyprosopon maldivensis (Regan, 1908)					S	C		
Engyprosopon longipterum Amaoka, Mihara & Rivaton, 1993					S	C		
Grammatobothus pennatus (Ogilby, 1913)	S				S	C		340
Grammatobothus polyophthalmus (Bleeker, 1866)					P	U		
Lophonectes gallus Günther, 1880	S				S	C		
Parabothus kiensis (Tanaka, 1918)					S	R	South	341
Psettina gigantea Amaoka, 1963					S	C		
Psettina iijimae (Jordan & Starks, 1904)					S	U		
Paralichthyidae								
Pseudorhombus arsius (Hamilton, 1822)	S			P		A		
Pseudorhombus dupliciocellatus Regan, 1905					P	C		
Pseudorhombus elevatus Ogilby, 1912	S					R	South	342
Pseudorhombus jenynsii (Bleeker, 1855)	S			P	S	A		
Pseudorhombus tenuirastrum (Waite, 1899)					S	C		
Samaridae								
Plagiopsetta glossa Franz, 1910					S	C		
Samariscus triocellatus Woods, 1966			S			R		343
Soleidae								
Aesopia cornuta Kaup, 1858					S	R		344
Aseraggodes melanostictus (Peters, 1877)					S	U	South	345
Aseraggodes nigrocirratus Randall, 2005	S					R	North	346
Aseraggodes normani Chabanaud, 1930	S				P	U		
Brachirus nigra (Macleay, 1880)	S			P		C		
Dexillus muelleri (Steindachner, 1879)	S					R	South	347

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Pardachirus hedleyi Ogilby, 1916	S		S	S	S	C		
Phyllichthys sclerolepis (Macleay, 1878)	S					R	South	348
Soleichthys microcephalus (Günther, 1862)	S			P		U		
Synclidopus macleayanus (Ramsay, 1881)	S				S	C		
Zebrias scalaris Gomon, 1987	S				S	U		
Cynoglossidae								
Cynoglossus bilineatus (Lacepède, 1802)	L				P	U	South	349
Cynoglossus maccullochi Norman, 1926	S					U	South	350
Cynoglossus maculipinnis Rendahl, 1921	S				S	C		
Cynoglossus sp. 1	S					U	?	351
Cynoglossus sp. 2	S					U	?	352
Cynoglossus sp. 3	S					U	?	353
Cynoglossus sp. 4					S	U	?	354
Paraplagusia bilineata (Bloch, 1787)	S				S	C		
Paraplagusia sinerama Chapleau & Renaud, 1993	S				S	C	South	355
Paraplagusia unicolor (Macleay, 1881)	S				S	C		356
Triacanthodidae								
Triacanthodes ethiops Alcock, 1894					P	U		357
Triacanthidae								
Tripodichthys angustifrons (Hollard, 1854)	S					C		358
Balistidae								
Abalistes stellatus (Anonymous, 1798)	S		S	P	P	U		
Balistapus undulatus (Park, 1797)	S					R	South	359
Balistoides conspicillum (Bloch & Schneider, 1801)		S	S			C		
Canthidermis maculatus (Bloch, 1786)	S				S	R		
Melichthys vidua (Richardson, 1845)		S				C	South	360
Pseudobalistes flavimarginatus (Rüppell, 1829)		V		P		U		
Pseudobalistes fuscus (Bloch & Schneider, 1801)		S	P	P		U		
Rhinecanthus lunula Randall & Steene, 1983		P				R		P
Rhinecanthus rectangulus (Bloch & Schneider, 1801)			V			U		
Sufflamen bursa (Bloch & Schneider, 1801)		P				R		
Sufflamen chrysopterum (Bloch & Schneider, 1801)	S	P	V	P		C		
Sufflamen fraenatus (Latreille, 1804)	S	S	P		P	C		
Monacanthidae								
Aluterus monoceros (Linnaeus, 1758)		S	S	P		C		
Aluterus scriptus (Osbeck, 1765)		P	V			U		
Anacanthus barbatus Gray, 1831	S			P	S	C	South	361
Brachaluteres jacksonianus (Quoy & Gaimard, 1824)	S			S		C	North	
Cantherhines dumerilii (Hollard, 1854)		S	S			U		
Cantherhines fronticinctus (Günther, 1866)		P	P			U		P
Cantherhines pardalis (Rüppell, 1837)	S	S	S	P		C		
Cantheschenia grandisquamis Hutchins, 1977	S	S	P	P		C		
Chaetodermis penicilligerus (Cuvier, 1816)	S			P		C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Eubalichthys mosaicus (Ramsay & Ogilby, 1886)	S	V			S	U		
Meuschenia trachylepis (Günther, 1870)	S	V	P	P		C		
Monacanthus chinensis (Osbeck, 1765)	S		V	P		A		
Nelusetta ayraudi (Quoy & Gaimard, 1824)	S				S	C	North	
Oxymonacanthus longirostris Bloch & Schneider, 1801		P				U	South	
Paraluteres prionurus (Bleeker, 1851)	S		V	P		U		
Paramonacanthus filicauda (Günther, 1880)	S				S	A		
Paramonacanthus lowei Hutchins, 1997					P	U		
Paramonacanthus otisensis Whitley, 1931	S				S	A		
Pervagor alternans (Ogilby, 1899)		P	P			C		
Pervagor janthinosoma (Bleeker, 1854)	S	S	P	S		C		
Pseudalutarius nasicornis (Temminck & Schlegel, 1850)	S					R		362
Pseudomonacanthus peroni (Hollard, 1854)	S	S	V	S		C	South	P; 363
Thamnaconus hypargyreus (Cope, 1871)					S	U		
Thamnaconus tessellatus (Günther, 1880)					S	C		
Ostraciidae								
Anoplocapros inermis (Fraser-Brunner, 1935)					S	C		364
Lactoria cornuta (Linnaeus, 1758)	S					C		
Lactoria diaphana (Bloch & Schneider, 1801)	S					C		
Lactoria fornasini (Bianconi, 1846)	S					U		
Ostracion cubicus Linnaeus, 1758	S	P	S	P		C		
Ostracion meleagris Shaw, 1796		S		V		R		
Tetrosomus reipublicae (Whitley, 1930)	S		S		S	C		
Tetrosomus gibbosus (Linnaeus, 1758)	S					R	South	365
Tetraodontidae								
Arothron caeruleopunctatus Matsuura, 1994		V				R	South	
Arothron firmamentum (Temminck & Schlegel, 1847)					S	U	North	366
Arothron hispidus (Linnaeus, 1758)	S	V	S	S		C		
Arothron manilensis (de Proce, 1822)	S	V	V	P		C		
Arothron meleagris (Lacepède, 1798)			P			R	South	P
Arothron nigropunctatus (Bloch & Schneider, 1801)	S	P	P			U		
Arothron reticularis (Bloch & Schneider, 1801)				P		R		P; 367
Arothron stellatus (Bloch & Schneider, 1801)	S	V	V	P		C		
Canthigaster amboinensis (Bleeker, 1865)		S				R		
Canthigaster axiologa Whitley, 1931	P		P	P		U		368
Canthigaster bennetti (Bleeker, 1854)	S	P	P	P		C		
Canthigaster callisterna (Ogilby, 1889)	V	V	V	S	S	C		
Canthigaster janthinoptera (Bleeker, 1855)	S	S	S			U		
Canthigaster valentini (Bleeker, 1853)	S	S	S	P		C		
Feroxodon multistriatus (Richardson, 1854)				P	S	U		
Lagocephalus cheesemanii (Clarke, 1897)					S	C		369
Lagocephalus inermis (Temminck & Schegel, 1850)	S					C		

FAMILY/SPECIES	1	2	3	4	5	Abun.	Range	Note
Lagocephalus lunaris (Bloch & Schneider, 1801)	S					C		
Lagocephalus sceleratus (Gmelin, 1788)	S				S	C		
Marilyna pleurosticta (Günther, 1871)	S					A		
Reicheltia halsteadi (Whitley, 1957)					S	R		370
Sphoeroides pachygaster (Müller & Troschel, 1848)					S	C		
Tetractenos glaber (Freminville, 1813)	S					R	North	371
Tetractenos hamiltoni (Gray & Richardson, 1843)	S			S		A		
Torquigener altipinnis (Ogilby, 1891)	S				S	C		
Torquigener hicksi Hardy, 1983					S	U	South	
Torquigener perlevis (Ogilby, 1908)	S					C		
Torquigener pleurogramma (Regan, 1903)	S			S		C		
Torquigener squamicauda (Ogilby, 1911)	S			S		A		
Torquigener tuberculiferus (Ogilby, 1912)	S				P	C		
Torquigener whitleyi (Paradice, 1927)	S					C		
Diodontidae								
Chilomycterus reticulatus (Linnaeus, 1758)	V	V	P			U		P
Dicotylichthys punctulatus Kaup, 1855	S	V	V	S	S	C		
Diodon holocanthus Linnaeus, 1758	S		P			C		
Diodon hystrix Linnaeus, 1758		P	P	P		U		
Tragulichthys jaculiferus (Cuvier, 1818)	S				S	C	South	
Molidae								
Mola mola (Linnaeus, 1758)					P	R		

END NOTES

1. Vouchers QM-I26457-58, from off Stradbroke I. in 180 m.

2. Report from coastal area of Moreton Bay by Johnson (1999: 720) based on old QM specimens with imprecise locality data of 'Moreton Bay'.

3. Reported by Ogilby (1916a).

4. Specimen caught on drum line and washed up on beach, not retained.

5. Several QM voucher specimens, reported by Kyne *et al.* (2005).

6. Voucher QM-I38676, from off Cape Moreton.

7. Reported as *M. antarcticus* Günther by Johnson (1999: 719).

8. Reported as *H. microstoma* Bleeker in Johnson (1999: 719).

9. Voucher QM-I38199.

10. Reported by Kyne *et al.* (2005) from Moreton Bay.

11. Two specimens, QM-I7976–77, removed from female taken at Tangalooma. Photograph also verified of 2.8 m specimen caught at Bulwer in 1996.

12. Voucher QM-I14073.

13. Voucher QM-I5166.

14. Vouchers QM-I14071–72.

15. Voucher QM-I14909.

16. One individual visually recorded at Flat Rock in 25 m depth on several occasions.

17. Not recorded in the region since the 1960s.

18. Photographs of *Rhynchobatus* examined for this survey appear to depict *R. laevis* rather than *R. australiae* Whitley (P. Last, pers. comm. 2009).

19. Voucher CSIRO H5768-01.

20. Forms seasonal aggregations near mouth of Southport Seaway.

21. Regarded by Last & Stevens (2009) as distinct from *P. sephen* (Forsskål).

22. *Aetobatus ocellatus* Kuhl has recently replaced *A. narinari* (Euphrasen) as the valid name for the member of this genus occurring in the Indo-west Pacific (White *et al.* 2010).

23. Reported as *Manta birostris* (Donndorff) by Johnson (1999: 718). The latter was shown to be distinct from *M. alfredi* by Marshall *et al.* (2009).

24. Only record that of Last & Stevens (1994: 453).

25. See comments by Johnson (1999: 718).

26. Reported as *A. neoguinaica* Valenciennes in Johnson (1999: 720).

27. Vouchers QM-I36455, QM-I37620 and QM-I37697 from Flat Rock and QM-I38291 from Flinders Reef.

28. Voucher QM-I31149.

29. Vouchers QM-I36417 and QM-I37602.

30. Voucher QM-I38354 from Flinders Reef.

31. Reported as *G.* sp. in Johnson (1999: 721). Vouchers QM-I5141 and QM-I20041.

32. Voucher QM-I37603.

33. Voucher QM-I37618.

34. Reported as *G. boschii* (Bleeker) in Johnson (1999: 721).

35. Voucher QM-I18872.

36. Vouchers QM-I37680-81 from Shag Rock.

37. Collected off Cape Moreton in 97 m depth. Voucher QM-I38248.

38. Vouchers QM-I36454 and QM-I37695.

39. Voucher QM-I38468.

40. Voucher QM-I30222.

41. Reported as *Thyrsoidea macrura* (Bleeker) by Johnson (1999: 722).

42. New Australian record. Voucher QM-I33860, collected east of Moreton Island in 162 m.

43. Vouchers QM-I14147 and QM-I33877.

44. Reported as *O. episcopus* Castelnau by Johnson (1999: 721). The latter has a type locality of Moreton Bay and is reported as a junior synonym of *O. bonaparti* (Kaup) by McCosker (2002).

45. Vouchers QM-I14562 from Moreton Bay, and QM-I33347 and QM-I36517 from off Cape Moreton.

46. Voucher QM-I31100. Reported as *Muraenichthys* cf *laticaudatus* (Ogilby) by Johnson (1999: 721).

47. Voucher QM-I30226.

48. Voucher QM-I21094.

49. *G. castlei* Karmovskaya & Paxton is probably also found in the area. Most of the diagnostic characters between these two species overlap and they are readily confused.

50. Voucher QM-I38247.

51. Voucher QM-I26680.

52. Reported as *Arius macrocephalus* Bleeker by Johnson (1999: 723).

53. Locally common at Southport Seaway, but rare or absent elsewhere in MBMP. Voucher QM-I30306.

54. Recorded by Paxton *et al.* (1989: 224) and Murdy & Ferraris (2006: 86), however there appear to be no voucher specimens from the area and these records may be based on misidentifications of *E. lepturus* (Günther).

55. Voucher QM-I30220 from Redcliffe.

56. Voucher QM-I30151.

57. This species has been confused with *S. undosquamis* (Richardson) in most prior reports (Inoue & Nakabo 2006).

58. Vouchers QM-I19158, QM-I26676 and QM-I38293.

59. In eastern Australia mostly referred to as *S. similis* McCulloch, 1921, a species doubtfully distinct from this one.

60. Known from MBMP by photographs, but several QM specimens to the near north of the area.

61. Voucher QM-I34262, trawled in 165 m east of Caloundra, identified by J. Paxton.

62. Beach washed specimens. Reported as *T. arawatae* Clarke by Johnson (1999: 725).

63. Beach washed specimens.

64. Voucher QM-I28228.

65. Vouchers QM-I36423 from Flat Rock, QM-I38273 from Wellington Point and QM-I38313 from Flinders Reef.

66. Vouchers QM-I20991 and QM-I34335 from off Stradbroke Is. in depths of 165-183 m.

67. Voucher QM-I37755.

68. Vouchers QM-I4462 and QM-I29810.

69. Voucher QM-I37621 includes two black morph adults accompanied by a pale juvenile.

70. Vouchers QM-I33334, QM-I33949 and QM-I34045, from off Stradbroke I. in 161-163 m. This population highly disjunct from the remainder, which is known only as far north as Bermagui, NSW (36°23'S).

71. Voucher QM-I33952. Species more frequently encountered in depths greater than 200 m.

72. Vouchers QM-I9697, QM-I9699, QM-I9704 and QM-I30959.

73. Voucher QM-I30250.

74. Reported as *A. ogilbyi* (Whitley) by Johnson (1999: 725).

75. Voucher AMS-IB1340.

76. Voucher QM-I30987.

77. Reported by Paxton *et al.* (1989: 343) and Hoese *et al.* (2006: 719). No vouchers.

78. Vouchers QM-I28281-82.

79. Occasionally seen leaping from the surface in oceanic waters.

80. Populations in MBMP appear to have steadily declined.

81. Reported (as *Optivus* sp.) from coastal area of Moreton Bay by Johnson (1999: 725) based on old QM specimen with imprecise locality data of 'Moreton Bay'.

82. Same comment as previous.

83. Vouchers QM-I28230 and QM-I31011.

84. Vouchers QM-I28290 and QM-I34241.

85. Voucher QM-I19771.

86. Voucher QM-I30285.

87. Vouchers QM-I37679 and QM-I37747 from Flat Rock, and QM-I31167 from Southport Seaway.

88. Reported as *H. planifrons* Peters by Johnson (1999: 726).

89. Reported as *H. whitei* Bleeker by Johnson (1999: 726).
90. Voucher QM-I31385.
91. Voucher QM-I36477.
92. Voucher QM-I30885.
93. Extends north to off Swain Reefs (22°09'S), QM-I18600.
94. Extends north to off Noosa (26°21'S), QM-I34211.
95. New record for Australian east coast, QM-I38264.
96. Vouchers QM-I36414 and QM-I37653 from Flat Rock, QM-I38345 from Flinders Reef and QM-I38730 from Southport Seaway.
97. Voucher QM-I27604.
98. Vouchers QM-I29254 from Tangalooma, QM-I 38467 from Flinders Reef, QM-I36485 from Manta Ray Bommie and QM-I37652 from Shag Rock.
99. Voucher QM-I36504.
100. Vouchers QM-I20990 and QM-I26924.
101. Undescribed species determined by H. Motomura.
102. Voucher QM-I25732. Undescribed species determined by H. Motomura.
103. Listed as *S. scaber* (Ramsay & Ogilby) by Johnson (1999: 727).
104. Voucher QM-I37654.
105. Misidentified as *S. gibbosa* (Bloch & Schneider) by Johnson (1999: 727). Vouchers QM-I29869 from Moreton Bay, QM-I31136 from Southport Seaway and QM-I38359 from Flinders Reef.
106. Voucher QM-I36480.
107. Voucher QM-I36413.
108. Voucher QM-I36412.
109. Voucher QM-I34047.
110. Voucher QM-I34221 and QM-I34263.
111. Voucher AMS-IA.7380 from Southport.
112. Voucher QM-I38350 from Flinders Reef. Probable undescribed species, distinguished from *P. vespa* Ogilby by narrower interorbital ridges, smaller eye, and slightly higher pectoral-fin ray count.
113. Misidentified as *B. curtisensis* Whitley, 1933 by Johnson (1999: 728).
114. Listed as C. sp. by Johnson (1999: 728).
115. Voucher QM-I34184.
116. Voucher QM-I33277.
117. Imamura (2008) has determined that *P. arenarius* Ramsay & Ogilby is a junior synonym of *P. endrachtensis* Quoy & Gaimard. Furthermore, he found that the species with 3 or 4 dark bands to the caudal fin and a yellow blotch on the upper caudal lobe, previously misidentified as '*P. endrachtensis*' (eg Hoese *et al.* 2006: 941), should be referred to *P. westraliae* (Whitley).
118. Imamura (2008) has shown that *P. westraliae* (Whitley) is the correct name for the species recently misidentified as '*P. endrachtensis*' (eg Hoese *et al.* 2006: 941).
119. Voucher QM-I33260.
120. Voucher QM-I36456.
121. Vouchers QM-I29809 from Curtin Artificial Reef and QM-I38728 from Southport Seaway.
122. Voucher QM-I37642.
123. Voucher QM-I11521.
124. Known only by 2 specimens collected prior to 1917.
125. Voucher QM-I17827. Reports of *C. schlegelii* (Günther) from eastern Australia are referable to this species.
126. Extends north to Barwon Banks (26°40'S), QM-I17873.
127. Extends north to off Peregian Beach (26°27'S), QM-I34148.
128. Voucher QM-I38666, trawled in 110 m off Cape Moreton.
129. Voucher QM-I37740.
130. Probable undescribed species, distinguished by colouration: head mostly reddish pink above and yellow below; two oblique pink stripes, extending from upper and lower margins of eye posteriorly to pectoral fin base; body red, infused with pink and yellow; dorsal fin mostly yellow, but with red spine tips and rays; caudal fin red and yellow, lobes with broad pink tips. Voucher QM-I38668, trawled in 110 m off Cape Moreton.
131. Voucher QM-I17619 from Flinders Reef. An adult also photographed at the South Wall, Southport Seaway.
132. Voucher QM-I12193.
133. Voucher QM-I19525.
134. Voucher QM-I5212.
135. Voucher QM-I20719.
136. Only record from coastal Moreton Bay is holotype of *E. viridipinnis* De Vis, 1884.
137. Voucher QM-I31307.
138. Voucher QM-I38667, trawled 110 m off Cape Moreton.
139. Voucher a paratype, QM-I10783.
140. Voucher QM-I31165.
141. Voucher QM-I29158.
142. Known only by the holotype of *P. wildii* Ogilby, 1908, QM-I784.
143. Voucher QM-I38338 from Flinders Reef.
144. Voucher QM-I29968.
145. Reported south to Moreton Bay by Hoese *et al.* (2006). Extends to Tweed River (28°10'S), QM-I31832.
146. Voucher QM-I31177.
147. Vouchers QM-I37643 and QM-I37708.
148. Voucher QM-I25721.
149. Voucher QM-I36436 and QM-I37640.
150. Voucher QM-I29873.
151. Voucher QM-I33257.
152. Misidentified as *A. fuscus* Quoy & Gaimard, 1824 by Johnson (1999: 732). Vouchers QM-I29745, QM-I30419 and QM-I31334.

153. Voucher QM-I37641.

154. Similar to *A. crassiceps* Garman, but differs in colouration and has more rounded head and snout, deeper body and stouter caudal peduncle. Voucher QM-I29156.

155. Confused with *F. brachygramma* Jenkins in previous reports from southern Qld.

156. Voucher QM-I29877 and QM-I30357.

157. Voucher QM-I37645, from Shag Rock.

158. Voucher QM-I29193.

159. Voucher QM-I25737.

160. New record for east coast of Australia. Vouchers QM-I30187, QM-I33164 and QM-I33167, from off Moreton and Stradbroke Is. in depths of 73–91 m.

161. Voucher QM-I29546.

162. Voucher QM-I22345.

163. Voucher QM-I34337.

164. Voucher QM-I16670.

165. Only record QM-I2158, collected in 1914.

166. Voucher QM-I31372.

167. Voucher QM-I30933.

168. Voucher QM-I26892.

169. Voucher QM-I3118.

170. Smith-Vaniz & Jelks (2006) report that the Qld and Lowe Howe I. population of *Pseudocaranx* may represent an undescribed species.

171. Voucher QM-I29835.

172. Reports from unpublished fisheries data extend range north to Wide Bay (25°50′S).

173. Voucher QM-I10609.

174. Reported by Johnson (1999: 735) as *Leiognathus decorus* (De Vis). Voucher QM-I25332.

175. Two specimens beach-washed on Stradbroke Island, QM-I9632 and QM-I36644.

176. Vouchers QM-I33202 and QM-I 34106.

177. Voucher QM-I21059.

178. Voucher QM-I17819.

179. Voucher QM-I28593.

180. Vouchers QM-I31102-04.

181. Reported from Moreton Bay by Ogilby (1916b).

182. Voucher QM-I26072.

183. Only record QM-I3071.

184. Voucher QM-I30321.

185. Vouchers QM-I15377-78.

186. *P. unicolor* (Macleay) may be a valid name for a closely related species occurring widely throughout the Indo-west Pacific outside of the Red Sea.

187. Voucher QM-I20171.

188. Voucher AMS-I18667-001.

189. Vouchers QM-I10589 and QM-I14777.

190. Voucher QM-I38083.

191. Listed as *P. sheridani* (Macleay) by Johnson 1999: 743). In 2007 numerous specimens up to 15 kg were noted in the Brisbane River after a fish kill. Voucher QM-I8042.

192. Reported as *J. novaehollandiae* (Steindachner) by Johnson (1999: 737).

193. Reported as *J. vogleri* (Bleeker) by Johnson (1999: 737).

194. Reported by Ogilby (1918). Voucher QM-I3173.

195. Photographs of a subadult at Wavebreak Island and a juvenile at the Southwest Wall.

196. Three subadults photographed at Wavebreak I.

197. Voucher QM-I31001.

198. Almost certainly confused with *U. tragula*, Richardson in previous reports on fishes of the area. Readily diagnosed from congeners by dorsal spine count of seven, with the first spine longest (versus dorsal spines eight, initial spine minute and inconspicuous) and low gill raker count (total rakers on first arch 22–23).

199. Extends south to at least Cook Island, NSW (28°10′S), based on photograph by I. Banks.

200. Voucher QM-I31012.

201. Vouchers QM-I30439 and QM-I31353 from Amity Point and QM-I31164 from Southport Seaway.

202. Voucher QM-I30438.

203. Voucher QM-I1015.

204. Vouchers QM-I8997 and QM-I13601 taken NE of Cape Moreton in 106–128 m.

205. Voucher QM-I10529.

206. Listed as *C. trifasciatus* Park by Johnson (1999: 739).

207. Photograph identified by G.R. Allen.

208. One visual record from Myora only.

209. Voucher QM-I19751.

210. Voucher QM-I1861.

211. Voucher QM-I10507.

212. Reported by Ogilby (1915). One visual record from Myora.

213. Voucher QM-I10591.

214. Voucher QM-I33351.

215. Voucher QM-I22660.

216. Vouchers QM-I36514 from Flinders Reef and QM-I8703 from Flat Rock.

217. Occasionally taken by anglers off the eastern beaches of Stradbroke and Moreton Islands.

218. Distributed widely throughout northern Australia, from at least Shark Bay, WA to Moreton Bay, Qld. Generally included in *Pelates*, but differs by a narrower body, tricuspid versus unicuspid teeth, and fewer gill rakers (total on first arch 21–24 versus 35–44). It is closely related to *H. octolineatus* Jenyns, 1840, from SA and southern WA. Voucher QM-I30884.

219. Most reports of *P. quadrilineatus* (Bloch) from MBMP are almost certainly based on misidentifications of *P. sexlineatus*. *P. quadrilineatus* is distinguished by longer dorsal-fin spines, a dark blotch in the spinous dorsal fin, a distinct (versus vague or absent) large black spot on the shoulder, and an additional half stripe on the sides, that extends through the shoulder spot. The latter has recently been confirmed from Moreton Bay (voucher QM-I38783), but appears to be rare south of Wide Bay.

220. Voucher QM-I38748.

221. Voucher QM-I36422.

222. Voucher QM-I12097. Extends north to Mudjimba Island (26° 37'S), QM-I8605.

223. Vouchers QM-I5145, QM-I5155-56, QM-I12073 and QM-I38682 from off Moreton Island.

224. First record for east coast of Australia. Voucher QM-I21141.

225. Visual records from off Smith Rock in 30 m.

226. Report from coastal area of Moreton Bay by Johnson (1999: 743) based on old QM specimens with imprecise locality data of 'Moreton Bay'.

227. Five males recorded; distinctive by dark anterior half of body contrasting with pale posterior half, small white patch above and behind eyes, falcate pelvic fins and strongly lunate caudal fin.

228. Voucher QM-I30430.

229. Voucher QM-I31015.

230. Visual records of one large specimen resident at Flat Rock in recent years.

231. Several recorded on baited underwater video near Flinders Reef and Flat Rock.

232. Voucher QM-I37658.

233. Both the common brown and yellow colour forms have been visually recorded.

234. Vouchers QM-I28134 and QM-I28595.

235. Voucher QM-I28106.

236. One visual record from Myora.

237. Two specimens from off Caloundra, QM-I4376-77.

238. Voucher QM-I37736.

239. Listed as *T. jansenii* (Bleeker) by Johnson (1999: 745).

240. Voucher QM-I28612.

241. Voucher QM-I15998.

242. Spearfishing record for Qld, taken on 4.2.1996 (McDade 2008).

243. Voucher QM-I14978.

244. Spearfishing record for Qld, taken on 13.11.1994 (McDade 2008).

245. Spearfishing record for Australia, taken on 23.9.2005 (McDade 2008).

246. Common locally in freshwater and upper estuarine conditions, but also recorded at the mouth of the Brisbane River.

247. Previously recorded north to Moreton Bay, but extends to at least the wreck of the ex HMAS Brisbane, off Mooloolaba (26° 37'S).

248. Voucher QM-I38348 from Flinders Reef.

249. Voucher QM-I21664, from Caloundra Head.

250. Voucher QM-I8993.

251. Vouchers QM-I27601 and QM-I37617.

252. Voucher QM-I2547. Extends north to Murphy's Reef (26°40'S), QM-I31320.

253. Voucher QM-I37742.

254. Voucher QM-I37624.

255. Vouchers QM-I37623 from Shag Rock and QM-I29887 from Myora.

256. Easily confused with *P. coelestis* and *P. australis* in visual surveys.

257. Voucher QM-I25718.

258. Voucher holotype, QM-I33274 from off Cape Moreton in 86 m.

259. Entered as *Parapercis* sp. 3 of Johnson in CSIRO Codes for Australian Aquatic Biota.

260. Uncommon in MBMP, but commonly trawled in depths of 98–132 m to the near north.

261. Voucher QM-I19402.

262. Vouchers QM-I30958 and QM-I33199.

263. Probable undescribed species determined by M. Gomon (pers com.). Vouchers QM-I9716-17, from off Cape Moreton in 118 m.

264. Voucher QM-I37669 from Shag Rock.

265. Voucher QM-I38362 from Flinders Reef.

266. Listed as *E. hemimelas* (Kner & Steindachner) by Johnson (1999: 747).

267. Vouchers QM-I29165 and QM-I29245 from Tangalooma Wrecks.

268. Vouchers QM-I38311 and QM-I38361 from Flinders Reef.

269. Identified as *H.* sp 7 of Fricke (1997).

270. Known in the area only by QM-I29671 from Redcliffe, collected in early 1900s.

271. Reported as *N. thomasi* Whitley by Johnson (1999: 747).

272. Vouchers QM-I37668 from Shag Rock and QM-I37712 from Manta Ray Bommie.

273. Voucher QM-I29753, from Amity Point.

274. Vouchers QM-I7514 and QM-I10646, from Southport.

275. Determined as an undescribed species by D. Hoese. Voucher QM-I34404.

276. Voucher QM-I38469.

277. Voucher QM-I38466.

278. Voucher QM-I36434, from Flat Rock.

279. Voucher QM-I37703, from Manta Ray Bommie.

280. Voucher QM-I37664, from Shag Rock.

281. Voucher QM-I31301, from Frenchmans Bay, Point Lookout.

282. Voucher QM-I25243, from Brisbane River mouth.

283. Compares closely with *C. australis* from Western Australia. Vouchers QM-I33041 and QM-I33163, from off Cape Moreton in 73–75 m.

284. Voucher QM-I38416 from South Wall in 15 m. Also photographed at Wavebreak Island.

285. Vouchers QM-I33075 and QM-I34043, from depths of 98–163 m.

286. Vouchers QM-I31027, QM-I31093 and QM-I31190 identified by H. Larson.

287. Voucher QM-I31370.

288. Confirmed from a photograph taken in an estuarine creek on North Stradbroke Island in January 2010.

289. Vouchers QM-I27039 and QM-I31097.

290. Reported from Moreton Bay by Young & Wadley (1979) and Hoese *et al.* (2006:1617). Occurs north to Maroochy River (26°37'S), QM-I38587.

291. Voucher QM-I30961 from Tangalooma Point.

292. Identified as *A.* sp. 4 by H. Larson. Five specimen lots in QM.

293. Voucher QM-I37637 from Shag Rock.

294. Undescribed species referred to as *C.* sp. 6 by D.F. Hoese.

295. Vouchers QM-I13628, QM-I14198 and QM-I29715, trawled in Moreton Bay.

296. Reported as *Brachyamblyopus rubristriata* (Saville-Kent) by Johnson (1999: 749). Distinguished from *C. urolepis* by more elongate body and total lack of scales on head and body. Common in estuaries of Moreton Bay. Fifteen lots in QM.

297. Vouchers QM-I8152, QM-I26356 and QM-I35775.

298. Vouchers QM-I31278-79 identified by H. Larson. Reported as *Calamiana* sp. by Johnson (1999: 748).

299. Vouchers QM-I31132 from Southport Seaway, QM-I38340 from Flinders Reef and QM-I36438 from Flat Rock. According to Greenfield & Randall (2010) records of *E. albolineata* Jewett & Lachner from Australian waters are referable to *E. guttata*.

300. Vouchers QM-I36475, QM-I37678 and QM-I37750 from Flat Rock.

301. Vouchers QM-I36437 and QM-I37751 from Flat Rock and QM-I38356 from Flinders Reef.

302. Vouchers QM-I16708, QM-I17913, QM-I29226 and QM-I30165, identified by D.F. Hoese.

303. Vouchers QM-I37662 from Shag Rock and QM-I37744 from Manta Ray Bommie.

304. Reported as *G.* sp. by Johnson (1999: 749).

305. Voucher QM-I37671 from Shag Rock.

306. Voucher QM-I37662 from Shag Rock.

307. Vouchers QM-I29150 and QM-I29748. Extends south to Tweed River mouth, NSW, QM-I31829.

308. Voucher QM-I38747.

309. Three records, all obtained in May 2010. QM-I38681 and QM-I38706, trawled off Redcliffe, and photographs of a specimen trawled in the Broadwater, between Woogoompah and South Stradbroke Is.

310. Nine lots trawled from Moreton Bay in QM.

311. Only records QM-I2738, collected in 1895, and report by Castelnau (1878).

312. Voucher QM-I38341 from Flinders Reef.

313. Voucher QM-I29805, from Curtin Artificial Reef.

314. Voucher QM-I37760, from Shag Rock.

315. Voucher QM-I30695.

316. Voucher AMS-I17125–001, also visual record of a small school at Tangalooma Wrecks in January 2009.

317. Voucher QM-I29234 from Tangalooma Wrecks.

318. Known in the area only by one lot, QM-I2614, collected in 1916.

319. Voucher QM-I11610.

320. Voucher QM-I14976, from Flinders Reef.

321. Vouchers QM-I28609-10, from Flinders Reef.

322. Vouchers QM-I3169 and QM-I6692.

323. Vouchers QM-I29792, QM-I31314 and QM-I30372.

324. Voucher QM-I27620, from Flinders Reef.

325. Voucher QM-I31169.

326. Vouchers QM-I10540 and QM-I11429.

327. Voucher QM-I15375, from Flinders Reef.

328. Vouchers QM-I30831, QM-I30934 and QM-I32638, from Flat Rock.

329. Vouchers QM-I20048 and QM-I20712, from Flinders Reef.

330. Voucher QM-I18478, from Flinders Reef.

331. Voucher QM-I22237, from Flinders Reef.

332. Voucher QM-I37227, from Cape Moreton.

333. Reported by Ogilby (1912), on the basis of six fish market specimens from off Moreton Bay. Voucher QM-I71.

334. Voucher QM-I28196, from Flinders Reef.

335. Vouchers QM-I26378 and QM-I38246.

336. Specimen caught by handline in 140 m off Cape Moreton in May 2008.

337. Reported as *C. squamiceps* (Lloyd) by Johnson (1999: 752).

338. New record for Australia based on three lots from off Cape Moreton in depths of 104–148 m, QM-I33027, QM-I34230 and QM-I34339.

339. Voucher QM-I37463, from off Moreton Island.

340. Known in coastal Moreton Bay area only by the holotype, QM-I1557. More regularly trawled in offshore waters.

341. Voucher QM-I32713 from off Cape Moreton.

342. Known in the area only by the holotype, QM-I1569.

343. Voucher QM-I37610, from Shag Rock.

344. Voucher QM-I38784, from off Stradbroke Island.

345. Voucher QM-I38266, from off Caloundra in 120 m.

346. Reported as *Aseraggodes* sp. by Johnson (1999: 752). Voucher QM-I29807, from Curtin Artificial Reef.

347. Reported as *Dexillichthys* sp. by Johnson (1999: 752). Vouchers QM-I11440 and QM-I26926.

348. Vouchers QM-I12355, QM-I12392 and QM-I12550.

349. Reported by Stephenson & Burgess (1980).

350. Voucher QM-I30210.

351. Identified as *C.* sp.1 'punctate' by T. Munroe in 2007. Vouchers QM-I14491 and QM-I30161.

352. Identified as *C.* sp. 'cf *sibogae*' by T. Munroe in 2007. Voucher QM-I36491.

353. Identified as *C.* sp. 'long snout' by T. Munroe in 2007. Vouchers QM-I29517-19.

354. Identified as *C.* sp. 4 by T. Munroe in 2007. Voucher QM-I34197.

355. Ten lots in QM. Voucher QM-I26383.

356. Most recently regarded as a junior synonym of *P. bilineata* (Bloch), it is here treated as a distinct species based on differences in branching of the labial papillae, number of lateral lines, and colouration. Reported as *P.* sp. by Johnson (1999: 753).

357. Identified from MBMP area by photographs, but several QM specimens to the near north of the area.

358. Reports of *Triacanthus biaculeatus* (Bloch) by Stephenson & Burgess (1980) and Johnson (1999: 753) were almost certainly based on misidentifications of this species.

359. Known only by QM-I303, collected in 1912.

360. Vouchers QM-I19183, QM-I26593 and QM-I31000, from Flinders Reef.

361. Seventeen lots from MBMP area in QM.

362. Voucher QM-I10788.

363. Vouchers QM-I10749 from Dunwich and QM-I30366 from Myora.

364. Extends north to Noosa (26°21'S), QM-I12666.

365. Voucher QM-I12382.

366. Voucher QM-I11427.

367. One specimen photographed at the South Wall.

368. Recently distinguished from *C. coronata* (Vaillant & Sauvage) by Randall *et al.* (2008).

369. Often confused with *L. spadiceus* (Richardson), which appears to be distributed in more northern waters of Queensland.

370. Vouchers QM-I10876, QM-I10882 and QM-I38750.

371. Known in area only by QM-I344, collected in 1912.

DISCUSSION

The total of 1,190 species listed here for MBMP is 440 (58.7%) higher than that recorded by Johnson (1999) for Moreton Bay, mainly due to the inclusion of species from the more diverse offshore reefs around Flinders Reef and Flat Rock, and species from greater depths in offshore waters. The species total listed here for coastal Moreton Bay is almost identical to the number recorded by Johnson (1999), however the composition of the current list differs through the inclusion of subsequent new records, and exclusion of doubtful records, misidentifications and records exclusive to the Southport Seaway. The area from Comboyuro Point to Cape Moreton and west to Caloundra Head and Skirmish Point added minimally to the number of species recorded from coastal Moreton Bay. Only three species were exclusive to the additional area. *Thysanophrys cirronasus, Carangoides oblongus* and *Chrysiptera glauca,* all from Caloundra Head, were each recorded by a single lot. Within MBMP, 238 species were exclusive to the area defined as coastal Moreton Bay.

The following records, regarded as doubtful in Johnson (1999), have since been determined as invalid and are here excluded from MBMP:

Heterodontus portusjacksoni (Meyer) — no vouchers; probable misidentification of *H. galeatus* in litt. (Saville-Kent 1897: 193).

Galeorhinus galeus (Linnaeus) — no extant vouchers; probable misidentification.

Carcharhinus melanopterus (Quoy & Gaimard) — no vouchers; probable misidentification in litt. (Ogilby 1908b; 1916a).

Cymbacephalus staigeri (Castelnau) — no vouchers; not verified from south of the Great Barrier Reef.

Inegocia harrisi (McCulloch) — no vouchers; misidentification of *I. japonica.*

Plesiops corallicola Bleeker — single voucher, but locality data probably in error.

Amniataba caudavittata (Richardson) — no extant vouchers; locality in litt. probably in error (Ogilby & McCulloch 1916).

Acreichthys tomentosus (Linnaeus) — single voucher, but locality data probably in error.

Other species recorded by Johnson (1999), but removed from this list include:

Himantura granulata (Macleay) — no vouchers; not verified south of Great Barrier Reef; locality of Brisbane in litt. (Last & Stevens 1994: 402) in error.

Scorpaenopsis gibbosa (Bloch & Schneider) — misidentification of *S. diabolus.*

Table 2. Species counts by location for the fifteen most speciose families in Moreton Bay Marine Park (MBMP). Abbreviations: Flinders = Flinders Reef area, Flat R. = Flat Rock area, Southport = Southport Seaway, Offshore = Offshore in 40–200 m.

Family	Coastal Bay spp.	Flinders spp.	Flat R. spp.	Southport spp.	Offshore spp.	MBMP		
						genera	spp.	% total
Labridae	44	60	48	35	5	32	81	6.8
Gobiidae	49	10	15	16	1	42	64	5.4
Pomacentridae	38	39	35	27	2	13	53	4.5
Serranidae	20	30	17	17	10	15	47	3.9
Carangidae	35	21	9	19	6	20	43	3.6
Chaetodontidae	28	27	23	19	2	9	37	3.1
Apogonidae	20	15	13	15	1	8	34	2.9
Tetraodontidae	21	10	10	12	10	9	31	2.6
Lutjanidae	16	20	12	9	6	8	27	2.3
Acanthuridae	10	23	18	15	–	6	26	2.2
Blennidae	14	8	13	10	–	14	25	2.1
Monacanthidae	15	12	12	11	8	17	24	2.0
Scorpaenidae	12	12	17	14	5	9	23	1.9
Muraenidae	12	10	10	8	1	4	23	1.9
Syngnathidae	13	1	5	7	3	15	20	1.7
Total	**347**	**298**	**257**	**234**	**60**	**221**	**558**	**46.9**

Odax cyanomelas (Richardson) — probable misidentification in litt. (Ogilby 1908a).

Chromis viridis (Cuvier) — misidentification of old QM specimen of *C. atripectoralis*.

Dischistodus fasciatus (Cuvier) — old specimen in poor condition; probable misidentification.

Peronedys anguillaris Steindachner — locality of single voucher erroneous.

Petroscirtes variabilis Cantor — misidentification of *P. lupus*.

Triacanthus biaculeatus (Bloch) — misidentification of single juvenile AMS specimen of *Tripodichthys angustifrons*.

Four species usually found in in depths greater than 40 m were recorded by Johnson (1999) based only on old QM specimens with imprecise locality data of 'Moreton Bay' or 'Off Moreton Bay'. In this study *Heterodontus galeatus*, *Centroberyx affinis*, *Optivus agastos* and *Bodianus unimaculatus* are removed from coastal Moreton Bay, but listed for the deeper offshore zone.

Species composition of the Flinders Reef area (477 spp.) varies considerably from that of the Flat Rock area (420 spp.) (Table 2). Within the MBMP, 95 species were recorded only around Flinders Reef, while 50 were exclusive to the Flat Rock area. Variation in the occurrence of the species of some families may be partially explained by differing emphasis of sampling methodologies employed between the two areas. Historically, collectors that have lodged specimens at the QM have more intensively sampled Flinders Reef by hook and line and spear, hence groups most susceptible to these methods, such as serranids, carangids and lutjanids, may be disproportionately well documented compared to Flat Rock. However, it is to be expected that the more extensive and complex coral communities at Flinders Reef would support a greater diversity of some groups, especially labrid, scarid and acanthurid fishes. Reefs around Flat Rock appear to hold slightly more diverse communities of some other groups, including scorpaenid, blennid and gobiid fishes.

