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Species diversity of opisthobranch molluscs on Lizard Island, Great Barrier Reef, Australia

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Abstract – During several visits from 1999 to 2004 to the Australian Museum Research Station on Lizard Island (LIRS) (Great Barrier Reef, Northern Section, Queensland, Australia) the authors collected 158 different opisthobranch species from the reefs and lagoon areas surrounding Lizard Island. The number of species found gives an estimate of the diversity of the opisthobranch fauna on the northern Great Barrier Reef. The manuscript also provides colour plates of most species found so far on Lizard Island that will facilitate species identification, data usage and further data collection.

Key words: Biodiversity, Opisthobranchia, Mollusca, Australia, Lizard Island, Great Barrier Reef

INTRODUCTION

Coral reefs have more species per unit area than any other marine ecosystem but, with the exception of a few groups such as fishes and corals, most taxa are poorly known (Done *et al.* 1996). However, the wealth of coral reef biodiversity lies in small, cryptic invertebrates and there is a need for systematic inventories that address these types of fauna (Mikkelsen and Cracraft 2001). This was convincingly shown by an investigation of a coral reef in New Caledonia, where several discrete stations were intensively collected and a total of 2738 molluscan species were found, including 258 opisthobranchs (Bouchet *et al.* 2002).

Although faunal investigations of the Great Barrier Reef (GBR) are very important, for a better understanding of marine biodiversity and conservation on Australian coral reefs, many taxa are still inadequately understood with respect to their species diversity, seasonal and geographic distribution. Despite their often-dazzling appearance, this holds true for the Opisthobranchia, a relatively well known and diverse group of marine gastropod molluscs. The annotated work of Marshall and Willan (1999) on the opisthobranchs of Heron Island (at the southern end of the GBR Marine Park) is an unusual exception and is of great assistance for many scientists working to identify and document information related to tropical opisthobranch species. In addition, several popular books with good photographs of opisthobranchs (seaslugs) are available and give an accurate impression of the general morphology and diversity of these fascinating animals. These publications usually cover both the Indonesian and Australian regions (e.g. Willan and Coleman 1984, Coleman 2001).

The Great Barrier Reef is the largest coral reef ecosystem in the world and has been designated both a Marine Park and a World Heritage Area (Chadwick and Green 2002). Our aim is to contribute to the knowledge of biodiversity and distribution of the opisthobranch mollusc fauna on the Great Barrier Reef by summarizing our data from several scientific visits to Lizard Island Research Station over a 5-year period. Lizard Island is a continental island surrounded by fringing reefs and is situated very close to the northern section of the GBR Marine Park, approximately 1200 km north of Heron Island where the work of Marshall and Willan (1999) was conducted. This is the first time that a complete inventory of collected opisthobranchs from Lizard Island is presented.

MATERIALS AND METHODS

We sampled the full range of coral reef habitat types present on Lizard Island, ranging from mangrove areas, intertidal sandy bottoms, intertidal and subtidal fringing reefs, and shallow lagoon areas to coral patch reefs both inside, and outside the lagoon. Collections and observations were performed by four methods; walking over the reefs during low tides, sieving sediment, snorkelling, and scuba diving to a maximum depth of 20 m. Preliminary identification and photography of living animals was performed in the LIRS laboratories on Lizard Island by referral to Marshall and Willan (1999) and Coleman (2001). Subsequent re-identification followed later by using the extensive data file of the first author, where nearly all published pictures on opisthobranchs worldwide are available. Additionally, Bill Rudman's sea slug forum at the Australian Museum in Sydney (www.seaslugforum.net) was also consulted.

Collection site names and locations are indicated in Figure 1, the species found are listed in Table 1 and presented in Figures 3–13. Figures presented here in the colour plates, and additional figures, are separately available in Bill Rudman's Australian Museum sea slug forum (www.seaslugforum.net). Material that has already been published, even under synonymised names, is mentioned, as well as the name of the author and where material is stored.