Southport Seaway is clearly the smallest of the five areas treated here, and has the least complex habitat composition. Despite this, 404 species were recorded, 23 of which were not recorded elsewhere in the MBMP. The relatively high diversity of species in this area is probably due

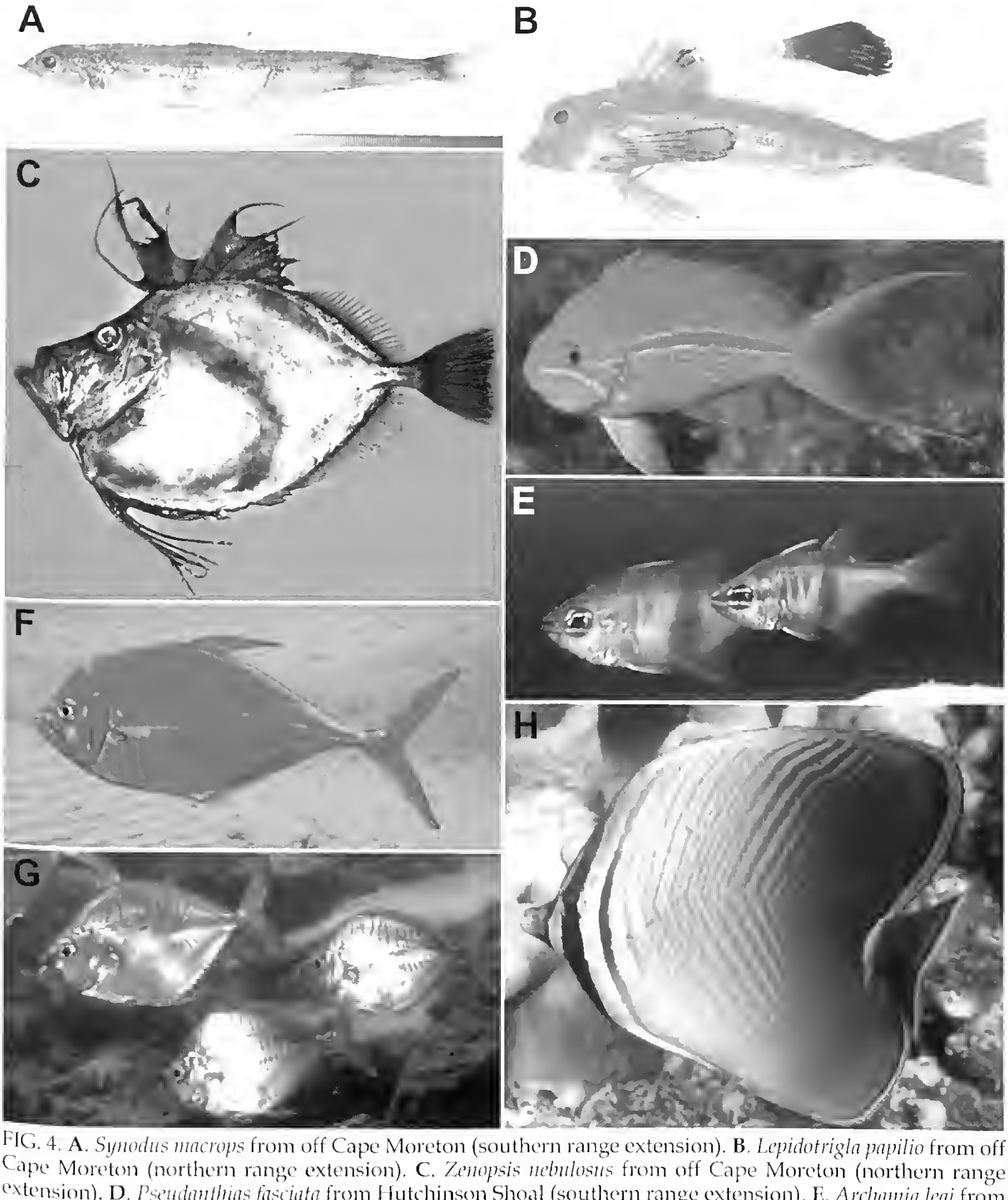

FIG. 4. A. *Synodus macrops* from off Cape Moreton (southern range extension). B. *Lepidotrigla papilio* from off Cape Moreton (northern range extension). C. *Zenopsis nebulosus* from off Cape Moreton (northern range extension). D. *Pseudanthias fasciata* from Hutchinson Shoal (southern range extension). E. *Archamia leai* from Flinders Reef (southern range extension). F. *Ulua mentalis* from Southport Seaway (southern range extension). G. *Leiognathus fasciatus* from Southport Seaway (southern range extension). H. *Chaetodon baronessa* from Flinders Reef (southern range extension). Photos: A–C by D. Roy; D & F–H by I. Banks; E by J. Jensen.

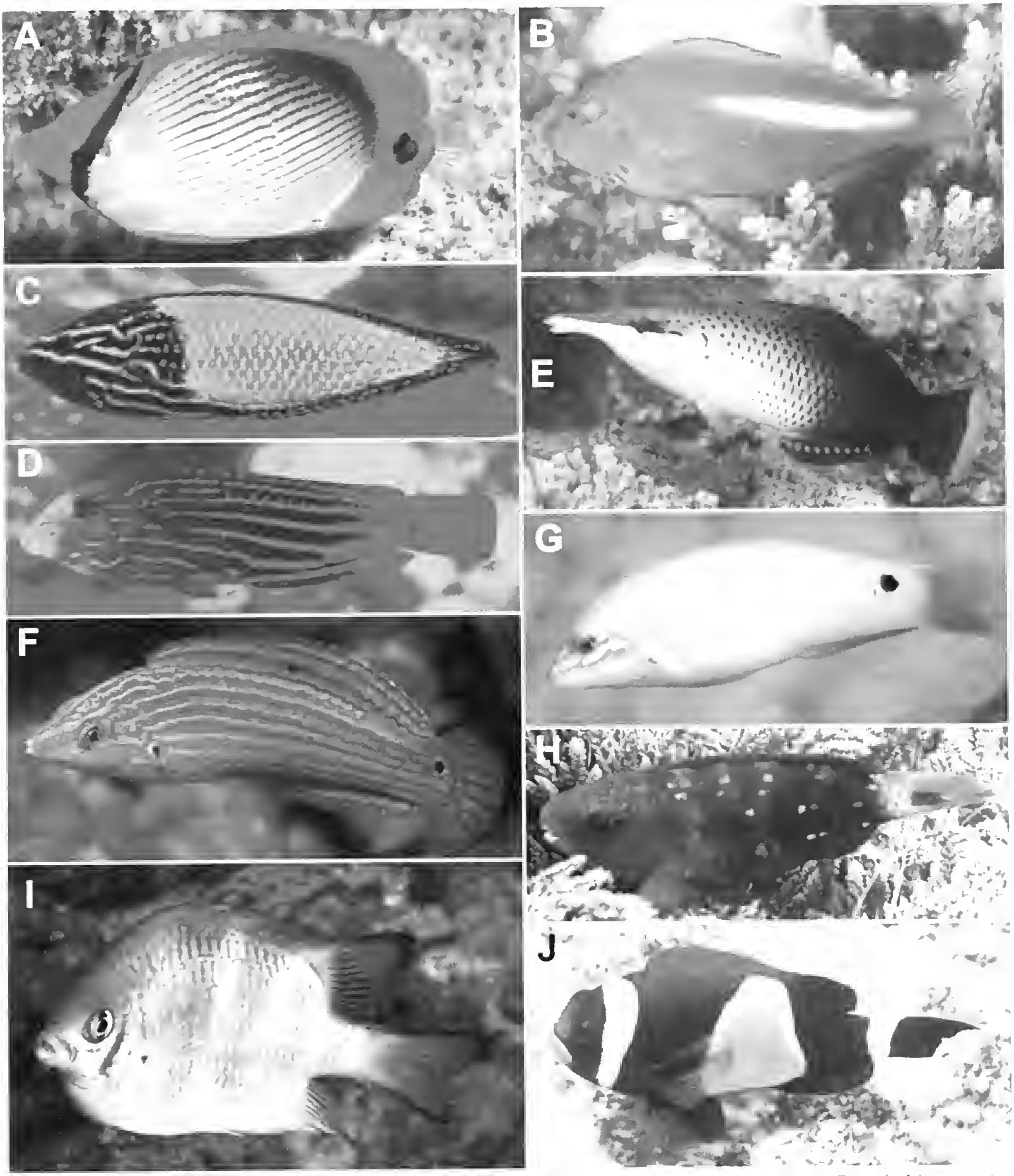

FIG. 5. A. *Chaetodon ocellicaudus* from Southport Seaway (southern range extension). B. *Paracirrhites arcatus* from Hutchinson Shoal (southern range extension). C & D. *Anampses femininus* (male & female pair) from Flinders Reef (northern range extension). E. *Gomphosus varius* from Flinders Reef (southern range extension). F. *Halichoeres melanurus* from Flinders Reef (southern range extension). G. *Halichoeres trimaculatus* from Southport Seaway (southern range extension). H. *Chlorurus sordidus* from Flinders Reef (southern range extension). I. *Amblyglyphidodon curacao* from Flinders Reef (southern range extension). J. *Amphiprion latezonatus* from Flat Rock. All photos I. Banks.

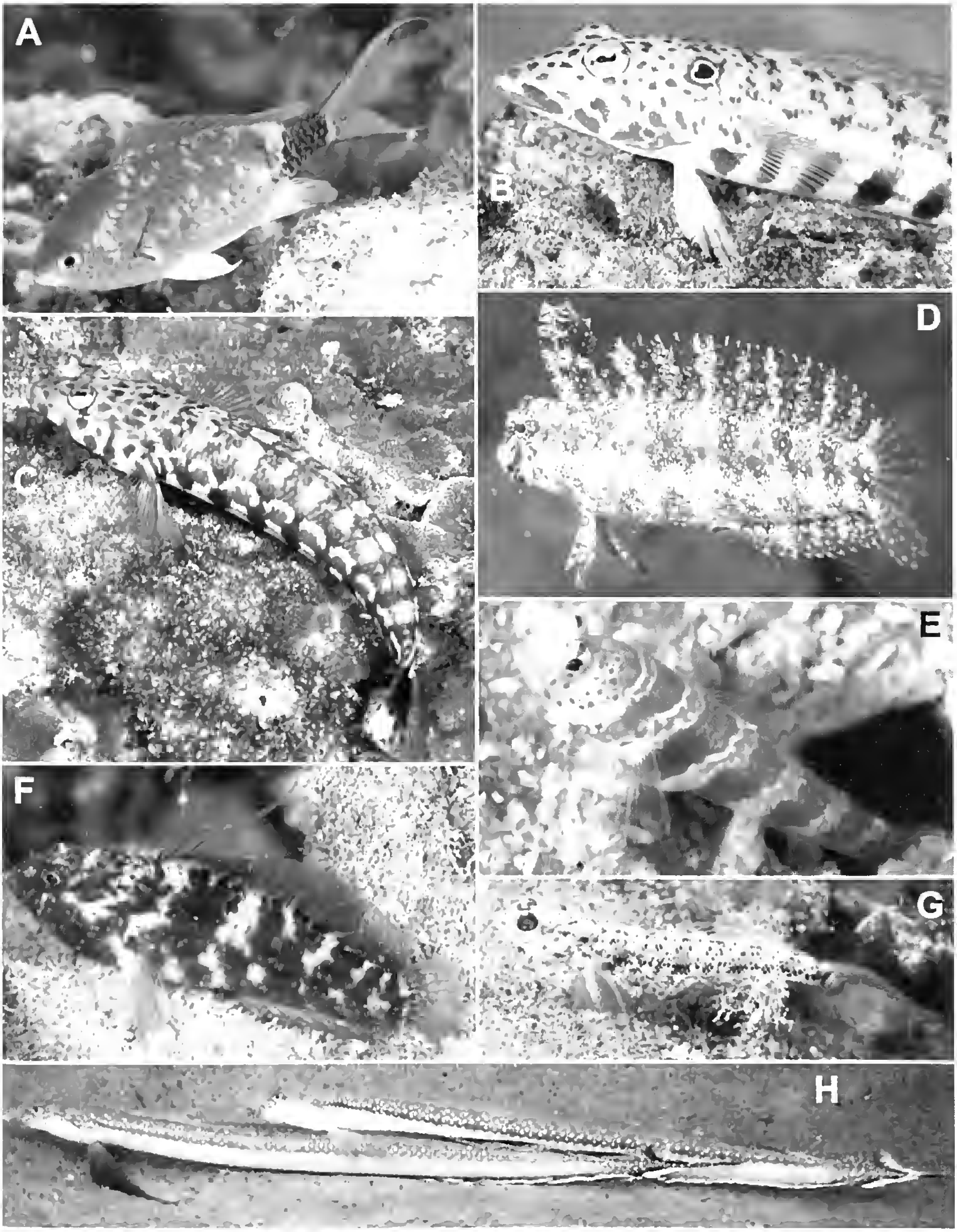

FIG. 6. A. *Chromis atripectoralis* from Flinders Reef (southern range extension). B. *Parapercis clathrata* from Flinders Reef (southern range extension). C. *Parapercis millepunctata* from Flinders Reef (southern range extension). D. *Petroscirtes mitratus* from Southport Seaway (southern range extension). E. *Amblyeleotris wheeleri* from Flinders Reef (southern range extension). F. *Asterropteryx semipunctatus* from Southport Seaway. G. *Vanderhorstia ornatissima* from Southport Seaway (southern range extension). H. *Trichonotus setiger* from Southport Seaway (southern range extension). All photos I. Banks.

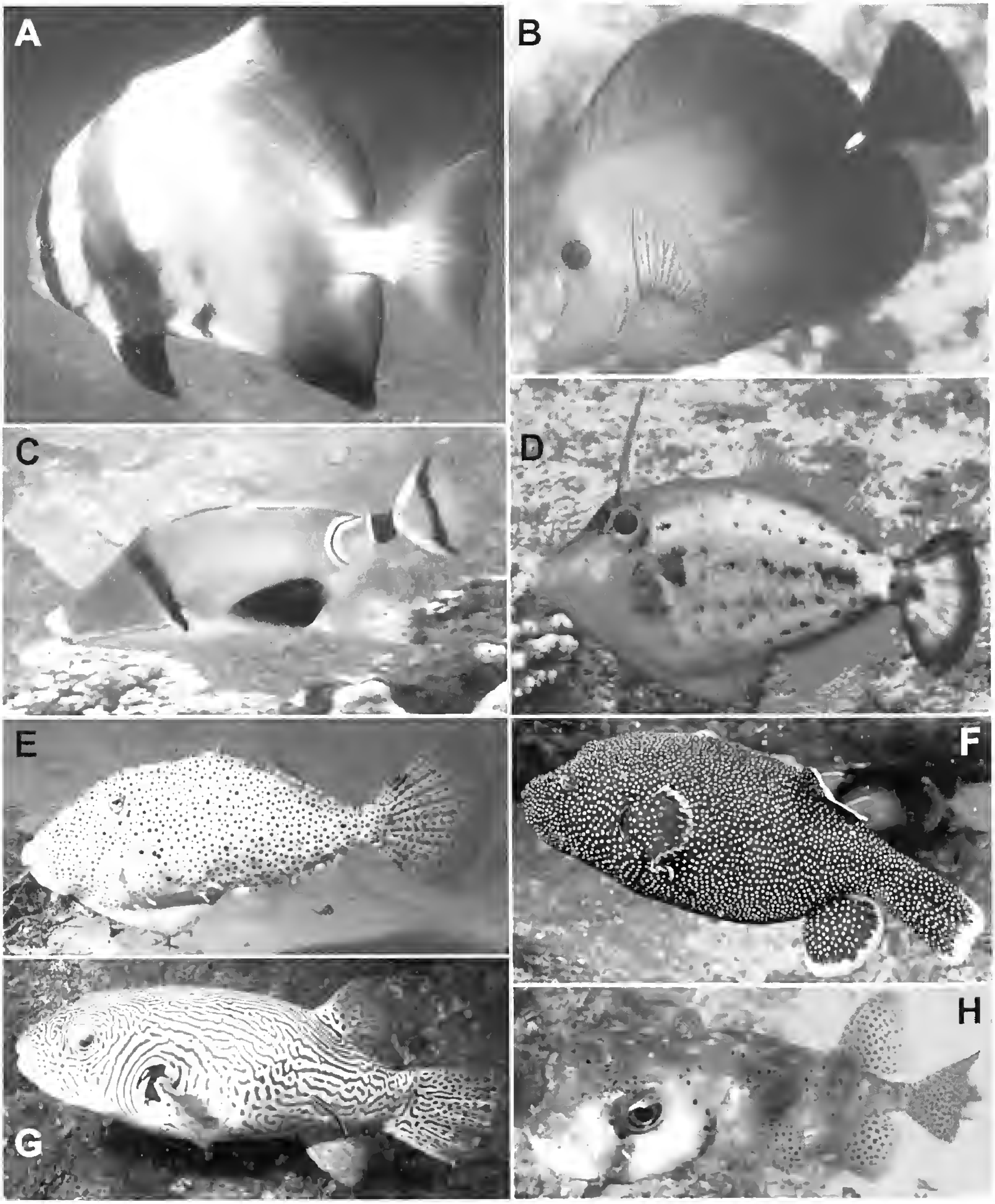

FIG. 7. A. *Platax batavianus* from Tangalooma Wrecks (southern range extension). B. *Zebrasoma scopas* from Flinders Reef (southern range extension). C. *Rhinecanthus lunula* from Flinders Reef. D. *Cantherhines fronticinctus* from Flinders Reef. E. *Pseudomonacanthus peroni* from Southport Seaway (southern range extension). F. *Arothron meleagris* from Flat Rock (southern range extension). G. *Arothron reticularis* from Southport Seaway. H. *Chilomycterus reticulatus* from Shag Rock. Photos: A, B, D–H by I. Banks; C by J. Jensen.

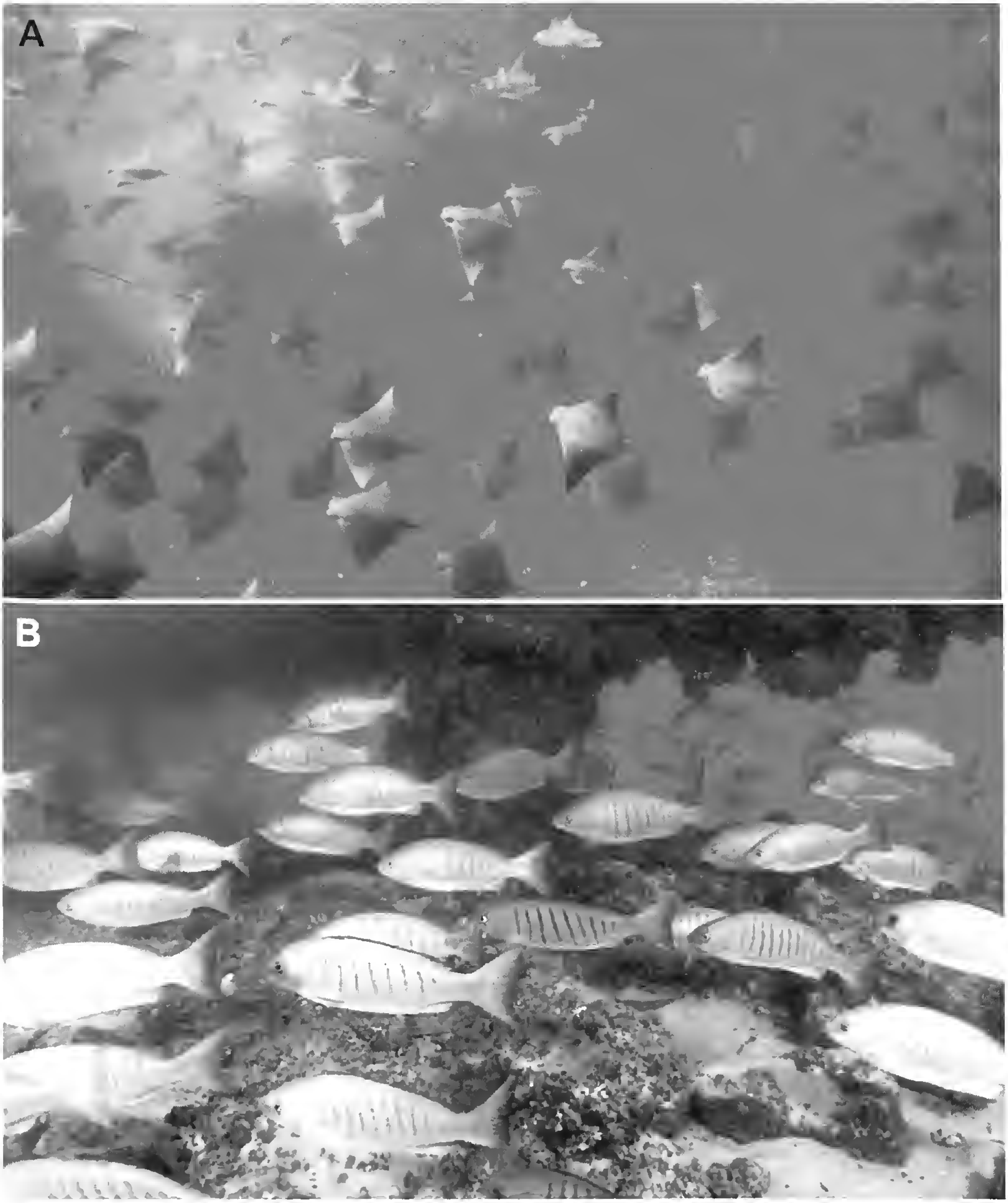

FIG. 8. **A**. *Rhinoptera neglecta* aggregating at the mouth of the Southport Seaway in May 2007. **B**. *Girella tricuspidata* schooling around the cross-channel sandpipe at the Southport Seaway. Photos: I. Banks.

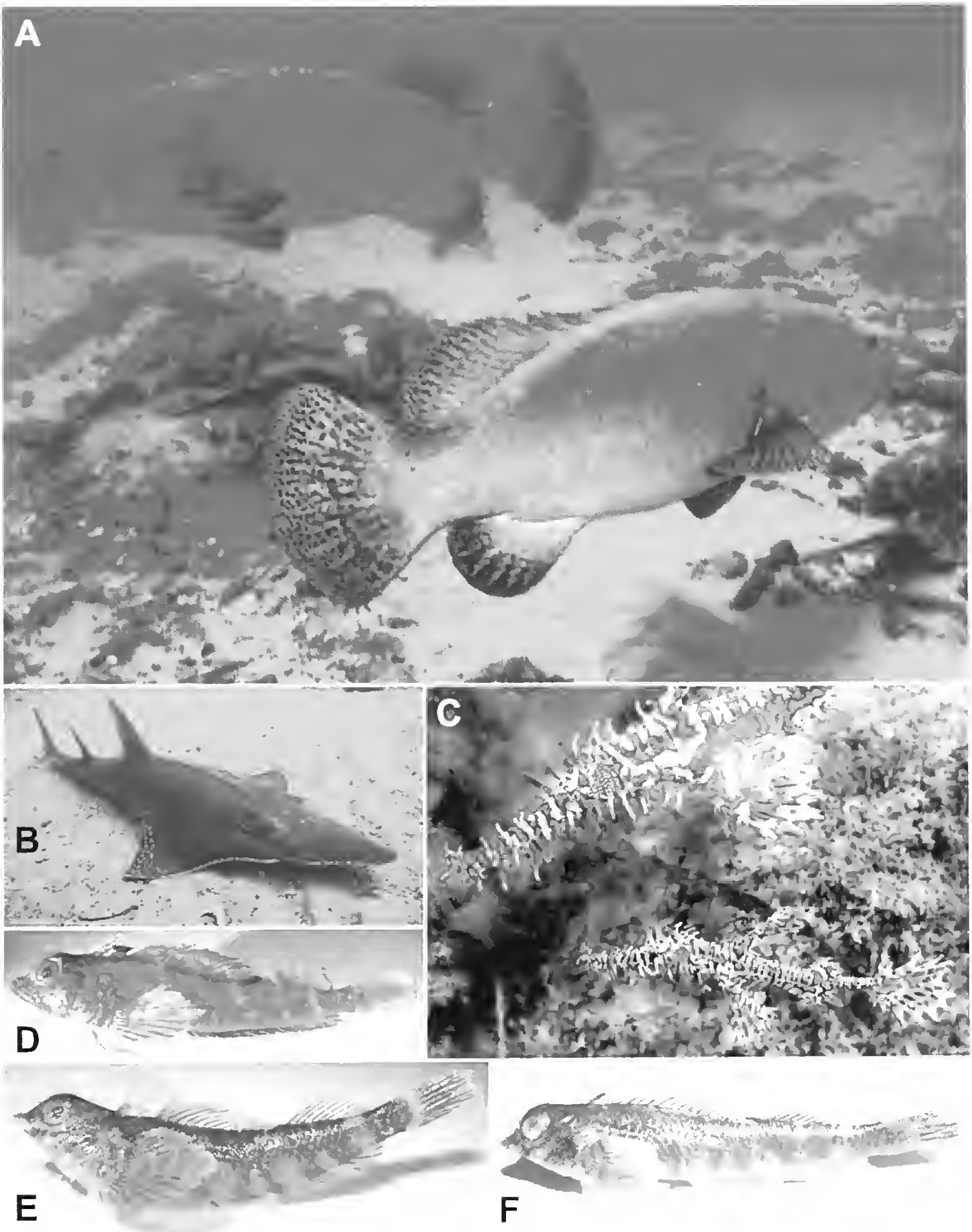

FIG. 9. A. Several of a group of eight large *Epinephelus lanceolatus* at the north-east wall, Southport Seaway in March 2008. B. One of a group of twelve *Rhynchobatus laevis* at the Southport Seaway entrance in November 2008. C. Pair of *Solenostomus paradoxus* at the Southport Seaway, in December 2006. D. *Helcogramma* sp. 1, male, QM-I38310 from Flinders Reef. E. *Enneapterygius* sp. 1, female, QM-I38311 from Flinders Reef. F. *Enneapterygius* sp. 1, male, QM-I38311 from Flinders Reef. Photos A–C by I. Banks.

to a combination of good water quality, low turbidity and nutrient rich outflow from the Nerang River estuarine system, regular inflow and flushing from clean oceanic water, and extensive boulder walls, which together provide an environment favoured by a wide range of fishes. Observations made during this study (many logged on video), indicate that this area hosts regular seasonal aggregations of a number of species that are not commonly recorded in other parts of MBMP, or more widely in southern Queensland. Whitespotted Guitarfish (*Rhynchobatus laevis*) (Fig. 9B), whiprays (*Himantura fai* and *H. uarnak*) cownose rays (*Rhinoptera neglecta*) (Fig. 8A), ghost pipefishes (*Solenostomus cyanopterus* and *S. paradoxus*) (Fig. 9C), pipefishes (*Stigmatophora nigra* and *Trachyrhamphus bicoarctatus*), seahorses (*Hippocampus procerus*), and Queensland Groper (*Epinephelus lanceolatus*) (Fig. 9A) are regularly seen in such aggregations. While sightings of two or three individuals of Queensland Groper in the seaway are commonplace, on a number of occasions up to eight separate individuals of 1.2–1.6 m have been recorded at one time, especially in July, when large shoals of luderick (*Girella tricuspidata*) (Fig. 8B) form near the mouth of the seaway. Aggregations of various other more common species, such as Bigeye Trevally (*Caranx sexfasciatus*) and Mulloway (*Argyrosomus japonicus*) were by far the largest observed in the MBMP. Spawning in Dusky Flathead (*Platycephalus fuscus*), usually involving single females of 60–90 cm accompanied by numerous much smaller males, has been observed and filmed here on a regular basis. Whitespotted Eagle Rays (*Aetobatus narinari*) and other large fishes regularly move with the flood tide to particular 'cleaning stations' in the seaway to have ectoparasites removed by the Common Cleanerfish (*Labroides dimidiatus*).

The offshore zone in depths of 40–200 m was not surprisingly the least diverse of the five areas under study, with 297 species recorded. However, all sampling was undertaken by hook and line or bottom trawling, so fishes closely associated with deep reefs are likely under-represented in the results. Some baited underwater video footage was viewed from reef sites off Moreton and Stradbroke Islands, however depth considerations discounted underwater visual and photographic surveys and the ability to collect small and cryptic reef fishes using ichthyocides on SCUBA gear, as in the other areas. Trawling effort in the 160–200 m depth range was not as extensive as it was in the 40–160 m depth range, due to limitations of gear and boat time. Capacity to document species diversity across all habitats of this area was thereby more limited than in other areas.

New records for Australia include *Dysomma anguillare*, *Apogon seminigracaudus* and *Arnoglossus dalgleishi*.

New records for the east coast of Australia include *Dactyloptena peterseni*, *Pristigenys niphonia*, *Bodianus bilunulatus*, and *Spinicapitichthys draconis*. Material identified here as *Calliurichthys* c.f. *australis* appears to be distinct from *C. australis* (Fricke), which is currently recognised only from Western Australia.

Two species known only from Flinders Reef appear to be undescribed: *Enneapterygius* sp. 1 (Fig. 9E–F) and *Paracentropogon* sp. 1. The genus *Enneapterygius* is highly speciose and its species often occur in aggregations. Additional research would be required to more fully elucidate the range and relationships of *Enneapterygius* sp. 1. In contrast, the genus *Paracentropogon* as currently recognised contains only three or four species, with only a single Australian representative. The habitat where specimens of *Paracentropogon* sp. 1 was collected (rock pools on tidal reef flat, exposed to extreme wave action from ocean swells) is quite different to that where the other species of *Paracentropogon* are usually found.

Four terminal males of an unknown, possibly undescribed species of *Bodianus* (see brief diagnosis in endnote no. 227) were recorded from sites near Henderson Rock, off Moreton Island (approx. 27°08′S, 153°29′E) in 27 and 28 m, and Flinders Reef in 10 and 24 m, from baited underwater video footage. The Henderson Rock sites included thick beds of kelp, *Ecklonia radiata*. In this area, *E. radiata* is at the northern limit of its known range on the east coast of Australia. A still image of a fifth terminal male was obtained near the mooring buoys at Flinders Reef, on sparse coral and rubble bottom at a depth of 10 m. Attempts to collect a specimen, or to find and correctly associate the female colour form of this species to the male, have so far been unsuccessful.

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Phytoplankton productivity across Moreton Bay, Queensland, Australia: the impact of water quality, light and nutrients on spatial patterns

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ABSTRACT

Phytoplankton productivity and the factors that regulate it were studied across Moreton Bay (27°S, 153°E), a large embayment on the subtropical East Australian coast. Depth profiles of salinity, temperature, pH, turbidity and dissolved oxygen were measured at 73 sites across the Bay. Our measurements showed a general landward to seaward trend in salinity, turbidity and dissolved oxygen profiles, so we have used a representative 20 km transect extending from the mouth of the Brisbane River to the Moreton Bay Research Station at Dunwich on North Stradbroke Island to present our findings. Phytoplankton pigment concentrations were measured at all 73 sites and were generally highest in areas with lower water clarity (Secchi depths < 3.25 m), suggesting nutrients (often associated with turbid waters) rather than light may be determining phytoplankton distributions in Moreton Bay. Based on traditional light/dark bottle experiments undertaken on samples collected at fourteen sites, the Bay was found to be net autotrophic with primary production rates ranging between 0.16 to 3.90 g C m^{-2} day^{-1}. Resource limitation (also known as nutrient addition) assays, undertaken on samples collected at seven sites in the Bay, indicated that phytoplankton productivity was generally limited by nitrogen (N) sources except at Dohles Rocks in the Pine River mouth where silicate was co-limiting with N. Light limited primary production in the lower reaches of the Brisbane River. Phosphate additions had no impact on phytoplankton productivity. Phytoplankton community composition (ratios of the major groups) did not change over the 48 hour incubation period in the resource limitation assays suggesting either the different components of the community had insufficient time to respond or all components responded similarly. Findings from both the resource limitation assays and the bay-wide phytoplankton pigment survey suggest that nitrogen was the major limiting factor of phytoplankton productivity in Moreton Bay in the summer of this study. ❑ *primary productivity, light, nitrate, ammonium, silicate, phosphate, limitation*.

Changes in the characteristic hydrological and physio-chemical nature of estuaries world wide are occurring as a result of increased nutrient inputs (e.g., anthropogenic inputs from waste water treatment facilities and groundwater seepage) associated with urbanization and industrialization, alterations in the magnitude and frequency of freshwater inflows, changes in water circulation patterns (e.g., dredging programs for ship channels) and other human-induced changes including but not limited to tourism. Of these, the most frequently investigated phenomena are eutrophication (Howarth 1988; Howarth & Marino 2006) and harmful algal blooms (Granéli & Turner 2006), which may lead to fish kills (Thronson & Quigg 2008) and the loss of other fauna, flora, and/or habitats (e.g., mangroves; Phillips & Kevekordes 2008). Decreased water quality in Moreton Bay (Fig. 1), an embayment in Southeast Queensland, Australia is no exception. Changing land use patterns, largely driven by rapid coastal development, has increased pressure to develop management strategies to protect marine flora, fauna and habitats whilst providing for human activities. To achieve this, we need to determine how Moreton Bay and other estuaries respond to environmental perturbations. We still lack a clear understanding of specific factors which are important in individual estuarine systems.

Temperature, photosynthetically active radiation (PAR) and nutrients are the main factors controlling algal growth and primary productivity. These factors act synergistically to promote phytoplankton growth but can, in certain combinations, be antagonistic. The role of temperature in primary productivity has been studied under controlled laboratory conditions (Eppley 1972) and *in situ* (e.g. Malone *et al.* 1988; Glibert *et al.* 1995), including in the Logan River and southern Moreton Bay where temperature was found to limit primary productivity during winter but not in summer (O'Donohue & Dennison 1997). Similar findings have been reported for other freshwater and estuarine systems. These seasonal changes in productivity can also be associated with changes in phytoplankton community composition. For example, in Offatts Bayou, a small embayment in south Texas, there is an annual shift in phytoplankton community structure from predominantly diatoms in the winter/spring to predominantly cyanobacteria in the summer (Quigg & Roehrborn 2008). Defining the role of temperature *in situ* is complicated and often modulated by the interactive effects of other factors in controlling productivity, particularly PAR and nutrients.

Experiments based on light-controlled turbidostats (e.g. Quigg & Beardall 2003) and nutrient-controlled chemostats (e.g. Rhee *et al.* 1980) support the general notion that an increase in either PAR or nutrients will result in a corresponding increase in productivity. However these relationships are not as clear in field experiments as productivity measurements show great spatial and temporal variability (e.g. Quigg *et al.* 2007) due to a number of interactive components which cannot be controlled for and, in many cases, are less well defined. In estuaries, the ability of PAR to penetrate the water column is linked to riverine and terrestrial derived freshwater runoff introducing silts, particulates and nutrients. On the oceanic side, water clarity means PAR is often not limiting but nutrient concentrations may be. Hence, along an estuarine (salinity) gradient, phytoplankton productivity responses will be tempered by the availability of PAR and nutrients. This has been shown in Chesapeake and Delaware Bays, USA (Harding *et al.* 1986; Malone *et al.* 1988; Fisher *et al.* 1999), Strait of Georgia, BC (Harrison *et al.* 1991) and Galveston Bay, USA (Quigg *et al.* 2007).

While phytoplankton productivity in some parts of Moreton Bay has been previously reported (e.g., O'Donohue & Dennison 1997), little is known of the year round endemic phytoplankton communities in Moreton Bay (no published studies were available at the time this manuscript was prepared). The report by Dennison & Abal (1999) and studies by Eyre & McKee (2002) and Glibert *et al.* (2006) imply that Moreton Bay phytoplankton communities are potentially under threat from eutrophication. This is supported by the increased frequency of blooms of *Lyngbya majuscula* over the last decade (Bell *et al.* 1999; Ahern 2003; Elmetri & Bell 2004; Albert *et al.* 2005 Ahern *et al.* 2007). Blooms of this benthic cyanobacterium appear to be fuelled by phosphorus-rich waste-water discharge combined with warm, calm conditions

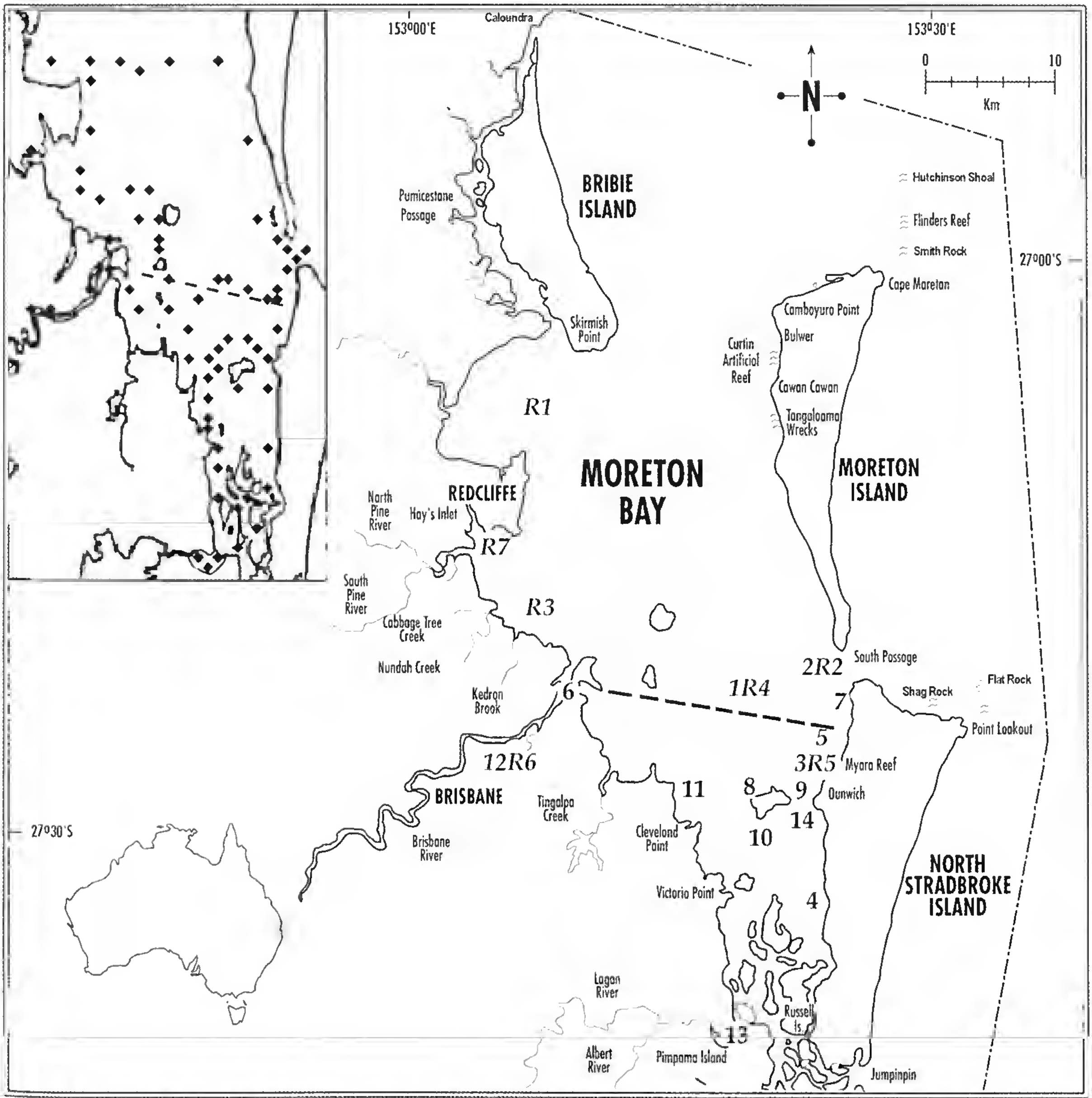

FIG. 1. Moreton Bay (27°S, 153°E) estuary in Southeast Queensland, Australia. Collection sites for resource limitation assays (R1–R7) and primary productivity/respiration studies (1–14), with the corresponding latitudes, longitudes and site description given in Tables 1 & 2. A transect (dashed line) extending from the mouth of the Brisbane River to the Moreton Bay Research Station on North Stradbroke Island was used to present water quality data. Inset map shows the locations of all 73 collection sites. See Table 1 for details.

during summer in an otherwise oligotrophic system. The ability of this species to fix it's own nitrogen allows it to out-compete other phytoplankton. Given the constraints of this workshop, we were not able to conduct a year round study, nor were we able to undertake a careful phytoplankton community analysis. Such efforts are nonetheless warranted. We used pigment analysis to obtain a preliminary insight into the major phytoplankton groups dominating Moreton Bay in the summer.

This current study investigates the role of water quality, PAR and nutrients on the spatial distribution of phytoplankton productivity in

Moreton Bay, Australia during the Thirteenth International Marine Biological Workshop on the Marine Fauna and Flora of Moreton Bay, Queensland (7th to 25th February 2005). Pigment concentrations and ratios were used to examine spatial distributions of phytoplankton groups. Primary productivity and respiration were measured at fourteen sites across the Bay. Resource limitation (nutrient addition) assays were concurrently undertaken for seven sites to determine which resource, if any, limited phytoplankton productivity. The addition of nitrogen (N) as nitrate or ammonium, phosphate, silicate, the combination of all these nutrients (all) and a control (no addition) on phytoplankton growth were examined.

MATERIALS AND METHODS

STUDY SITE

Moreton Bay (27°S, 153°E) is a subtropical estuary in Southeast Queensland, Australia (Fig. 1). Located adjacent to the City of Brisbane (western mainland coast), it is separated from the South Pacific Ocean (east side) by Moreton and North Stradbroke Islands. Moreton Bay covers approximately 1845 km^2 with an average depth of 6 m (up to 29 m in some areas). Water exchange with the Pacific Ocean occurs via the wide Bay opening to the northeast, South Passage to the east and Jumpinpin in the southern part of the Bay. Terrestrial and freshwater runoff along the western side of the Bay comes from four major river catchments: Brisbane (13,556 km^2), Logan/Albert (3650 km^2), Pine and Caboolture (together ~ 1820 km^2). The largest of these includes the subcatchments of the Upper Brisbane, Stanley, Lockyer, and Bremer Rivers. During dry periods, salt water penetrates into the lower tidal portions of the four major rivers (Steele 1990; Cox 1998). The net movement of water in Moreton Bay, due to tides, creates a pattern of northward water movement on the western side of the Bay and a generally southward water movement on the eastern side. This establishes an overall clockwise pattern of water circulation in the Bay (Newel 1971; Milford & Church 1977; Patterson & Witt 1992).

SAMPLE COLLECTION

Surveys were conducted aboard the *RV Scarus* from 7 to 25 February 2005 at locations indicated on Fig. 1 and detailed in Table 1 (73 sites in total) in order to obtain comprehensive spatial coverage. The sampling regime also included sites situated in the mouth of the four major rivers and in the Bay's three openings to the Pacific Ocean. During survey trips, physical and chemical characteristics of the water were examined at the surface, at 2 m, 4 m and near the bottom (6–9 m) at all sampling sites. The parameters measured with a calibrated Horiba Water Quality Checker Model U-10 (California, USA) included: Salinity (psu), pH (relative units), dissolved oxygen (DO; mg L^{-1}), turbidity (Nephelometric Turbidity Units; NTU) and temperature (°C). Water clarity was determined using Secchi depth (m) measurements. General trends for water quality, found during this study, were well represented by data collected along a transect line (dashed line in Fig. 1) extending 20 km from the Brisbane River to the Moreton Bay Research Station on North Stradbroke Island (designated 0 km and 20 km respectively, in depth profiles, Fig. 2). Discrete water samples were also collected from the surface (0.5 m) in acid-cleaned PVC bottles and transported to the laboratory in the dark (to avoid photo-induced chemical changes) at ambient temperature. These were kept at room temperature (19°C) and at low light (<50 μmol photons m^{-2} s^{-1}) until known volumes were filtered for phytoplankton pigment determination later the same day. At some of these sites, additional water samples were taken for primary productivity measurements (1–14 in Tables 1 & 2) and for resource limitation assays (R1–R7 in Table 1) described below. These experiments were started immediately upon returning to the laboratory.

PRIMARY PRODUCTION

Light-saturated phytoplankton productivity (net, gross productivity and respiration, expressed in g C m^{-2} day^{-1}) was determined using the light-dark bottle method of Strickland & Parsons (1972). Each seawater sample, collected from discrete sites (1–14 in Fig. 1, Tables 1 & 2), was decanted into 7 acid-washed glass Biological Oxygen Demand (B.O.D.) bottles (250 mL). Each bottle was filled to overflowing to avoid air bubbles. Three bottles were used for the light treatments and two bottles, wrapped in foil, were used for the dark treatments. Two additional bottles, with buffered Formalin (10% final), were used as controls to assess the impact of abiotic reactions on dissolved O_2 levels in light and dark conditions. The initial DO concentration (mg O_2 L^{-1}) was measured in the original source water from each collection site. Treatment bottles were incubated in an outdoor water bath at ambient temperature (± 3°C), maintained with a circulating water pump, under 50% of ambient sunlight. Bottles floated near the surface of the incubator but did not overlap. Phytoplankton responses to each treatment were determined by measuring the change in DO concentration using a YSI Environmental Oxygen Probe (John Morris Scientific Pty Ltd). Daily net/gross productivity and respiration were calculated by taking into account the 13:11 light:dark period at this time of year. Oxygen produced was converted to carbon fixed, using a photosynthetic quotient of 1.2 and a respiratory quotient of 1.0 (Laws 1991). Values were expressed, per square metre, as we totalled rates to the base of the euphotic zone by multiplying productivity by Secchi depth (Wetzel & Likens 2000).

The ratio of the dark respiration rate to the photosynthetic (gross) rate (RR:GPR ratio) has been proposed as a useful parameter in evaluating primary productivity measurements on natural phytoplankton communities (Verity 1982); that is, whether a phytoplankton community is net autotrophic. In addition, we also assessed net growth efficiency which Falkowski *et al.* (1985) defined as the ratio of net to gross photosynthesis. This ratio quantifies the amount of photosynthetically fixed carbon that is lost in relation to that used for new growth.