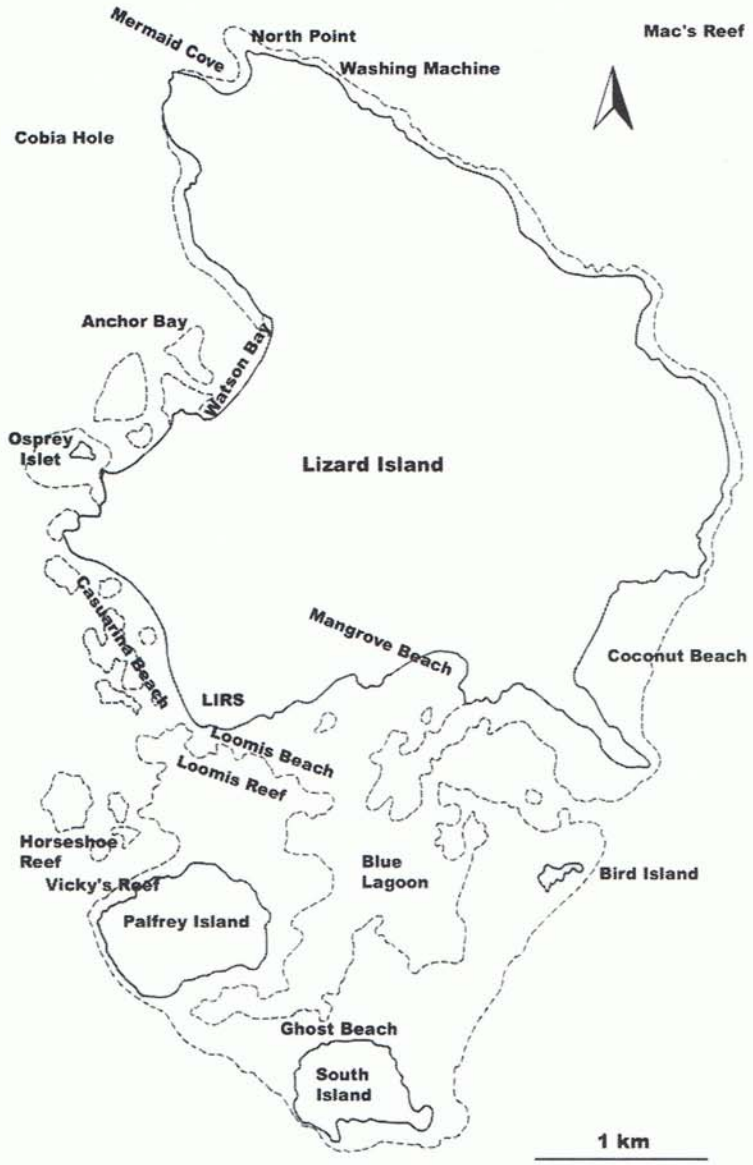
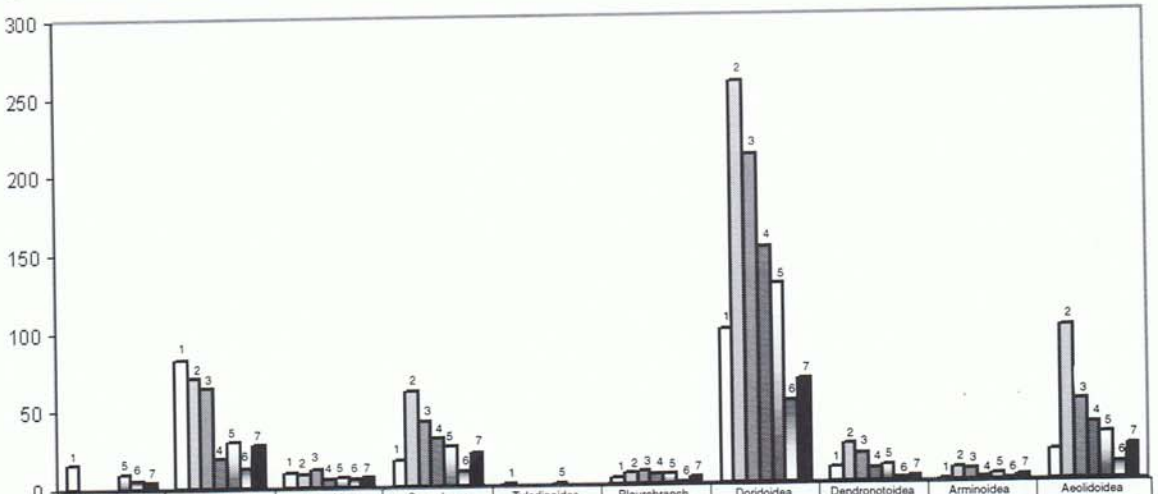


Figure 1 Map of Lizard Island with collection sites labelled.