RESOURCE LIMITATION BIOASSAYS

Two-day resource limitation bioassays were undertaken to identify which resource (nutrient (s) and/or light) limited phytoplankton growth at sampling sites in Moreton Bay during the period of investigation. These bioassays were carried out essentially as described by Fisher *et al.* (1999) on water samples collected from seven sites (R1 to R7 in Fig. 1, Table 1). Surface (top 0.5 m) water (8 L) was collected, stored in a cool, low light area of the boat, until we returned to the laboratory (< 4–6 hrs). Immediately before starting the bioassays, a subsample was taken for pigment analysis. Aliquots (1 L) of water sample were subsequently placed into acid washed containers and each received one of the following nutrient additions (final concentrations in each treatment): +N-nitrate (30 μmol L^{-1} NO_3^-), +N-ammonium (30 μmol L^{-1} NH_4^+), +P (2 μmol L^{-1} PO_4^{3-}), +Si (30 μmol L^{-1} SiO_3), All (30 μmol L^{-1} NO_3^-, 30 μmol L^{-1} NH_4^+, 2 μmol L^{-1} PO_4^{3-} and 30 μmol L^{-1} SiO_3) and a control (no addition). Treatments were incubated at ambient temperature under 50% ambient sunlight in an outdoor facility described above. Subsamples (≥4) were harvested for pigment analysis, from control and nutrient treatments, at identical times over the 48 hr incubation period to assess changes in phytoplankton biomass. The response potential of phytoplankton in each treatment was quantified using the phytoplankton response index (PRI) which calculates the phytoplankton growth response using the maximum biomass relative to the initial biomass and the time taken to reach the maximum biomass (Fisher *et al.* 1999). We also included a response classification (as recommended by Fisher *et al.* 1999) to accommodate for errors and temperature differences between assays; the threshold for a significant response was set to 140% > than the control.

Given the time and resource constraints of the workshop and the questions we were seeking to address, water samples were collected from seven sites across the Bay for resource limitation bioassays at the expense of experimental replication, that is, we did not have replicate bottles for each treatment. As our findings are consistent within bioassays and across assays on samples, collected from sites with similar water quality, our findings are nonetheless significant.

PIGMENT ANALYSIS

A known volume of water was filtered through a Whatman GF/F filter under low pressure (< 130 kPa) and immediately frozen. Filters were thawed on ice and pigments extracted in 100% acetone overnight at 4°C in darkness. Immediately prior to spectrophotometric analysis, the acetone was diluted to 90% with distilled water and the sample stirred with a vortex mixer. The filter was removed from the sample and the supernatant centrifuged for 10 mins at 5000g to remove any remaining particulates. High performance liquid chromatography (Jeffrey *et al.* 1997) is the current method used for assessing phytoplankton composition based on pigment profiles. However, given this was not available, we used earlier spectrophotometric methods. Concentrations of the pigments, listed below, were calculated as follows: Chlorophyll (chl) *a* using the equations in SCOR-UNESCO (1966); cyanobacterial (cyano) pigment using the equation by MacKinney (1941); carotenoids in Chlorophyta/Cyanobacteria (Chloro/Cyano) and Chrysophyta/Pyrrophyta (Chryso/Pyrro) using the equations of Strickland & Parsons (1972). Phycocyanin and phycoerythrin were estimated according to information at http//pubs.water.usgs.gov/twri9A from the ratio of wavelengths 652: 665 and 615:665 respectively (no units).

Means ± standard deviations are presented for field measurements and lab-based results.

RESULTS

PHYSICAL AND CHEMICAL WATER ANALYSES

Generally, vertical water profiles for salinity, turbidity and DO at 73 sites across Moreton Bay indicated a well mixed water column given that there were no significant differences in values at the surface relative to bottom waters (Table 1). Along a transect line (shown in Fig. 1) from the Brisbane River mouth (0 km) to Moreton Bay Research Station (20 km), vertical profiles (Fig. 2) for salinity, turbidity and DO showed a clear gradient for each parameter extending across the Bay. Salinity readings ranged from 34 ±2 psu, recorded in surface waters in the mouth and lower Brisbane River, increasing to 38 ±0.5 psu near North Stradbroke Island (Fig. 2A). The salinity gradient recorded along this transect is typical for the Bay with lower salinity levels, due to riverine runoff, on the landward side increasing towards the oceanic side of the Bay (see also Table 1). At the time of the study, 82% of measured salinities were ≥ 34 psu (n = 196 of 239 measurements; Table 1) indicating that the oceanic influence dominated Moreton Bay salinities. High salinity levels were also recorded in the mouths of the Logan River (37±0.3 psu) and Pine/Caboolture Rivers (35±0.5 psu).

Highest turbidity (NTU) levels were measured near the four major river outlets and along coastlines flanking dense residential areas of Brisbane (Table 1). Depth profiles along the 20 km transect line showed high turbidity levels (36–44 NTU) on the landward side of the Bay, decreasing by 50% some 8 km from the Brisbane River mouth and then to 0–4 NTU near North Stradbroke Island (Fig. 2B). In Moreton Bay, a curvilinear relationship was found between turbidity and Secchi depth (Fig. 3A) with the highest turbidity readings recorded in areas with the lowest water clarity (Table 1). Secchi depths were as shallow as 0.7 m, 2–3 km up the mouth of the Brisbane River (corresponding turbidity of 15 NTU) and as deep as 7.5 m at sites in the northern and eastern parts of the Bay (< 5 NTU). In general, Secchi readings along the landward coastline and river openings were < 1 m (Table 1).

Lowest DO concentrations were recorded in areas of highest turbidity (r^2 = 0.79) near the mainland coastline, with DO values increasing towards the oceanic end of the transect (Fig. 2C). Water temperature and pH did not vary significantly in Moreton Bay during the course of this study (not shown). Surface water temperatures averaged 27.7°C (±1.2°C, n = 111) and there was a 1–2°C temperature range in the water column to a depth of 9 m. The average pH was 7.88 (±0.10, n = 75) across Moreton Bay, except for several sample sites in the Brisbane River where surface water pH ranged from 7.2–7.5.

PIGMENT DISTRIBUTIONS

Chl *a*, measured as a proxy for phytoplankton biomass in surface waters, averaged 2.80 (±1.75) μg L^{-1} across the 73 sites in the Bay (Table 1). Phytoplankton pigment concentrations were generally highest in areas with lower water clarity (Secchi depths < 3.25 m, Fig. 3B, Turbidity < 25 NTU, Fig. 3C); this was particularly evident in the mouths of the four major rivers (Table 1). The highest concentrations of Chl *a* (5.26–6.93 μg L^{-1}) were recorded in waters with Secchi depths <1.7 m (Fig. 3B). There was no significant relationship between Chl *a* concentrations and turbidity (Fig. 3C) indicating PAR did not substantially control phytoplankton biomass distribution.

Generally, the bay-wide survey of pigments showed no clear distribution pattern of phytoplankton groups in Moreton Bay. Ratios of

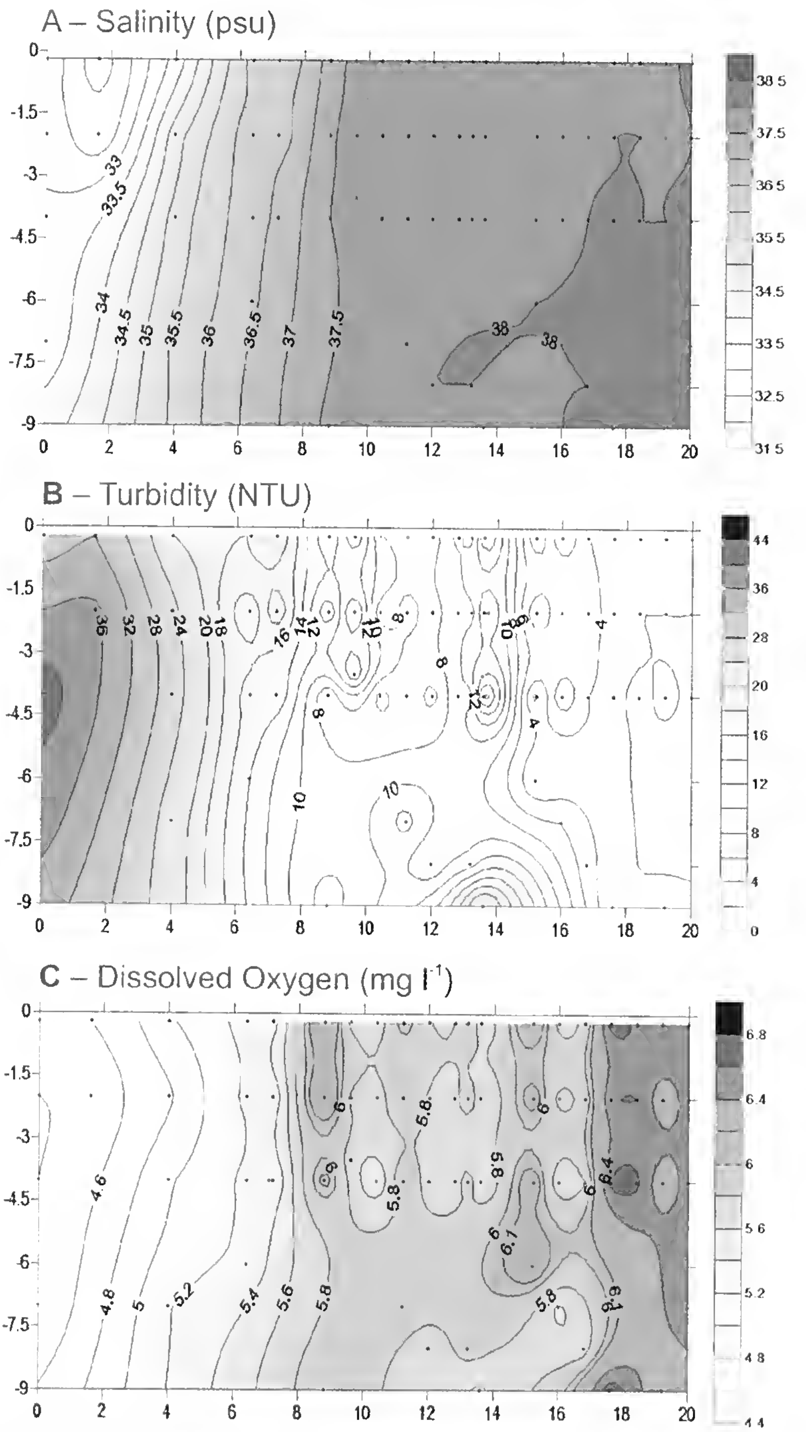

FIG. 2. Water quality parameters were measured across the entire Moreton Bay estuary. Data collected along a 20 km transect (shown in Fig. 1) represents the general landside-to-seaside trends for this Bay. Distance, shown on the x-axis, extends from the mouth of the Brisbane River (0 km) to the Moreton Bay Research Station (20 km). Dots on the contour maps indicate sampling sites in the water column with depth (m below the surface) plotted on the y-axis. Profile values are presented in the legend to the right for each water quality parameter. (A) Salinity (psu), (B) turbidity (NTU) and (C) dissolved oxygen (mg l^{-1}).

Table 1. Water quality and pigment data for 73 sampling sites throughout Moreton Bay. Given the homogenous nature of the vertical water column, averages (± standard deviations) are given for salinity (psu), turbidity (NTU) and dissolved oxygen (DO; mg l^{-1}). Secchi (m) depth was measured at each site. Pigment concentrations were measured in surface samples only. Chlorophyll a (Chl a; µg L^{-1}), Cyanobacteria (Cyano; µg L^{-1}), carotenoids in Chlorophyta/Cyanobacteria (Chloro/Cyano) and Chrysophyta/Pyrrophyta (Chryso/Pyrro), phycocyanin:chlorophyll a and phycoerythrin:chlorophyll a (estimated as ratio of wavelengths 652:665 and 615:665 respectively; no units) were used to examine the phytoplankton community composition. Water sample collection sites for primary productivity (gross and net) and respiration rate measurements (1–14) and resource limitation assays (R1–R7) (see also Fig.1).

Expt	Site Location	Latitude South	Longitude East	Salinity (psu)	Turbidity (NTU)	DO (mg L^{-1})	Secchi (m)	Chl a (µg L^{-1})	Cyano (µg L^{-1})	Chloro/ Cyano	Chryso/ Pyrro	Phyco-cyanin/ Chl a	Phyco-erythrin/ Chl a
14	Adam's Beach	27.5083	153.2357	38.08(0.05)	4.75(0.96)	6.42(0.15)	2.5	3.80	4.56	1.37	3.43	0.44	0.23
	Between Peel I. & Dialba Passage	27.4760	153.3707	38.00(0.08)	4.25(0.50)	4.69(2.25)	2	3.67	4.25	1.23	3.07	0.44	0.24
	Between Lazaret Gutter & Maroom Bank	27.4678	153.3547	38.00	4.75(0.50)	6.03(0.07)	2	2.68	3.09	1.12	2.80	0.57	0.36
	NW of Peel I.	27.4720	153.3368	37.95(0.06)	4.25(0.96)	5.99(0.03)	2.5	2.47	2.82	0.83	2.07	0.54	0.33
	WNW of Peel I.	27.4888	153.3180	37.95(0.06)	4.50(1.29)	6.26(0.10)	3	2.83	3.27	1.05	2.63	0.54	0.35
	W of Peel I.	27.5085	153.3203	37.95(0.06)	6.00(1.41)	6.10(0.11)	2.2	2.37	2.73	0.80	2.00	0.49	0.27
	N of Toondah Harbour entrance	27.5347	153.3042	37.87(0.06)	11.00(1.73)	5.64(0.09)	1.6	2.63	3.04	0.96	2.40	0.47	0.27
	N of Point Halloran	27.5562	153.3073	38.03(0.06)	10.67(4.62)	5.81(0.14)	1.8	2.60	3.00	0.93	2.33	0.46	0.21
	Point Halloran	27.5678	153.3083	38.00	7.33(0.58)	5.84(0.06)	2	2.61	3.00	0.99	2.47	0.48	0.31
	E of Victoria Point	27.5855	153.3188	37.90(0.14)	7.25(0.96)	5.90(0.12)	2	2.67	3.09	1.00	2.50	0.49	0.29
	NE of Redland Bay	27.6065	153.3180	38.03(0.05)	7.50(1.73)	5.66(0.04)	2	2.39	2.73	0.88	2.20	0.49	0.28
	SE of Redland Bay	27.6228	153.3227	37.93(0.10)	10.75(1.26)	5.62(0.05)	1.8	1.76	2.01	1.04	2.60	0.56	0.37
	Between Point Talburpin & Karragarra I.	27.6405	153.3412	37.97(0.06)	10.67(3.79)	5.47(0.10)	1.6	1.56	1.79	0.71	1.77	0.46	0.28
13	Logan River mouth	27.7043	153.3203	37.20(0.28)	36.00(19.80)	5.08(0.20)	1.2	5.26	6.17	1.99	4.97	0.48	0.26
	Between Logan River mouth & Russell I.	27.6893	153.3420	37.80	52.50(0.71)	5.31(0.07)	0.7	6.43	7.60	2.48	6.20	0.46	0.26
	W of Russell I.	27.6697	153.3563	38.10(0.10)	14.00(0.75)	5.35(0.05)	1.7	1.42	1.43	0.53	1.33	0.82	0.40
	W end, Macley/Karragarra Is Channel	27.6337	153.3568	38.10	26.25(3.30)	5.61(0.12)	1	2.97	3.13	1.28	3.20	0.61	0.39
	E of Lamb I.	27.6238	153.3928	38.08(0.05)	21.00(2.71)	5.55(0.16)	1	4.05	4.56	1.55	3.87	0.51	0.26
4	Near Blakesley's Anchorage	27.5843	153.4028	37.87(0.06)	11.67(1.53)	5.46(0.07)	1.5	4.08	4.65	1.57	3.93	0.55	0.37
	One Mile Anchorage	27.4872	153.4010	38.00(0.14)	4.50(0.71)	7.16(0.13)	2.5	2.11	2.42	0.72	1.80	0.34	1.00
9	S of Dunwich, in Deanbilla Bay	27.5083	153.4023	37.87(0.06)	6.67(0.58)	6.39(0.17)	1.75	3.39	3.98	1.36	3.40	0.56	1.10
3/R5	NE end of Dialba Passage	27.4757	153.3918	37.88(0.88)	2.40(1.14)	6.61(0.11)	3.2	2.06	2.37	0.76	1.90	0.51	1.05
	Amity Channel, near Fingue Passage	27.4352	153.4070	37.93(0.05)	2.75(0.50)	6.77(0.04)	4.5	0.85	0.89	0.25	0.63	0.44	0.98
2/R2	South Passage Bar, near Amity	27.3863	153.4512	37.80(0.14)	9.50(4.95)	7.09(0.12)	2.5	1.15	1.16	0.31	0.77	0.32	0.94
	Rainbow Channel, between Amity/Kooringal	27.3765	153.4337	37.77(0.05)	3.67(1.70)	6.89(0.16)	3.25	1.21	1.39	0.72	1.80	0.65	1.35
7	NW Amity, E entrance to Rous Channel	27.3877	153.4338	37.80	2.00(1.00)	7.14(0.04)	5	1.64	1.88	0.81	2.03	0.61	1.23
	Rainbow Channel, Amity Point	27.4000	153.4338	37.78(0.08)	2.00(0.71)	6.97(0.07)	3	1.75	2.01	0.65	1.63	0.66	1.05
5	NE corner Amity Banks	27.4183	153.4087	37.90	4.50(1.50)	7.10(0.04)	2	1.36	1.52	0.65	1.63	0.73	1.20
	Rainbow Channel / Cooloolo Passage	27.4405	153.4083	37.98(0.08)	6.25(3.70)	7.03(0.02)	2.5	1.11	1.25	0.56	1.40	0.68	1.17
	Amity Banks, near Cooloolo Passage	27.4403	153.4040	37.90	5.00(1.00)	6.89(0.05)	2.2	3.04	3.58	1.35	3.37	0.60	1.16
	Between Lazaret Gutter / Maroom Banks	27.4677	153.3548	37.95(0.05)	4.50(0.50)	5.83(0.04)	2.5	2.28	2.51	0.61	1.53	0.54	0.40
	NW Peel I.	27.4722	153.3370	37.93(0.04)	7.00(1.00)	5.70(0.04)	2.5	3.29	3.91	1.27	3.17	0.50	0.29
11	N of Cleveland Point	27.5000	153.2925	37.83(0.08)	19.00(3.39)	5.57(0.05)	1.2	2.81	3.27	0.99	2.47	0.45	0.99
	N of Raby Bay	27.5043	153.2728	37.77(0.05)	10.33(0.47)	5.70(0.06)	1.75	4.54	5.28	1.69	4.22	0.47	0.25
	ENE of Wellington Point	27.4737	153.2732	37.90(0.07)	8.75(1.30)	6.02(0.04)	2	2.33	2.68	0.80	2.00	0.54	0.33
	N of Wellington Point	27.4512	153.2550	37.95(0.05)	6.75(1.09)	5.75(0.05)	2			1.20	3.00	0.54	0.36
	Waterloo Bay, N area	27.4515	153.2193	37.76(0.05)	6.33(1.25)	5.60(0.14)	1.5	2.80	3.27	1.03	2.57	0.54	0.33
8	Between Wynnum & Green I.	27.4335	153.2033	37.76(0.05)	16.33(0.47)	5.71(0.02)	1.2	4.46	5.28	1.71	4.27	0.47	0.24
.	Between Lytton & Fishermans I.	27.4003	153.1573	36.26(0.25)	18.66(1.89)	5.24(0.05)	1.1	6.16	7.34	2.63	6.57	0.48	0.23

Table 1 (continued) ...

Expt	Site Location	Latitude South	Longitude East	Salinity (psu)	Turbidity (NTU)	DO (mg L^{-1})	Secchi (m)	Chl a (µg L^{-1})	Cyano (µg L^{-1})	Chloro / Cyano	Chryso / Pyrro	Phyco-cyanin / Chl a	Phyco-erythrin / Chl a
12/R6	Brisbane River, near Breakfast Creek	27.4408	153.0413	33.02(0.08)	36.25(4.71)	4.47(0.09)	1.2	6.66	7.96	2.64	6.60	0.50	0.25
	Breakfast Creek, joining Brisbane River	27.4383	153.0413	31.85(0.15)	34.50(2.50)	4.52(0.08)	1	2.76	3.22	1.07	2.67	0.53	0.32
6	Brisbane River, near Gateway Bridge	27.4408	153.0883	34.82(0.71)	23.25(2.38)	4.91(0.10)	1	4.08	4.89	1.63	4.07	0.51	0.28
	Brisbane R. between Pinkenba/Bulwer I.	27.4195	153.1378	36.30(0.07)	15.25(1.64)	5.26(0.02)	1.5	5.49	6.53	2.20	5.50	0.47	0.23
	Luggage Point, Brisbane River mouth	27.3738	153.1563	36.35(0.05)	16.50(1.50)	5.80(0.08)	1.4	3.08	3.62	1.25	3.13	0.47	0.23
	N of Fisherman's I.	27.3418	153.1833	37.42(0.15)	7.75(1.48)	6.35(0.11)	1.7	6.91	8.32	2.73	6.83	0.49	0.24
	Between Fisherman's Is & Mud I.	27.3588	153.2177	37.60(0.08)	29.67(0.47)	5.91(0.07)	1	6.21	7.43	2.43	6.07	0.50	0.29
	Between St Helena Is & Mud I.	27.3680	153.2408	37.80(0.07)	9.50(2.06)	6.04(0.14)	1.5	5.68	6.80	2.14	5.36	0.50	0.29
	Fisherman's Gutter, Boolong Bank	27.4015	153.3257	38.00	1.75(0.43)	6.27(0.05)	2	1.56	1.82	0.60	1.51	0.44	0.21
1/R4	Rous Channel, near Amity Point	27.4048	153.3717	38.05(0.05)	2.75(0.43)	6.65(0.05)	2.5	1.93	2.28	0.83	2.08	0.54	0.36
	Moreton Banks, near Rous Channel	27.3702	153.3905	38.00	2.00(0.82)	6.60(0.04)	3.2	1.04	1.21	0.54	1.34	0.50	0.28
	Rous Channel / Rainbow Channel banks	27.3762	153.4265	38.07(0.04)	1.50(0.5)	6.54(0.05)	3.2	0.95	1.07	0.40	1.00	0.53	0.32
10	South West Rocks, Peel I.	27.5203	153.3557	37.75(0.11)	5.00(1.87)	6.18(0.02)	7.5	0.11	0.09	0.21	0.52	0.68	0.70
	Rainbow Channel, near Myora	27.4672	153.4068	37.97(0.08)	3.00(0.71)	6.30(0.07)	2.2	2.18	2.57	0.85	2.13	0.49	0.30
	Between Lazaret Gutter / Maroom Banks	27.4672	153.3545	38.07(0.08)	3.00	5.70(0.07)	3	1.43	1.68	0.60	1.50	0.46	0.27
	W entrance to Rous Channel	27.4255	153.3027	38.17(0.04)	1.00	6.35(0.08)	4	0.96	1.07	0.47	1.17	0.44	0.26
	N point of St Helena I.	27.3767	153.2412	38.10	6.50(1.12)	6.14(0.25)	1.5	0.92	1.05	0.50	1.25	0.57	0.34
	Between Fishermans Is & Mud I.	27.3587	153.2267	38.20	9.00(0.82)	6.08(0.08)	1.2	0.87	0.94	0.43	1.07	0.68	0.46
	N of Fisherman's I.	27.3392	153.1933	37.80(0.16)	10.25(1.09)	5.89(0.04)	2	2.87	3.40	1.19	2.98	0.46	0.24
R3	E of Nudgee	27.3372	153.1420	37.35(0.35)	13.00(3.00)	6.28	1.5	6.08	7.25	2.41	6.02	0.47	0.24
	E of Shorncliffe / Cabbage Tree Creek	27.3222	153.1087	37.43(0.26)	13.67(1.70)	6.29(0.14)	1.4	2.17	2.53	1.11	2.78	0.51	0.27
	Cabbage Tree Creek	27.3343	153.0743	33.95(1.65)	21.50(4.50)	4.50(0.22)	1.1	5.52	6.58	2.33	5.83	0.55	0.29
	Bramble Bay, NE of Shorncliffe	27.3028	153.1003	37.30(0.08)	19.33(3.30)	5.72(0.04)	1.5	1.57	1.83	0.88	2.20	0.54	0.33
R7	Pine River, closest to Dohles Rocks	27.2752	153.0420	35.35(0.25)	17.50(2.50)	5.79(0.16)	1.25	6.93	8.32	3.74	9.36	0.50	0.27
	E of Scott's Point, Redcliffe	27.2515	153.1208	37.36(0.12)	14.00(4.24)	5.63(0.18)	1.5	2.23	2.62	1.29	3.22	0.53	0.29
	E of Scarborough	27.2038	153.1252	37.43(0.15)	8.25(1.09)	5.55(0.27)	2.2	1.64	1.91	0.80	2.00	0.53	0.31
	Deception Bay, NW of Scarborough	27.1758	153.0733	37.50	20.00	6.21(0.16)	1.1	4.52	5.28	2.43	6.07	0.56	0.37
R1	NE of Scarborough	27.1752	153.1545	37.50(0.25)	6.75(2.59)	6.08(0.04)	2.2	1.57	1.83	0.83	2.07	0.56	0.41
	ENE of Scarborough	27.1760	153.1850	37.68(0.15)	6.50(1.12)	6.07(0.04)	1.9	1.65	1.83	0.72	1.80	0.54	0.36
	Pearl Channel	27.1837	153.2178	37.70(0.07)	3.00(0.71)	6.04(0.05)	3	1.12	1.27	0.69	1.72	0.63	0.63
	E of Pearl Channel	27.1743	153.2590	37.83(0.15)	3.00(1.00)	6.02(0.02)	3.7	0.61	0.67	0.37	0.92	0.55	0.33
	WNW of Tangalooma, Moreton I.	27.1595	153.3203	37.78(0.08)	1.75(0.83)	6.10(0.04)	6.7	0.32	0.34	0.23	0.58	0.75	0.43
	Moreton Banks, near Rous Channel	27.2925	153.3563	37.68(0.40)	5.25(2.49)	5.79(0.03)	6	0.62	0.69	0.21	0.52	0.60	0.43
	Fisherman's Gutter	27.4020	153.3373	37.87(0.05)	4.33(2.49)	5.75(0.18)	3.5			0.10	0.24	0.59	0.41

Table 2. Primary productivity (gross and net photosynthesis) and respiration rates (water sample collection sites shown on Fig. 1). Ratio of dark respiration to gross photosynthesis (RR:GPR ratio) and ratio of net to gross photosynthesis (also referred to as net growth efficiency) are used to evaluate primary productivity measurements on natural phytoplankton communities.

Site no.	Site Location	Gross photosynthesis rate (g C m^{-2} day^{-1})	Net photosynthesis rate (g C m^{-2} day^{-1})	Respiration rate (g C m^{-2} day^{-1})	RR:GPR ratio	Net growth efficiency (NPR:GPR)
1	Rous Channel, middle	-0.006	-0.084	0.077		
2	South Passage Bar, near Amity	-0.080	-0.122	0.042		
3	Northeast end of Dialba Passage	0.224	0.158	0.065	3.44	0.71
4	Near Blakesley's Anchorage, South of Dunwich	0.690	0.571	0.119	5.79	0.83
5	Amity Banks, Northeast corner	0.648	0.603	0.045	14.41	0.93
6	Brisbane River, near Gateway Bridge	0.893	0.859	0.034	26.46	0.96
7	Northwest Amity, East entrance to Rous Channel	1.481	0.975	0.506	2.93	0.66
8	Between Wynnum & Green Island	1.257	1.155	0.101	12.41	0.92
9	South of Dunwich in Deanbilla Bay	1.277	1.248	0.030	43.25	0.98
10	South West Rocks, Peel Island	1.906	1.420	0.486	3.92	0.74
11	North of Cleveland Pt	1.531	1.477	0.054	28.35	0.96
12	Brisbane River, near Breakfast Creek	3.231	2.252	0.979	3.30	0.70
13	Logan River mouth	3.113	2.390	0.724	4.30	0.77
14	Adam's Beach, North Stradbroke I.	4.062	3.900	0.162	25.07	0.96

Chlorophyta/Cyanobacteria (0.10–3.74) and Chrysophyta/Pyrrophyta (0.24–9.36) (Table 1) however, revealed that when water clarity was low (1.2±0.27 m) and turbidity was relatively high (22±13 NTU), Chlorophyta predominated over Cyanobacteria (Chloro/Cyano > 2). When Cyanobacteria predominated over Chlorophyta (Chloro/Cyano ≤ 0.37), water clarity was high (4.9 ±1.7 m) and turbidity was very low (4.5±2.3 NTU). There was no correlation with water

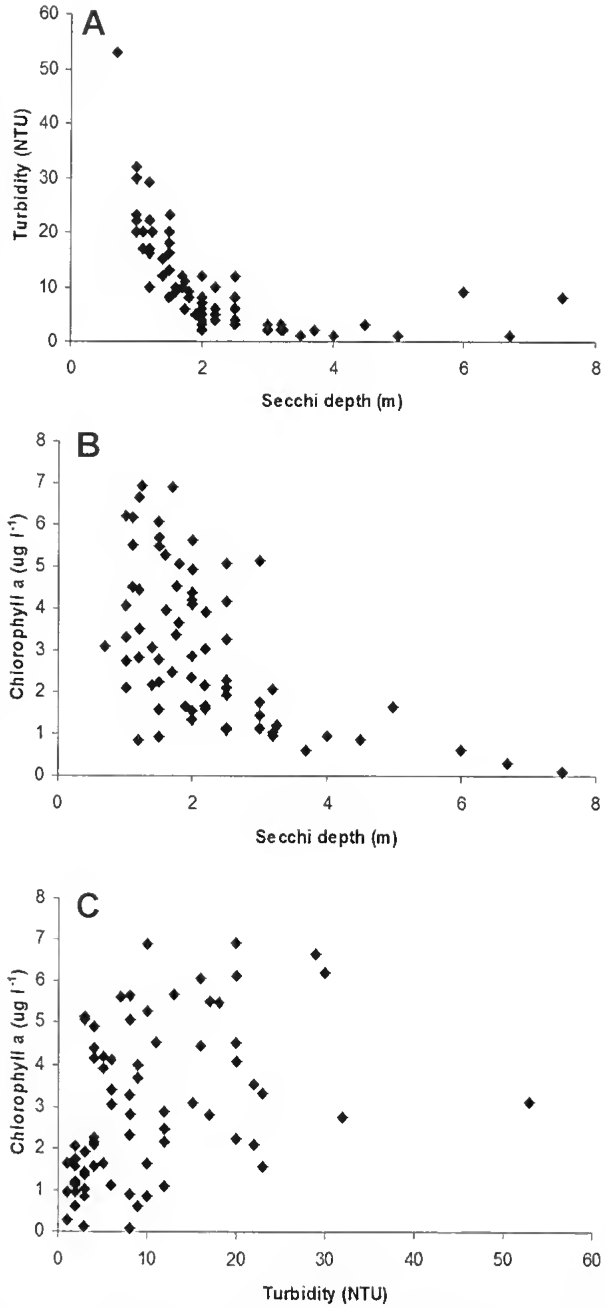

FIG. 3. Primary productivity is controlled to a large extent by the ability of PAR to penetrate the water column. A. Based on samples, collected across Moreton Bay, there is a curvilinear relationship between turbidity (NTU) and water clarity (Secchi depth, m). B. There was no empirical relationship between chlorophyll a ($\mu g\ l^{-1}$), often used as a proxy for phytoplankton biomass, and water clarity (Secchi depth, m). C. There is no relationship between chlorophyll a ($\mu g\ l^{-1}$) and turbidity (NTU).

quality or location in Moreton Bay when Chloro/Cyano ratios ranged between 0.37–1.99 (Table 1). Similarly, ratios of Chrysophyta/Pyrrophyta show Chrysophyta (Chryso/Pyrro > 5) favoured regions of Moreton Bay with high turbidity (≥22 NTU) while Pyrrophyta (Chryso/Pyrro < 1) were more prominent in areas of low turbidity (≤5 NTU) (Table 1). Again, there was no correlation in the distribution of Chrysophyta/Pyrrophyta with water quality or location in Moreton Bay when Chryso/Pyrro ratios ranged between 1–5 (Table 1).

Phycocyanin and phycoerythrin are found predominately in Cyanobacteria and Cryptophyta (Jeffrey *et al.* 1997) however plastids of the genus *Dinophysis* in the Pyrrophyta also contain phycoerythrin. Phycocyanin and phycoerythrin were present, on average, in relative concentrations of 0.53 (±0.08) and 0.45 (±0.30) respectively (Table 1). There was no clear association of phycocyanin distributions with either water quality parameters or other pigments (Table 1). In general (52 of the 73 sites), relative concentrations of phycoerythrin were <0.40 (Table 1) indicating low levels in the Bay. However, elevated phycoerythrin levels (1.11 ±0.12, n = 11) were recorded along the northern reaches of North Stradbroke I. near Amity Point extending into South Passage. This stretch of water had low turbidity (4.5±2.2 NTU) and high water clarity (2.95 ±0.97 m).

PRIMARY PRODUCTIVITY

Twelve of the fourteen sites, sampled throughout Moreton Bay were net autotrophic with daily net production rates varying from 0.16 to 3.90 g C m^{-2} day^{-1} (Table 2, Fig. 1). Primary productivity (net photosynthesis) measurements showed variability on the eastern side of Moreton Bay. The highest primary productivity rate (3.9 g C m^{-2} day^{-1}) in the Bay was measured in the Adam's Beach sample (Site 14), North Stradbroke Island. The lowest three net primary productivity rates (Sites 3, 4, 5) were measured from samples also collected from the eastern section of the Bay, offshore of North Stradbroke Island. Primary productivity rates from the Deanbilla Bay sample, North Stradbroke Island (Site 9) were 2 to 8-fold higher than those from samples at Sites 3, 4 and 5 but, 3-fold less than rates from the sample collected nearby at Adam's

Beach (Site 14). Samples from Sites 1 & 2, near the South Passage, were net heterotrophic (Fig. 1, Table 2) while the sample collected near South Passage at the east entrance of Rous Channel (Site 7) had a primary productivity rate of 0.975 g C m^{-2} day^{-1}.

In the western bay, samples collected from sites located near the mouth or just north of the Brisbane River (Sites 6, 8) tended to have relatively low primary productivity rates (0.86–1.15 g C m^{-2} day^{-1}) whereas samples in the central bay, south of the Brisbane River (Sites 10, 11), had slightly higher daily net production rates of 1.42 to 1.48 g C m^{-2} day^{-1}. Higher rates were recorded in samples collected in the Brisbane River near Breakfast Creek (Site 12, 2.25 g m^{-2} day^{-1}) and at the Logan River mouth (Site 13, 2.39 g C m^{-2} day^{-1}).

Respiration rates varied more than 30-fold across the Bay, with rates ranging between 0.03 to 0.98 g C m^{-2} day^{-1} (Table 2). The RR:GPR ratios at sampling sites, along the mainland coast, ranged from 12.41 to 28.35 (Sites 6, 8 & 11) while ratios of 3.3 and 4.3 were measured in samples collected in the Brisbane River, near Breakfast Creek (Site 12), and the Logan River mouth (Site 13) respectively. Excluding the two net heterotrophic sites near South Passage (Sites 1 & 2), net growth efficiencies ranged from 0.66–0.98 in samples collected across Moreton Bay (Table 2, Fig. 1).

RESOURCE LIMITATION BIOASSAYS

Bioassays revealed that in 6 of the 7 sites N, as nitrate, ammonium or both, was the limiting resource (R1–R5 Fig. 4A–E, R7, Fig. 4G). The PRI was well above the threshold (140%, see methods) in treatments where N was added. Phytoplankton responded well when all nutrients were added, yielding PRI values of around 800 or greater (Fig. 4) in samples collected from all seven sites in Moreton Bay (R1–R7 in Figs. 1, 4A–4G). Light was found to be the limiting factor in the water sample taken in the Brisbane River near Breakfast Creek (R6 in Fig.1; Fig. 4F), as phytoplankton growth was similar in the control and the nutrient treatments. At Dohles Rocks, near the Pine River mouth, phytoplankton growth was co-limited by N-sources and silicate (R7 in Fig. 1; Fig. 4G). Phosphate and silicate were generally not limiting to phytoplankton production during the period of this study in Moreton Bay (Fig. 4).

Ratios of Chloro/Cyano and Chryso/Pyrro which accounted for 37 to 52% and 48 to 63% of the communities respectively, remained relatively constant over the 48 hr incubation period (see example; Fig. 4H) irrespective of treatments or sample locations. This is indicative of the lack of a specific response by these phytoplankton groups to the addition of nutrients.

DISCUSSION

Present and previous investigations on primary productivity (e.g. O'Donohue & Dennison 1997; Eyre & McKee 2002; Glibert *et al.* 2006) have clearly established Moreton Bay as a complex, dynamic system in which differing spatial and temporal patterns are observed. Temperature limits primary productivity during winter (O'Donohue & Dennison, 1997) while nutrients are more important during summer (O'Donohue & Dennison 1997; Eyre & McKee 2002; Glibert *et al.* 2006; present study). Additional factors affecting primary productivity in Moreton Bay include salinity, turbidity, DO gradients (Fig. 2), PAR (Fig. 3) as well as bay hydrodynamics (Newel 1971; Milford & Church 1977; Patterson & Witt 1992). In the northern section of the Bay, the Pacific Ocean plays an important role in flushing the system. A clockwise current operating in the upper portion of the Bay carries riverine outflow north along the western coastline. To the south, water quality is patchy due to the large number of islands and a comparatively smaller oceanic opening via Jumpinpin. Overlying these factors is the occurrence of big events such as cyclones and continuing anthropogenic disturbances such as effluent discharge, mangrove clearing, shipping and recreational activities that occur in the Bay and surrounding catchments.

Phytoplankton productivity in Moreton Bay measured in the present study (0.16 to 3.90 g C m^{-2} day^{-1}; Table 2) was higher than that previously reported in this estuary by O'Donohue & Dennison (1997). The disparity in results may be due to different methods (light/dark bottle method in current study versus C14 method in the earlier study) or to different sampling regimes (e.g. bay-wide in current study — Fig. 1, Table

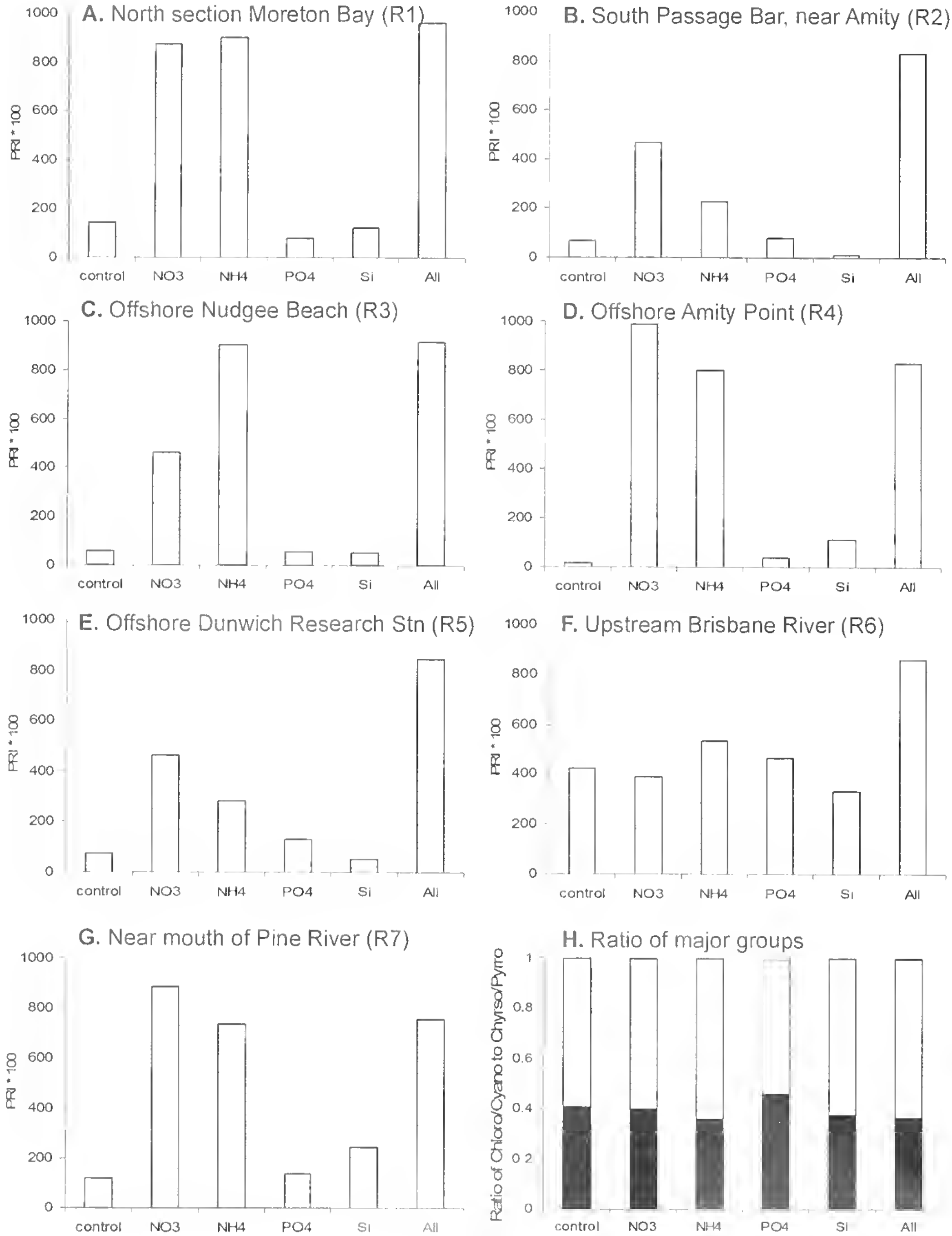

FIG. 4. Resource limitation assays on water samples collected at Sites R1–R7 in Moreton Bay (Fig. 1). Phytoplankton response index (PRI) values were multiplied by 100 (PRI*100) in all cases and plotted against each treatment. The threshold for a significant response was set to 140% greater than the control in order to incorporate errors and temperature effects between assays. (H) Ratios of the major phytoplankton groups did not vary during the course of the assays. In this representative example, we show the ratio of Chlorophyta/Cyanobacteria (Chloro/Cyano) (solid bars) to Chrysophyta/Pyrrophyta (Chryso/Pyrro) (empty bars) after 48 hrs in each of the treatments using water collected at the northern opening of Moreton Bay, R1.

1) versus a focus in southern Moreton Bay and the Logan River in the previous study. From our findings, the southern part of Moreton Bay had lower overall water clarity and phytoplankton communities were N-limited. Both factors would account for lower primary production measurements (0.34 to 0.58 g C m^{-2} day^{-1}) reported by O'Donohue & Dennison (1997). Moreover, our bay-wide results are consistent with average summertime productivity measurements undertaken in other locations in northeastern Australia. Averages recorded for the Gulf of Carpentaria were 0.914 g C m^{-2} day^{-1} (Rothlisberg *et al.* 1994) and 1.33 g C m^{-2} day^{-1} (Motoda *et al.* 1978) while rates in the mid-continental shelf waters off the Great Barrier Reef were 0.55 g C m^{-2} day^{-1} (Furnas & Mitchell 1987). Our findings are also similar to estimates of productivity measured in other temperate and subtropical estuaries further afield, including 0.91 g C m^{-2} day^{-1} in Chesapeake Bay (Harding *et al.* 1986), 0.94 g C m^{-2} day^{-1} in the Neuse River Estuary, USA (Mallin *et al.* 1991) and 0.8 to > 3 g C m^{-2} day^{-1} in temperate Galveston Bay (Quigg *et al.* 2007).

Based on our primary productivity measurements, the Moreton Bay ecosystem was net autotrophic during the period of this study, and generally during Austral summers (Dennison & Abal 1999; Eyre & McKee 2002; Glibert *et al.* 2006). Samples from four sites (Sites 6 & 11 to the west and Sites 9 &14 to the east of the bay had high (25–43) ratios of dark respiration to gross photosynthesis (RR:GPR) compared to other sites sampled (2.9–14.4) (Table 2). Decreases in PAR, sufficient to reduce growth (e.g., due to the highly turbid water column), would impact photosynthesis more than dark respiration. This is consistent with the higher RR:GPR ratios and net growth efficiencies measured landside of the Bay. Although *in situ* PAR is an important factor governing phytoplankton growth (e.g. Quigg & Beardall 2003), and despite a turbidity gradient extending across the Bay, light was not the primary factor controlling phytoplankton productivity during the course of this study.

The combination of oceanic flushing from the east, with riverine nutrient loading from the mainland (west), and the overall clockwise water circulation of the bay establishes a strong nutrient gradient in the bay (Moss *et al.* 1992; Gabric *et al.* 1998; McEwan *et al.* 1998; Glibert *et al.* 2006). Higher productivity rates (net photosynthesis) at sites on the mainland coast of Moreton Bay may be due to nutrient loading from riverine inputs carried north along the mainland by prevailing water currents (Newel 1971; Milford & Church 1977; Patterson & Witt 1992). Bell and Elemetri (2007) reported higher NO_3 levels upstream of the Brisbane River mouth (20.5 µM) compared to the river mouth (14 µM). Low primary production in most sites along the oceanic side of Moreton Bay (Sites 1–5) reflect the influence of oligotrophic waters (Gabric *et al.* 1998; Glibert *et al.* 2006) drawn in by tidal exchange through South Passage. This tidal movement generates strong currents flowing past Dunwich to the south side of Peel I. (Patterson & Witt 1992). Similar cross-bay variation in primary production rates have been reported for other estuaries. For example, in Galveston Bay (Texas, USA), Quigg *et. al.* (2007) recorded summertime high productivity rates of > 3 g C m^{-2} day^{-1} at sites nearest to the Trinity River and 0.8-1.2 g C m^{-2} day^{-1} on the ocean side near the Gulf of Mexico. Similar findings have also been reported for other estuaries including Chesapeake Bay (Harding *et al.* 1986; Malone *et al.* 1988; Fisher *et al.* 1999) and the Strait of Georgia (Harrison *et al.* 1991).

While general trends were observed in water quality and productivity on large spatial scales in Moreton Bay, it is important to appreciate the heterogenous nature of such systems and that exceptions do exist. The sites recording the two highest productivity rates in Moreton Bay, Adam's Beach (Site 14) and the Logan River mouth (Site 13) (Table 2; Fig. 1), are strongly influenced by localized nutrient inputs rather than the general hydrodynamic patterns of the Bay. Despite the presence of oligotrophic oceanic waters in the vicinity, Adam's Beach (Site 14), had the highest net photosynthetic rate (3.9 g C m^{-2} day^{-1}) measured in the study. In the last decade, high phytoplankton productivity along with blooms of the benthic cyanobacterium *Lyngbya majuscula* have been reported at this location (Ahern 2003; Albert *et al.* 2005). These are thought to be fuelled by two nutrient sources. Nutrient-loaded ground water, originating from the Island's extensive sand dune system, picks up dissolved organic matter (8 mg/L) from nearby *Melaleuca* and *Phragmites* swamps as it travels through sandy substrata before percolating into the supra- and intertidal regions of Adam's Beach (Pointon *et al.* 2003). Effluent, from the outskirts of Dunwich and Adam's Beach caravan parks also ends up at this site (Ahern 2003). The second highest production rate (2.39 g C m^{-2} day $^{-1}$) was measured in the mouth of the Logan River (Site 13); fueled by urban runoff and the nearby prawn aquaculture facility.

In the majority of resource limitation assays (6 of 7), N as nitrate and/or ammonium limited primary productivity across Moreton Bay (Fig. 4). This is consistent with previous studies by O'Donohue & Dennison (1997) and Glibert *et al.* (2006) which reported summertime N limitation in this estuary. Given the predominant influence of oceanic waters (Fig. 2; Table 1), N-limitation in the Bay is consistent with an oligotrophic environment (Hecky & Kilham 1988; Howarth & Marino 2006). We found no evidence of phosphorus limitation in Moreton Bay, supporting findings of previous studies (O'Donohue & Dennison 1997; Glibert *et al.* 2006) but see Eyre and McKee (2002). Resource limitation bioassays performed on macroalgae and seagrasses, growing in Moreton Bay, also showed preferential responses to N additions (Jones *et al.* 1996; Udy & Dennison 1997) which further raises concerns about the impact of nutrient enrichment in the Bay (Quigg *et al.* 2008).

Although previous studies have reported chlorophyll *a* concentrations in Moreton Bay, this is the first study to our knowledge, using diagnostic photopigments to examine relative abundances of major phytoplankton groups (phylum-level) in the bay. While patterns in phytoplankton biomass distribution (based on chl *a*) were associated with physical and chemical characteristics of the water column, at the phylum level, patterns were less clear. We found Cyanobacteria were a significant component of the phytoplankton pool (Table 1) whereas Wood (1964) and Heil *et al.* (1998 a, b) reported only eukaryotic phytoplankton from Moreton Bay. However Gabric *et al.* (1998) did report the occurrence of *Trichodesmium*, a diazatrophic prokaryotic cyanobacterium in the northern section of Moreton Bay during spring and summer. This pigment approach was not sufficient to provide information on phytoplankton population dynamics and whether the population reflected available resources and/or the physical environment. Using more sensitive techniques for pigment analysis (see Jeffrey *et al.* 1997) and/or microscopic examination of samples may have provided more useful insights into phytoplankton phyla distribution patterns. Assessing phytoplankton population dynamics under a range of resource (e.g., nutrients, light, temperature) conditions would lead to more effective predictive models for Bay protection and identify species which could be used as key bioindicators in defining a healthy estuarine system. Such studies would also identify conditions which can switch either invasive or endemic species into harmful agents (Granéli & Turner 2006). Blooms of the toxin-producing dinoflagellate *Dinophysis caudata*, for example, have been recorded in Moreton Bay from the 1940s and 50s (Wood 1954) and are considered part of the natural cycle. However a change in bloom frequency or occurrence may indicate a perturbation in estuary function. More controversially, there has been an increase in reports of the cyanobacterium *L. majuscula* (which forms dense filamentous mats during the summer months) in Moreton Bay (Bell *et al.* 1999; Elmetri & Bell 2004; Ahern *et al.* 2007), particularly in Deception Bay and near the Port of Brisbane. One of the key factors driving blooms of this species may be its ability to fix nitrogen (Lundgren *et al.* 2003; Elmetri & Bell 2004) so while eukaryotic phytoplankton maybe N-limited during the Austral summer, diazotrophic cyanobacteria such as *L. majuscula* are able to continue growing. Hence the change in *L. majuscula* bloom frequency and magnitude suggests it could be a useful monitoring tool. The occurrence of algal blooms, whether they are considered harmful or simply offensive to humans, has led not only to the loss of wildlife (e.g., fish kills) and flora (e.g., smothering of seagrasses) in Moreton Bay (Dennison & Abal 1999) and other estuaries around the world (Fisher *et al.* 1999; Howarth & Marino 2006; Thronson & Quigg 2008) but also to the loss of revenue e.g. from fewer tourist dollars.

MANAGEMENT IMPLICATIONS

While this study considered the impact of water column quality on phytoplankton productivity in Moreton Bay, future studies should consider nutrient partitioning between the water column, sediment and biota in the Bay. This would provide much needed information to better predict the impact of increased nutrient loading on this coastal ecosystem rather than the generalisations alluded to by the above measurements. For example, based on elemental fluxes, particularly for carbon, nitrogen and phosphorus, Eyre & McKee (2002) concluded that primary productivity was phosphorus limited at the *whole* ecosystem level in Moreton Bay. Our findings indicated that primary productivity was N-limited at the time of the study which was consistent with the conclusions of Moss *et al*. (1992), O'Donohue & Dennison (1997) and Glibert *et al*. (2006). The disparity in these conclusions indicates that we need a better understanding of how nutrient inputs are modified as they move around estuaries by physical, biological and anthropogenic processes, particularly nutrient partitioning and recycling. Such studies can better inform managers of the significance of regulating nutrient loads. While many studies focus on regulating N loading to reduce the impacts of eutrophication (e.g. Rabalais *et al*. 2007) we are becoming increasingly aware of the need to also consider reducing P loads (Eyre & McKee, 2002; Ammerman *et al*. 2003; Elmetri & Bell 2004; Sylvan *et al*. 2007). Irrespective of the source of nutrient-enrichment, our findings support the need for coastal water quality managers to address impacts of nutrient-loading, not only in Moreton Bay, but also in other estuaries.

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The abundance, biomass and size of macrograzers on reefs in Moreton Bay, Queensland

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ABSTRACT

Reef systems in subtropical Moreton Bay were surveyed using underwater visual census techniques to assess the structure of macrograzer assemblages relative to tropical reefs. The community was dominated by acanthurids, pomacentrids, and siganids, with relatively few scarids, blennies and didemnid urchins. Biomass of fish grazers on Moreton Bay reefs at Amity rock-wall and Myora was not significantly different from other Pacific reefs indicating that even at high latitudes fish grazing might be an important structuring influence on coral communities. ❑ *keystone species, epilithic algal community, coral reef, fishes, urchins, reef health.*

The health of tropical coral reefs is sustained in part by the grazing activity of fishes that remove the algal competitors of corals, link a highly productive source of primary production with other members of the coral reef food web (Choat 1991; Polunin & Klumpp 1992), and influence the structure of benthic communities (Ogden & Lobel 1978; Hatcher 1981; Horn 1989; Carpenter 1990; Petraitis 1990). Their role is of such significance in Indo-Pacific reef systems that they are considered a keystone guild (Choat 1991). Herbivorous and omnivorous members of the Pomacentridae, Scaridae, Siganidae and Acanthuridae are widely recognized as the main families involved. More recently the tribe Salariini of the family Blenniidae has been added to the guild (Townsend & Tibbetts 2000, 2004). Invertebrate grazers are also recognized to play a role in maintaining the balance between coral and algae (Ogden & Lobel 1978; Klumpp *et al.* 1988). However, the role of grazing fishes and invertebrates in the health of coral reefs outside of the tropics is less well understood. Many of the families important in tropical reef systems are represented in subtropical communities but there is little information on whether their role is of the same pivotal importance (Horn 1989).

Moreton Bay is a major embayment on the eastern coast of Australia. It is a marine park and supports a diversity of marine habitats that include significant coral reef outcrops. Lying just outside the bay, but within the marine park, is Flinders reef, for which 119 species of corals have been recorded (Harrison *et al.* 1998). Within the bay the communities are less diverse (64 species) yet substantial outcrops lie adjacent to bay islands (Mud, Green, St Helena and Peel), near Dunwich on the western side of North Stradbroke Island, and along the south western shores of Moreton Bay between Point Halloran and Wellington Point (Flood 1978; Johnson & Neil 1998; Wallace *et al.* 2009). These subtropical coral communities are chiefly dominated by faviid corals; however, in the eastern bay acroporids are locally abundant (Johnson & Neil 1998; Harrison *et al.* 1998).

Herbivory as a community structuring agent is generally considered to be less important outside

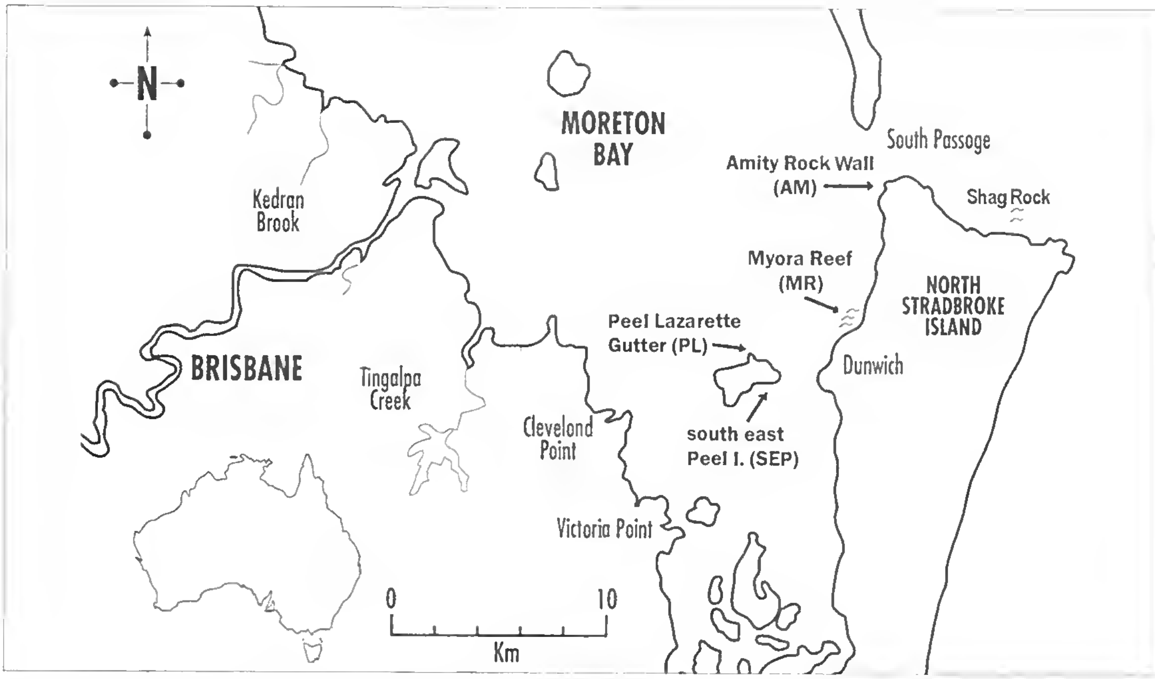

FIG. 1. Map of study locations in Moreton Bay, where AM = Amity Rock Wall, MY = Myora Reef, PL = Peel Lazarette Gutter, and SEP – south east Peel Island.

of the tropics (Ogden & Lobel 1978). Herbivores tend to comprise a smaller proportion of the overall abundance of reef fish; however, they can make up a substantial proportion of the biomass (Russell 1977). Thus the role of fish herbivory in coral reefs at high latitudes may have been underestimated (Russell 1983). Indeed Russell (1983) suggested that subtidal algal turfs in New Zealand were partially maintained by fish grazing, and blennies are important grazers in temperate rocky reef systems (Ojeda & Munoz 1999). To assess the role of fishes and larger invertebrates in the health of subtropical reef systems of Moreton Bay we surveyed and compared the abundance and biomass of herbivorous and omnivorous macrograzers on reef outcrops within Moreton Bay, southeast Queensland.

MATERIALS AND METHODS

Grazer biomass was estimated at four sites in central eastern Moreton Bay (Fig. 1): Lazarette Gutter, Peel Island (27°28′52″S, 153°21′16″E) comprising high cover of principally faviid corals with soft corals; south east Peel Island (27°30′07″S, 153°22′21″E) comprising lateritized sandstone outcrops and scattered faviid coral colonies; Myora (27°28′21″S, 153°24′36″E) comprising high cover of acroporid corals; and, Amity Point Rock Wall (27°24′02″S, 153°26′13″E), a retaining sea wall with scattered coral colonies of *Acropora*, *Pocillopora* and faviids. At the time the surveys were conducted, the Amity Rock Wall site was heavily fished by anglers targeting bream, whiting and pelagic species. The recreational catch of grazing fish is dominated by siganids with occasional scarids landed from the jetty (pers. obs.). Spear fishing occurs at this site, with parrot and surgeon fishing being regularly targeted (N. VanDyke pers. com). Recreational line fishing activity at other reef areas in the bay was intense, and while grazers are not targeted it is likely that some are caught. Discussions with local spear fishermen indicate that parrot and surgeon fish are commonly targeted, as they are relatively easy to catch, their habitat is easily accessible for shore divers and the flesh is valued for consumption, while siganids are actively avoided due to their venomous spines (N. VanDyke pers. com). A commercial fishery existed for siganids on reefs around Peel, but its intensity has declined with protection of the area and a drop in demand (Tibbetts & Connolly 1998).

Table 1. Constants used to estimate biomass (M) from length (L_T) for major families of grazing fish $M=aL_T^b$.

Family	Species	a	b	Source
Acanthuridae	*Acanthurus fuscus*	0.0089	3.278	Letourneur (1998)
Blenniidae	*Blennius ocellaris*	0.0140	2.963	Pereda & Villamor (1991)
Kyphosidae	*Kyphosus bigibbus*	0.0275	2.860	Froese (1998)
Pomacentridae	*Pomacentrus coelestis*	0.370	2.630	Kochzius (1997)
Scaridae	*Scarus ghobban*	0.0233	2.919	Murty (2002)
Siganidae	*Siganus fuscescens*	0.0162	3.010	Letourner *et al.* (1998)

Four to six underwater visual censuses were completed at each site by divers on SCUBA using a measuring tape to centre a 50 x 4 m belt transect. The identity and length (± 10 mm) of individuals from families of grazing fishes and the grazing urchin, *Diadema* sp. were recorded in February (late summer) 2005. Fish biomass was estimated using equations relating length estimates to mass (Table 1). Average size of fish in each transect was computed by dividing the total biomass by the total number of fishes in a transect. This measure was used to examine whether grazing is being done by smaller or larger fishes at different sites.

Values of biomass.200 m^{-2} were compared graphically both among sites in Moreton Bay, and between Moreton Bay and data sets collected by the senior author from: Heron Island reef slope and reef crest, Great Barrier Reef (23°26′S, 151°55′E); Solomon Islands sites — Mbili Marine Protected Area in outer Marovo Lagoon; Tengamo patch reefs in mid lagoon with low level protection by the family living on Tengamo Island; and two inner lagoon patch reef sites subject to terrestrial runoff and situated close to villages Koreke and MerusaA, Marovo Lagoon (8°39′S, 158°08′E); and lastly Gaulin reefs, San Salvador, Bahamas (24°02′N, 74°30′W). Four replicates were taken at each location. While having suffered some coral bleaching in recent episodes Heron reef might be considered a healthy functional reef as it is remote from land-based nutrient sources and closed to fishing. The two sites in San Salvador are oligotrophic, moribund reef systems in which non-herbivorous fishes are heavily exploited but herbivores appear not to be taken for food (pers. obs.). The Marovo Lagoon sites represent a gradient of health from the oceanic influenced Mbili MPA to the inner sites at Merusu.

Non-parametric multidimensional scaling (MDS) of similarity (Bray Curtis) matrices derived from square root transformed abundance and biomass data were used to assess general patterns among sites (Primer V5.2.4, Plymouth Marine Laboratories, Clark & Warwick 1994). Means were tested using one-way Analysis of Variance on data that if necessary to satisfy assumptions inherent in ANOVA had been log(x+1) transformed. Due to unequal numbers of replicates post hoc comparisons of means were conducted using Tukey's HSD for unequal N ($\alpha = 0.05$).

RESULTS

Twenty four species of herbivorous and omnivorous grazing fishes were identified from reef sites in Moreton Bay. Most species belonged to the Pomacentridae (11 species), followed by the Acanthuridae (5 species), and Kyphosidae (2 species), with the Siganidae, Blenniidae and Scaridae each represented by a single species (Table 2). Four families of grazers were found at Peel Lazarette and all seven families were found at both Myora Reef and Amity Rock Wall. No grazers were observed in transects at the southeast Peel site, so it was ignored in further analyses.

The biomass and abundance of the grazing families surveyed were highly variable across the sites at which grazers were observed (Figs 2A, B). There were no significant differences in mean overall abundance of grazers (5 ± 4.7 at Peel Lazarette, 14 ± 12.1 at Myora, and 15.5 ± 21.1 individuals.200 m^{-2} at Amity Point), mean abundance of *Diadema* between the two sites at which they were found, Myora and Amity Point (2.5 individuals.200 m^{-2}), and mean biomass of grazers between Amity Point (374 ± 305.7g.200 m^{-2}) and Myora Reef (576 ± 828.4g.200 m^{-2}).

A multidimensional scaling plot of reef sites based on mean estimated biomass by family of

Table 2. List of grazing fishes and urchins observed in transects on reef areas in Moreton Bay. Trophic groupings are H = herbivore, O = omnivore, ? unknown.

Name & authority	Common name	Trophic Grouping
Acanthuridae		
Acanthurus dussumieri Valenciennes, 1835	Eyestripe surgeonfish	H
Acanthurus grammoptilus Richardson, 1843	Finelined surgeonfish	H
Acanthurus nigrofuscus (Forsskål, 1775)	Brown surgeonfish	H
Ctenochaetus binotatus Randall, 1955	Twospot surgeonfish	H
Prionurus microlepidotus Lacep de, 1804	Sixplate sawtail	H
Blenniidae		
Omobranchus punctatus (Valenciennes, 1836)	Muzzled blenny	O
Blennidae unid		?
Kyphosidae		
Kyphosus sydneyanus (Günther, 1886)	Silver drummer	H
Microcanthus strigatus (Cuvier, 1831)	Stripey	O
Pomacentridae		
Abudefduf bengalensis (Bloch, 1787)	Bengal sergeant	O
Dascylls melanurus Bleeker, 1854	Blacktail humbug	O
Parma oligolepis Whitley, 1929	Big-scale parma	H
Plectroglyphidodon leucozonus (Bleeker, 1859)	Singlebar devil	H
Pomacentrus australis Allen & Robertson, 1974	Australian damsel	H
Pomacentrus chrysurus Cuvier, 1830	Whitetail damsel	H
Pomacentrus moluccensis Bleeker, 1853	Lemon damsel	O
Pomacentrus wardi Whitley, 1927	Ward's damsel	H
Stegastes gascoynei (Whitley, 1964)	Coral sea gregory	H
Scaridae		
Scaridae unid juvenile		
Scarus ghobban Forsskål, 1775	Blue-barred parrotfish	H
Siganidae		
Siganus fuscescens (Houttuyn, 1782)	Mottled spinefoot	H
Invertebrates		
Diadema setosum	Long spined seaurchin	H
Diadema (white)		

grazing fishes revealed that Moreton Bay did not form a separate grouping, rather the sites intergraded with the tropical sites studied (Fig. 3). The first dimension (X axis) appeared to separate on biomass, whereas the second dimension (Y axis) was driven more by the number of families. Amity and Myora sites were not markedly dissimilar to communities surveyed at Heron Island, Solomon Islands and Bahamas. However, Peel Lazarette was very clearly distinguished from other sites in having very low grazer biomass.

Mean abundance of grazing fishes did not differ significantly among the Moreton Bay sites (Fig. 4A, Table 3A). However the abundances of grazers at Moreton Bay sites were significantly lower than at Heron reef crest and reef slope, Koreke and Mbili MPA in the Solomon Islands and the two Bahamian sites. Grazer biomass was significantly lower at Peel Lazarette Gutter than at Amity and Myora reefs, which in turn were only significantly different from the two Bahamian reefs of the other sites studied (Fig. 4B,

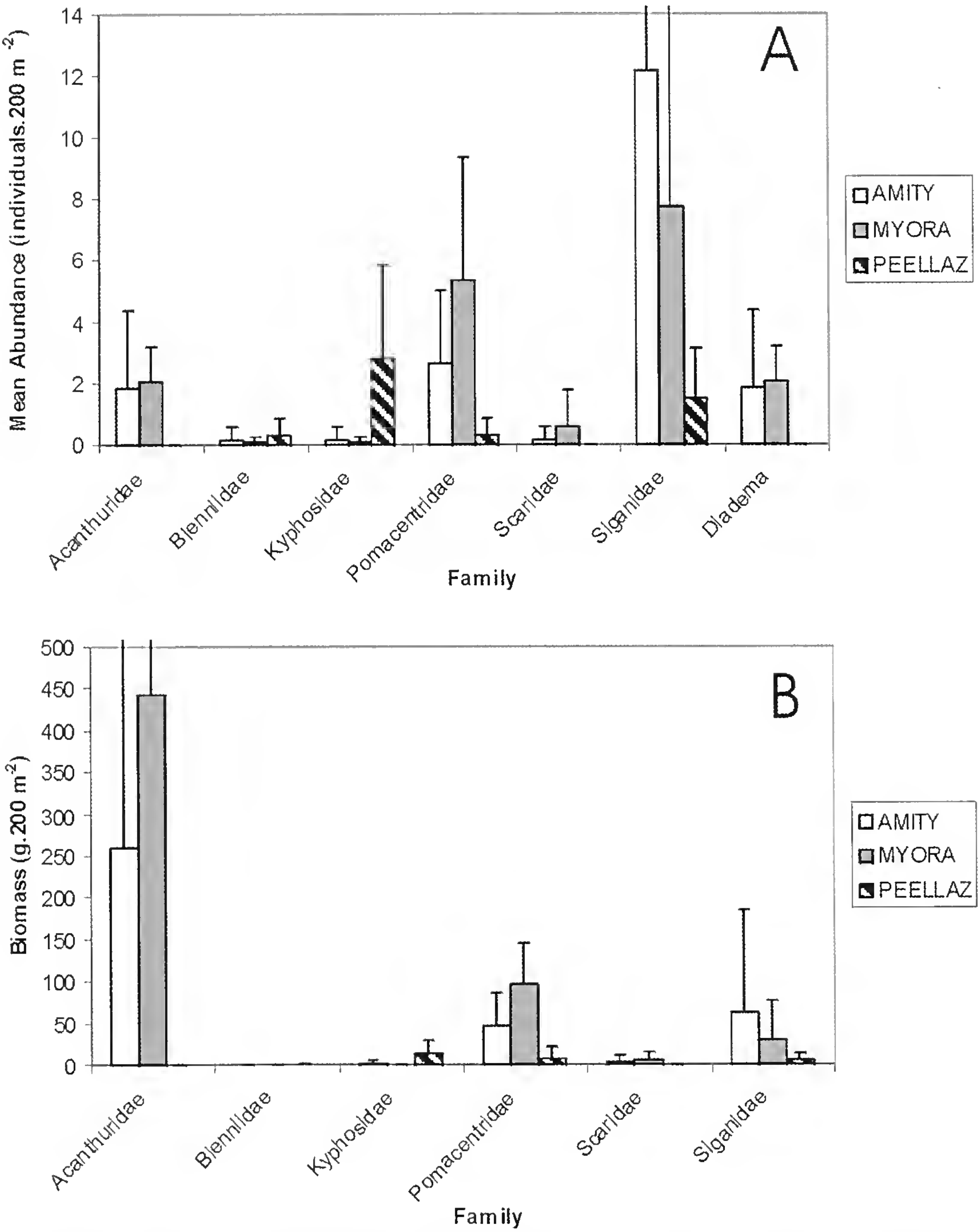

FIG. 2. **A**, Mean biomass of grazing fishes (g.200 m-2) and **B**, mean numerical abundance (for grazing fishes and grazing fish families and the urchin *Diadema*)(individuals.200 m-2) of grazing fish families at three reef sites in Moreton Bay. Error bars = SD (Note for A, SD values for Amity and Myora were 311.2 and 870.9, respectively; and for B, SD values for Amity and Myora were 21.3 and 8.8, respectively. **Note**: reef at SE Peel Island was surveyed but no grazers were recorded in transects. AMITY, Amity Point; MYORA, Myora Reef; PEELLAZ, Lazarette Gutter, Peel Island.

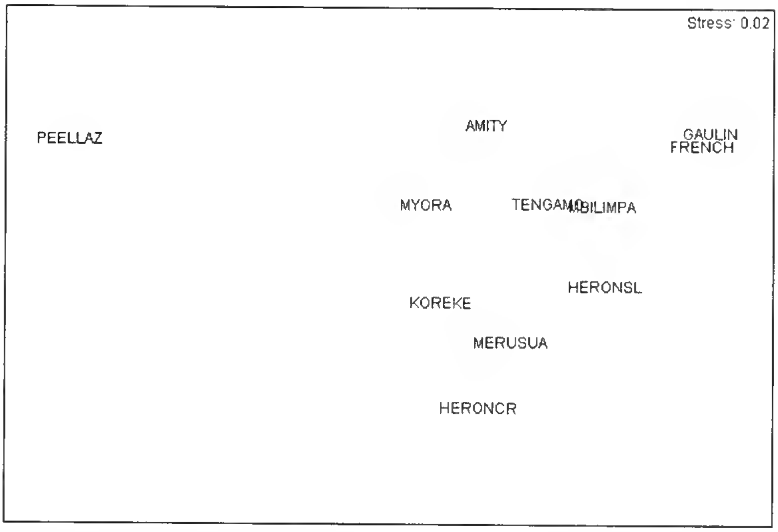

FIG. 3. Multidimensional scaling plot of reef sites based on mean estimated biomass by family of grazing fishes. Sites within Moreton Bay are AMITY = Amity Point Rock Wall, MYORA = Myora Reef, PEELLAZ = Lazarette Gutter, Peel Island; sites on Heron Island, Great Barrier Reef are HERONCR = Heron reef crest, HERONSL = Heron reef slope; sites in Marovo Lagoon Solomon Islands include the managed open lagoon sites of TENGAMO = reefs near Tengamo Island, MBILIMPA = Mbili Village Marine Protected Area, and the non-managed, terrestrial runoff sites dominated by massive corals of KOREKE = near Koreke Village and MERUSUA = near Merusu Village; and sites in the lagoon of San Salvador Island, Bahamas, GAULIN = Gaulin Reef, Graham's Harbour and FRENCH = French Reef, French Bay. Stress 0.02.

Table 3B). Peel Lazarette had a significantly smaller mean size of grazing fishes than the other sites (Fig. 4C, Table 3C).

DISCUSSION

The subtropical coral reefs of Moreton Bay support grazing fish communities dominated by acanthurids, pomacentrids and siganids, and while scarids and kyphosids were observed, they were relatively unimportant in terms of either abundance or biomass. Blennies are important grazers in tropical reef systems (Townsend & Tibbetts 2000, 2004), and on high latitude reefs in the Atlantic (Ojeda & Munoz 1999), however they did not feature in grazing assemblages of Moreton Bay reefs, despite the authors' experience with identifying and counting these cryptic fishes. However, grazing blennies are a generally a feature of rocky intertidal communities in south-east Queensland (Tibbetts *et al.* 1998), and at Flinders Reef, a diverse coral assemblage (Harrison *et al.* 1998) lying just outside of Moreton Bay, but within the Moreton Bay Marine Park (pers. obs.). Only a single specimen of the omnivorous genus *Omobranchus* (Tibbetts *et al.* 1998) was recorded.

The absence of grazing fishes and urchins from transects conducted on the site to the southeast of Peel Island is unusual. Siganids were observed outside of transects but no other macrograzers were seen during the observation period. This might be an effect of low habitat complexity (see Hixon & Beets 1993). At south east Peel faviid corals occur on rocky ledges offering little cover to fish. Similarly the faviid-dominated reef at Peel Lazarette Gutter offers relatively few refugia for small fish. Interestingly the venomous, planktivorous blenny *Meiacanthus lineatus* (De Vis, 1884) was relatively common at Peel Lazarette Gutter, but this may result from a combination of its venomous nature and its diet of plankton, with space occupied by algal turfs required for grazers being particularly limited at this site. In contrast the rock wall at Amity Point and the acroporid-dominated reef at Myora provide algal turf substrates and excellent cover for fishes, which may well have contributed to the high diversity and abundance of grazers at these sites.

Amity Rock Wall and the reef at Myora had populations of didemnid sea urchins. *Diadema* were absent from the Lazarette Gutter, Peel Island. The dense field of massive corals at Peel would

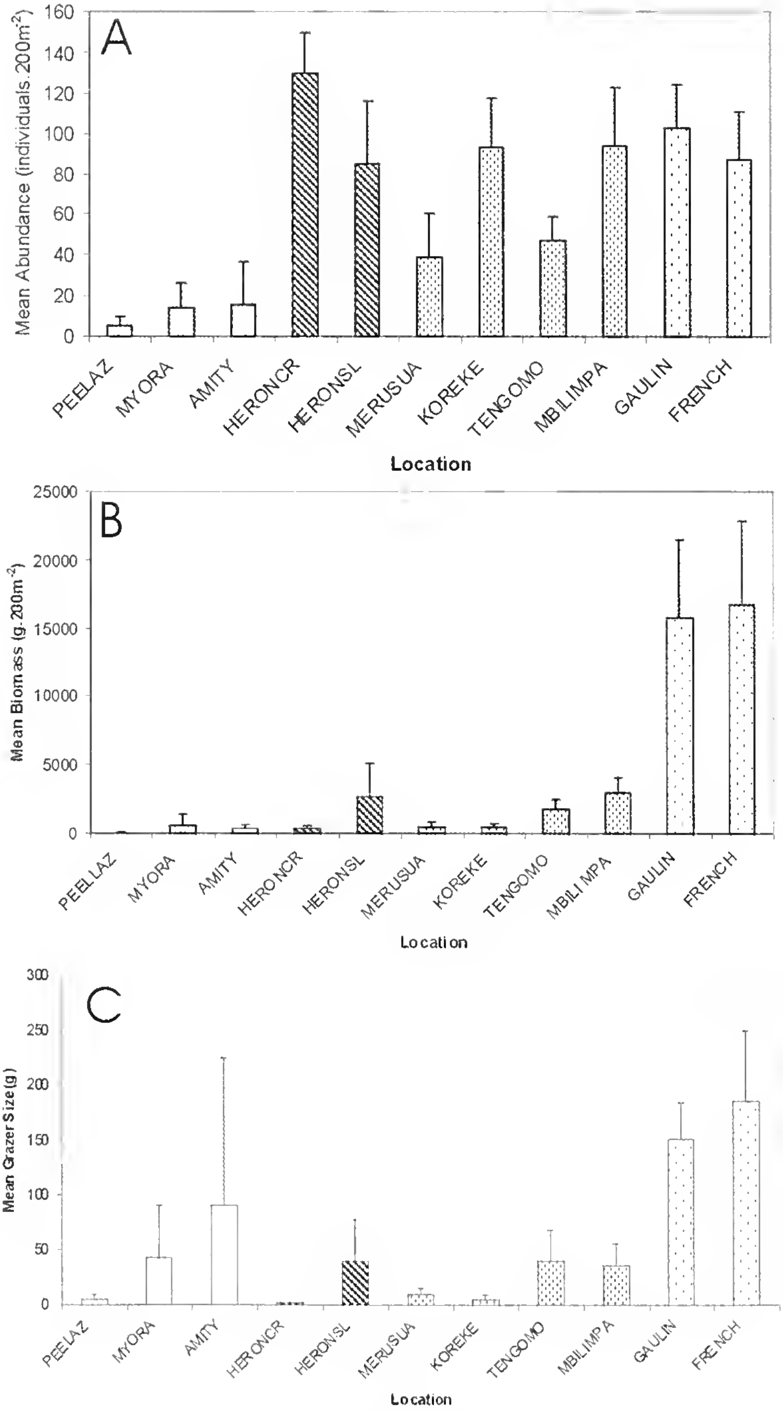

FIG. 4. Mean abundance (A), biomass (B) and mean grazer size (C) for reefal areas in Moreton Bay compared with Heron reef crest (HERONC) and slope (HERONS); Merusu Site A (MERUSUA), Koreke (KOREKE), Tengamo (TENGAMO) and Mbili Marine Park Area (MBILIMPA), Marovo Lagoon, Solomon Islands; and Gaulin (GAULIN) and French Bay (FRENCH) Reefs, San Salvador, Bahamas). Values for graph A were derived from means of the ratios of total biomass to total numerical abundance for all grazing fishes among replicate 50 x 4 m belt transects. Error bars = SD.

Table 3. Post hoc comparisons of means using Tukey's HSD for unequal N for one way Analysis of Variance on A) Abundance, B) Log (X+1) Biomass and C) Log (X+1) Size for sites within Moreton Bay are AMITY = Amity Point rock wall, MYORA = Myora Reef, PEELLAZ = Lazarette Gutter, Peel Island; sites on Heron Island, Great Barrier Reef are HERONCR = Heron reef crest, HERONSL = Heron reef slope; sites in Marovo Lagoon Solomon Islands include the managed open lagoon sites of TENGAMO = reefs near Tengamo Island, MBILIMPA = Mbili Village Marine Protected Area, and the non-managed, terrestrial runoff sites dominated by massive corals of KOREKE = near Koreke Village and Merusu A = near Merusu Village; and sites in the lagoon of San Salvador Island, Bahamas, GAULIN = Gaulin Reef, Graham's Harbour and FRENCH = French Reef, French Bay. Values in bold highlight significant differences between pairs of sites ($\alpha = 0.05$).

A

Mean Abundance	15.50	14.00	5.00	129.25	84.50	38.75	93.25	47.25	93.5	102.75	87.00
Location	AMITY	MYORA	PEEL	HERONCR	HERONSL	MERUSUA	KOREKE	TENGOMO	MBILMPA	GAULIN	FRENCH
AMITY		1.0000	0.9983	**0.0002**	**0.0019**	0.8856	**0.0005**	0.5577	**0.0004**	**0.0002**	**0.0012**
MYORA			0.9999	**0.0002**	**0.0015**	0.8413	**0.0004**	0.4918	**0.0004**	**0.0002**	**0.0009**
PEEL				**0.0002**	**0.0004**	0.4702	**0.0002**	0.1797	**0.0002**	**0.0002**	**0.0003**
HERONCR					0.1272	**0.0002**	0.3777	**0.0003**	0.3876	0.7800	0.1797
HERONSL						0.1100	0.9999	0.3306	0.9999	0.9745	1.0000
MERUSUA							0.0270	1.0000	**0.0258**	**0.0049**	**0.0754**
KOREKE								0.1061	1.0000	0.9999	1.0000
TENGOMO									0.1022	**0.0227**	0.2473
MBILMPA										0.9999	1.0000
GAULIN											0.9912
FRENCH											

B

Mean Biomass	2.4084	2.4195	1.0946	2.5367	3.1977	2.5008	2.5882	3.2069	3.444	4.2017	4.1792
Location	AMITY	MYORA	PEEL	HERONCR	HERONSL	MERUSUA	KOREKE	TENGOMO	MBILMPA	GAULIN	FRENCH
AMITY		1.0000	**0.0010**	1.0000	0.3897	1.0000	1.0000	0.3733	0.0936	**0.0003**	**0.0003**
MYORA			**0.0103**	1.0000	0.4098	1.0000	1.0000	0.3930	0.1009	**0.0003**	**0.0004**
PEEL				**0.0039**	**0.0002**	**0.0052**	**0.0025**	**0.0002**	**0.0002**	**0.0002**	**0.0002**
HERONCR					0.6399	1.0000	1.0000	0.6215	0.2106	**0.0007**	**0.0008**
HERONSL						0.5680	0.7385	1.0000	0.9995	0.1157	0.1340
MERUSUA							1.0000	0.5495	0.1702	**0.0005**	**0.0006**
KOREKE								0.7214	0.2803	**0.0010**	**0.0011**
TENGOMO									0.9996	0.1229	0.1421
MBILMPA										0.4484	0.4918
GAULIN											1.0000
FRENCH											

TABLE 3. Continued ...

C											
Mean Size	1.5006	1.4667	0.5807	0.5727	1.3406	1.0156	0.7297	1.5559	1.5033	2.1997	2.2535
Location	AMITY	MYORA	PEEL	HERONCR	HERONSL	MERUSUA	KOREKE	TENGOMO	MBILMPA	GAULIN	FRENCH
AMITY		1.0000	0.0158	0.0859	1.0000	0.8404	0.2586	1.0000	1.0000	0.3890	0.2885
MYORA			0.1182	0.1113	1.0000	0.8911	0.3164	1.0000	1.0000	0.3234	0.2341
PEEL				1.0000	0.2765	0.9112	1.0000	0.0589	0.0895	0.0003	0.0002
HERONCR					0.2635	0.9015	1.0000	0.0552	0.0841	0.0003	0.0002
HERONSL						0.9870	0.5819	0.9996	1.0000	0.1437	0.0965
MERUSUA							0.9951	0.7370	0.8359	0.0093	0.0056
KOREKE								0.1808	0.2543	0.0007	0.0004
TENGOMO									1.0000	0.5074	0.3921
MBILMPA										0.3945	0.2931
GAULIN											1.0000
FRENCH											

not seem conducive to the provision of either shelter or feeding opportunities for didemnids. The distribution of urchins was patchy, and appeared not to be related to the biomass of grazing fishes. We infer from this that grazing at sites with low biomass of grazing fishes is not compensated by urchins. Either grazing on Moreton Bay reefs is being carried out by other invertebrates that were not seen by us (e.g., crustaceans, Shaw & Tibbetts 2004) or that grazing is not required to limit algal growth. It is possible that bottom up control of algal growth is an important regulating factor in the oligotrophic waters of eastern Moreton Bay (see Albert *et al.* 2009).

Macroalgal cover at the sites studied varied from 5% at Amity Point to 20% at Peel Island (Dennison & Abal 1999), while macroalgal diversity was highest at Peel Island (23 species) and lowest at Amity Point (1 species), with nine species recorded for Myora (Phillips 1998). The extent to which grazers are responsible for this trend in macroalgal abundance and diversity must be resolved empirically; however, it broadly matches the trend in grazer biomass across these sites, suggesting that such experiments might be productive. With the exception of Harrison *et al.* (1998) data for Myora Reef, there are no data available for Moreton Bay concerning cover of epilithic algae, which are a principal focus of the grazing activities of fishes and invertebrates, and comprise microalgae, the early life developmental stages of macroalgae, sediment, detritus, phytoplankton and meiofauna (Wilson & Bellwood 1997). Such data would be very useful, not only for grazing studies but also in simple monitoring for trends in the health of Moreton Bay reefs.

The grazing assemblage of Moreton Bay reefs were not distinct from comparison reefs but instead community analysis suggested that they tend to intergrade with the tropical sites studied, supporting the notion that grazers might be important structuring agents on high latitude reefs (Russell 1983). The two sites in Moreton Bay with the highest abundance of grazing fish had lower grazer abundances than sites at Heron Reef, some Solomon Islands reefs and Bahamian reefs. However, in terms of both biomass and mean grazer size these Moreton Bay sites were not significantly different from the other Pacific reefs studied, although we feel this is partly attributable to high variation in the data and the low power of the parametric tests applied. It is clear from our data that grazer biomass on coral outcrops within Moreton Bay is very low (0.025–0.078 g m^{-2}) compared with reefs worldwide; 7.5–44 g m^{-2} in the Great Barrier Reef (Russ 2003), 2.7–15.4 g m^{-2} in the Caribbean (Williams & Polunin 2001), 25–160 g m^{-2} in Hawaii (Friedlander & DeMartini 2002).

Pandolfi *et al.* (2003) suggested that the health of reefs is directly indexed to the level of human impact on reef systems, and that as a consequence reefs worldwide are threatened by the cumulative effects of over fishing and pollution. They emphasized that the removal of grazers by over fishing can lead to a phase shift in the coral reef community from a coral dominated substrate in which grazers restrict the growth of algal communities to a low turf, to a community dominated by foliose algae that overgrow, shade and lead to the death of corals. Following European settlement the reefs of Moreton Bay have become degraded in terms of species richness, coral cover, and health (Lybolt *et al.* 2010), yet the biomass of grazing fishes at some sites is comparable to some tropical reefs. The population of grazing fishes is low in most areas and the function of grazing appears not to have been visibly replaced by other groups of grazers. *Diadema* have the potential to fulfill this role in the grazing guild, but they are neither abundant nor ubiquitous. Edmunds & Carpenter (2001) in a Caribbean reef found mean densities of *Diadema antillarum* of 5m^{-2} in habitats in which they effectively control algal growth to the benefit of corals. In the present study the highest density observed was two orders of magnitude lower, indicating that their role is likely to be neither pivotal nor compensatory.

As far as we are aware anglers seldom either target or capture grazing fishes (with the exception of siganids) in Moreton Bay. However, spearfishers actively target larger herbivorous species in the bay due to their ease of access and value as a food fish. Of greater concern is that experienced spearfishers target parrotfish at dawn and dusk, when they are settled into their protective mucous cocoons within crevices (N. VanDyke, pers. com). This also occurs in Marovo Lagoon, where locals participate in night spearfishing known as 'tope ipu' in the Marovo language. Thus spearfishing potentially explains the low abundance and size of parrotfish in both Moreton Bay and Marovo Lagoon. Indeed, during our surveys in both Marovo and Moreton Bay larger parrotfish seemed inordinately nervous and rapidly fled from us suggesting that they might indeed be targeted, but also that their biomass might have been underestimated under such conditions. Interestingly the Bahamian reefs are relatively remote, heavily line fished but seldom speared, which has perhaps resulted in unusually large parrotfishes dominating these reef assemblages and not fleeing at the approach of snorkelers and SCUBA divers. While on a numerical basis there is little to distinguish the Atlantic and Pacific reefs, these larger and more approachable parrotfish on the Bahamian reefs confer the biomass dominance by the Atlantic reefs investigated by us. It will be interesting to see whether parrotfish populations and average fish size in Moreton Bay increase following the recent (1 March 2009) closure of extensive reefal areas in the bay with the refinement of the Moreton Bay Marine Park provisions (http://www.legislation.qld.gov.au/LEGISLTN/SLS/2008/08SL343.pdf).