	Acteonoidea	Cephalaspidea	Anaspidea	Sacoglossa	Tylodinoidea	Pleurobranch.	Doridoidea	Dendronotoidea	Arminoidea	Aeolidoidea
1	16	82	10	17	1	4	98	10	1	19
2	0	71	9	61	0	8	257	25	9	98
3	0	64	12	42	0	9	210	18	8	51
4	0	20	5	31	0	7	151	9	2	36
5	10	30	6	26	1	6	127	11	4	30
6	5	13	5	10	0	1	53	2	1	11
7	4	28	6	21	0	4	66	3	3	23

Figure 2 Opisthobranch species records for the different Indo-Pacific areas; split in different subtaxa. 1 New Caledonia (Bouchet *et al.* 2002), 2 Papua New Guinea (Gosliner 1992), 3 Great Barrier Reef (Marshall and Willan 1999), 4 Heron Island (Marshall and Willan 1999), 5 Fiji (Brodie and Brodie 1990), 6 Marshall Islands (Johnson and Boucher 1983), 7 Lizard Island (present paper).

RESULTS

In total 158 opisthobranch species were collected or documented at Lizard Island and surrounding areas (Table 1) from 1999–2004. This is 38% of the 414 species mentioned in the checklist of the Great Barrier Reef by Marshall and Willan (1999) and 60 % of the 261 species found by these authors at Heron Island (Table 2). Quite a number of species found at Lizard Island are not indicated in the GBR checklist by Marshall and Willan (1999). Figure 2 shows species numbers of opisthobranch subtaxa taken from different authors and different tropical areas of the Indo-Pacific (columns 1 to 6) in comparison to the numbers found at Lizard Island (column 7). Species numbers per subtaxon found at Lizard Island are less than expected compared to the numbers known from most other areas.

New species records for the Great Barrier Reef are indicated in Table 1. These are *Gastropteron bicornutum, Costasiella usagi, Elysia amakusana* (= *E. japonica*), *Thuridilla livida, Cerberilla annulata, Embletonia gracilis, Facelina rhodopos* and *Godiva quadricolor*. Undescribed or unidentified species are presented in Figures 3–5. They include: one cephalaspid (Figure 3G); three aglajids (Figures 3A–C), *Gastropteron* spec.(Figure 3E), *Melanochlamys* spec. (Figure 3F) (probably the same species depicted as *Melanochlamys* spec.1 in Marshall and Willan 1999); cf. *Siphopteron cf. pohnpei* (Figure 3H); two unknown *Cyerce* species (Figures 4A, B); *Elysia* spec. (Figures 4C, D); *Thuridilla* spec. (Figure 4E) (already depicted in Coleman (2001) as "Coleman's *Thuridilla*"); a *Discodoris* spec. (Figure 4G); *Goniodoris* sp. (Figure 5A) two *Gymnodoris* species (Figures 5C, D), one of which is figured in Coleman (2001) as yellow-daubed *Gymnodoris; Thecacera* spec. (Figure 5B); *Doto* spec.; *Dermatobranchus* spec. (Figure 5F) an unidentified aeolid (Figure 5G); *Cerberilla* spec. (Figure 5M); *Eubranchus* spec.(Figure 5H); *Godiva* spec. (Figure 5K) and *Phyllodesmium* spec. (Figure 5I).

DISCUSSION

Gosliner and Draheim (1996) estimated that the number of opisthobranch species in the Indo-Pacific Ocean exceeded 3,400, probably ranging between 4,000 and 4,800, with 1,000 or more undescribed species. "Hot spots" with the highest numbers reported are Papua New Guinea with 646 and Philippines with 563 species (see Gosliner and Draheim 1996). The project focus for each of the authors of this current study was directed to different habitats and substrates, therefore many different areas around Lizard Island have been sampled. The number of species presented here indicate a high species richness of opisthobranchs around Lizard Island, however reefs on the exposed

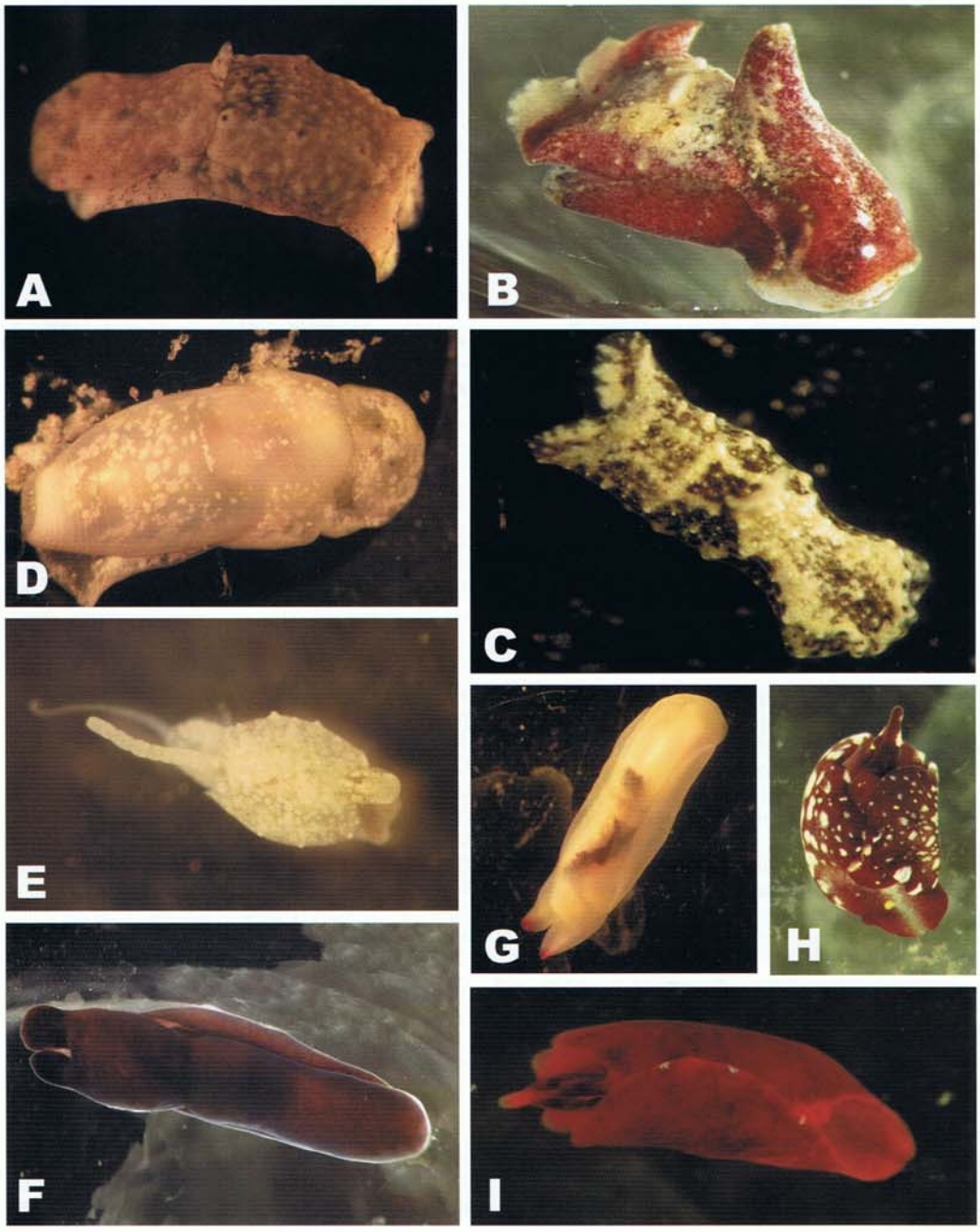


Figure 3 Unidentified or undescribed cephalaspid species: A Aglajid spec. 1, B Aglajid spec. 2, C Aglajid spec. 3, D *Atys* spec., E *Gastropteron* spec., F *Melanochlamys* spec., G Cephalaspid spec., H *Siphopteron* spec., I *Siphopteron* spec. (colour variety).