The main canopy forming macroalgae in Moreton Bay are the fucoids *Sargassum natans* (Linnaeus) Gaillon and *Cystoseira trinodis* (Forsk.) C. Ag. (pers obs). Periodically these grow on faviid corals and form extensive canopies; an event that is apparently survived by the corals. These canopy algal-coral assemblages appear to be associated with shore areas (e.g. close to Goat Island and Polka Point, pers. obs.) and may well be supported by nutrients from local runoff. There is no apparent limitation on the initiation of these events by grazing fishes or any apparent control of the canopies by browsing fishes once they are formed. The relatively mobile schools of kyphosids and siganids we observed might offer a counter to these blooms, but we have observed no browsing activity and, interestingly, little apparent damage to the coral hosts of these algae.

More recently the potential role of Moreton Bay as a coral refuge from the effects climate change has been discussed. Supporters point to the extensive reef communities that occupied the bay pre-European settlement, while opponents suggest that even with considerable improvements in water quality Moreton Bay has only held coral for 50% of the past 7000 years (Lybolt *et al.* 2010). Should tropical corals either naturally find a home in Moreton Bay, or be transplanted there, they will be welcomed by only a modest diversity of grazing fishes and urchins; however, high grazer abundance may not be essential to control algae in the oligotrophic waters of eastern Moreton Bay (Albert *et al.* 2008; Brown 2010). Moreover, the other important positive effects of grazing such as the opening up of sites for coral settlement will still occur while the negative effects of grazer removal of coral spat will be less than in more grazer-replete systems (Christiansen *et al.* 2009). Notwithstanding, in the potential face of oblivion a 50% chance is better than none, and we feel that efforts should be directed toward improving our understanding of the biology and dynamics of Moreton Bay's grazing fishes in the event that they may support a refuge for Indo-Pacific coral reef diversity.

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Peracarid crustacean assemblages of benthic soft sediments around Moreton Island, Queensland

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ABSTRACT

The potential for differences in the benthic peracarid assemblage composition of soft sediments around Moreton Bay was examined. Peracarid assemblages are described from van Veen grab samples collected at 26 stations during the Moreton Bay workshop of February 2005. The samples were all from soft sediments, at 6–40 m depth. Assemblages were analysed at the family level for all peracarids, at the genus level for cumaceans and tanaidaceans, and at the species level for tanaidaceans only (using data from a further 15 stations). Five main station groupings were identified at the family level by multivariate analysis. While an indication of association with sediment type and, by inference, organic content, was indicated, neither sampling gear nor depth seemed to influence the pattern. Analysis at generic level for cumaceans and tanaidaceans showed a distinction in the stations east of Moreton and North Stradbroke Islands by depth. However, the inclusion of polytypic genera introduces confusion to the interpretation. Analysis of the tanaidaceans at the specific level, which allowed inclusion of further sampling stations on muddier substrata, showed more detailed community distinctions based on substratum, depth and, by association, on geography. Microhabitat development off the South Passage is discussed. With the intrageneric habitat-distinctions demonstrated in the tanaidacean component of the community, it is clear that, while analysis at higher taxon levels shows some gross trends in the community distribution in relation to substratum type, the added detail provided by a species-level analysis affords a more comprehensive, more logical, and explicable interpretation. These results show that analysis of assemblages of the Peracarida alone does allow interpretation of habitat-associations, and thus biotopes. ❑ *Crustacea, Peracarida, Queensland, Australia, Amphipoda, Cumacea, Tanaidacea, assemblage, community, depth, substratum, taxonomic sufficiency.*

Moreton and North Stradbroke Islands separate Moreton Bay, a subtropical Pacific water mass, from the main ocean (Fig. 1). Moreton Bay is also a complex estuarine system into which the Brisbane, Logan–Albert, Pine and Caboolture Rivers drain. At times Moreton Bay has almost full oceanic salinity throughout, at other times a large proportion of freshwater is present particularly in the western part (Milford & Church 1977).

Oceanic water enters the Bay on each tide, mainly from the north, flooding in a south-westerly direction predominantly through the Main Passage and Pearl Channel (Milford & Church 1977). Some water enters from the (eastern) South Passage flooding westwards through the Rous Channel and southwards through the Rainbow Channel. At half-tide, surface currents of more than 5.5 km/hr were observed at the

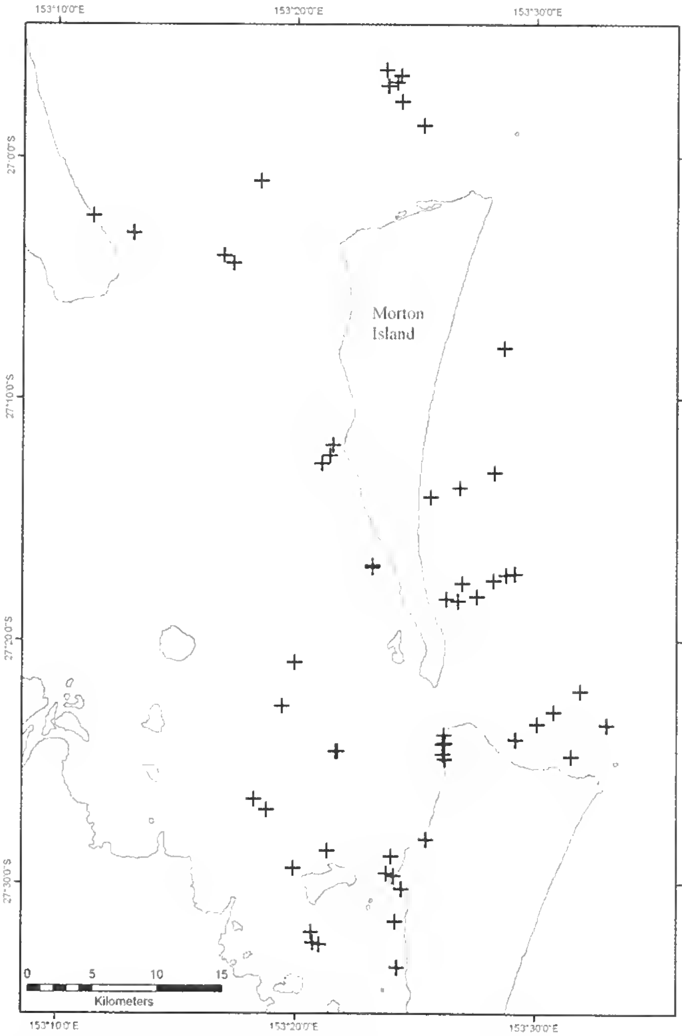

FIG. 1 Location of stations sampled for Peracarida Febuary 2005.

Bay entrance (Stephenson *et al.* 1970). On the ebb tide, the flow through the narrow South Passage, between Moreton and North Stradbroke Islands, is particularly rapid and turbulent.

Hutchings (1999) contrasts other types of protected water that can fluctuate in salinity to estuaries, embayments and coastal lagoons. Moreton Bay is considered an embayment, as are Port Philip Bay, Westernport Bay, Jevis Bay and Botany Bay along the eastern Australian coast. These have similar hydrographic conditions to the mouths of large rivers. They are often shallow and with limited stratification as wind-generated waves ensure good mixing. Typically the embayments are fully marine except during periods of heavy rain when salinity falls, as has been recorded for Moreton Bay by Stephenson *et al.* (1977).

According to Stephenson *et al.* (1970) mud-scouring action causes the corrugated nature of the north-eastern bay. Maxwell (1970) analysed sediment samples in Moreton Bay. We did not undertake sediment analyses but a description of the sediment was made for each sample.

Moreton Bay is relatively well-studied scientifically; biological samples have been taken and analysed since the mid-1950s (e.g. Slack-Smith 1960), and macrobenthic communities were a particular focus of Stephenson and his students and colleagues during the 1970s and 1980s (see

Table 1. Summary information for the study sites sampled for Peracarida off Moreton Island considered in the family analysis. Abbreviations: vV = van Veen; lavV=long arm van Veen

Sample	Feb 2005	Lat	Long	Depth (m)	‰	Temp.	Gear	Habitat
16.1	16	26°58.68′S	153°25.32′E	15.8	35	28.7	vV	clean medium sand
16.2	16	26°57.70′S	153°24.39′E	18	35	28.6	vV	clean medium sand
16.3	16	26°56.62′S	153°24.35′E	27.9	35	28.6	vV	clean medium sand with shell breccia
16.4	16	26°57.05′S	153°23.81′E	23.6	35	28.3	vV	clean medium sand with shell breccia
16.5	16	26°56.38′S	153°23.73′E	41.3	35	28.8	vV	muddy medium sand with shell breccia and holothurians
16.6	16	26°56.89′S	153°24.19′E	23.6	35	28.3	vV	clean medium sand with shell breccia
16.7	16	27°01′S	153°18.5′E	6.6–10.2	35	27.6	vV	North of Moreton I., clean well-sorted sand.
17.1	20	27°32.46′S	153°20.74′E	3.1	33	28	lavV	Banana Bank (sandy mud with some seagrass)
19.1	19	27°24.10′S	153°29.18′E	10.7	35	28	lavV	clean medium sand
19.2	19	27°23.46′S	153°30.08′E	20			lavV	clean medium sand
19.3	19	27°22.95′S	153°30.79′E	26.6			lavV	slightly muddy medium sand with holothurians
19.4	19	27°22.10′S	153°31.91′E	35.5		27.9	lavV	slightly muddy medium sand with holothurians,
19.5	19	27°18.29′S	153°26.28′E	11		28.5	lavV	East of S Moreton Island, clean medium sand
19.6	19	27°17.65′S	153°26.95′E	19.4			lavV	clean medium sand with some shell, ophiuroids
19.7	19	27°17.54′S	153°28.26′E	29		28.1	lavV	clean medium sand with some shell, dense holothurians
22.2	22	27°17.26′S	153°29.141′E	40			lavV	medium sand with plethora of holothurians & organics
22.3	22	27°18.19′S	153°27.56′E	20.6			lavV	clean medium sand
22.4	22	27°18.37′S	153°26.77′E	9.9			lavV	clean medium sand
22.5	22	27°13.07′S	153°28.29′E	35.6			lavV	coarse sand and shell with holothurians
22.6	22	27°13.70′S	153°26.84′E	25.2			lavV	cleaner medium sand with sparse holothurians
23.1	23	27°12.70′S	153°21.07′E	2.8	35	28.2	lavV	fine sand with shell, Nepthys
23.2	23	27°12.37′S	153°21.42′E	16.8			lavV	fine sand with shell, Nepthys
23.4	23	27°04.41′S	153°17.36′E	7.2			lavV	clean sand with polychaetes
23.5	23	27°04.10′S	153°16.95′E	8.5			lavV	medium sand with shell
23.6	23	27°03.17′S	153°13.17′E	10.2			lavV	medium sand with coarse shell breccia, callianassids, ophiuroids
23.7	23	27°02.46′S	153°11.49′E	8.3		28.8	lavV	coarse sand with gorgonians, pebbles, crabs, callipallenids

Table 2. Breakdown of average similarity into contributions from each family of the peracarid assemblage sampled; families are ordered in decreasing contribution. A= Average Abundance, see text for meaning of remaining symbols.

Group/Family	A	Si	Si/SD	Contrib%	Cum%
Group A: Average similarity= 33.33%					
Bodotriidae	52.38	33.33		100	100
Group B: Average similarity= 53.11%					
Platyschnopidae	64.83	49.11	2.64	92.46	92.46
Phoxocephalidae	4.33	2.01	2	3.79	96.25
Group C: Average similarity= 51.99%					
Platyschnopidae	19.78	16.41	22.9	31.57	31.57
Phoxocephalidae	16.69	13.8	4.43	26.54	58.11
Photidae	7.86	7.26	11.4	13.97	72.09
Urohaustoridae	11.43	7.01	1.34	12.49	85.58
Amphipoda Fam. B	6.41	5.2	3.53	10	95.58
Group D: Average similarity= 50.13%					
Parapseudidae	29.01	17.28	4.04	34.48	34.48
Platyschnopidae	19.4	12.35	1.44	24.63	59.1
Oedicerotidae	18.52	9.26	0.58	18.47	77.57
Urohaustoridae	13.1	6.61	1	13.19	90.77
Bodotriidae	5.86	2.78	0.58	5.54	96.31
Group E: Average similarity= 56.68%					
Urohaustoridae	55.08	44.42	3.85	78.37	78.37
Phoxocephalidae	13.36	4.57	0.62	8.06	86.43
Platyschnopidae	8.59	3.01	0.57	5.3	91.73
Lysianassidae	7.17	2.37	0.57	4.18	95.91

Stephenson 1980a–c; 1981; Stephenson & Cook 1977, 1979; Stephenson & Sadacharan 1983; Stephenson *et al.* 1970, 1974, 1976, 1977, 1978). Such studies led to taxonomic revisionary work on a number of groups (e.g., Brachyura by Campbell & Stephenson 1970), and while some peracarids have also received attention (e.g., cumaceans by Tate & Greenwood 1996a, b; and the Tanaidacea by Bamber 2008), diverse peracarid groups such as the Isopoda and Amphipoda remain neglected, and the literature identifications mostly cursory.

In the present paper we focused on peracarid crustaceans sampled in Moreton Bay as well as in open Pacific waters to the east of North Stradbroke and Moreton Islands.

The sample area extends from south of Peel Island to 10 km north of Moreton Island, and from close to the shore of Bribie Island to as far west as Flat Rock, see Table 1 and Fig. 1. The sampled area extends 50 km from north to south and 25 km from east to west. The sampling area to the north and east of Moreton Island is open to the Pacific Ocean, whereas the area east of Moreton and Stradbroke Islands, Moreton Bay itself, is sheltered between the Australian mainland and these long islands.

METHODS

FIELD AND LABORATORY

In February 2005, over one hundred stations were sampled of which 26 sublittoral stations were sampled quantitatively and thus considered for this analysis. The depth range of the samples studied was 6 to 40 m. Samples were collected using a small van Veen grab, surface sampling area 0.1 m^2, and a long-arm van Veen grab with a surface sampling area of 0.2 m^2. Faunal samples were washed on a 0.5 mm mesh. In the laboratory the faunal samples were rinsed in tap water to

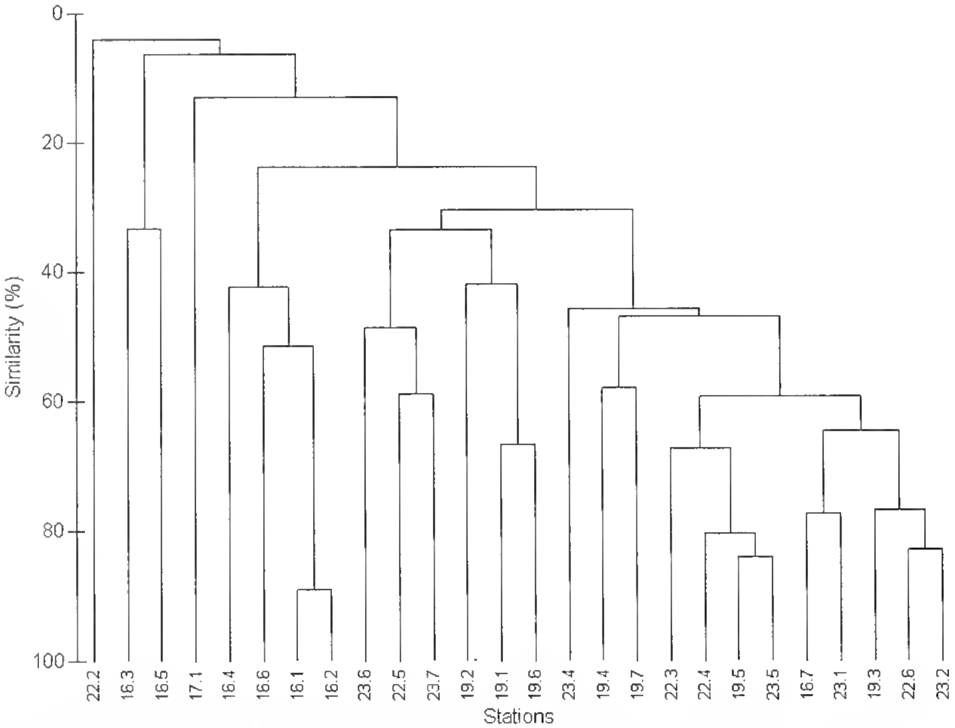

FIG. 2. Dendrogram of cluster analysis of peracarid families off Moreton Island based on the Bray-Curtis similarity matrix of family abundances.

relax the specimens, the fauna picked out under a dissecting microscope, sorted to major taxa and transferred to 95% ethanol or 4% buffered formalin.

Additional tanaidacean material was made available from a contemporaneous survey of the southern part of Moreton Bay by Davie *et al.* (2010, this volume); this survey sampled 15 stations by van Veen grab, five replicates per station. The tanaidaceans from all of these samples were made available for analysis.

The peracarids were identified at least to family level; cumaceans were identified to genus, and tanaidaceans to species (e.g. Bamber, 2008). The Amphipoda are deposited at the NIWA Marine Invertebrate Collection (NIC), Wellington, the Isopoda at NIC and the Museum Victoria, Melbourne and the Tanaidacea and Cumacea at the Queensland Museum, Brisbane, and the Natural History Museum, London. Mysidacea were very rare, and were not analysed.

DATA ANALYSIS

Multivariate analysis of the data was performed using the PRIMER (Clarke & Warwick 2001) and CAP (Pisces Conservation Ltd) suites of programs. Taxa represented by only one individual were omitted and stations where only one taxon was sampled were also omitted from the multivariate analysis. The resulting data matrix for the full peracarid analysis included 1224 individuals belonging to 36 families from 26 of 29 van Veen stations (73% of the peracarids collected). A triangular matrix of similarities between samples was derived using the Bray-Curtis similarity coefficient. Similarities in assemblage composition between the stations were displayed by constructing a dendrogram and ordination from the similarity matrix. Clustering was by a hierarchical agglomerative method using group-average linking. Ordination was by non-metric multidimensional scaling (MDS). The main taxa contributing to the average similarity within a group or average dissimilarity between groups were assessed using the Similarity Percentage routine (SIMPER).

Similar analyses were conducted at the genus level for cumaceans and tanaidaceans, and at the species level for tanaidaceans. For the

Table 3. Breakdown of average dissimilarity between groups into contribution of each family of the peracarid assemblage sampled. A=Average Abundance, see text for meaning of remaining symbols.

Groups/Families	A	A	A Diss	Diss/ SD	Con-trib %	Cum %
Groups A+B. Average dissimilarity = 94.46%	Group B	Group A				
Platyschnopidae	64.83	2.08	31.37	2.64	33.2	33.21
Bodotriidae	2.35	52.38	25.01	2.42	26.5	59.69
Ischyroceridae	0	14.29	7.14	0.94	7.56	67.25
Synopiidae	12.86	0	6.43	0.54	6.81	74.06
Aoridae	0	12.5	6.25	0.94	6.62	80.68
Groups B+E. Average dissimilarity = 79.53%	Group B	Group E				
Platyschnopidae	64.83	8.59	28.12	2.31	35.4	35.36
Urohaustoridae	6.6	55.08	24.24	2.42	30.5	65.84
Synopiidae	12.86	0.31	6.51	0.58	8.18	74.02
Phoxocephalidae	4.33	13.36	6.16	0.89	7.74	81.76
Groups A+E. Average dissimilarity = 95.52%	Group A	Group E				
Urohaustoridae	0	55.08	27.54	3.09	28.8	28.83
Bodotriidae	52.38	1.67	25.36	2.58	26.5	55.38
Ischyroceridae	14.29	1.67	25.36	2.58	26.5	55.38
Phoxocephalidae	0	13.36	6.68	0.84	6.99	69.85
Aoridae	12.5	0	6.25	0.98	6.54	76.39
Groups B+D. Average dissimilarity = 69.95%	Group B	Group D				
Platyschnopidae	64.83	19.4	22.71	1.82	32.5	32.47
Parapseudidae	0	29.01	14.51	1.83	20.7	53.21
Oedicerotidae	2.2	18.52	8.89	1.52	12.7	65.92
Synopiidae	12.86	2.38	7.03	0.66	10	75.97
Urohaustoridae	6.6	13.1	5.7	1.37	8.15	84.12
Groups A+D. Average dissimilarity = 84.95%	Group A	Group D				
Bodotriidae	52.38	5.86	23.26	2.18	27.4	27.38
Parapseudidae	0	29.01	14.51	1.75	17.1	44.45
Platyschnopidae	2.08	19.4	8.66	1.74	10.2	54.65
Oedicerotidae	8.33	18.52	7.87	1.46	9.26	63.91
Ischyroceridae	14.29	1.23	7.14	0.99	8.41	72.32
Urohaustoridae	0	13.1	6.55	1.5	7.71	80.02
Aoridae	12.5	0	6.25	0.91	7.36	87.38
Groups D+E. Average dissimilarity = 70.99%	Group D	Group E				
Urohaustoridae	55.08	13.1	20.99	2.16	29.6	29.57
Parapseudidae	3.62	29.01	12.71	1.6	17.9	47.47
Oedicerotidae	1.03	18.52	9.09	1.46	12.8	60.28
Platyschnopidae	8.59	19.4	7.12	1.53	10	70.3
Phoxocephalidae	13.36	2.16	6.21	0.83	8.75	79.05
Lysianassidae	7.17	2.16	3.4	0.94	4.79	83.84
Groups B+C. Average dissimilarity = 69.75%	Group B	Group C				
Platyschnopidae	64.83	19.78	22.53	1.91	32.3	32.29

Table 3 continued ...

Groups/Families	A	A	A Diss	Diss/ SD	Con-trib %	Cum %
Synopiidae	12.86	0	6.43	0.55	9.22	41.51
Phoxocephalidae	4.33	16.69	6.18	2.39	8.86	50.37
Urohaustoridae	6.6	11.43	5.19	1.73	7.45	57.82
Photidae	0	7.86	3.93	10.16	5.64	63.46
Groups A+C. Average dissimilarity = 93.41%	Group A	Group C				
Bodotriidae	52.38	2.48	24.95	2.38	26.7	26.71
Platyschnopidae	2.08	19.78	8.85	3.26	9.47	36.18
Phoxocephalidae	0	16.69	8.35	4.25	8.94	45.12
Ischyroceridae	14.29	0	7.14	0.91	7.65	52.76
Aoridae	12.5	0	6.25	0.91	6.69	59.46
Urohaustoridae	0	11.43	5.71	1.89	6.12	65.57
Groups C+E. Average dissimilarity = 68.13%	Group C	Group E				
Urohaustoridae	55.08	11.43	21.83	2.35	32	32.03
Phoxocephalidae	13.36	16.69	6.94	1.58	10.2	42.23
Platyschnopidae	8.59	19.78	6.71	1.77	9.85	52.08
Lysianassidae	7.17	0	3.58	0.84	5.26	57.34
Photidae	0.96	7.86	3.45	3.01	5.07	62.4
Groups C+D. Average dissimilarity = 66.49%	Group C	Group D				
Parapseudidae	29.01	2.48	13.26	1.64	20	19.95
Oedicerotidae	18.52	0	9.26	1.33	13.9	33.88
Phoxocephalidae	2.16	16.69	7.27	3.5	10.9	44.81
Platyschnopidae	19.4	19.78	4.36	1.73	6.56	51.37
Urohaustoridae	13.1	11.43	4.05	1.36	6.08	57.46
Photidae	0.93	7.86	3.47	4.35	5.22	62.67
Leptocheliidae	0	6.67	3.33	0.67	4.32	72.01

latter, the station data from the survey of Davie *et al.* (2010) were standardised as the integer (rounded up) of the mean of the five replicates per station; a further 13 stations were thus included in the dataset.

RESULTS

PERACARID FAUNA

In total 1224 peracarids were sampled in the van Veen samples, the bulk (1098) belonging to 24 families of Amphipoda. The most numerous family was the Urohaustoridae (359), followed by Platyischnopidae (218), the families Phoxocephalidae and Synopiidae were also represented by more than 100 specimens. Of the non-amphipod taxa the tanaidacean family Parapseudidae was most abundant, with nearly 50 specimens caught.

MULTIVARIATE ANALYSIS

Family-level analysis of all Peracarida

The cluster analysis for the 26 grab stations at the family level is shown in the dendrogram (Fig. 2). The peracarid family groups revealed are shown on the map (Fig. 3)

The dendrogram of the station data clearly illustrates the pattern in assemblage composition. The four stations north of Moreton Island group closely; with exception of these northern stations, the grouping of the sites does not reflect their geographic separation.

SIMPER analysis indicated that the average similarity in assemblage composition within groups ranged from 50% (group D) to 57% (group E) and that individual taxa within groups contributed from 2–49% to the similarities observed (Table

2). Taxa that contributed the most to within-group similarity and/or which were characterising taxa (i.e., those for which the ratio of Sim/SD was relatively high) for each group varied, although some taxa were 'typical' for a number of groups. The peracarid assemblages of group B and group C were primarily characterised by the amphipod family Platyischnopidae. Group D was primarily characterised by the tanaid family Parapseudidae. The amphipod family Urohaustoridae characterised group E.

Simper analysis also indicated the individual taxa that contributed the most to the dissimilarity and/or discriminate between the different groups (i.e. the ratio of Diss/SD is relatively high) (Table 3). Results show that, overall, the two amphipod families Platyischnopidae and Urohaustoridae and the tanaid family Parapseudidae have a large contributory influence on the dissimilarities observed between groups (dissimilarity contributions over 10%). The dissimilarities observed between groups are detailed below (see Table 2 for pairwise comparisons of dissimilarity between all groups). The dissimilarities between groups ranged from 66% (between C and D) to 95% (between A and E).

Groups A and E show the highest dissimilarity. Platyischnopidae are dominant in group A, but not in group E, whereas Urohaustoridae are present in group E, but not in group A. Average dissimilarity was 70% between groups B and D. The tanaid family Parapseudidae mainly discriminated between the two groups, being only present at group D. The average dissimilarity between groups D and E is 71%. Urohaustoridae are abundant in group E, whereas the tanaidaceans of the Parapseudidae, the amphipods of the Oedicerotidae and Platyischnopidae and the cumaceans are more abundant in group D. The average dissimilarity between B and C is 70%, mainly discriminated by the amphipod family Photidae which occurred only in group C, resulting in their extraordinarily high Diss/SD of 10.16. The groups E and C, located east and west of Moreton Island, show an average dissimilarity of 68%. Again based on the high abundance of Urohaustoridae in group E, as well as Photidae, Platyischnopidae and Phoxocephalidae being more dominant in group C. The average dissimilarity between groups D and C is based on eight families, Photidae showing the highest Diss/SD of 4.35.

Genus-level analysis of Cumacea & Tanaidacea

Figure 4 shows the similarity clustering of stations based on the thirteen genera of the Tanaidacea and Cumacea which were available for analysis. This shows a more structured separation of assemblages. Group 4A, characterised by the tanaidacean genus *Remexudes*, is of the shallower sands of the Pacific Coast (stations within groups D and E of Figs 2, 3). Group 4B comprises stations of the deeper Pacific-coast waters, characterised by the tanaidacean genus *Bathytanais*, the cumacean genus *Dicoides* and many other of the cumacean genera. Group 4C comprises some less-characterised stations on the east coast plus those on muddier, more heterogeneous substrata within Moreton Bay itself, the genera *Pakistanapseudes* (Tanaidacea) and *Cyclaspis* (Cumacea) dominating.

The generic-level interpretation, although more restricted in both taxa and stations, is thus offering further interpretation on the assemblage distribution by habitat, with depth clearly a factor as well as substratum.

The genus-level analysis was expanded for the Tanaidacea by the inclusion of the thirteen additional southern Moreton Bay stations. Figure 5 shows the resulting dendrogram. Group 5A is the same as group 4A of Fig. 4, the stations of the shallower sands of the Pacific Coast. Group 5B includes the deeper sand stations of group 4B (Fig. 4) but here they are associated with a number of shallower stations on muddier substrata within the southern part of Moreton Bay. Similarly group 5D associates the northern and southern Moreton Bay stations. This result implies that, with a wider range of habitat, there is some breakdown of assemblage distinction when restricted to the generic level.

Species-level analysis of Tanaidacea

All the tanaidaceans collected have been distinguished to species (see Bamber 2008). In addition, the broad survey of the southern part of Moreton Bay by Davie *et al.* (2010) produced further quantitative data from van Veen grab samples for the tanaidaceans, to species level. Thus, the wider geographic/habitat interpretation was investigated by analysis of the distribution of the Tanaidacea at the species-level.

The fifteen species analysed, and their familial affiliations, are shown in Table 4.

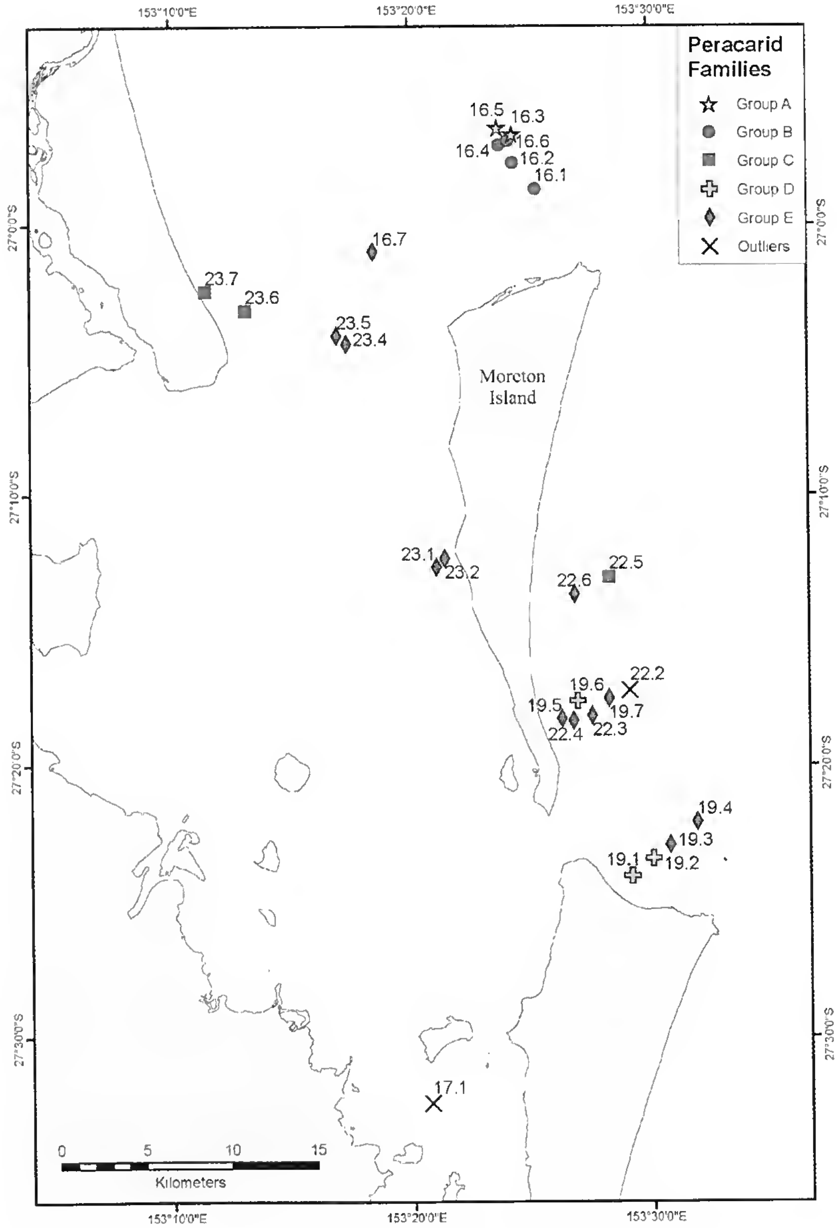

FIG. 3. Study region with groups resulting from peracarid family cluster analysis.

Figures 6 and 7 show the clustering of stations from this analysis. Figure 8 shows the reciprocal clustering of the species.

There is a now clear distinction between stations well within Moreton Bay (groups 6D and 6E) and those outside (groups 6A to 6C). In addition, the stations within the Bay separate into those on seagrass beds in muddy substrata, characterised by *Transkalliapseudes banana* (group 6D; station 17.1 of the family-level analysis is the same location as station 10 within this dataset), and those on sandier substrata (group 6E), characterised by *Whiteleggia stephensoni* and *Pakistanapseudes australianus*.

The stations peripheral to and outside Moreton Bay are distinguished into three groups, those of the shallower sands of the Pacific Coast (group 6A, identical to group 4A above), characterised by *Remexudes toompani* with sparse *Pakistanapseudes perulpa*, those of the deeper Pacific waters

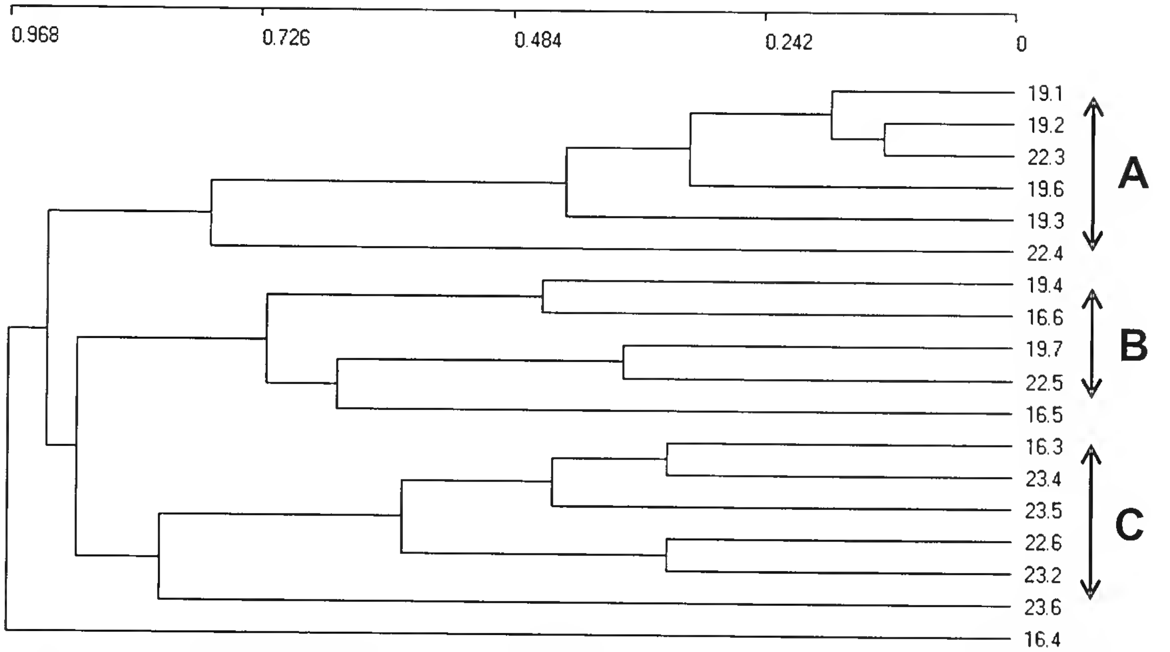

FIG. 4. Dendrogram of cluster analysis of Tanaidacea and Cumacea at genus level off Moreton Island.

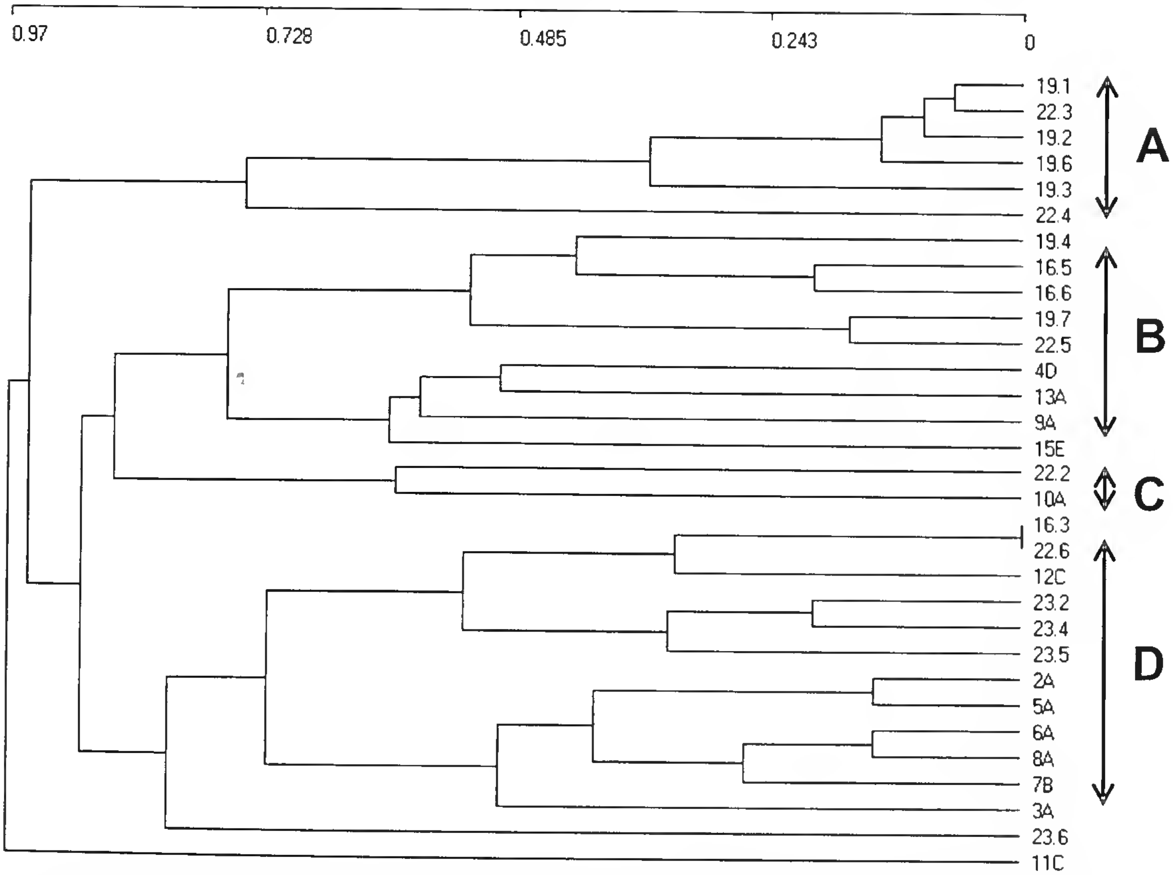

FIG. 5. Dendrogram of cluster analysis of Tanaidacea across the whole area sampled at genus level.

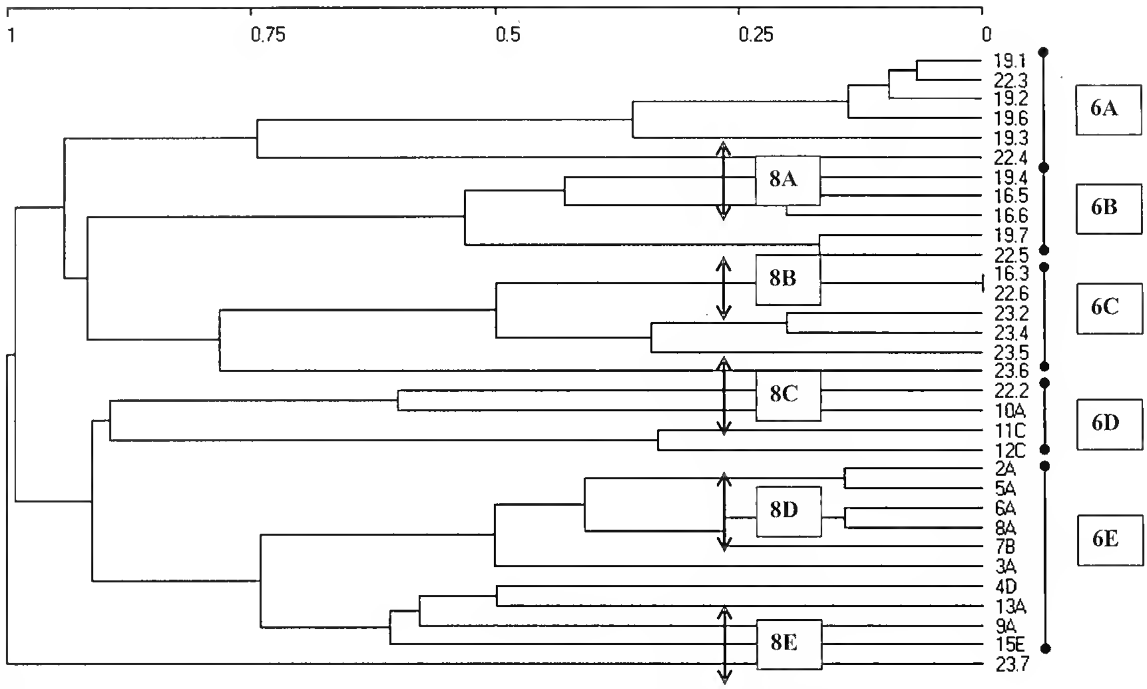

FIG.6. Dendrogram of Tanaidacea across the whole area sampled at species level.

(group 6B, identical to group 4B above), characterised by *Bathytanais bathybrotes*, and the shallower 'northern' stations around Moreton Island (group 6C, identical to group 4C above), characterised by *Pakistanapseudes perulpa*. That these groups relate to those of the genus-level analysis is not surprising, as the genera concerned were monotypic in this analysis.

The species clustering (Fig. 8) confirms these groupings. The three species of group 8E were present only sparsely, and separate as they occur within southern Moreton Bay at stations where *Whiteleggia stephensoni* density is sparse. Only *Antiplotanais coochimudlo* (occasionally sympatric with and thus confusing the linkage of *Bathytanais bathybrotes*) and *Konarus cheiris* occur both offshore and within the Bay.

These analyses at the species level confirm a separation of the fauna by depth, by geography, and by substratum. Further, they demonstrate that this separation is clearly shown at the species level, rather than the generic level (each of the two species of each of *Pakistanapseudes*, *Bathytanais* and *Leptochelia* separate fully), and less so at the family level (see Table 4).

DISCUSSION

Results of the present study of the marine peracarids of Moreton Island, support the hypothesis that there is a difference in peracarid composition around the Island.

Depth showed no significant effect on the station assemblage at the family level (Figs 2, 3). Even though stations of group B were located deeper than 20 m, and the two stations of group A were taken at very similar depth, 16–20 m, the depth of the stations of groups C varies from 8–37 m and group D extends from 11–20 m. The depth of group E, comprising 12 stations, extends from 7–35 m.

There are potential logistical limitations on the techniques herein. Owing to our inconsistent sampling methods such as grabs, dredges, hand collections and trowels, only peracarids from the grabs have been considered for the multivariate analysis. The van Veen grab sampled 0.1 m² whereas the long-arm van Veen grab sampled 0.2 m². Even though groups A and B only include stations sampled by the van Veen grab and groups C and D only include stations sampled by the long armed van Veen grab,

Table 4. Tanaidaceans used in the multivariate assemblage analyses, with higher taxonomy.

Suborder	Family	Species
Apseudomorpha	Apseudidae	*Gollumudes larakia* (Edgar, 1997)
	Apseudidae	*Bunakenia (E.) anomala* Guţu, 2006
	Whitelegiidae	*Whiteleggia stephensoni* Boesch, 1973
	Kalliapseudidae	*Transkalliapseudes banana* Bamber, 2008
	Parapseudidae	*Remexudes toompani* Błażewicz-Paszkowycz & Bamber,2007
	Parapseudidae	*Pakistanapseudes perulpa* Błażewicz-Paszkowycz & Bamber,2007
	Parapseudidae	*Pakistanapseudes australianus* Guţu, 2006
Tanaidomorpha	Anarthruridae	*Tanaopsis canaipa* Bamber, 2008
	Leptocheliidae	*Leptochelia guduroo* Bamber, 2008
	Leptocheliidae	*Leptochelia opteros* Bamber, 2008
	Leptocheliidae	*Pseudoleptochelia fairgo* Bamber, 2005
	Leptocheliidae	*Konarus cheiris* Bamber, 2006
	Paratanaidae	*Bathytanais bathybrotes* (Beddard, 1886)
	Paratanaidae	*Bathytanais culteriformis* Larsen & Heard, 2001
	Typhlotanaidae	*Antiplotanais coochimudlo* Bamber, 2008

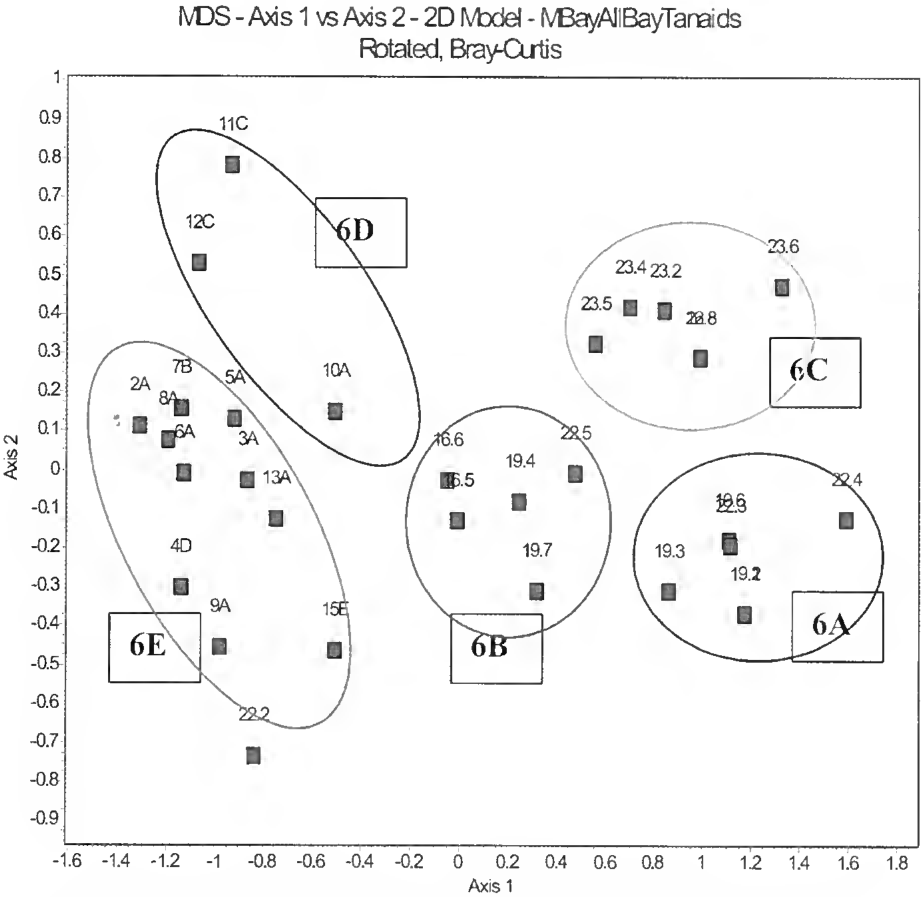

FIG. 7. Species level MDS ordination of Tanaidacea at species level from Fig. 5 (excluding *Gollumudes*/ stn 23.7).

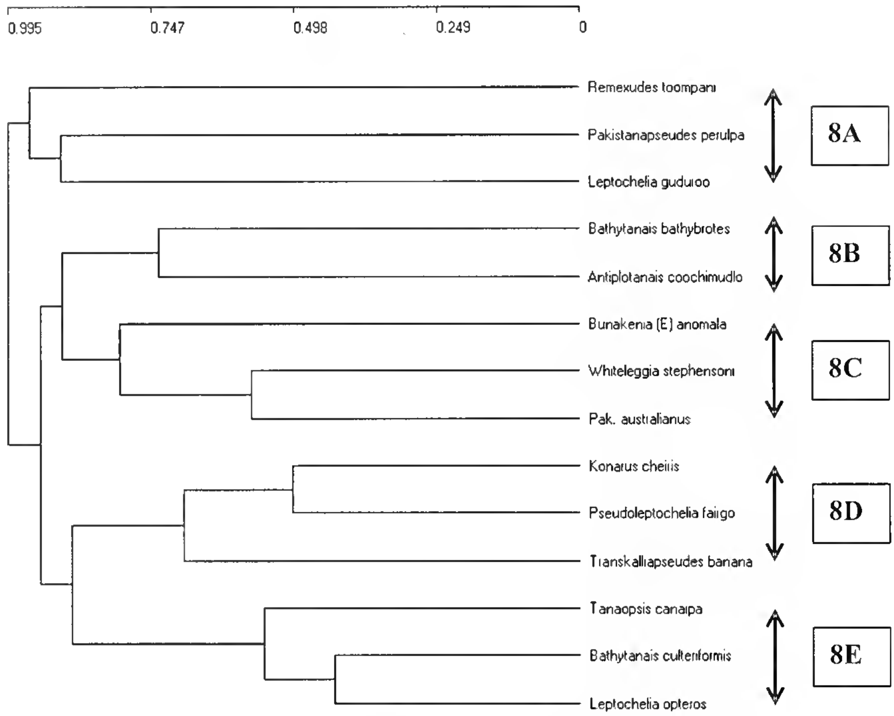

FIG. 8. Clustering of tanaidacean species sampled off Moreton Island.

group E has the majority of stations (11) of the long armed van Veen grab and one 'normal' van Veen grab. The distribution of stations cannot be explained by gear type.

One factor having a major influence on the distribution of macrobenthic assemblages is sediment (e.g. Cranfield *et al.* 2004). We have not undertaken sediment analysis, but noted appearance, see Table 1. The majority of stations have clean medium sand. Group C has only stations with coarse sand, including pebbles and shells. On the other hand, sand with shell breccia also occurs on stations of groups B and E. Only the outlier stations 17.1 and 22.2 contained organic matter, mud and seagrass.

A relationship to sediment would be expected owing to the predominant feeding-association of the taxa concerned. Phoxocephalid amphipods are almost entirely benthic amphipods, and include deposit feeders (Enequist 1949) and predators (Oliver & Slattery 1985). Platyischnopidae are widely distributed benthic infaunal species in shallow waters, closely related to phoxocephalids; Thomas & Barnard (1983) found some species to be micropredators. Urohaustoridae, a family confined to the Southern Hemisphere and mainly to Australia, mostly occur in shallow water and often in the surf zone of oceanic beaches. Synopiids live from subtidal to bathyal depths, may be benthic, demersal or pelagic. Oedicerotids are cosmopolitan amphipods found at all depths, mainly in the benthic infauna; again, Enequist (1949) regarded them as deposit feeders. The parapseudid tanaidaceans are generally understudied, but again are known to be deposit feeders (e.g. Bamber 2008). The cumaceans are surface-resuspension feeders. All of these benthic taxa are thus dependent upon the sediment, including its granulometry and organic content, for feeding.

The analysis at genus level, restricted to the cumaceans and tanaidaceans, does give further separation of the assemblages within the north of the Bay and down the Pacific coast. As the genera structuring the analysis were represented by single species, discussion of this analysis is deferred to the species-level discussion below. Suffice to say that the assemblage distributions by habitat indicated by the dominant tanaidaceans are also reflected by the cumacean distribution.

When the generic-level analysis, for the tanaidaceans only, is extended to include muddier stations further south within Moreton Bay, and thus including polytypic genera, some confusion is generated. Although the distinctions by depth and substratum are still evident, stations from distinct depth and substrata cluster together, owing to the merging of distinct congeneric species with different habitat preferences.

At the species level, the distinctions of the tanaidaceans relate firstly to the cleaner sand and coastal/offshore sites showing a different community from those sheltered and muddier sites within Moreton Bay itself. The linkage of these predominantly deposit-feeding taxa to the sediment-type is discussed above, being indicated at the family level. Further distinctions are shown at the species level between sea-grass beds and more open substrata. Indeed, analysis of all the tanaidacean species of this region, including a number of taxa not represented in the quantitative samples analysed herein, by Bamber (2008) found a number of examples of intrageneric niche-specification based on substratum and habitat-type. The present analyses confirm those conclusions.

The distinction of different depth ranges at the species level in the tanaidaceans, particularly to the southeast of Morton Island and the northeast of North Stradbroke Island is of further interest. Observation of the seabed samples along the transects off the South Passage between these two islands showed a consistent pattern, with shallower stations appearing to be open clean sand, while deeper stations supported very dense communities of irregular echinoids (heart urchins) and surface-dwelling filter-feeding holothurians (in densities of hundreds per m^2). The distinction between these two sub-habitats was very evident, the shallowest dense appearance of the echinoderms being around 25 m (>28 m on transect 16, thus station 16.5; >25 m on transects 19, thus stations 19.3, 19.4 and 19.7; >26 m on transects 22, thus stations 22.1, 22.2 and 22.5). No samples were taken deeper than 40 m.

We therefore postulate that, during the ebbing tide, the strong seaward flow through the South Passage will carry a large quantity of organic matter and debris from Moreton Bay, in adjacent areas of which occur muddy substrata and seagrass beds; this material will flow down the slope and, as the water velocity decreases, will be deposited onto the seabed. The density of echinoderms, particularly the filter-feeding holothurians, is attributed to this supply of organic material; equally, both the organic material and the holothurians themselves will be structuring the habitat profoundly. These are essentially the stations of group 6B of Figure 6, characterised by *Bathytanais bathybrotes* and many cumacean genera (*Dicoides, Gynodiastylis, Iphinoe* and *Campylaspis*, these last three genera being taken at no other sampling stations). Note that this distinction within the peracarid community does not show at the family level.

These analyses thus indicate that, while analysis at higher taxon levels shows some gross trends in the community distribution, here in relation to substratum, the added detail of species-level analysis affords a more comprehensive, more logical, and explicable interpretation. Past hypotheses that benthic community interpretation is valid at higher taxonomic levels such as family level or even higher ('taxonomic sufficiency'; e.g. Warwick 1988; Mistri & Rossi 2001) are clearly refuted by the present analyses. A more detailed analysis at the species level over a wider taxon base would be expected to reinforce the conclusions shown herein. Nevertheless, these results show that analysis of assemblages of the Peracarida alone does allow interpretation of habitat-associations, and thus biotopes.

ACKNOWLEDGEMENTS

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Assessment of long-term temporal changes in the macrobenthic communities south of Peel Island, Moreton Bay, Queensland

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ABSTRACT

A grab sampling survey of 15 sites in a relatively small geographic area to the south of Peel Island, Moreton Bay, Queensland, was undertaken in February 2005. This broader area is already known as a biodiversity hot-spot within the Bay. The sampling was designed to replicate a longer-term survey undertaken 35 years earlier between March 1970 and December 1971. The new study was intended to assess changes to species composition of those earlier communities after so many years, and provide a yardstick on the present ecological health of the system. The sediments, and hydrographic features such as depth and currents appear not to have changed significantly. There have however been some minor changes in site groupings based on species presence, and a marked change in the species characterising the site groupings. In particular, in 2005 there was an absence of benthic tunicates that had been an important component at some sites in the earlier survey; and secondly, there has been the development of significant *Trichomya* mussel aggregations that had not been noted from this area in the past. An analysis of community trophic structure found essentially the same site classification as the simple species x sites analysis, and as found in other studies, deposit feeders predominate in the muddiest site-groups. Overall, the species richness was very high (564 species), and this was greater than the 394 species found earlier. It is believed the earlier survey had under-estimated the number of species present. There is every indication that the present communities in this area are healthy and resilient. ❑ *ecology, marine, macrobenthos, Moreton Bay, communities, sediments, trophic structure, biodiversity.*

Around the world, human impacts on estuarine and coastal environments have been dramatic since the advent of the industrial revolution (Lotze *et al.* 2006), but arguably have accelerated significantly over the last 50 years. This has been a time of massive human population explosion with concomitant encroachment and destruction of coastal environments, pollution from an increasingly complex and unpredictable arsenal of chemicals, and wholesale marine resource over-exploitation. Moreton Bay (Fig. 1), is a sheltered, coastal embayment, with one of Australia's largest cities on its foreshores. Over the last 30 years, the Brisbane–Gold Coast corridor has become one of the fastest growing human population centres in the developed

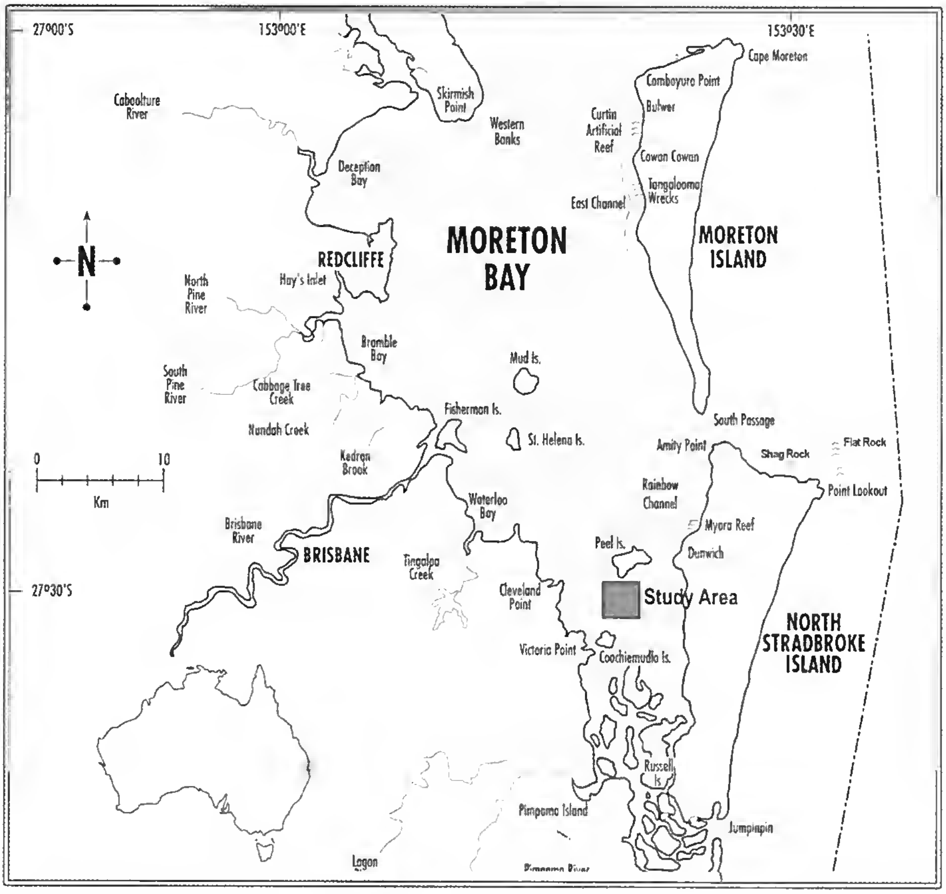


FIG. 1. Map of Moreton Bay showing the sampling area (dark gray square) just to the south of Peel Island, in the southern part of the Bay.

world, and thus has a major impact potential on the Moreton Bay region.

Moreton Bay is protected from the South Pacific Ocean by the large sand islands of North and South Stradbroke, Moreton and Bribie. To the north and east it is primarily oceanic while to the south and west the Bay becomes a complex estuarine system, with numerous islands and muddy banks in its southern portion. Interestingly it lies at the subtropical/temperate biogeographic transition zone (see Davie & Hooper 1998), and has an extraordinary mix of southern Australian endemic species and widespread tropical Indo-West Pacific and Great Barrier Reef species.

Our understanding of Moreton Bay's faunal composition and ecological processes have grown considerably over the last 30–40 years (see review by Skilleter 1998). Extensive studies have been made of the soft bottom macrobenthos of Moreton Bay (e.g. Raphael 1974; Stephenson *et al.* 1970, 1974, 1976, 1977, 1978; Poiner 1979a, b; Stephenson & Cook 1977, 1979; Stephenson 1980a, b, c; Stephenson & Sadacharan 1983; Lörz & Bamber 2010, this volume). Trawl studies were conducted by Jones (1973), Stephenson & Dredge (1976), Quinn (1979, 1980), Burgess (1980), Stephenson & Burgess (1980), and Stephenson *et al.* (1982a, b). Dredged macrobenthos near the mouth of the Brisbane River was reported on by Hailstone (1972, 1976), Boesch (1975) and Park (1979). Campbell *et al.* (1974) studied nine estuaries in southeastern Queensland, most of which feed into Moreton Bay, and Campbell *et al.* (1977), Stephenson & Campbell (1977) and Davie (1986), reported on the sublittoral macrobenthic fauna of Serpentine and Jackson's Creeks. Young & Wadley (1979) also examined the distribution of shallow water epibenthic macrofauna in the Bay. Most recently Stevens & Connolly (2005) mapped and classified macrobenthic habitat types by using a compact video array at 78 sites spaced 5 km apart. They recognised nine habitats, with only one being on hard substrate. These included previously unreported deep-water algal and soft-coral reefs, and new areas of seagrasses. Broader ecological work on understanding nutrient cycling and the impact of sewage on the western Bay was also undertaken during the 1990s, and this has also contributed significantly to our understanding of the ecological dynamics of the Bay and the Brisbane River (Dennison & Abal 1999).

Conservation of biodiversity is a major priority for the continued healthy functioning of communities, but marine biodiversity issues have not received the attention currently given to terrestrial systems, perhaps because they are less easily studied, impacts are less conspicuous, and taxonomic difficulties are immense. Davie & Hooper (1998) examined the species richness and distributional patterns of the fauna inside Moreton Bay and identified two major biodiverse regions — an inshore estuarine-dominated region, and an eastern marine-dominated region. This latter region, including the northern end of Stradbroke Island, and Peel, Bird and Goat Islands had the highest species richness in the whole Bay, most likely because of its well developed coral reefs and a mix of consolidated hard and muddy-sand bottoms.

The study reported here was undertaken during the Thirteenth International Marine Biological Workshop, held in Moreton Bay. The intention was to repeat the earlier survey of Stephenson *et al.* (1974) of 15 sites in a relatively small geographic area to the south of Peel Island. As already noted this region has been identified as one of the biodiversity hot-spots in the bay. The work of Stephenson *et al.* (1974) involved 8 sampling times over three-monthly intervals for two years from March 1970 to December 1971, thus also providing them with patterns of seasonal change. While the new sampling was a once-off snapshot of the area 35 years later, we hoped that this would provide some interesting insights into the state and composition of these communities after so many years, and provide an indication of the system's current ecological health.

MATERIALS AND METHODS

POSITIONS AND DEPTHS OF SITES

The present work was carried out towards the northern end of the southern half of Moreton Bay immediately south of Peel Island.

Table 1. Station details for grab samples taken south of Peel Island, southern Moreton Bay, February 2005. Salinities were not taken consistently, but were around 28‰ at all sites during the period of sampling.

Station No.	Latitude	Longitude	Depth	Date
1	27°31.25′	153°22.00′	6.5 m	17.02.2005
2	27°31.25′	153°21.85′	6.6 m	17.02.2005
3	27°31.25′	153°21.65′	6.4 m	18.02.2005
4	27°31.53′	153°21.44′	5.9 m	20.02.2005
5	27°31.53′	153°21.70′	6.5 m	20.02.2005
6	27°31.55′	153°20.80′	8.5 m	18.02.2005
7	27°31.48′	153°20.72′	9.0 m	18.02.2005
8	27°31.48′	153°20.48′	9.2 m	18.02.2005
9	27°31.61′	153°20.38′	7.6 m	20.02.2005
10	27°31.68′	153°20.54′	8.4 m	18.02.2005
11	27°32.39′	153°20.80′	4.2 m	17.02.2005
12	27°32.20′	153°20.75′	3.9 m	20.02.2005
13	27°31.98′	153°20.62′	7.0 m	20.02.2005
14	27°32.29′	153°20.42′	5.1 m	20.02.2005
15	27°32.61′	153°20.42′	4.4 m	17.02.2005

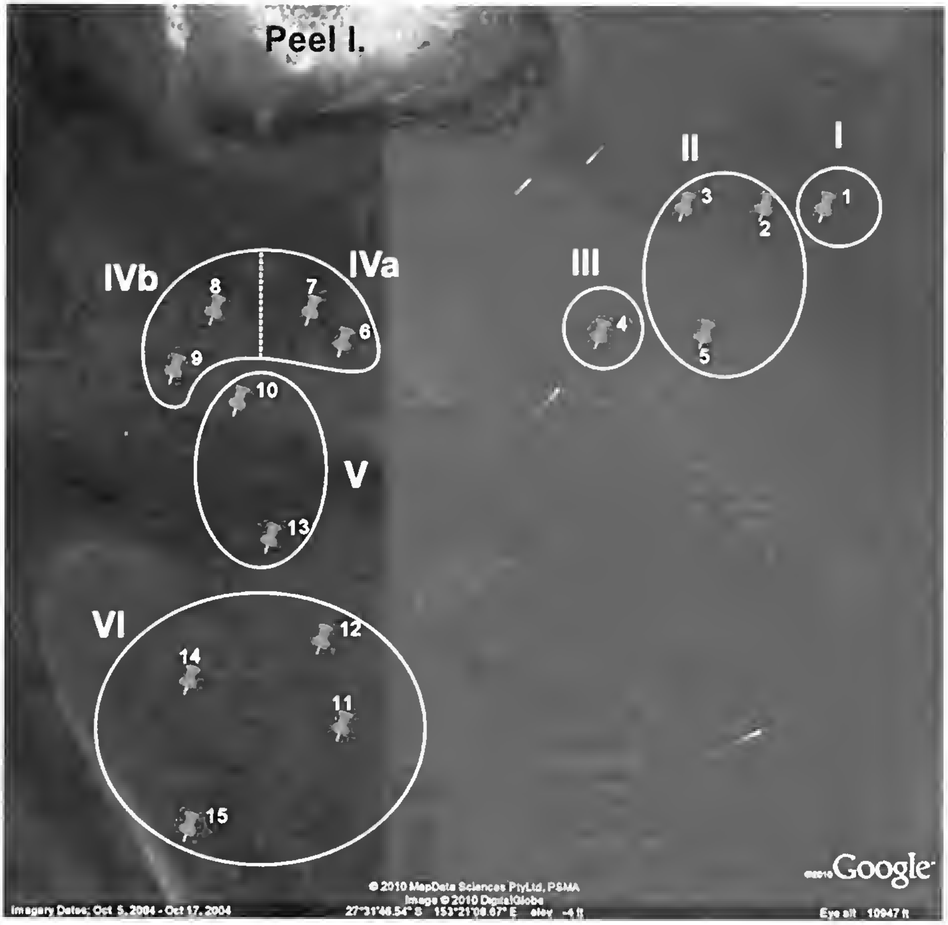


FIG. 2. Positions and groupings of the sample sites. Specific coordinates are given in Table 1. The explanation for the site-groupings is explained later in the text.

In a landmark dredge study of the macrobenthos of Moreton Bay, Stephenson *et al.* (1970) established this area as having a rich fauna and a small scale patterning of 'communities'. Their work was subsequently followed-up (Stephenson *et al.* 1974), by an intensive grab-sampling study where fifteen stations were sampled in quintuplicate in each of four seasons for two years (from March 1970 to December 1971). The objective of that work was to investigate a suspected complex benthic biota and to attempt to resolve the complexity into a number of spatial and temporal patterns.

Stephenson *et al.* (1974) sampled five sites in each of three areas to reflect contrasting bottom topographies as revealed in published charts available at the time. While they stated in their paper that the site 'positions have been established by horizontal sextant angles of conspicuous fixed points (data filed in archives of Queensland Museum)', we were unable to locate these data in the Queensland Museum, and instead we interpolated the positions using modern mapping software. The positions of the sites for the 2005 sampling are shown in Fig. 2, and the coordinates are given in Table 1. All sites are enclosed within an area of approx. 3 km^2. Topographic grouping of sites can be summarised as: 'Goat Island slope' (Sites 1–5); 'Northwest gutter' (6–10, 13); 'Southern shallows' (11, 12, 14, 15).

Depths of sampling sites ranged from 3.9–9.2 m at the time of sampling (Table 1), reflecting the depths of 2.4–9.3 m given by Stephenson *et al.* (1974). The apparent slightly greater depth at our shallowest sites may be due to factors such as sampling on a higher tide, or differences in specific site location. Overall there appears to have been no significant movement of banks, or changes in depths, since the sampling at the beginning of the 1970s.

SAMPLING

Quintuplicate samples were collected at each site using a long-arm van Veen grab with a surface sampling area of 0.1 m² (total sampling area = 0.5 m²/site). Faunal samples were washed on board the vessel through a series of graded sieves down to a 0.5 mm mesh, and the contents of each sieve were washed into a large plastic bag and preserved with 4% fomalin. In the laboratory the faunal samples were again washed, transferred to 70% ethanol, and stained with Rose Bengal. The fauna was removed from the samples using elutriation, and by hand-picking using forceps under a dissecting microscope. Despite the 0.5 mm fraction being retained, sorting was only undertaken to the 1 mm stage due to time and labour constraints, and because this was sufficient to provide a valid comparison with the original sampling regime of Stephenson *et al.* (1974). The initial sort was to major taxa, followed by more precisely splitting group by group into recognisable OTUs (operational taxonomic units). Identification was undertaken to the lowest taxonomic rank possible depending on available expertise. Unfortunately it was logistically impossible to check identifications against the original reference collection of Stephenson *et al.* (1974), so there is not necessarily concordance in nomenclature between that and the present study. In addition, there have been significant changes in nomenclature in many groups over the last 35 years, and we have not tried to track these when comparing the two data sets. It is nevertheless interesting, as will be further discussed, that there has been a very clear and real shift in characterising species at many sites.

Individual species counts from the replicate samples were lumped for further analyses in order to minimise the effects of micro-patchiness between samples, and to get the best possible reflection of the community composition at each site. All species were also assessed for their trophic status, and assigned to one of five categories, viz., 1, Suspension feeder; 2, Deposit feeder; 3, Grazer; 4, Predator/Scavenger; or 5, Parasite. The trophic structure of each site was then also assessed against sediment structure to see if any obvious patterns emerged in community structure.

All samples are deposited in the collections of the Queensland Museum, Brisbane.

SEDIMENTS

At each site a separate grab sample was taken, and subsequently a 200–250 gm subsample was taken in the lab for sediment particle size analysis. Sediments were washed through a series of graded sieves (2.0, 1.0, 0.5, 0.250, 0.125, 0.063 mm). Similar sieves were used by Stephenson *et al.* (1974) (viz. 1.98, 1.02, 0.53, 0.211, 0.15, 0.099 mm) to grade the series of retained fractions as gravel, very coarse sand, coarse sand, medium sand, fine sand and very fine sand respectively, and the non-retained fraction as mud. The retained portion of each sieve was air dried, baked in a microwave oven to remove all moisture, and weighed; the remaining sediment was washed into a coffee-filter paper, similarly dried and weighed (minus the weight of the filter paper). Weights were converted to percentages so that the composition of each sample could be compared. Results are presented in Table 2. The general results are not dissimilar to those of Stephenson *et al.* (1974). Figure 7 clearly shows the significant differences in sediment composition between the derived site-groups. These are discussed further in relation to faunal trophic patterns later in the paper. Stephenson *et al.* (1974) considered 'mud' to be the portion not retained by their finest sieve (99 μm) — in the present study our finest sieve was 63 μm and thus the results are not directly comparable. Their 'mud' component could be expected to be relatively higher than our result, as less was retained by their finest sieve. This is highlighted by Site-Group II (Sites 2–5) where they found a >50% mud component (< 99 μm), whereas our result was 34% for <63 μm, but 87% at 63 μm. Thus the sites we sampled were similarly very muddy, but not directly comparable with the terminology of Stephenson *et al.* (1974), at least at the very finest particle size.

Stephenson *et al.* (1974) found some significant changes in sediment structure at a number of sites between sampling times from March 1970 and December 1971. In particular important changes were: less mud at Stn 5; less fine sand

Table 2. Sediment composition at each site as retained by graded sieves, and particle size expressed as a percentage of each sample.

Stn No./ Grain Size	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2 mm	0.8	2.5	4.6	0.9	0.7	9.3	10.2	20.4	16.7	8.6	4.3	7.1	4.2	9.0	12.7
1 mm	0.7	1.3	2.3	0.5	0.6	9.7	0.7	8.3	7.9	6.7	2.9	2.0	3.2	8.1	6.4
500 µm	0.7	1.0	1.7	0.5	0.6	16.2	15.2	10.0	11.5	5.4	2.8	2.2	2.4	6.8	8.4
250 µm	18.5	3.8	1.4	0.7	0.7	24.6	26.3	14.6	29.3	11.9	34.8	38.7	5.7	36.3	41.9
125 µm	30. 6	6.7	5.2	33.8	6.8	23.6	21.0	13.8	24.1	55.3	48.0	42.8	55.0	33.5	21.0
63 µm	18.9	50.2	50.8	47.0	56.2	4.2	6.1	5.5	2.2	7.7	2.9	2.9	20.7	3.0	5.6
<63 µm	29.9	34.5	34.0	16.5	34.4	12.6	20.5	27.4	8.2	4.4	4.3	4.3	8.8	3.4	4.0

and more mud at Stn 12; more very coarse and medium sand and less mud at Stns 13 and 14; and less coarse, medium and fine sand and more very fine sand and mud at Stn 15 (11–15). Most of these changes over time occurred in the group of 'Southern Shallows' sites. The most aberrant sites in terms of sediments were 1, 4 and 13 (very similar to the present results), and they were able to further subdivide sites on the basis of percentages of coarse sand, with sites 6, 7 & 8 having > 60%, and 9, 10 & 13 < 60% (again very close to the site-groupings based on sediment obtained in the present work).

WATER MOVEMENTS

Tidal currents flow south around Peel Island from the north-east and north-west, leaving a 'slacker-water' area which includes sites 1–5 (see Patterson & Witt 1992: fig. 11). Conversely, the more westerly area that includes sites 6–13 has strong tidal currents that may reach 2-3 knots (at the surface at least), during spring tides. The more easterly sites (1–5) are also more influenced by clean oceanic water flowing from the north-east through the Rainbow Passage (Stephenson *et al.* 1974). The other more westerly and southerly sites (6–15) are more influenced by tidal flows from the western and central portions of the Bay and are thus under greater terrestrial influence, particularly dilution by flood waters (consequently higher turbidity and greater possibilities of pollution), and greater temperature variation. The main influence of floods in the area is from the Logan-Albert Rivers which discharge from the south. Overall, the whole study area is generally relatively protected from the open Bay to the north, and waves are due to local winds. There is typically a seasonal pattern with winds from north to east predominating between December and April, and from south to southwest between May and August (Newell 1971). The longest wind-fetches in the sampling area are in an arc from south to southeast, and wave-action is severest when these winds blow against a flooding tide from the north. This, and the shallow depths, makes the most southerly sites 11, 12, 14 and 15, the most wave-affected.

TROPHIC STRUCTURE

The relationship between feeding type and sediment characteristics has been well documented and explored for many years (e.g. see Gray, 1974; Rhoads 1974; Lopez & Levinton 1987). The classification of benthic invertebrates into infaunal trophic feeding groups can be quite complex, and has even been developed into a numerical index for ecological mapping (Word 1980).

We have adopted a basic system consisting of five categories: 1, suspension feeder; 2, deposit feeder; 3, grazer; 4, predator/scavenger; 5, parasite. This is similar to that used in some recent Australian studies that have explored the trophic relationships of both tropical (Long & Poiner 1994), and temperate macrobenthic infaunal communities (Poore & Rainer 1974; Wilson *et al.* 1993). A 'parasite' category was included initially because of the high incidence of a bopyrid isopod in the gill chamber of a common porcellanid, *Pisidia dispar*, however it was removed from the graphical presentation of the final analyses as no other similar parasites were identified, and it merely mirrored the presence of its host so did not contribute to any better understanding of community structure.

The predators and scavengers were grouped as in this context the definitions are ambiguous, and many such species commonly switch roles according to available resources.

Suspension feeding organisms (= filter feeders) either actively pump suspended particles and organic matter through a filtration apparatus, or use complex feeding appendages including mucous nets, to separate such matter from the water column with the aid of bottom currents. Bivalve molluscs, tunicates and bryozoans are important suspension feeders, as are some crustaceans and polychaetes. The organic matter is typically living or dead phyto- and zooplankton and bacteria, resuspended benthic particles, and dissolved organic matter.

Deposit feeders may be either mobile or sedentary, and feed at or near the surface, or burrow to some depth. They feed on living or dead organic content, often including degraded plant material, and typically ingest sediment with its attached interstitial meiofauna and microflora. Deposit feeders typically process at least one body weight in sediment daily (Lopez & Levinton 1987), and considerable amounts of sediment are processed in this way. Many species switch between deposit- and suspension-feeding modes (Lopez & Levinton 1987). Switching is often influenced by local environmental variables (current flow, concentration of suspended particles). Interactions between deposit- and suspension-feeding animals influence nutrient cycling and community structure (Wilson *et al.* 1993).

Trophic status of each species was obtained from Poore & Rainer (1974), Fauchald & Jumars (1979), Brusca & Brusca (1990) and Todd (2001).

STATISTICAL METHODS

Between-sites similarity matrices, using the Bray-Curtis index on the untransformed data, were formed separately for the sediment, species-counts, and trophic structure data sets. Bray-Curtis was used because it does not derive similarity from conjoint absences (Clark & Warwick 1994), and has been shown to be a robust index across both raw and standardised data (Faith *et al.* 1987). These similarities formed the basis of group-average hierarchical clustering to produce dendrograms. Dissimilarities, calculated as one minus similarity, were used for a multidimensional scaling (MDS) representation for each data set. The degree of association between the two between-sites similarity matrices (namely, using the sediment and the species-counts data respectively) was estimated using the Mantel test of the product-moment correlation. Canonical correspondence analysis (CCA) was used to derive and interpret the inter-relationships between these two sets of variables.

RESULTS

In total, a remarkable 564 species were collected (see Appendix 1) consisting of 11,892 individuals (average of 793 individuals/m^2). Of these a large number (150) occurred only once, and only 264 species occurred at least 5 times. The fauna was relatively evenly represented across the three major taxa: Mollusca — 181 species (32.1%) of which the largest number was bivalves (108 spp.); Crustacea — 160 spp. (28.4%); and the Annelida — 180 spp. (31.9%). The Echinodermata were represented by relatively few species (16; 2.8%), though a couple of species played a major characterising role in some site communities.

Data Reduction. The large number of species recorded meant that a meaningful analysis of species correlations required some significant data reduction. Initial analyses were restricted to the 264 species which occurred 5 times or more. The biplot from the full CCA still showed too many species vectors to be interpretable, so this was re-run with only the 28 most abundant species. These 28 totalled 65% of all captures, and all other species represented less than 0.5% each. It was felt that this was reasonable to reflect the key species defining the communities

SITES CLASSIFICATION

The site groupings recognised here are the result of concordance between three separate site classifications based on: sediment structure vs sites; species presence and abundance vs sites; and trophic classes vs sites. The combined sites x sediments x species data were then shown in relationship to each other using a canonical correspondence analysis (CCA) biplot. Dendrograms of sediments and species site groupings (not presented here) largely revealed the same groupings as the MDS analyses,

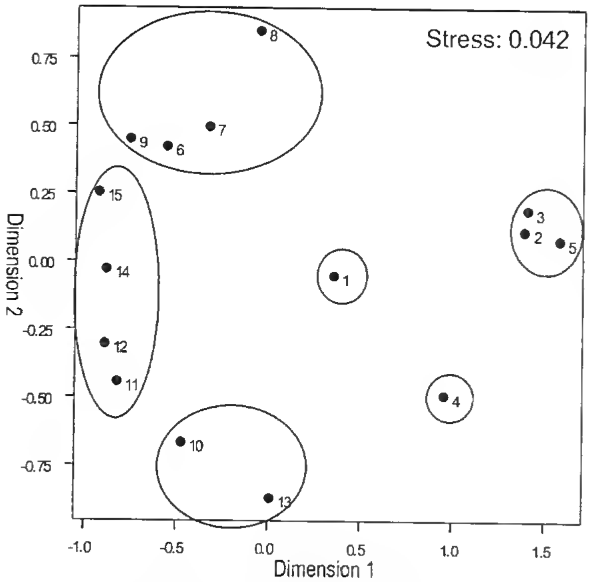


FIG. 3. MDS of sites x sediment data indicating 6 site-groupings (I–VI) based on relative proportions of sediment grades.

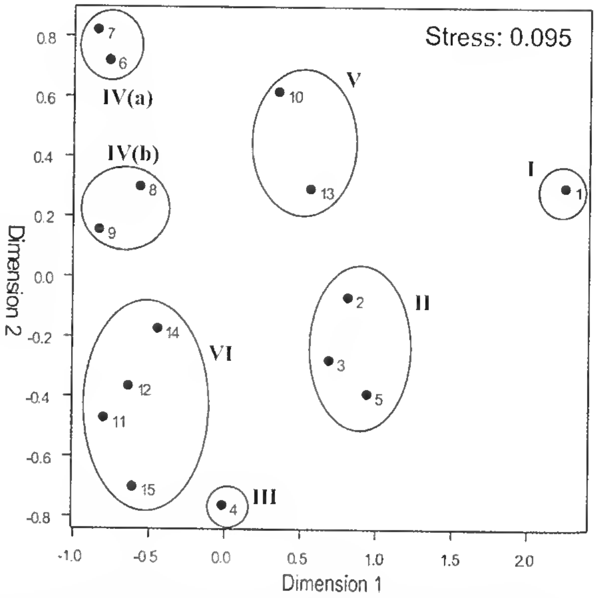


FIG. 4. MDS of spp. x sites classification showing seven discrete site-groups. Sites 6 & 7 and 8 & 9 are treated as Site-Group IVa and IVb respectively.

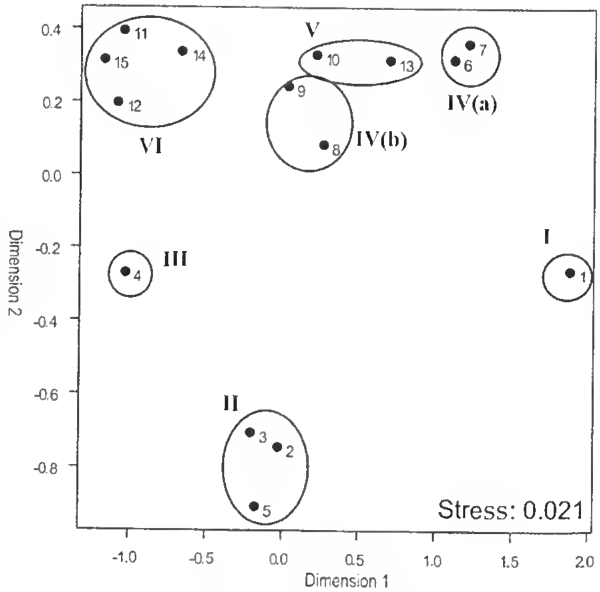


FIG. 5. MDS of trophic class x sites classification.

although a few sites that appear closer to each other in the MDS plots, moved into neighbouring clades in the dendrograms. Overall we considered the dendrograms did not give as conceptually a satisfying result probably because of the nature of the clustering algorithm, and that the MDS analyses gave a more visually understandable result in a two dimensional framework.

Under multidimensional scaling, two dimensions adequately represented these data, with stresses of much less than 0.2. These stress values were 0.042 for the sediments data, 0.021 for the trophic-level counts and 0.095 for the species-counts. These two-dimensional multi-dimensional patterns of sites are shown in Figs 2, 3 and 5 respectively.

The Mantel test showed a significant ($P<0.01$) association between the similarity matrices, with a correlation of 0.51. The resultant biplot is shown in Fig. 6.

Sediments x Sites classification. The MDS of sites by sediment data (Fig. 3) suggests 6 site-groupings (I–VI) based on relative proportions of sediment grades. As found by Stephenson *et al.* (1974), sites 1 (Site-Group I) and 4 (Site-Group III) differ significantly from all other individual sites. The specific differences in sediment structure are explored in more detail under the discussion of the trophic analysis. Noteworthy is that Sites 6, 7 & 9 clustered most closely together according to sediment composition with Site 8 being the outlier within the group. However, according to spp x sites and trophic structure x sites groupings, sites 6 & 7 are distinctly separated from 8 & 9, although relatively closely

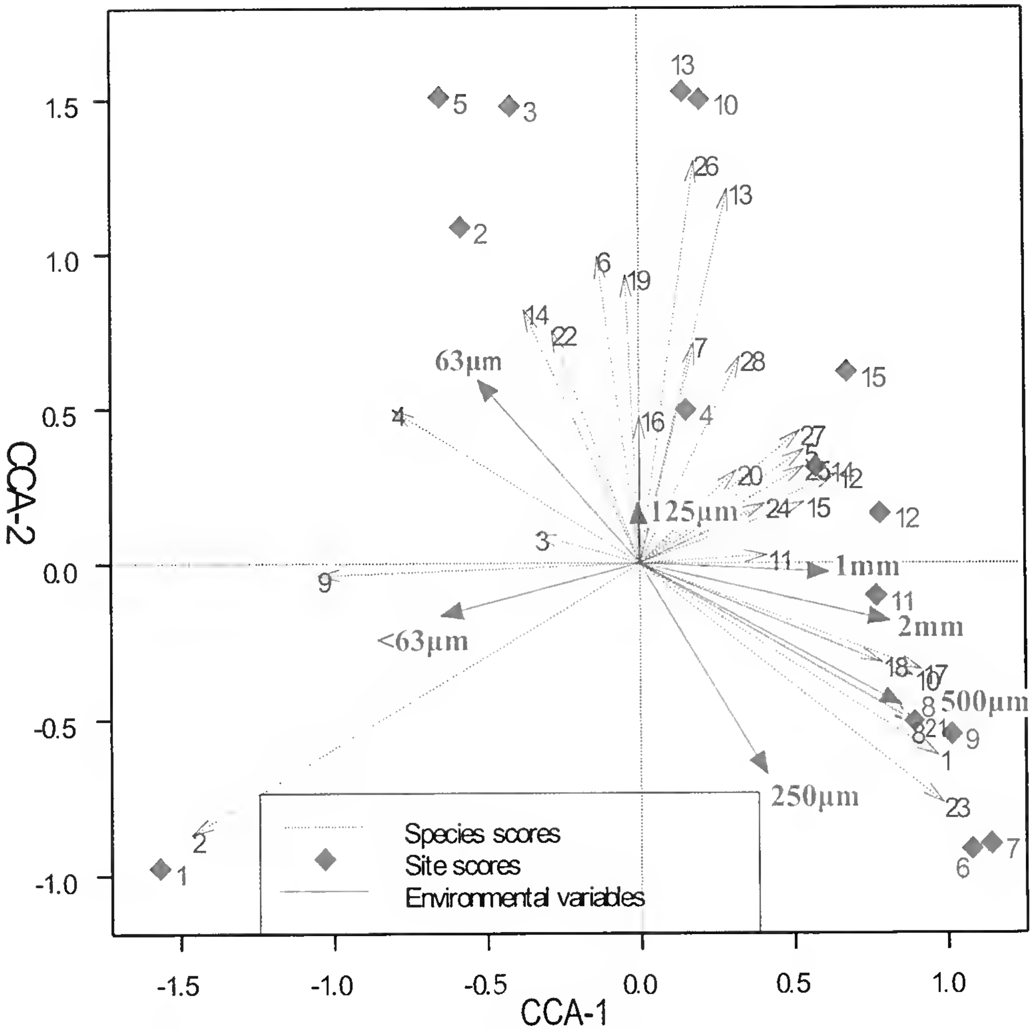


FIG. 6. CCA Biplot showing 3-parameter representation of species x sites x sediment characteristics.

allied. Because sites 6–9 are situated close together geographically, and thus form a logical site-grouping, we have decided to treat these four sites as a single site-group, but use a subgrouping notation to indicate that there are differences in species composition.

Species x Sites classification. The spp. x sites classification (Fig. 4) shows seven discrete site-groups, though as already mentioned, sites 6 & 7 and 8 & 9 are treated as Site-Group IVa and IVb respectively. Comparison with the map of sites (Fig. 2) shows that the the site-groups all include sites that are clustered close to each other topographically.

Trophic Classes vs Sites classification. The analysis of trophic class x sites classification (Fig. 5) essentially gives the same groupings as the species classification, and in particular sites 6, 7, 8, 9, 10 & 13 are clustered in close proximity (this is further discussed under a separate heading later).

CCA Biplot. This plot (Fig. 6) provides an informative 3-parameter visual representation of the species x sites x sediment characteristics. In general, the closer the arrow to the centre the more evenly distibuted the values, such that inner cluster of species are the most widespread across all sites. Some strong trends in the data are apparent. Site 1 (Site-Group I) is strongly characterised by an increased proportion of 125 µm sediments and the marked presence of 'sp. 2' (*Mesochaetopterus minutus*). Sites 2, 3 and 5

(Site-Group II) have the greatest proportion of 63 µm sediments and are most strongly characterised by species 22 and 14 (*Whiteleggia stephensoni* and maldanid sp. 3 respectively). Species 4 (*Maldane* sp.) and 9 (*Golfingia trichocephala*) are characteristic of both Site-Groups I and II. Site 4 (Site-Group III) is characterised by primarily 63 µm and 125 µm sediments but does not have an obvious species characterisation. Sp. 16 (spionid sp. 4) lies close to Site 4 on the plot, but this is an artefact of its dual presence at sites 2, 3, 5 (Site-Group II) and at the widely separated sites 6 and 7 (Site-Group IVa). Sites 6–9 (Site-Group IVa, b) are clearly characterised by much sandier sediment grades, and characterised by spp. 23 (*Pharyngeovalvata* sp.), 8 (*Terebellides narribri*), 1 (*Trichomya hirsuta*) and 17 (*Paraoroides* sp. 1). These associations are further discussed in the following Site-Group accounts.