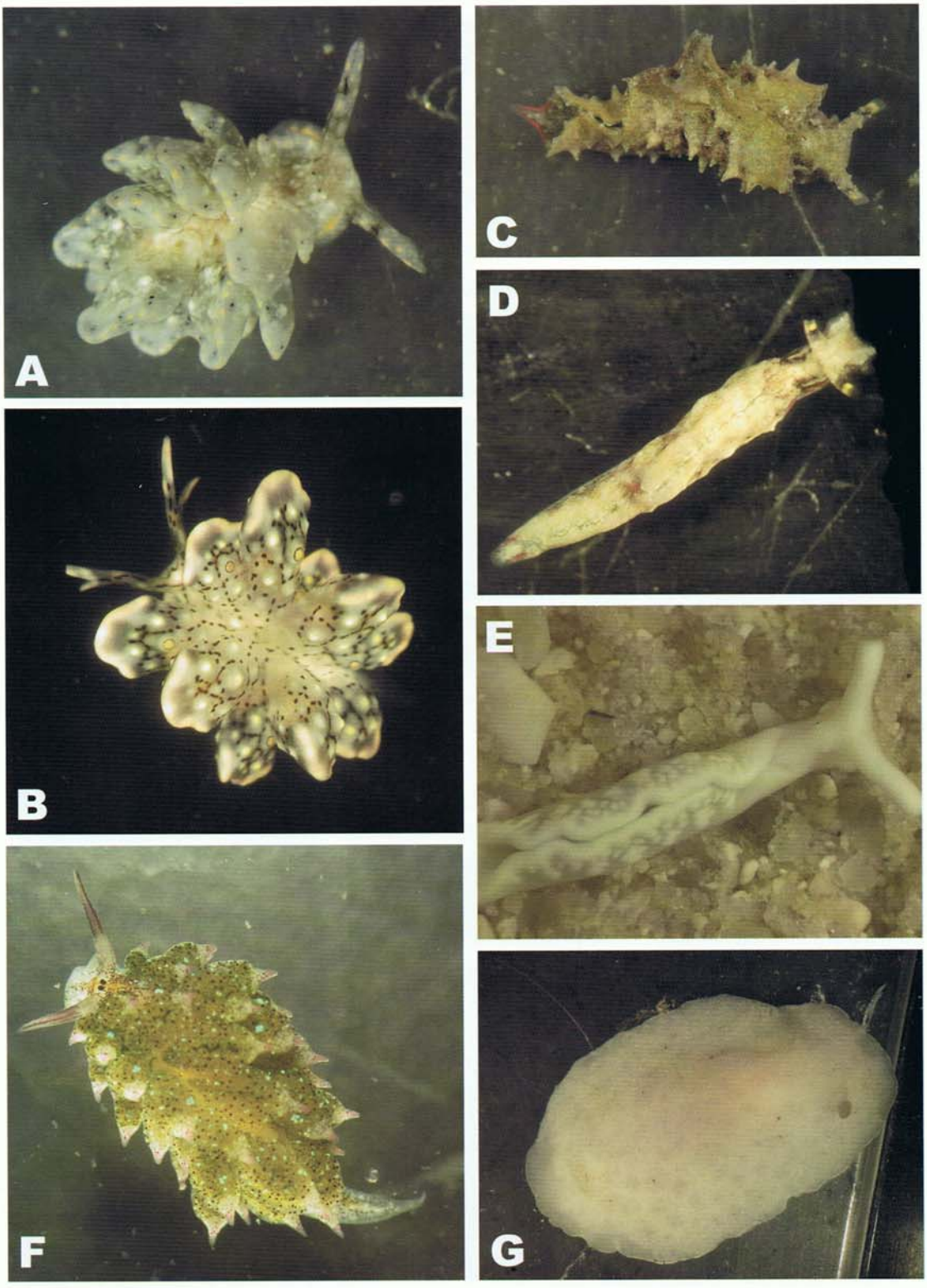


Figure 4 Unidentified or undescribed opisthobranch species: A *Cyerce* spec. 1, B *Cyerce* spec. 2, C *Elysia* spec., D *Elysia* spec. (variety), E *Thuridilla* spec., F *Costasiella* cf. *ocelligera*, G *Discodoris* spec.,

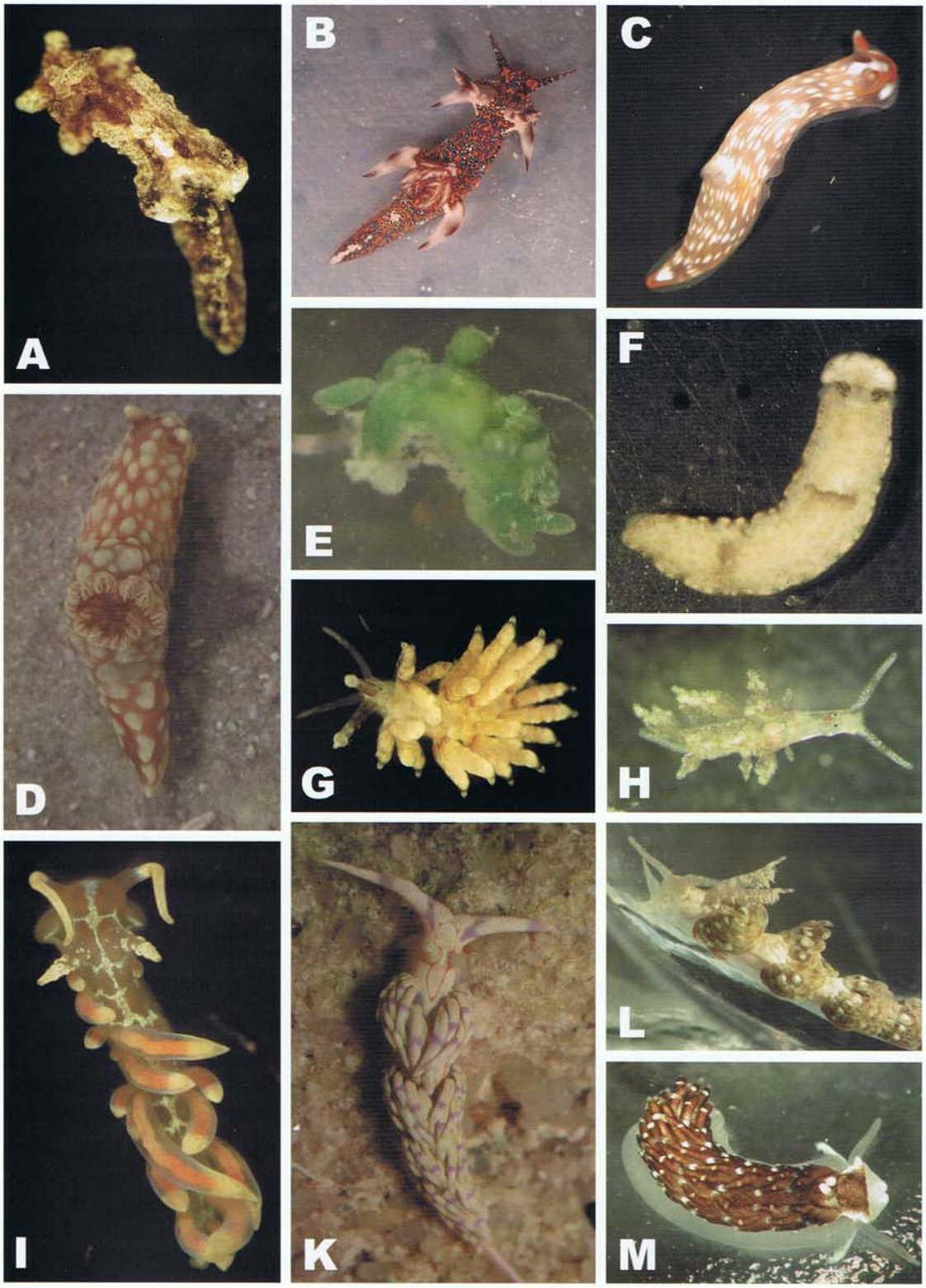


Figure 5 Unidentified or undescribed nudibranch species: A *Goniodoris* spec., B *Thecacera* spec., C *Gymnodoris* spec.1, D *Gymnodoris* spec.2, E *Doto* spec., F *Dermatobranchus* spec., G Aeolid spec. 2, H *Eubranchus* spec., I *Phyllodesmium* spec., K *Godiva* spec., L Aeolid sp. 1, M *Cerberilla* spec.