SITE-GROUP CHARACTERISING SPECIES

The species x sites classification largely agreed with the sediments x sites classification in supporting the recognition of six major site-groups, however there was some disparity between the two pairs of adjacent sites within Site-Group 4, and this was resolved by erecting subgroups IVa and IVb for the purposes of understanding the dominant species that characterise these communities.

In order to limit discussion of characterising species for each site-group, we have arbitrarily assigned a cut-off of 10 or more individuals being present at least one site within the site-group. This count represents the sum of quintuplicate 0.1 m^2 grab samples, so in effect, we only further consider species composition at any given site if they occurred in a density greater than 2 individuals per grab sample. We feel intuitively that at densities lower than this any given species will be a minor component of the community at that site-group.

Where a species is discussed as uniquely characterising a site-group, this is based on the reduced data set. It is possible that such a species may occasionally occur in other site-groups, but in sufficiently low numbers as to not make a significant contribution to site-group classification.

Site-Group I. This site 'group' is composed only of Site 1. All analyses (see Figs 2, 3, 5 & 6) indicated that Site 1 was unique. This result agreed with that of Stephenson *et al.* (1974) who, although they included it in their Site-Group I (with sites 2–5), remarked that it was aberrant. While it was a relatively muddy/fine sand site (49% 63 µm), it was not as obviously muddy as the adjacent sites otherwise included in Site-Group II (see Fig. 7). In total 95 spp. were present consisting of 2179 individuals (4358 m^{-2}), making it the most densely populated of all the sites. There were 16 characterising species (>10 individuals), but it was remarkable for very high densities of four species: *Mesochaetopterus minutus*, *Golfingia trichocephala*, *Maldane* sp. and *Ophiura kinbergi*. In particular it was markedly different from all other sites by having a very large number of the tubicolous, suspension feeding polychaete *Mesochaetopterus minutus* (1986 m^{-2}), which occurred at no other site. The other most abundant species, the sipunculid *Golfingia trichocephala*, characterised this site and Site-Group II, but nowhere else. The deposit feeding polychaete *Maldane* sp. also occurred at Site-Groups II , III, and V, but was three times more abundant at Site 1 than at the sites comprising Site-Group II, and at least six times or more abundant than at sites III and V. The predatory *Ophiura kinbergi* was the other major component of the dominant fauna, and is presumably responding to the number of prey species present.

Twelve species were present in relatively lower but consistent numbers. Of these, *Protaukyra* sp., capitellid sp. 5 and polynoid sp. 4 are unique to this site; Amphiuridae sp. 1, Ophiuridae sp. 2, *Sternaspis scutata*, *Nematonereis unicornis* and maldanid sp. 3 are characteristic of only this site and the adjacent Site-Group II, while *Ophiothrix* sp 1 is shared only with Site-Group V. Overall it is clear this site shares it closest affinities with Site-Group II, but having four uniquely characteristic species, including the very abundant *Mesochaetopterus minutus*, sets it clearly apart faunistically. This species may have a patchy presence, or may be seasonal in occurrence, and without it, this site would be far more faunistically similar to Site-Group II. However there were also significant sediment differences, and this may, in the end, be the determining factor in the observed faunistic differences.

Table 3. Species characterising Site-Group I (Site 1). Trophic composition: 1, Suspension feeder; 2, Deposit feeder; 3, Grazer; 4, Predator/Scavenger.

Id.	Species	Phylum	Family	Trophic	Totals	Fidelity
2	*Mesochaetopterus minutus*	Annelida	Chaetopteridae	1	993	1/1
4	*Maldane* sp.	Annelida	Maldanidae	2	307	1/1
3	*Ophiura kinbergi*	Echinodermata	Ophiotrichidae	4	304	1/1
9	*Golfingia trichocephala*	Sipuncula	Golfingiidae	2	121	1/1
40	Amphiuridae sp 1	Echinodermata	Amphiuridae	4	32	1/1
45	*Ophiothrix* sp 1	Echinodermata	Ophiocomidae	1	20	1/1
56	Ophiuridae sp 2	Echinodermata	Ophiuridae	4	17	1/1
34	*Sternaspis scutata*	Annelida	Sternaspidae	2	16	1/1
80	*Protankyra* sp.	Echinodermata	Synaptidae	2	15	1/1
61	capitellid 5	Annelida	Capitellidae	2	13	1/1
39	*Nematonereis unicornis*	Annelida	Eunicidae	4	12	1/1
6	amphipod 02	Crustacea	–	4	11	1/1
14	maldanid 3	Annelida	Maldanidae	2	11	1/1
73	polynoid 4	Annelida	Polynoidae	4	11	1/1
7	*Ampelisca* sp.	Crustacea	Ampeliscidae	1	10	1/1
11	*Cheiriphotis* sp 1	Crustacea	Corophiidae	1	10	1/1

Site-Group II. Site-Group II includes sites 2, 3 and 5 (Figs 2, 3, 5, 6) and were the 'muddiest' sites (ca. 87% at 63 µm), and this concurs with the earlier assessment of Stephenson *et al.* (1974). These three sites in total included 160 species and 2036 individuals, with an average of 105 spp. and 679 individuals (1358 m^{-2}) per site. So, on a per site (area sampled) basis, there was a similar number of species to site 1, but total abundances were much lower (about one-third).

As already discussed, this Site-Group is closest faunistically to Site-Group I, and is geographically adjacent (Fig. 2). Fifteen species occurred in abundances >10 for at least one constituent site (Table 4). The four species with the highest fidelity to the group were also the most abundant, *viz. Maldane* sp., amphipod sp. 2, *Ophiura kinbergi* and maldanid sp. 3. Amphipod sp. 2 occurred in significant numbers not only at this site, but also relatively widely at other sites (Site-Groups I, IVb, V & VI), at abundances at least twice as high as Site-Group II. As already mentioned, the deposit feeding polychaete *Maldane* sp. is also at Site-Groups I, III, and V, but was only about one-third as abundant at Site 1 though still 2–3 times more abundant than at Site-Groups III and V. *Ophiura kinbergi* was again a dominant component of the fauna, but its wide occurrence across all site-groups, prevents the species from characterising this site-group. *Golfingia trichocephala*, similarly to Site 1, also occurred in large numbers but at only two of the three sites in the group. Amphiuridae sp. 1, Ophiuridae sp. 2, *Sternaspis scutata*, *Nematonereis unicornis* and maldanid sp. 3 are all shared only with Site-Group 1. Of the other species, spionid sp. 4 only also occurs at Site-Group IVa; the maldanid sp. 2 is also at Site-Groups III and V; and *Eunice vittata* also occurs at Site-Group V. The tanaid, *Whiteleggia stephensoni* appears to be the only species to occur uniquely at this site-group, with a fidelity of 2 of the 3 sites, and this species and maldanid sp. 3 are clearly shown in the CCA Biplot (Fig. 6) to be most characteristic of this site-group. The presence of *Halophila spinulosa* was also noted at this site.

Site-Group III. Like Site-Group I, Site-Group III comprises only a single unique site (Site 4). It is characterised by a somewhat lower species richness (86 species), and relatively low abundances (332 individuals or 664 m^{-2}). While having a smaller component of fine sediment (63 µm) than Site-Group II, there was a higher proportion of 125 µm sediment grade, and a negligible coarser sand component (see Fig. 7). Only seven species occurred in an abundance >10, and none stood out as having particularly high individual abundances. Like the adjacent Site-Group II,

Table 4. Species characterising Site-Group II (Sites 2, 3, 5). Trophic composition: 1, Suspension feeder; 2, Deposit feeder; 3, Grazer; 4, Predator/Scavenger.

Id.	Species	Phylum	Family	Trophic	Totals	Fidelity
4	*Maldane* sp	Annelida	Maldanidae	2	384	3/3
6	amphipod 02	Crustacea	–	4	177	3/3
3	*Ophiura kinbergi*	Echinodermata	Ophiotrichidae	4	124	3/3
14	maldanid 3	Annelida	Maldanidae	2	116	3/3
9	*Golfingia trichocephala*	Sipuncula	Golfingiidae	2	94	2/3
7	*Ampelisca* sp.	Crustacea	Ampeliscidae	1	57	2/3
16	spionid 4	Annelida	Spionidae	2	50	2/3
22	*Whiteleggia stephensoni*	Crustacea	Whiteleggiidae	2	49	2/3
11	*Cheiriphotis* sp 1	Crustacea	Corophiidae	1	42	2/3
19	maldanid 2	Annelida	Maldanidae	2	24	2/3
39	*Nematonereis unicornis*	Annelida	Eunicidae	4	15	1/3
56	Ophiuridae sp 2	Echinodermata	Ophiuridae	4	15	1/3
34	*Sternaspis scutata*	Annelida	Sternaspidae	2	14	1/3
29	*Eunice vittata*	Annelida	Eunicidae	4	12	1/3
40	Amphiuridae sp 1	Echinodermata	Amphiuridae	4	10	1/3

Maldane sp. and *Ophiura kinbergi* were among the more common species. However unlike Site-Groups I and II, *Trichomya hirsuta* is present. *T. hirsuta* is the dominant species at Site-Group IVa, b, and an important component of the community at Site-Group VI. Two polychaete species, *Nephtys australiensis* (predator) and maldanid sp. 5 (deposit feeder) were uniquely found at this site.

Site-Group IVa. Site-Group IVa consisted of only two sites (6 and 7), with a total of 178 species, and the highest average per site species diversity (av. 136 spp./site), and 2584 individuals; (av. 1292 individuals = 2584 m^{-2}). Site-Groups IVa and IVb together were characterised by large numbers of the clumping mussel, *Trichomya hirsuta*. This species grows to about 40 mm shell length and helps to structure the rest of the community by providing habitat above the sediment. In particular, at Site-Group IVa *Trichomya* was the dominant animal occurring at an average density of 1760 m^{-2}. This may help explain why both these site-groups had the highest species diversity of any of the sites. The predatory polychaete, *Opisthosyllis* sp., was the next most abundant but also occurred at Site-Groups III, IVb, V and VI, so is not particularly diagnostic of this community. *Terebellides narribri*, *Pisidia dispar*, *Paraoroides* sp. 1, capitellid sp. 1, *Chama limbula*, and *Heteropilumnus fimbriatus* all characterised Site-Groups IVa and IVb, occurring nowhere else. Eleven species occurred uniquely at Site-Group IVa: syllid sp. 7, *Pharyngeovalvata* sp., nereid sp. 4, *Arca navicularis*, polynoid sp. 3, *Prionospio* sp. 1, sponge sp. 1, polynoid sp. 5, *Syllis* sp., *Barbatia foliata*, and *Eunice australis*.

Table 5. Species characterising Site-Group III (Site 4). Trophic composition: 1, Suspension feeder; 2, Deposit feeder; 3, Grazer; 4, Predator/Scavenger.

Id.	Species	Phylum	Family	Trophic	Totals	Fidelity
4	*Maldane* sp	Annelida	Maldanidae	2	34	1/1
1	*Trichomya hirsuta*	Mollusca	Mytilidae	1	32	1/1
3	*Ophiura kinbergi*	Echinodermata	Ophiotrichidae	4	21	1/1
33	*Nephtys australiensis*	Annelida	Nephtyidae	4	18	1/1
53	maldanid 5	Annelida	Maldanidae	2	14	1/1
19	maldanid 2	Annelida	Maldanidae	2	13	1/1
5	syllid 1 [*Opisthosyllis* sp.]	Annelida	Syllidae	4	10	1/1

Table 6. Species characterising Site-Group IVa (Sites 6, 7). Trophic composition: 1, Suspension feeder; 2, Deposit feeder; 3, Grazer; 4, Predator/Scavenger.

Id.	Species	Phylum	Family	Trophic	Totals	Fidelity
1	*Trichomya hirsuta*	Mollusca	Mytilidae	1	880	2/2
5	syllid 1 *Opisthosyllis* sp	Annelida	Syllidae	4	140	2/2
8	*Terebellides narribri*	Annelida	Terebellidae	2	130	2/2
10	*Pisidia dispar*	Crustacea	Porcellanidae	1	106	2/2
11	*Cheiriphotis* sp 1	Crustacea	Corophiidae	1	78	2/2
3	*Ophiura kinbergi*	Echinodermata	Ophiotrichidae	4	73	2/2
23	syllid 7 *Pharyngeovalvata* sp	Annelida	Syllidae	4	68	2/2
21	nereid 4	Annelida	Nereididae	4	55	2/2
17	*Paraoroides* sp 1	Crustacea	Corophiidae	1	51	2/2
18	capitellid 1	Annelida	Capitellidae	2	36	2/2
31	*Arca navicularis*	Mollusca	Arcidae	1	34	2/2
16	spionid 4	Annelida	Spionidae	2	30	2/2
15	cirratulid 1, *Tharax* sp	Annelida	Cirratulidae	2	23	2/2
51	polynoid 3	Annelida	Polynoidae	4	22	2/2
38	*Prionospio* sp 1	Annelida	Spionidae	2	17	1/2
36	*Chama limbula*	Mollusca	Chamidae	1	16	1/2
12	*Gammaropsis* sp.	Crustacea	Isaeidae	1	14	1/2
71	sponge 1	Porifera	–	1	14	1/2
82	polynoid 5	Annelida	Polynoidae	4	13	1/2
47	*Heteropilumnus fimbriatus*	Crustacea	Pilumnidae	4	12	1/2
7	*Ampelisca* sp.	Crustacea	Ampeliscidae	1	12	1/2
42	syllid 5 *Syllis* sp	Annelida	Syllidae	4	11	1/2
52	nematode	Nematoda	–	2	11	1/2
86	*Barbatia foliata*	Mollusca	Arcidae	1	10	1/2
48	*Eunice australis*	Annelida	Eunicidae	4	10	1/2

Site-Group IVb. Placed geographically adjacent to IVa, it also consisted of only two sites (8 and 9), and had a very high species diversity, with a total of 155 species (av. 112/site), and 1443 individuals; (av. 722 individuals = 1444 m^{-2}). As with Site-Group IVa the most conspicuous faunal component was *Trichomya hirsuta*, though the abundance was a little less than a third of Site-Group IVa. Species composition in general was very similar to Site-Group IVa, though generally lower numbers and fewer species occurring in abundances >10. Of this category only three species were 'unique' to the site-group, *viz.*, syllid sp. 2, capitellid sp. 3 and spionid sp. 7. Another species, capitellid 2 was uniquely shared with Site-Group VI.

Site-Group V. This site-group also consisted of only two sites (10 and 13) either side of the wide channel separating Site-Group IV(a, b) and Site-Group VI (see Fig. 2). It had a similarly high species diversity (156 spp.) to Site-Group IVb with a total of 1849 individuals collected (1484–2214 m^{-2}). Each site averaged averaged 114 spp. and 925 individuals. The obvious difference separating this site-group from Site-Group IV(a, b) is the absence of *Trichomya hirsuta*. Of the species with abundance >10, only 7 species occurred at both sites.

Unique to this site-group is *Byblis* sp. 3 which occurred at both sites in large numbers and probably helped contribute to its separation. Also unique to the site-group, but found at only one site in the pair were nine other species: *Solen vaginoides*, amphipod sp. 4, *Magelona dakini*, *Ophiocomella sexradia*, paraonid sp. 2, *Goniada* sp., *Konarus cheiris*, Sphaeromatidae sp. 6 and Sphaeromatidae sp. 7. The cirratulid sp. 1 (*Tharax* sp.) was only at Site 10 and shared with the closest sites in Site-Group IV (a, b).

Table 7. Species characterising Site-Group IVb (Sites 7, 8). Trophic composition: 1, Suspension feeder; 2, Deposit feeder; 3, Grazer; 4, Predator/Scavenger.

Id.	Species	Phylum	Family	Trophic	Totals	Fidelity
1	*Trichomya hirsuta*	Mollusca	Mytilidae	1	258	2/2
8	*Terebellides narribri*	Annelida	Terebellidae	2	115	2/2
3	*Ophiura kinbergi*	Echinodermata	Ophiotrichidae	4	66	2/2
10	*Pisidia dispar*	Crustacea	Porcellanidae	1	53	2/2
5	syllid 1 *Opisthosyllis* sp	Annelida	Syllidae	4	44	2/2
15	cirratulid 1, *Tharax* sp	Annelida	Cirratulidae	2	42	2/2
11	*Cheiriphotis* sp 1	Crustacea	Corophiidae	1	38	2/2
18	capitellid 1	Annelida	Capitellidae	2	32	2/2
12	*Gammaropsis* sp.	Crustacea	Isaeidae	1	30	2/2
41	spionid 1	Annelida	Spionidae	2	26	2/2
17	*Paraoroides* sp 1	Crustacea	Corophiidae	1	25	2/2
46	syllid 2	Annelida	Syllidae	4	29	1/2
58	capitellid 3	Annelida	Capitellidae	2	22	1/2
20	capitellid 2	Annelida	Capitellidae	2	13	1/2
47	*Heteropilumnus fimbriatus*	Crustacea	Pilumnidae	4	12	1/2
36	*Chama limbula*	Mollusca	Chamidae	1	12	1/2
66	spionid 7	Annelida	Spionidae	2	12	1/2
6	amphipod 02	Crustacea	–	4	12	1/2
32	Chitons (unidentified)	Mollusca	–	3	11	1/2
7	*Ampelisca* sp.	Crustacea	Ampeliscidae	1	10	1/2

Site-Group VI. This is a cluster of four sites (11, 12, 14, 15) situated on the northern end of the Banana Banks (Fig. 2), in generally shallower water (3.1–4.3 m at high tide), and while not tidally exposed, would be only under 1–2 metres of water at low tide. It was also characterised by the presence of seagrasses (mainly *Halophila* species). Overall this site-group had the highest species diversity (193 spp.), but only a moderate per site diversity (av. 91 spp./site). Of these 193 species only 14 occurred in abundances of 10 or more across the group. Thus, most species at this site-group occurred in relatively low numbers, and with a large number of single species occurrences at one or more sites. In total 1469 individuals were collected at an average of 367 per site (734 m^{-2}), so abundances were generally lower than at other sites.

Only the suspension feeding anomuran crustacean, *Pisidia dispar*, showed complete fidelity to all four sites. As for Site-Groups III and IV, *Trichomya hirsuta* was present at three sites but in relatively lower numbers. All of the other high fidelity species (3/4 sites) had broad-ranging occurrences across a number of other site-groups. A number of species were only found at this site-group, but all had low fidelity (1/4 sites), *viz. Pupa* sp., *Macrophiothrix* sp. 1, *Magelona 'papillicornis'*, and *Eusarsiella* sp. 1.

PATTERNS IN TROPHIC STRUCTURE

The faunal taxonomic composition and an analysis of trophic structure within the site-group communities in our study area are presented here. The MDS analysis of trophic class x sites classification (Fig. 5) essentially gives the same groupings as the species classification, and in particular sites 6, 7, 8, 9, 10 & 13 (Site-Groups IV & V) are clustered in close proximity. These sites are the closest geographically, although interestingly Site-Group V differs significantly from Site-Group IV in sediment structure (Fig. 7), though this apparently is not reflected as a marked difference in trophic composition.

The Predator/Scavenger component made up the greatest percentage of species (nearly 40%) but was lower in total abundance than the other two major feeding guilds (Table 10). The Deposit Feeders comprised the next most speciose

Table 8. Species characterising Site-Group V (Sites 10, 13). Trophic composition: 1, Suspension feeder; 2, Deposit feeder; 3, Grazer; 4, Predator/Scavenger.

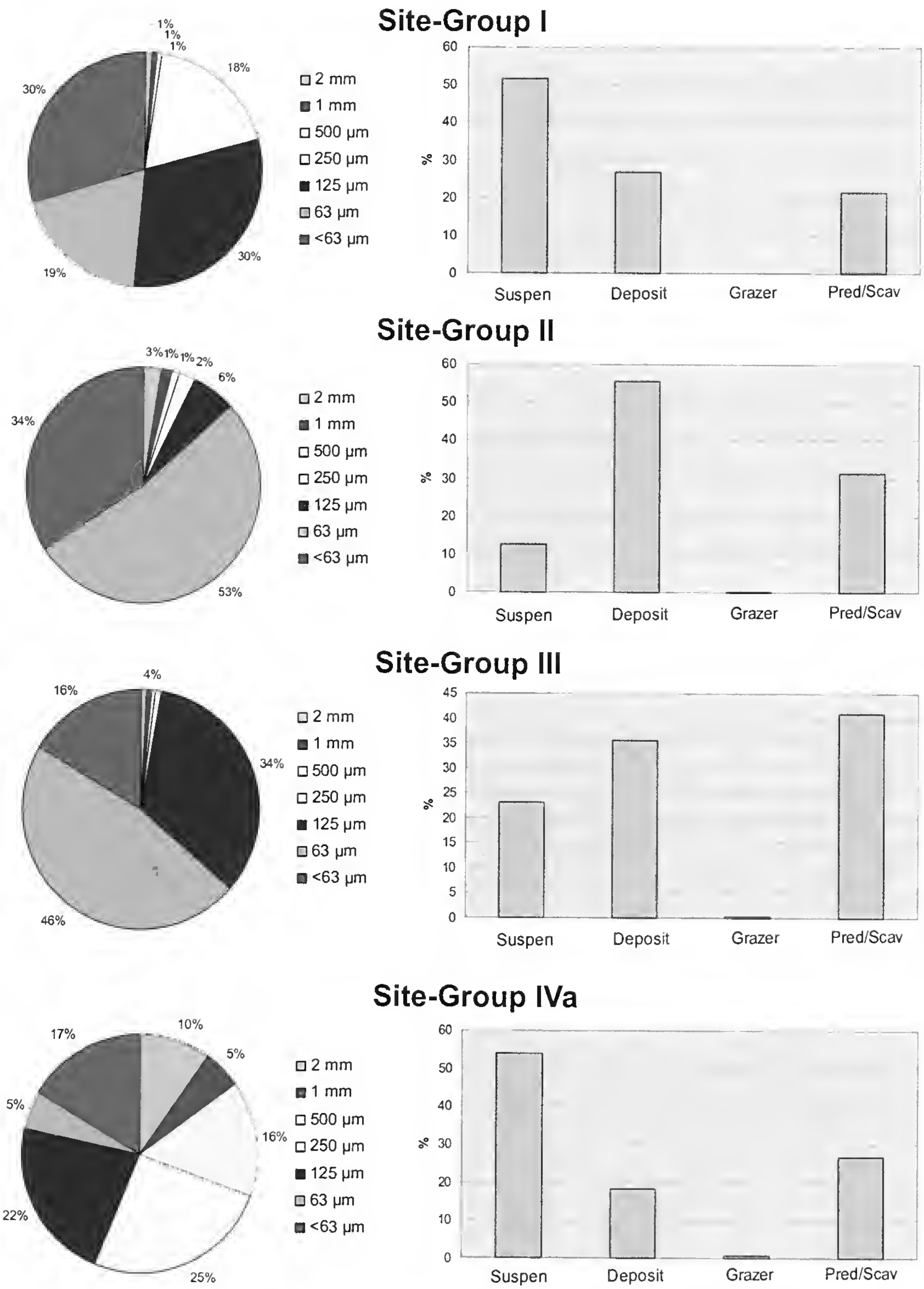
Id.	Species	Phylum	Family	Trophic	Totals	Fidelity
3	*Ophiura kinbergi*	Echinodermata	Ophiotrichidae	4	198	2/2
7	*Ampelisca* sp.	Crustacea	Ampeliscidae	1	164	2/2
13	*Byblis* sp 3	Crustacea	Ampeliscidae	1	157	2/2
6	amphipod 02	Crustacea	–	4	110	2/2
12	*Gammaropsis* sp.	Crustacea	Isaeidae	1	54	2/2
19	maldanid 2	Annelida	Maldanidae	2	32	2/2
11	*Cheiriphotis* sp 1	Crustacea	Corophiidae	1	26	2/2
5	syllid 1 *Opisthosyllis* sp	Annelida	Syllidae	4	178	1/2
4	*Maldane* sp	Annelida	Maldanidae	2	98	1/2
26	*Solen vaginoides*	Mollusca	Solenidae	1	51	1/2
30	amphipod 04	Crustacea	–	4	31	1/2
15	cirratulid 1 (*Tharax* sp.)	Annelida	Cirratulidae	2	24	1/2
25	*Magelona dakini*	Annelida	Magelonidae	2	17	1/2
45	*Ophiothrix* sp 1	Echinodermata	Ophiocomidae	1	16	1/2
95	*Ophiocomella sexradia*	Echinodermata	Ophiocomidae	1	16	1/2
98	paraonid 2	Annelida	Paraonidae	2	15	1/2
28	*Goniada* sp.	Annelida	Goniadidae	4	13	1/2
123	*Konarus cheiris*	Crustacea	Leptocheliidae	2	12	1/2
29	*Eunice vittata*	Annelida	Eunicidae	4	12	1/2
131	Sphaeromatidae sp. 6	Crustacea	Sphaeromatidae	4	12	1/2
152	Sphaeromatidae sp. 7	Crustacea	Sphaeromatidae	4	10	1/2

Table 9. Species characterising Site-Group VI (Sites 11, 12, 14, 15). Trophic composition: 1, Suspension feeder; 2, Deposit feeder; 3, Grazer; 4, Predator/Scavenger.

Id.	Species	Phylum	Family	Trophic	Totals	Fidelity
1	*Trichomya hirsuta*	Mollusca	Mytilidae	1	104	3/4
12	*Gammaropsis* sp.	Crustacea	Isaeidae	1	72	3/4
10	*Pisidia dispar*	Crustacea	Porcellanidae	1	71	4/4
3	*Ophiura kinbergi*	Echinodermata	Ophiotrichidae	4	71	3/4
20	capitellid 2	Annelida	Capitellidae	2	34	3/4
5	syllid 1 *Opisthosyllis* sp	Annelida	Syllidae	4	49	2/4
7	*Ampelisca* sp.	Crustacea	Ampeliscidae	1	38	2/4
6	amphipod 02	Crustacea	–	4	31	2/4
35	*Pupa* sp.	Mollusca	Acteonidae	4	15	1/4
68	*Macrophiothrix* sp 1	Echinodermata	Ophiotrichidae	4	13	1/4
32	Chitons (unidentified)	Mollusca	–	3	11	1/4
49	caprellid 3	Crustacea	–	4	10	1/4
91	*Magelona 'papillicornis'*	Annelida	Magelonidae	2	10	1/4
50	*Eusarsiella* sp 1	Crustacea	–	4	10	1/4

group, and although the Suspension Feeders had a slightly lower species richness again, they clearly dominated the fauna in terms of total abundance.

It is evident from Fig. 7 that the most interpretable faunal trophic response occurred in Site-Groups II & III where deposit feeders dominated the species composition, and their magnitude appears directly proportional to the size of the 63 µm sediment fraction. Site-Group II (Sites 2, 3 & 5) has 87% of the retained sediment in the


Site-Group I
1%
1%
1%
18%
30%
30%
19%
2 mm
1 mm
500 µm
250 µm
125 µm
63 µm
<63 µm
%
60
50
40
30
20
10
0
Suspen
Deposit
Grazer
Pred/Scav
Site-Group II
3%
1%
1%
2%
6%
34%
53%
2 mm
1 mm
500 µm
250 µm
125 µm
63 µm
<63 µm
%
60
50
40
30
20
10
0
Suspen
Deposit
Grazer
Pred/Scav
Site-Group III
4%
16%
34%
46%
2 mm
1 mm
500 µm
250 µm
125 µm
63 µm
<63 µm
%
45
40
35
30
25
20
15
10
5
0
Suspen
Deposit
Grazer
Pred/Scav
Site-Group IVa
10%
17%
5%
5%
16%
22%
25%
2 mm
1 mm
500 µm
250 µm
125 µm
63 µm
<63 µm
%
60
50
40
30
20
10
0
Suspen
Deposit
Grazer
Pred/Scav

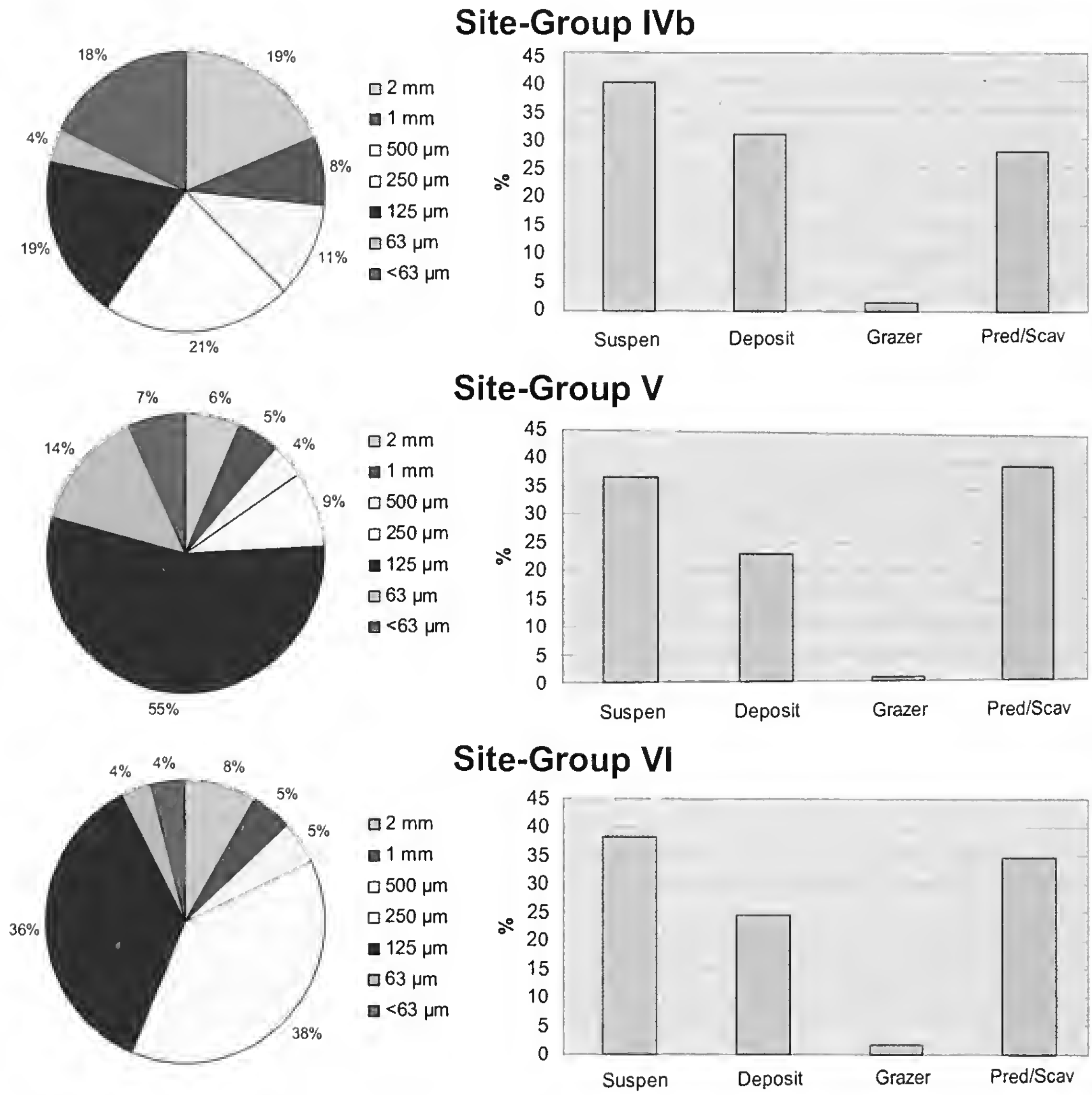


FIG. 7. Graphical presentation of average sediment composition compared with trophic categories for each site-group.

63 μm fraction, and 56% deposit feeders (the included sites are the same ones as those that Stephenson *et al.* (1974) recorded as having >50% mud). Similarly Site-Group III (Site 4) has 35% deposit feeders (compared to 23% suspension) and this corresponds with a smaller 63 μm fraction (62%). Thus it seems that the magnitude of the 63 μm fraction is a reasonable biological predictor for the switch from deposit feeding dominated communities to suspension feeding domination (finer sediments being more likely to choke suspension feeding mechanisms). Poore & Rainer (1979: 483) similarly noted that all numerically important species in muddy environments in Port Phillip Bay are deposit feeders, and deposit feeders comprise 'a major portion of the biomass' in these habitats.

All other site-groups are dominated by suspension feeders. There does not seem to be a direct correlation with coarser sediment fractions, but the next 'muddiest' Site-Group I has approx. 49% 63 μm fraction, with suspension feeders

Table 10. Species composition and abundance according to trophic structure.

Trophic Type	No of Spp.	% of all Spp.	Abundance	% Total Abundance
Suspension Feeders	145	25.8%	4547	38.3%
Deposit Feeders	161	28.6%	3506	29.6%
Grazers	21	3.7%	111	0.9%
Predator/Scavengers	220	39%	3176	26.8%
Parasite	1	0.2%	21	0.2%
Unallocated	16	2.8%	501	4.2%

comprising approximately 52% of the faunal composition against the deposit feeders at 27%.

Away from the obviously muddy sites (1, 2, 3, 5) the relative proportions of deposit and suspension feeders is relatively predictable (deposit feeders varying from about 18–31%, av. 25%; and suspension feeders comprising 37–54%, av. 44%).

Predators/Scavengers are generally well represented in all site-groups but numbers are a little less predictable ranging from 22–41% (av. 31%). Given the high species abundances and diversity at most sites, the abundance and variety of predator species will also no doubt rise and fall with potential prey. Numbers will also be affected by the presence of seagrass communities, and by mollusc aggregations such as the mussel, *Trichomya hirsuta,* which, as ecosystem engineers, provide complex 3-dimensional epibenthic niches. The predatory ophiuroid, *Ophiura kinbergi,* is known as an indicator species for fine-sandy mud substrates, particularly for sites 1–5 (Stephenson *et al.* 1974). In the present study the species appears to reach its highest numbers in these muddier sites, but nevertheless it was also present as a significant component (< 10 individuals) of all site-groups in the present study.

DISCUSSION

WHAT IS THE TRUE DIVERSITY IN THE STUDY AREA?

While 564 species were collected during the course of the present survey, does this adequately reflect the true diversity of these sandy-mud environments to the south of Peel Island? Site-Group IVa had an average of 136 species at each site (sampling surface area of 0.5 m^2/site), but the species presence was not identical, and the total count for both sites (sampling surface area of 1 m^2) had an additional 42 species represented. Similarly for Site-Group VI, the four included sites each had an average of 91 spp./site, but the cumulative total was 193 species (an additional 22 new species (ca. 25%) added per site). Many of these are 'rare' species represented by only 1–2 specimens, but given the simple species x area curve principle, on these figures one could expect increased sampling to increase the numbers of species significantly before there would be any obvious levelling off. Many of these extra species may also be already represented in other Site-Groups as well. However, given the differences in sediment profiles between the site--groups, and clearly different characterising species in each community, it still seems reasonable to expect that there is a significant under-representation of the number of species really present. This is further reinforced by the fact we only sorted and identified the fauna retained by a 1 mm sieve (generally most modern studies consider the macrobenthos to be > 0.5 mm), such that a significant component of the smallest macrobenthic fauna has not been sampled. Also, although it cannot be accurately quantified without significantly more work, it is clear that Stephenson *et al.* (1974) recorded a significant number of species not found in the present study. Finally, our study was a single season 'snapshot' and changes in communities over the course of a year, and between years, will undoubtedly add to the total species counts. On this basis, it seems reasonable to expect the number of macrobenthic species in this small area to approach 700. Such high species diversity is a good indication that the present communities in this area are healthy and resilient.

Davie & Hooper (1998) recorded 2512 invertebrates from the Bay, so the present tally from a relatively few grab samples of the soft sandy-mud habitats south of Peel Island, actually represents 22.5% of this total. It is also noteworthy that many of the present unidentified taxa are likely to be new species. For example, the tanaid fauna of Moreton Bay now includes 29 species in 20 genera. However 20 of these have been described as new since 2006, including 6 new genera (Guţu 2006; Błażewicz-Paszkowycz & Bamber 2007; Bamber 2008). Such a pattern of discovery will no doubt repeat for many other groups, as most have received relatively scant attention from taxonomists.

DIVERSITY COMPARISONS WITH OTHER AREAS

A similar one-off study was undertaken by Long & Poiner (1994) in the Gulf of Carpentaria. Their study also used a 0.1 m^2 grab (Smith-McIntyre) and a 1 mm sieve size. In total they sampled 105 stations with 3 replicates per station (total of 315 samples across the entire gulf area). They found 7928 animals representing 684 taxa, with an average maximum abundance of 1527 m^{-2} and a maximum average of 53.5 species/0.1 m^2. This can be compared with the present results where we found 564 species, but in relatively much higher abundances (11,892 individuals at an average of 1586 individuals/m^2 up to a maximum of 4358 m^{-2} at Site 1); and a greater maximum number of species (137) at any specific site. Though there were fewer species recorded overall in the present study, it must be remembered that the total area sampled across the Gulf of Carpentaria was 300,000 km^2 versus the 3 km^2 of our sampling area in Moreton Bay.

The study of Long & Poiner (1994) also found that only about 36% of their taxa were represented by at least 5 individuals, and there was a high incidence of rarity with 36% of species represented by a single individual only. In our present Moreton Bay study we had a relatively greater diversity of species represented at abundances of 5 or greater (47% or 264 spp.), and a slightly lower percentage of single occurrences (27% or 150 spp.).

Another comparison of relative species diversity can be made with the intensively studied Port Phillip Bay, Victoria. There, there has been only 680 macrobenthic invertebrate species recorded across a much larger area (total area of 1950 km^2 versus 3 km^2 in the Moreton Bay study area), and over multiple seasons and years (Poore & Rainer 1974, 1979; Poore 1993; Harris *et al.* 1996). By any standard, the study area south of Peel Island, in Moreton Bay, must be considered extremely rich.

DIFFERENCES IN COMMUNITY COMPOSITION SINCE 1970

Stephenson *et al.* (1974) reported a total of 394 faunal species from 8 sampling times, whereas in the present study we recorded 564 species from a single February sampling. While this outwardly appears to be a significantly higher diversity there are a number of factors that indicate the earlier study had underestimated the species present. Perhaps the most important factor was the level of scrutiny the samples received. Stephenson *et al.* (1974) stated: 'The normal method of collecting the biota from grab samples was by on-board wet sieving, with the final apertures ca. 1·2 mm square. Particular care was taken over samples containing small specimens of bivalves and gastropods which fortunately were infrequent.' Apparently all faunal sorting was undertaken on the boat, and there was no fine microscopic sediment sorting back in the laboratory (Stephen Cook, pers. comm.). While this was perhaps necessary at that time for logistical reasons, it would inevitably have led to a significant undersampling of the smaller faunal component.

Another difficulty in making a direct comparison between the two studies is that we have no access to the original individual sampling-times data of Stephenson *et al.* (1974). The data presented in their paper is in summary form only, and either gives accumulated totals or average values for the whole two-year sampling period. Given that seasonal communities exist, we are therefore unable to make direct summer community comparisons because of this lack of specific seasonal data.

Stephenson *et al.* (1974) specifically stated that they did not include amphipods 'Because of anticipated difficulties in identification and in recognition of species ... Amphipods were present in smaller numbers than in comparable surveys elsewhere, but nevertheless their omission is unfortunate.' Their assertion that amphipods were present in smaller numbers is perhaps also a comment on their less than desirable sorting

Table 11. A comparison of results for site-groupings and characterising species for Stephenson *et al.* (1974), and the presently reported 2005 sampling. VHC = very high conformity (or high fidelity to that site group); HI = high importance (high abundances in that site group). Species listings are not exhaustive — see text in Results for a more extensive analysis.

1970 Sites	Site Grp	Characterising Species	2005 Sites	Site Grp	Characterising Species
1, 2, 3, 5	IV	*Lygdamis* (VHC) *Tucetilla* (VHC) *Molgula rima* (VHC) *Polycarpa fungiformis* (VHC) *Glycera americana* (HI) *Paphia gallus* (HI) *Thermiste* sp. (HI) *Polycarpa fungiform* (HI)	1, 2, 3, 5	I & II	*Mesochaetopterus minutus* (VHC)(HI *Golfingia trichocephala* (VHC) (HI) maldanid 3 (VHC) Amphiuridae sp. 1 (VHC) Ophiuridae sp. 2 (VHC) *Sternaspis scutata* (VHC) *Nematonereis unicornis* (VHC) amphipod sp. 2 (HI) *Maldane* sp. (HI) *Ophiura kinbergi* (HI)
4, 12, 14	III	sabellid 4 (VHC) *Euclymene* spp. (VHC)(HI) *Isolda* (VHC) *Petaloproctus* (VHC)(HI) *Circe* (VHC) *Malleus* (VHC) *Eunice antennata* (HI)	4	III	*Nephtys australiensis* (VHC) maldanid sp. 5 (VHC) *Maldane* sp. (HI) *Trichomya hirsuta* (HI) *Ophiura kinbergi* (HI)
6, 7, 8, 9, 10, 13	II	*Tellina lilium* (VHC) *Protankyra* sp. (VHC) *Microcosmos* (VHC) *Ensiculus* (HI) *Protankyra* (HI)	6, 7, 8, 9	IVa IVb	*Terebellides narribri* (VHC) *Pisidia dispar* (VHC) *Pharyngeovalvata* sp. (VHC) nereid 4 (VHC) *Paraoroides* sp. 1 (VHC) capitellid sp. 1 (VHC) *Chama limbula* (VHC) *Heteropilumnus fimbriatus* (VHC) *Trichomya hirsuta* (HI) *Opisthosyllis* sp. (HI) *Cheiriphotis* sp. 1 (HI) *Ophiura kinbergi* (HI)
			10, 13	V	*Byblis* sp. 3 (VHC)(HI) *Ophiura kinbergi* (HI) *Ampelisca* sp. (HI) amphipod sp. 2 (HI) *Gammaropsis* sp. (HI) maldanid 2 (HI) *Cheiriphotis* sp 1 (HI)
11, 15	I	*Leocrates* (VHC) *Ophiura kinbergi* (VHC) *Rhizopa* (HI)	11, 12, 14, 15	VI	*Trichomya hirsuta* (HI) *Gammaropsis* sp. (HI) *Pisidia dispar* (HI) *Ophiura kinbergi* (HI) capitellid 2 (HI)

strategy. In the present survey, amphipods were a significant component of the fauna with 47 species recorded. In support of this contention that the sorting was at fault, it appears that the peracarid crustaceans in general were massively undersampled by the earlier study. Stephenson *et al.* (1974) recorded only two tanaids (*versus* 10 spp. in present study), three cumaceans (*versus* 11 spp.) and no isopods (*versus* 31 spp.). We did not include algae in the present study, whereas Stephenson *et al.* (1974) recorded 24 species — therefore no comparison can be made. The presence of seagrasses (primarily *Halophila* species) was merely noted as present or absent in both studies.

There were however some major differences between the two surveys that need discussion. We recorded no tunicates at all, whereas Stephenson *et al.* (1974) recorded 27 species, including eight that were sufficiently common to contribute to their sites and times classifications. In fact, two species, *Molgula rima* and *Polycarpa fungiformis* showed very high conformity to their Site-Group IV ('Southern shallows' sites). Similarly, for their site-groups II and III *Polycarpa pedunculata* showed high conformity. Stephenson *et al.* (1974) did note that seasonality was a factor in the presence of tunicates, and this was further discussed in detail by Kott (1972) who re-examined their original data. Kott (1972: 254, Table 1) clearly shows that in March 1970 only seven species were recorded from all sites, while in March 1971, this had dropped to four (three fixed-substrate species, and only a single free-living species). In both years all species were present in very low numbers. *Molgula* species in particular are highly seasonal, appearing in significant numbers only during the winter months from May to August. Kott (1972) clearly showed that *Molgula rima* was absent from both March samplings of Stephenson *et al.* (1974) (as was the related species, *M. exigua*). She considered that *M. rima* individuals probably have a life-span of less than 6 months, and recruitment to areas such as the 'Southern shallows' is likely to be from persistent populations in adjacent areas. This would explain the absence of *M. rima* and related species from the present February 2005 survey results. Similarly, while the two *Polycarpa* species, *P. fungiformis* and *P. pedunculata*, were present in the 1970/1971 survey, they were also in low numbers. These species both require suitable hard substrate to attach to, and therefore there is an element of chance that such substrates might be missed in any random grab-sampling. Kott (1972) also believed that there is annual mortality of larger breeding individuals, of these species and that *P. pedunculata* does not occur in sufficient densities for a self sustaining breeding population, and would rely on external recruitment.

Another conspicuous difference between the studies was the relatively large number of larger crustaceans recorded by Stephenson *et al.* (1974) — 50 species of Stomatopoda and Decapoda, including 37 species of crabs. The present study found 31 species, of which 20 were crabs. This could be reasonably explained by a slow incremental increase of 'rare' species, given there were seven additional sampling events over all seasons in the earlier study..

CHANGES TO SITE-GROUPS AND CHARACTERISING SPECIES

Stephenson *et al.* (1974) defined four major site-groups based on their species x sites classification, *viz.* I (sites 11, 15); II (sites 6, 7, 8, 9, 10, 13); III (sites 4, 12, 14); and IV (sites 1, 2, 3, 5). The major difference with the present results is the similarity of sites 11 and 15 as separate from the other two 'southern shallows' sites 12 and 14 — in the present study these four sites were all linked into our single site-group VI. In the earlier study sites 4, 12 and 14 also were the most similar in terms of sediment composition, and somewhat muddier than sites 11 and 15, whereas in the present study the sediment composition was more similar between the southern sites, and in particular quite similar between adjacent sites 11 and 12, while site 4 (our site-group III) was one of the muddiest sites, and most similar to sites 2, 3, and 5 (our site-group II). Otherwise, we further separated sites 10 and 13 into a separate site-group V, and recognised site 1 as being faunistically distinctive from the adjacent sites 2, 3, and 5 (our site-group II).

As can be seen from Table 11, there is almost no correspondence between the species that defined the site communities in 1970 and those present in 2005, either in terms of conformity to a site group, or in relative abundances. One major change appears to have been the development of beds of the hairy mussel, *Trichomya hirsuta*, at different densities within the western part of the study area along the 'Northwest gutter' (6–10, 13), and the 'Southern shallows' (11, 12, 14, 15). While this species was recorded in the earlier study, it must have been present in only very small numbers, whereas in 2005 it was the dominant animal at a number of sites, both in abundance and biomass.

BROADER DETERMINANTS OF COMMUNITY STRUCTURE

Stevens & Connolly (2005) undertook a broad study of benthic habitat mapping within the

Bay using video techniques. They included the current sites in their 'Habitat Group D', which included 10 sites, and also extended inshore to the north-west of Peel Island towards the Brisbane River. This area was loosely characterised as their 'inshore algae and sponge' habitat-group, and was the most taxon-rich (42 species) of all the habitat-groups they recognised. Although visually dominated by algae and sponges, they noted significant contributions from solitary ascidians, anemones, and seagrass. Despite the present sites being in the central part of this generalised 'community' it is interesting to note that sponges and ascidians were an insignificant component of the present grab-sampling. The Stevens & Connolly (2005) study was however based on a different scale and was based on identification and counts of macroscopic epibenthic fauna.

There is now an increasing understanding of broad scale community patterns within Moreton Bay (see for example, Davie & Hooper 1998; Skilleter 1998; Stevens & Connolly 2005). The major pattern to emerge shows high species numbers occurring around the mouth of the Brisbane River and along the western shores of the Bay, gradually diminishing to the north and east. There is also a marine dominated zone comprising two distinct centres of high diversity – one around the northern end of Stradbroke Island (including Myora), Peel, Bird and Goat Islands, where there is a shift to consolidated bottoms and reefal species; and a second area around Middle Banks and Tangalooma. The clean labile sands of the northern and eastern openings are extremely species poor. In general species richness is highest in areas of relative stability and with favourable hydrographic-sedimentary conditions, and this is emphasised by Poiner's (1979) two year study of sand and seagrass communities of the Sholl Bank, north-eastern Moreton Bay. He found that the biota of the sand communities was relatively depauperate, in a continual state of flux, and showed no evidence of a stable climax community. In contrast, seagrass communities were species-rich and relatively stable.

Inshore communities however, especially in the southern half of the bay, are significantly influenced by the four major rivers and numerous creeks that feed into the Bay – presumably providing an overlay of nutrient rich sediments and a variety of sediment particle sizes which would support a variety of feeding types. Annual or unpredictable flood events also add an element of instability to the fauna of this region, and this combined with regular 'fertilisation' presumably stimulates recruitment and encourages high diversities. Stephens (1992) calculated that the Brisbane River supplies mud to Moreton Bay at a minimum rate of 175,000 tonnes/yr. Flood events also lead to increased productivity in estuarine and inshore oceanic waters as a result of the influx of vitamins and nutrients (Copeland 1966).

Sediment characteristics have long been recognised as presenting a complex of limiting values influencing the distribution of benthic fauna (e.g. Rhoads 1974; Kay & Knights 1975; Coleman & Cuff 1980; Lopez & Levinton 1987). Coarser sediments with a greater range of grain sizes should create a large number of potential niches (Gray 1974), and indeed this is the case for the present study where the highest diversities occurred in the site-groups with relatively complex sediment structure and greater sandy to coarse particle sizes. Nevertheless by far the greatest abundances, in contrast, occurred in the fine silt to muddy sites where large numbers of deposit feeders dominated.

Intermediate levels of disturbance from both abiotic fluctuations and predation have also been suggested as causes of increased diversity (Paine 1966; Menge & Sutherland 1976; Caswell 1978; Connell 1978; Stephenson & Sadacharan 1983) and as stabilising factors (Murdoch & Oaten 1975), by preventing monopolisation by competitively dominant species. This occurs through the continual opening of new patches which are then available to opportunistic invaders. This hypothesis also agrees with the present results. Site-Group VI (the 'Southern Shallows' of Stephenson *et al.* 1974), contains the highest species richness of all the site-groups. It is also relatively shallow compared to other sites, and thus more open to disturbance from storms and strong wave action. In fact seasonal shifts in sediment composition at these sites have already been noted by Stephenson *et al.* (1974) between March 1970 and December 1971. At that time that there was less fine sand and more mud at Stn 12; more very coarse and medium sand and less mud at Stns 13 and 14; and less coarse, medium and fine sand and more very fine sand and mud at Stn 15 (11–15). It seems reasonable to expect that such low level lability continues to operate in this area.

SEASONAL PATTERNS

As our study was undertaken over a single summer sampling period, we have no contemporary data on seasonality. Stephenson *et al.* (1974) conducted their study at eight sampling times over two years in an attempt to assess seasonal changes. Somewhat unexpectedly, they found interannual variability to be more important than seasonal variation, and their quarterly sampling program was inadequate with respect to understanding temporal changes. They suggested a ten-year sampling regimen would probably be necessary for patterns to emerge. Of great importance was the finding that different species-groups could separately characterise different seasons, and different years, as well as different sites. One set of species was replaced by another set (or sets) of species as time proceeded, and the species-year variance was almost double that of species-seasons, indicating that annual changes in species composition are more important than seasonal ones. Thus it is no real surprise that the present study also found species assemblages somewhat different from the 1974 study. It appears that it is the diversity and abundance of species present that indicates a healthy and productive system, rather than close conformity with previously defined communities that inevitably exhibit considerable spatial and temporal variability.

High rainfall with concurrent reduced salinity has been proposed as a major cause of faunal seasonality in a number of local studies including Park (1979) working on macrobenthos at the mouth of the Brisbane River, Vohra (1965) and Stejskal (1984) working on intertidal fauna at Victoria Point and Cribb Island respectively, and Young & Wadley (1979) studying epibenthic fauna in Moreton Bay. The Brisbane River has an average annual streamflow of about 1.35 million megalitres (Cossins 1990), with very low flow periods interspersed with short mild to extreme flood events (Odd & Baxter 1981). This is similarly true for the Logan-Albert River system that has a smaller catchment, but nevertheless has the most direct influence on our study area to the south of Peel Island.

Later studies by Stephenson (1980a, b, c) have indicated major recruitment to the Bay's benthic communities occurs in August/September with major depletion of benthic stocks in December, probably due at least in some areas, to increases in mobile predators and benthic-disturbers (fish and prawns) (Stephenson *et al.* 1978, 1982). Presumably species diversity would also show such seasonal fluctuations. The occurrence and abundance of rarer species would certainly be related to periods of high and low flux levels. Predictability of benthic species occurrence is a complex issue. Stephenson (1980c) found that while some species showed annual cycles, more species showed significant long-term cycles of between 2–7 years, with evidence of successional replacement of species groups. The scale of this type of species replacement is unknown — it is probably a relatively local phenomenon, but it is also possible that it could be of a more general nature relying on recruitment events from outside the Bay.

TROPHIC PATTERNS

The availability of food resources is influenced by the strength and patterns of bottom water movement and the settling rates of particulates. These may also be affected by the feeding habits and life-styles (active/sedentary, tubicolous/non-tubicolous, surface/subsurface etc.) of the individual species. The interaction of these factors helps determine the optimum environment, and thus the potential dominance patterns for each species (Word 1980). Our results have largely agreed with other studies in recording the numerical dominance of deposit feeders in muddy environments, and suspension feeding guilds in sandier substrates. We have also noted, perhaps a little more unusually, a rich and diverse predator/scavenger community in some site-groups. This may be a predator response to the numerical abundance of more sedentary suspension/deposit feeders, or perhaps a factor of the compexity of the bottom type providing a greater range of niches (e.g., presence of seagrasses and/or the establishment of epibenthic communities based around the mussel, *Trichomya*). This aspect is worthy of more specific study and analysis.

One major element that our study did not address was the biomass of the faunal components. Biomass is a critical determinant of nutrient-cycling variables, yet reliable estimates of benthic faunal biomass are completely lacking for Moreton Bay. Wilson *et al.* (1993) estimated that, in Port Phillip Bay, suspension feeders (mostly bivalve molluscs) comprise half of the benthic macroinvertebrate biomass, and process a volume of water equivalent to the entire Bay in 16–17 days. Suspension feeders are estimated to be responsible for 15% of all organic matter ingested by benthic macroinvertebrates (including a significant fraction of planktonic primary production), but may account for over 40% of total assimilation of organic material. Deposit feeders (mostly crustaceans, echinoids and polychaete worms) make up about 35% of total macrobenthic biomass, and in a single year, are estimated to process a volume of sediment equivalent to the top 13 mm of Port Phillip Bay sediments. Estimates of nitrogen excretion from Port Phillip Bay benthic macroinvertebrates indicate that net annual secondary production by both benthic deposit- and suspension-feeding macroinvertebrates is about 62,700 tonnes C, equivalent to a Production/Biomass ratio of 2.81. The productivity of benthic organisms has so far been virtually ignored in Moreton Bay, and yet, given the unique geography and rich subtropical sediments, their contribution to net productivity may well exceed even the impressive figures estimated for Port Phillip Bay. Direct measurements of secondary production by benthic invertebrates are needed to firmly establish the important role of these organisms in the ecology of Moreton Bay.

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APPENDIX 1
Compete list of species.

Phylum Porifera
Class Calcarea
sponge 1
Phylum Cnidaria
Class Anthozoa
Order Actinaria
Cerianthidae
Cerianthus sp.
Family not determined
unident anemone 1
unident anemone 2
unident anemone 3
unident anemone 4
Phylum Nematoda
nematode
Phylum Nemertea
nemertean orange band
nemertean pink
nemertean white
Phylum Phoronida
Phoronis australis Haswell, 1883
Phylum Sipuncula
Class Phascolosomatidea
Order Phascolosomatiformes
Phascolosomatidae
sipunculid 1
sipunculid 2
Class Sipunculidea
Order Aspidosiphoniformes
Aspidosiphonidae
Aspidosiphon sp,
Order Golfingiiformes
Golfingiidae
Golfingia trichocephala Sluiter, 1902
Phascolionidae
Phascolion sp,
Themistidae
Themiste sp.
Phylum Annelida
Class Polychaeta
Order Canalipalpata
Ampharetidae
ampharetid 2
ampharetid 3
Isolda pulchella Muller, 1858
Isolda sp. 1
Chaetopteridae
chaetopterid 1
Cirratulidae
cirratulid 1 (*Tharax* sp)
cirratulid 2,
cirratulid 3,
cirratulid 4,
Flabelligeridae
Coppingeria longisetosa Haswell, 1892
Diplocirrus sp
Pherusa sp. 1
Pherusa sp. 2
Pironis sp
Magelonidae
Magelona "cincta" Ehlers, 1908
Magelona "papillicornis" Muller, 1858
Magelona dakini Jones, 1978
Oweniidae
Owenia fusiformis Delle Chiaje, 1844
Pectinariidae
Pectinaria sp.
Poecilochaetidae
Poecilochaetus sp.
Sabellariidae
Idanthyrsus sp.
Sabellidae
sabellid 1
sabellid 2

sabellid 3
sabellid 4
sabellid 5
Serpulidae
serpulid 1
serpulid 2
serpulid 3
Spionidae
Prionospio sp. 1
Prionospio sp. 2
Prionospio sp. 3
Pseudopolydora sp
Scolecolepides sp
spionid 1
spionid 2
spionid 3
spionid 4
spionid 5
spionid 6
spionid 7
spionid 8
Sternaspidae
Sternaspis scutata (Renier, 1807)
Terebellidae
Amaeana trilobata (Sars, 1863)
Lanice conchilega (Pallas, 1766)
Loimia medusa (Savigny, 1818)
Lysilla pacifica Hessle, 1917
Pista pectinata Hutchings, 1977
Pista sp. 1
Pista trunca Hutchings, 1977
Pista typha Grube, 1878
Rhinothelepus lobatus Hutchings, 1974
Streblosoma gracile Caullery, 1944
Streblosoma sp
Terebella sp
terebellid 1
terebellid 2
terebellid 3
terebellid 4
terebellid 5
terebellid 6
Terebellides narribri Hutchings & Peart, 2000
Terebellides woolawa Hutchings & Peart, 2000
Thelepus sp

Order Palpata

Amphinomidae
Eurythoe sp.
Chloeia flava Pallas, 1766
Chaetopteridae
Mesochaetopterus minutus Potts, 1914
Chrysopetalidae
Bhawania sp.
Chrysopetalidae
Palmyra sp.
Dorvilleidae
Schistomeringos filiforma Hutchings & Murray, 1984
Eunicidae
Eunice vittata (Delle Chiaje, 1828)
Nematonereis unicornis (Grube, 1840)
Eunice australis Quatrefages, 1865
Lysidice sp
Marphysa sp
Eunice sp. 2
Eunice sp. 3
Eunice sp. 4
Glyceridae
Glycera sp. 1
Glycera sp. 2
Goniadidae
Goniada sp.
Hesionidae
hesionid 1
hesionid 2
Lacydoniidae
Paralacydonia paradoxa Fauvel, 1913
Lumbrineridae
lumbrinerid 1
lumbrinerid 2
lumbrinerid 3
lumbrinerid 4
lumbrinerid 6
lumbrinerid 7
lumbrinerid 8
lumbrinerid 9
lumbrinerid 10
Nephtyidae
Nephtys australiensis Fauchald, 1965
Micronephthys spaerochaeta (Wesenberg-Lund, 1949)
Nereididae
nereid 1
nereid 2
nereid 3

nereid 4
nereid 5
nereid 6
nereid 7
nereid 8
nereid 9
Oenonidae
Arabella sp.
Onuphidae
Diopatra sp.
Onuphis sp. 2.
Phyllodocidae
phyllodocid 1
phyllodocid 2
phyllodocid 3
phyllodocid 4
phyllodocid 5
phyllodocid 6
phyllodocid 7
phyllodocid 8
phyllodocid 9
phyllodocid 10
phyllodocid 12
phyllodocid 13
phyllodocid 14
Polynoidae
polynoid 1
polynoid 2
polynoid 3
polynoid 4
polynoid 5
polynoid 6
polynoid 7
polynoid 8
Sigalionidae
sigalionid 1
sigalionid 2
sigalionid 3
sigalionid 4
sigalionid 5
Syllidae
syllid 1 (*Opisthosyllis* sp.)
syllid 2
syllid 3
syllid 4 (*Odontosyllis* sp.)
syllid 5 (*Syllis* sp.)
syllid 6
syllid 7 (*Pharyngeovalvata* sp.)
syllid 8
syllid 9
syllid 10
syllid 11
syllid 12
syllid 13
syllid 14

Order Scolecida

Capitellidae
capitellid 1
capitellid 2
capitellid 3
capitellid 4
capitellid 5
capitellid 6
Cossuridae
Cossura sp.
Maldanidae
Maldane sp.
maldanid 1
maldanid 2
maldanid 3
maldanid 5
maldanid 6
maldanid 7
maldanid 8
maldanid 9
maldanid 10
maldanid 11
Opheliidae
Armandia sp. 1
Armandia sp. 2
Ophelia sp
Polyophthalmus pictus (Dujardin, 1839)
Orbiniidae
Haploscoloplos sp
orbinid 1
orbinid 2
Phylo sp
Paraonidae
paraonid 1
paraonid 2
paraonid 3
Scalibregmatidae
Hyboscolex sp
Scalibregma inflatum Rathke, 1843

Polychaete Family not determined
unident sp. 1
unident sp. 2
Phylum Echinodermata
Class Echinoidea
Loveniidae
Echinocardium cordatum (Pennant, 1777)
Class Holothuroidea
Cucumariidae
Cucumariidae sp.
Holothuridae
Holothuria sp. 1
Holothuridae sp.
Synaptidae
Protankyra sp.
Class Ophiuroidea
Amphiuridae
Amphiuridae sp. 1
Amphiuridae sp. 2
Ophiocomidae
Ophiocomella sexradia (Duncan, 1887)
Ophiothrix sp. 1
Ophiotrichidae
Macrophiothrix sp. 1
Macrophiothrix sp. 2
Ophiotrichidae sp. 2
Ophiotrichidae sp. 3
Ophiuridae
Ophiura kinbergi Ljungman, 1866
Ophiuridae sp. 1
Ophiuridae sp. 2
Ophiuridae sp. 3
Phylum Mollusca
Class Bivalvia
Order Heterodonta
Cardiidae
Acrosterigma ? flava (Linnaeus, 1758)
Acrosterigma ? impolita
Fulvia sp.
Carditidae
Cardita preissii Menke, 1843
Chamidae
Chama asperella Lamarck, 1819
Chama fibula Reeve, 1846
Chama limbula Lamarck, 1819
Chama pulchella Reeve, 1846
Chama ruderalis Lamarck, 1819
Corbulidae
Corbula ? crassa Reeve, 1843
Corbula ? monilis Hinds, 1843
Corbula moretonensis Lamprell & Healy, 1996
Corbula sp.
Corbula stephensoni Lamprell & Healy, 1996
Crassatellidae
Salaputium ? torresi (Smith, 1885)
Galeommatidae
Ambuscintilla sp.
Borniola ? lepida (Hedley, 1906)
Borniola ? radiata (Hedley, 1905)
Kellia ? rotunda (Deshayes, 1855)
Kellia sp.
Montacuta sp.
Scintilla sp. 1
Scintilla sp. 2
Scintilla sp. 3
Hiatellidae
Hiatella australis (Lamarck, 1819)
Laternulidae
Laternula attenuata Reeve, 1860
Lucinidae
Linga sperabilis (Hedley, 1909)
Mactridae
Meropesta nicobarica (Gmelin, 1791)
Mesodesmatidae
Paphies sp.
Pharidae
Ensiculus cultellus (Linnaeus, 1758)
Siliqua sp.
Psammobiidae
Gari livida (Lamarck, 1818)
Gari weinkauffi (Crosse, 1864)
Solenidae
Solen sp.
Solen vaginoides (Lamarck, 1818)
Tellinidae
Exotica donaciformis (Deshayes, 1854)
Tellina ? brazieri Sowerby, 1869
Tellina ? pinguis Hanley, 1844
Tellina ? tenuilirata Sowerby, 1867
Tellina gemonia (Iredale, 1936)
Tellina languida Smith, 1885
Tellina lilium Hanley, 1844
Tellina sp. 1
Tellina sp. 2

Tellina sp. 3
Tellina sp. 4
Tellina sp. 5
Tellina sp. 6
Tellina sp. 7 (orange rays)
Tellina sp. 8 (pink elongate)
Ungulinidae
Felaniella sp.
Veneridae
Antigona chemnitzi (Hanley, 1844)
Callista ? roseotincta (Smith, 1885)
Callista sp.
Circe ? mistura (Iredale, 1936)
Circe ? plana Ohdner, 1917
Circe scripta (Linnaeus, 1758)
Clementia papyracea (Gray, 1825)
Dosinia sculpta (Hanley, 1845)
Dosinia sp.
Marcia hiantina (Lamarck, 1818)
Paphia ? crassisulca (Lamarck, 1818)
Paphia ? exarata (Phillipi, 1846)
Paphia gallus (Gmelin, 1791)
Paphia sp.
Paphia undulata (Born, 1780)
Pitar sp.
Placamen sidneyense (Menke, 1858)
Placamen tiara (Dillwyn, 1817)
Tapes ? dorsatus (Lamarck, 1818)
Tapes sp.
Venerupis anomala (Lamarck, 1818)
Order Protobranchia
Nuculanidae
Nuculana sp.
Yoldia ? lata (Hinds, 1843)
Nuculidae
Leionucula obliqua (Lamarck, 1819)
Leionucula sp.
Solemyidae
Solemya sp.
Order Pteriomorphia
Anomiidae
Patra australis (Gray, 1847)
Arcidae
Anadara trapezia (Deshayes, 1840)
Arca navicularis Brugui re, 1789
Barbatia foliata (Forssk l, 1775)
Trisidos tortuosa (Linnaeus, 1758)
Glycymerididae
Glycymeris radians (Lamarck, 1819)
Glycymeris striatularis (Lamarck, 1819)
Malleidae
Malleus albus Lamarck, 1819
Vulsella vulsella (Linnaeus, 1758)
Mytilidae
Modiolus ? ostentatus Iredale, 1939
Modiolus ? peronianus Laseron, 1956
Modiolus elongatus Swainson, 1821
Modiolus philippinarum Hanley, 1843
Modiolus sp.
Musculus alganus Laseron, 1956
Musculus chinensis Bernard, Cai & Morton, 1993
Musculus cuningianus Reeve, 1857, Mytilidae
Musculus nanus (Dunker, 1856)
Musculus sp.
Trichomya hirsuta (Lamarck, 1819)
Ostreidae
Dendrostrea sp.
Ostrea sp.
Saccostrea glomerata (Gould, 1850)
Pectinidae
Annachlamys sp.
Mimachlamys gloriosa (Reeve, 1853)
Mimachlamys sp.
Scaeochlamys livida (Lamarck, 1819)
Pinnidae
Pinna ? bicolor Gmelin, 1791
Pinna muricata Linnaeus, 1758
Plicatulidae
Plicatula australis Lamarck, 1819
Pteriidae
Pinctada albina (Lamarck, 1819)
Pinctada maculata (Gould, 1850)
Class Gastropoda
Order Caenogastropoda
Buccinidae
Cantharus sp.
Columbellidae
Anachis atkinsoni Tenison Woods, 1875
Anarchis ? troglodytes (Souverbie, 1866)
Anarchis marquesa (Gaskoin, 1852)
Anarchis miser (Sowerby, 1844)
Anarchis smithi (Angas, 1877)
Anarchis sp.
Mitrella ? dictua (Tenison Woods, 1878)

Mitrella sp.
Pyrene ? *testudinaria* (Link, 1807)
Zafra darwini Angas, 1877
Epitoniidae
Epitonium sp.1
Epitonium sp.2
Epitonium sp.3
Epitonium sp.4
Epitonium tacitum (Iredale, 1936)
Eulimidae
Eulima sp.
Hypermastus cf *mucronata* (Sowerby, 1866)
Mucronalia sp.
Pictobalcis sp.
Fasciolariidae
Latirus sp.
Muricidae
Latiaxena ficula (Reeve, 1848)
Nassariidae
Nassarius heavy sculpture
Nassarius pauperus (Gould, 1850)
Nassarius sp.
Naticidae
Natica ? *alapapilionis* (Röding, 1798)
Natica ? *vitellus* (Linnaeus, 1758)
Natica sp.
Natica subcostata (Tenison Woods, 1878)
Polinices ? *powisiana* (Récluz, 1844)
Polinices conicus (Lamarck, 1822)
Rissoidae
Estea sp.
Rissoinidae
Fictonoba sp.
Terebridae
Terenolla pygmaea (Hinds, 1844)
Triphoridae
Cautor similis (Pease, 1871)
Turridae
White turrid
Vitrinellidae
Pseudoliotia cf *speciosa* (Angas, 1877)
Sigaretornus planus (A. Adams, 1850)
Order Cephalaspidea
Philinidae
Philine sp.
Order Heterobranchia
Acteonidae
Pupa sp.
Amathinidae
Amathina tricarinata (Linnaeus, 1767)
Pyramidellidae
Pyramidellid sp. 1 ('*Elodiamea*' sp.)
Pyramidellid sp. 2 ('*Linopyrga*' sp.)
Pyramidellid sp. 3 ('*Miralda*' sp.)
Pyramidellid sp. 4 ('*Syrnola*' sp.)
Pyramidellid sp. 5 ('*Turbonilla*' sp.)
Pyramidellid sp. 6
Pyramidellid sp. 7 (spiral ribs, tall)
Retusidae
Retusa sp. 1
Retusa sp. 2 (tall spire)
Rhizorus sp.
Tornatina sp.
Ringiculidae
Ringicula sp.
Rissoellidae
Rissoella sp.
Scaphandridae
Atys sp.
Cylichna sp. 1
Cylichna sp. 2
Cylichna sp. 3
Order Neritimorpha
Neritinidae
Theodoxus ? *oualaniensis* (Lesson, 1831)
Order Vetigastropoda
Fissurellidae
? *Puncturella* sp.
Diodora jukesii (Reeve, 1850)
Scutus unguis (Linnaeus, 1758)
Phasianellidae
Tricolia ? *fordiana* (Pilsbry, 1888)
Trochidae
Calthalotia indistincta (Wood, 1828)
Herpetopoma atrata (Gmelin, 1791)
Order Polyplacophora
Chitons (unidentified)
Order Scaphopoda
Order Dentaliida
Dentaliidae
Dentalium ? *cheverti* Sharp & Pilsbry, 1897
Dentalium ? *octangulatum* Donovan, 1803
Dentalium goftoni Lamprell & Healy, 1998
Dentalium robustum Brazier, 1877

Laevidentaliidae
Laevidentalium ? longitrorsum (Reeve, 1842)
Order Gadilida
Pulsellidae
Compressidens platyceras (Sharp & Pilsbry, 1897)
Pulsellum eboracense (Watson, 1879)
Phylum Arthropoda
Class Pycnogonida
Order Pantopoda
Ammotheidae
Achelia assimilis (Haswell, 1885)
Ascorhynchus longicollis
Nymphonidae
Nymphon boogoora
Nymphon molleri
Phoxichilidiidae
Anoplodactylus cribellatus
Anoplodactylus tubiferus
Subphylum Crustacea
Class Ostracoda
Chelicopia pertinex Kornicker, 1994
Cycloleberis sp. 1
Eusarsiella fallomagna Kornicker, 1994
Eusarsiella sp. 1
Eusarsiella sp. 2
Eusarsiella sp. 3
Ostracod sp. 1
Ostracod sp. 2
Ostracod sp. 3
Ostracod sp. 4
Ostracod sp. 5
Ostracod sp. 6
Ostracod sp. 7
Ostracod sp. 8
Pleoschisma mindax Kornicker, 1994
Class Malacostraca
Order Leptostraca
Nebaliidae
Nebalia sp.
Paranebaliidae
Paranebalia levinebalia Walker-Smith, 2001
Paranebalia sp.
Order Amphipoda
Ampeliscidae
Ampelisca sp.
Byblis sp. 1
Byblis sp. 3
Aoridae
aorid Unident sp.
Caprellidae
caprellid 1
caprellid 2
caprellid 3
caprellid 5
Corophiidae
Cheiriphotis sp. 1
Cheiriphotis sp. 2
Cheiriphotis sp. 3
Cheiriphotis sp. 4
corophid 1
Paraoroides sp. 1
Paraoroides sp. 3
Paraoroides sp. 4
Siphonocetes sp.
Isaeidae
Ampelisciphotis sp. 1
Ampelisciphotis sp. 2
Gammaropsis sp.
Leucothoidae
Leucothoe assimilis Barnard, 1974
Liljeborgiidae
liljeborgid 1
liljeborgid 2
Lysianassidae
lysianassid 1
Oedicerotidae
oedicerotid 1
oedicerotid 2
oedicerotid 3
Phliantidae
Phliantis sp.
Phoxocephalidae
Birubius cf *wirakus* Barnard & Drummond, 1978
Birubius sp. 1
Birubius sp. 2
Birubius sp. 3
Birubius sp. 4
Platyischnopidae
Platyischnopus mirabilis Stebbing, 1888
Amphipod family not determined
amphipod 01
amphipod 02
amphipod 03
amphipod 04

amphipod 05
amphipod 06
amphipod 08
amphipod 09
amphipod 10
amphipod 11
amphipod 12
amphipod 13
amphipod 14
amphipod 15

Order Cumacea

Bodotriidae
Bodotriid sp.
Cyclaspis ornosculpta Tafe & Greenwood, 1996
Cyclaspis sp. 1
Cyclaspis sp. 3
Cyclapsis sp. 4

Diastylidae
Diastylid sp.
Gynodiastylis sp. 1
Gynodiastylis sp. 2

Lampropidae
Lampropidae sp.

Leuconidae
Leptostylis sp. 1

Nannastacidae
Nannastacidae sp.

Order Isopoda

Aegidae
Aegidae sp. 1

Antarcturidae
Antarcturidae sp. 1*

Anthuridae
Amakusanthura sp. 1
Amakusanthura sp. 2

Arcturidae
Neastacilla sp. 1
Neastacilla sp. 2
Neastacilla sp. 3
Neastacilla sp. 4
Neastacilla sp. 5

Austrarcturellidae
Austrarcturella sp. 1

Bopyridae
Anuropodione australiensis Bourdon, 1976 (in *Pisidia dispar*)

Cirolanidae
cirolanid 1

Cirolanidae sp. 1
Natatolana sp. 1

Gnathidae
Gnathia sp.
gnathid sp
Gnathidae sp. 1

Leptanthuridae
Ulakanthura namoo Poore, 1978

Paranthuridae
Paranthura sp. 1

Pseudidotheidae
Pseudidothea sp. 1

Serolidae
Serolina holia Poore, 1987
Serolina sp

Sphaeromatidae
Sphaeromatid sp. 1
Sphaeromatid sp. 2
Sphaeromatid sp. 3
Sphaeromatid sp. 4
Sphaeromatid sp. 5
Sphaeromatid sp. 6
Sphaeromatid sp. 7
Sphaeromatid sp. 8
Sphaeromatid sp. 9

Order Tanaidacea

Anarthruridae
Tanaopsis canaipa Bamber, 2008

Apseudidae
Bunakenia anomala Guþu, 2006

Kalliapseudidae
Transkalliapseudes banana Bamber, 2008

Leptocheliidae
Konarus cheiris Bamber, 2006
Leptochelia opteros Bamber, 2008
Pseudoleptochelia fairgo Bamber, 2005

Parapseudidae
Pakistanapseudes australianus Guþu, 2006

Paratanaidae
Bathytanais culteriformis Larsen & Heard, 2001

Typhlotanaidae
Antiplotanais coochimudlo Bamber, 2008

Whiteleggiidae
Whiteleggia stephensoni Boesch, 1973

Order Mysidacea

Mysidae

Gastrosaccus queenslandensis Bacescu & Udrescu, 1982
Mysid sp. 1
Mysid sp. 2
Mysid sp. 4
Mysid sp. 5
Mysid sp. 6
Mysid sp. 7
Mysid sp. 8
Mysid sp. 9
Mysid sp. 10

Order Decapoda

Alpheidae
Alpheus edwardsii (Audouin, 1826)
Alpheus sp. 2
Alpheus sp. 3
Alpheus sp. 4

Callianassidae
Callianassa australiensis Dana, 1852
Callianassa sp

Crangonidae
Pontophilus angustirostris De Man, 1918

Dorippidae
Paradorippe australiensis (Miers, 1884)

Hippolytidae
Lysmata sp

Leucosiidae
Leucosia sp. 1
Nursia sinuata Miers, 1877
Nursia nr *sinuata* sp. 2
Nursia nr *sinuata* sp. 3
Philyra sp. 1

Majidae
Achaeus sp. 1
Achaeus sp. 2
Hyastenus sp. 1

Pilumnidae
Cryptolutea sp. 1
Heteropilumnus fimbriatus (H. Milne Edwards, 1834)
Heteropilumnus sp. 2
Pilumnus sp. 2
Rhizopinae sp. 1

Pinnotheridae
Pinnotheres sp. 1:

Porcellanidae
Pisidia dispar
Polyonyx sp. 1

Portunidae
Thalamita sp. 1
Thalamita sp. 2

Processidae
Processa dimorpha Hayashi, 1975
Processa sulcata Hayashi, 1975

Xanthidae
Actaea sp. 1
Xanthid sp. 1
Xanthid sp. 2

Phylum Hemichordata

Class Enteropneusta

Ptychoderidae
Glossobalanus hedleyi (Hill, 1897)

Chordata

Cephalochordata

Leptocardii

Branchiostomidae
Branchiostoma moretonensis Kelly, 1966

ERRATUM

Tables ommitted in error from Hooper, J.N.A., Sutcliffe, P. & Schlacher-Hoenlinger, M.A. 2008. New species of Raspailiidae (Porifera: Demospongiae: Poecilosclerida) from southeast *Queensland. Memoirs of the Queensland Museum – Nature* 54(1): 1-22.

Table 1. Comparisons in the range (and mean) spicule measurements between *Raspailia* (*Raspailia*) *scorpa* sp. nov. and the allied *R.* (*R.*) *phakellopsis* Hooper, 1991.

Material	Ectosomal styles	Choanosomal styles	Subectosomal styles	Echinating acanthostyles
R. (*R.*) *scorpa* sp. nov. (holotype QM-G315208)	210–350 x 1–2 µm (315.8 x 1.9 µm)	290–460 x 10–11 µm (378.0 x 11.0 µm)	1000–1600 x 5–13 µm (1288.6 x 9.0 µm)	80–140 x 4–5 µm (125.8 x 4.9 µm)
R. (*R.*) *phakellopsis* (holotype NTM-Z1950)	173–302 x 0.5–3 µm (231.0 x 1.5 µm)	311–465 x 9–8 µm (392.7 x 13.2 µm)	820–1835 x 8–17 µm (1349.6 x 12..4 µm)	125–156 x 5–9 µm (133.2 x 7.1 µm)

Table 2. Range (and mean) of spicule measurements in *Raspailia* (*Raspailia*) *kennedyi* sp. nov.

Material	Choanosomal styles	Subectosomal styles	Ectosomal styles (anisoxeas)	Echinating acanthostyles
Holotype QMG317177	350–830 x 9–12 µm (497 x 8.53 µm)	900–1200 x 7–9 µm (1077 x 8.2 µm)	140–290 x 1–2 µm (203.50 x 1.66 µm)	50–70 x 4–6 µm (61.43 x 4.9 µm)

Table 3. Range (and mean) spicule measurements in specimens of *Aulospongus similiaustralis* sp. nov. and comparison with related species of *Aulospongus*.

Material	Choanosomal styles	Subectosomal tylostyles	Echinating acanthostyles
Holotype: QMG300079	230–380 x 9–20 µm (300.3 x 10.8 µm)	690–1120 x 4–10 µm (925.6 x 9.7 µm)	70–255 x 2–8 µm (97.9 x 4.4 µm)
Paratypes:			
QMG315526	150–350 x 8–20 µm (248.3 x 11.8 µm)	780–1260 x 10 µm (974.6 x 10 µm)	60–120 x 5–7 µm (87.3 x 5.1 µm)
QMG317317	210–435 x 10–20 µm (342.1 x 16.1 µm)	800–1200 x 6–11 µm (955.7 x 9.4 µm)	82–150 x 5–10 µm (101.2 x 6.8 µm)
QMG320055	180–370 x 6–20 µm (292.2 x 14.1 µm)	720–1110 x 6–10 µm (932.2 x 8.7 µm)	65–130 x 3–6 µm (85.4 x 4.6 µm)
Other specimens:			
QMG304007	150–340 x 12–20 µm	950–1300 x 8–15 µm	85–125 x 4–5 µm
QMG304879	240–370 x 10–20 µm	850–1050 x 10–15 µm	80–130 x 6–12 µm
QMG303963	190–345 x 15–20 µm	800–1100 x 5–10 µm	80–120 x 5–8 µm
QMG317276	310–430 x 18–20 µm	900–1250 x 5–10 µm	80–125 x 7–11 µm
QMG306292	270–440 x 8–25 µm	790–1200 x 4–11 µm	80–165 x 5–10 µm
QMG315777	280–400 x 4–10 µm	900–1410 x 6–15 µm	90–130 x 6–8 µm
QMG315732	270–370 x 9–18 µm	700–1400 x 5–15 µm	80–130 x 5–7 µm
QMG315610	175–390 x 7–20 µm	800–1350 x 4–16 µm	80–130 x 3–5 µm
A. tubulatus (Bowerbank, 1873) (data from Hooper *et al.* 1999)	304–462 x 16–24 µm	Absent (ectosomal styles: 212–250 x 2–3 µm)	109–126 x 5–10 µm

Table 4. Range (and mean) spicule measurements for specimens of *Echinodictyum luteum* sp. nov.

Material	Primary choanosomal oxeas	Secondary choanosomal oxeas	Echinating acanthostyles
QMG304769 holotype	205–440 x 5–11 µm (269.8 x 7.37 µm)	139-320 x 2-6 µm (204.80 x 3.76 µm)	90–135 x 4–7 µm (117.60 x 4.84 µm)
QMG317152 paratype	150–580 x 5–13 µm (247.5 x 8.75 µm)	110–425 x 1–7 µm (223.80 x 3.96 µm)	105–130 x 3–8 µm (115.60 x 5.96 µm)
QMG306395 paratype	200–500 x 4–11 µm (287.0 x 6.12 µm)	170–400 x 1–2 µm (220.27 x 1.33 µm)	120–180 x 4–8 µm (141.48 x 5.60 µm)

Table 5. Updated checklist of Raspailiidae recorded from Australian territorial waters (**1**, Dampierian Province, Geraldton (Western Australia) to Cape York (Queensland). **2**, Solanderian Province, Cape York (Queensland) to Coffs Harbour (New South Wales). **3**, Peronian Province, Coffs Harbour (New South Wales) to shallow coastal regions of northern Victoria and deeper waters off northeastern Tasmania. **4**, Maugean Province, Bass Strait and shallow waters of Tasmania. **5**, Flindersian Province, western Victoria to Geraldton (Western Australia). **6**, Australian Antarctic and subantarctic Territories. Provinces after Bennett & Pope (1957). Data modified and updated from Hooper (1991).

Species	1	2	3	4	5	6	Other locality
Raspailia (*Raspailia*) *atropurpurea* (Carter, 1885)			x	x			
Raspailia (*Raspailia*) *echinata* Whitelegge, 1907			x				
Raspailia (*Raspailia*) *kennedyi* sp. nov.		x					
Raspailia (*Raspailia*) *gracilis* (Lendenfeld, 1888)			x				
Raspailia (*Raspailia*) *phakellopsis* Hooper, 1991	x						
Raspailia (*Raspailia*) *pinnatifida* (Carter, 1885)				x			
Raspailia (*Raspailia*) *scorpa* sp. nov.		x					
Raspailia (*Raspailia*) *tenella* (Lendenfeld, 1888)			x				
Raspailia (*Raspailia*) *vestigifera* Dendy, 1896	x			x?			
Raspailia (*Raspailia*) *wilkinsoni* Hooper, 1991		x					New Caledonia, Vanuatu
Raspailia (*Clathriodendron*) *arbuscula* (Lendenfeld, 1888)	x		x				New Zealand
Raspailia (*Clathriodendron*) *bifurcata* Ridley, 1884	x	x	x				
Raspailia (*Clathriodeñdron*) *cacticutis* (Carter, 1885)				x			
Raspailia (*Clathriodendron*) *darwinensis* Hooper, 1991	x						
Raspailia (*Clathriodendron*) *desmoxyiformis* Hooper, 1991	x						
Raspailia (*Clathriodendron*) *keriontria* Hooper, 1991	x						
Raspailia (*Clathriodendron*) *melanorhops* Hooper, 1991	x						
Raspailia (*Clathriodendron*) *paradoxa* Hentschel, 1911					x		
Raspailia (*Raspaxilla*) *compressa* Bergquist, 1970	x	x			x		New Zealand
Raspailia (*Raspaxilla*) *frondula* (Whiteleggge, 1907)			x				
Raspailia (*Raspaxilla*) *reticulata* Hooper, 1991		x					
Raspailia (*Raspaxilla*) *wardi* Hooper, 1991	x						
Raspailia (*Parasyringella*) *australiensis* Ridley, 1884	x	x					
Raspailia (*Parasyringella*) *clathrata* Ridley, 1884		x					
Raspailia (*Parasyringella*) *elegans* (Lendenfeld, 1887)	x						
Raspailia (*Parasyringella*) *nuda* Hentschel, 1911	x						

Table 5. continued ...

Species	1	2	3	4	5	6	Other locality
Raspailia (Parasyringella) stelliderma (Carter, 1885)				x			
Raspailia (Hymeraphiopsis) irregularis Hentschel, 1914						x	
Aulospongus similiaustralis sp. nov.		x					
Sollasella digitata Lendenfeld, 1888			x				
Sollasella moretonensis Van Soest, Hooper, Beglinger & Erpenbeck, 2006	x	x					
Ectyoplasia frondosa (Lendenfeld, 1887)	x		?				
Ectyoplasia tabula (Lamarck, 1814)	x				x		
Ectyoplasia vannus Hooper, 1991	x						
Endectyon elyakovi Hooper, 1991	x	x					
Endectyon fruticosum aruense (Hentschel, 1912)	x						Indonesia, Thailand
Endectyon thurstoni (Dendy, 1887)	x						E coast India
Endectyon xerampelina (Lamarck, 1932)							Unknown, ? Australia
Trikentrion flabelliforme Carter, 1882	x				?		Indonesia, PNG
Cyamon aruense Hentschel, 1912	x						Indonesia
Eurypon graphidiophorum Hentschel, 1911					x		
Amphinomia sulphurea Hooper, 1991	x						
Ceratopsion dichotomum (Whitelegge, 1907)			x				
Ceratopsion axiferum (Hentschel, 1912)	x						Indonesia
Ceratopsion clavatum Thiele, 1898		x					Japan, New Caledonia, Papua New Guinea
Ceratopsion montebelloense Hooper, 1991	x						
Ceratopsion palmatum Hooper, 1991	x						New Caledonia
Thrinacophora cervicornis Ridley & Dendy, 1886	x						Indonesia, Philippines
Axechina raspailioides Hentschel, 1912	x						Indonesia
Echinodictyum arenosum Dendy, 1896				x			
Echinodictyum asperum Ridley & Dendy, 1886	x	x					Indo-Pacific, Tahiti to Gulf of Manaar, Chuuk to northern Australia
Echinodictyum austrinus Hooper, 1991					x		
Echinodictyum cancellatum (Lamarck, 1814)	x	x					Indonesia
Echinodictyum carlinoides (Lamarck, 1814		x					Indonesia
Echinodictyum clathrioides Hentschel, 1911	x				x		
Echinodictyum conulosum Kieschnick, 1900	x	x					
Echinodictyum costiferum Ridley, 1884		x					
Echinodictyum fruticosum Hentschel, 1911	x						
Echinodictyum lacunosum Kieschnick, 1898		x					
Echinodictyum luteum n.sp		x					Palau

Table 5. continued ...

Species	**1**	**2**	**3**	**4**	**5**	**6**	**Other locality**
Echinodictyum mesenterinum (Lamarck, 1814)	x	x	x	x	x		Indo-west Pacific: Philippines, New Caledonia, Singapore, Malaysia, Vietnam
Echinodictyum nidulus Hentschel, 1911	x				x		
Echinodictyum rugosum Ridley & Dendy, 1886	x						Indonesia

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