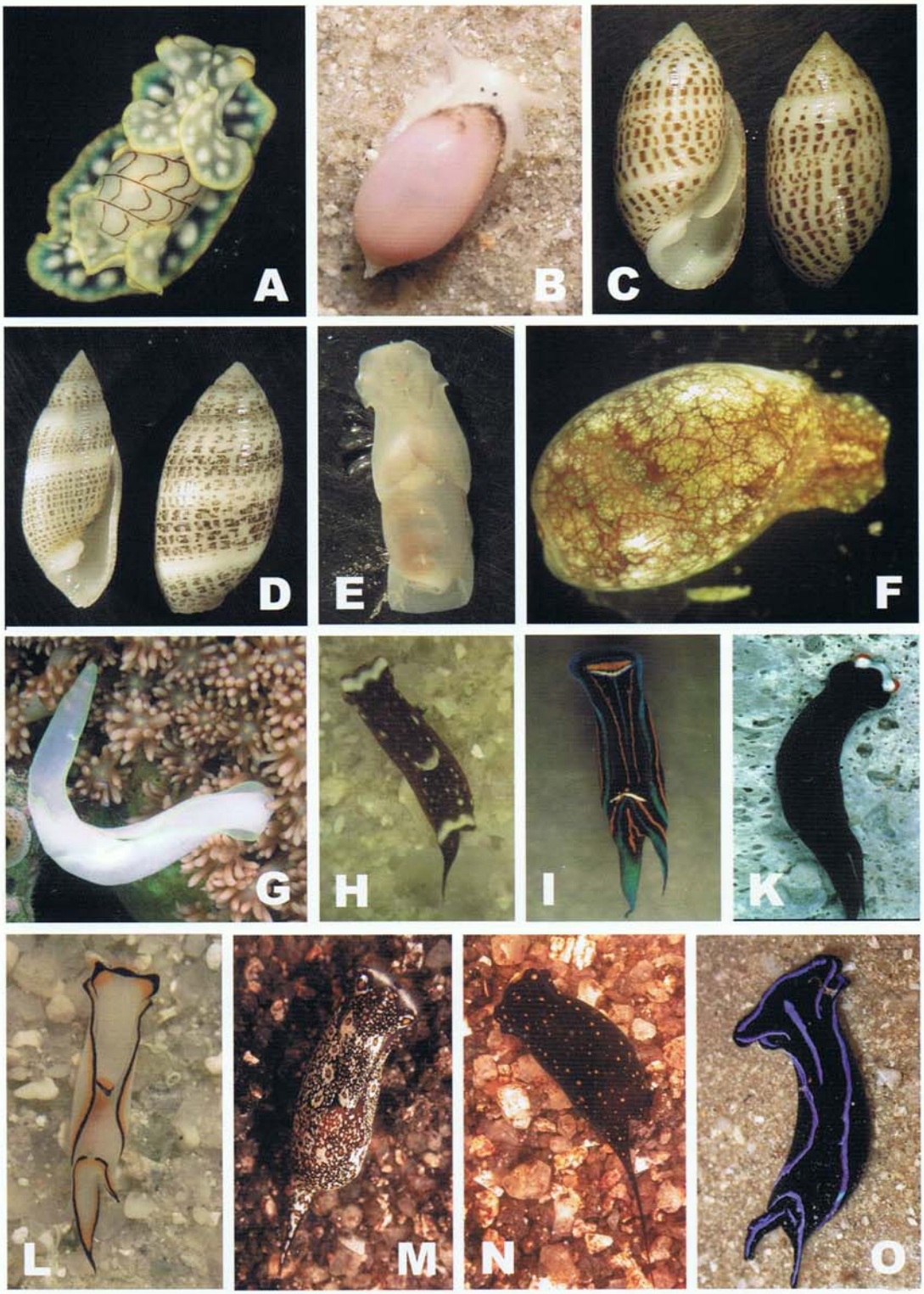


Figure 6 Acteonoidea (A–D), Cephalaspidea (E–O). A *Micromelo undata*, B *Pupa nitidula*, C *Pupa solidula*, D *Pupa sulcata*, E *Atys cylindrica*, F *Bulla vernicosa*, G *Chelidonura electra*, H *Chelidonura fulvipunctata*, I *Chelidonura hirundinina*, K *Chelidonura inornata*, L *Chelidonura pallida*, M *Chelidonura sandrana*, N *Chelidonura sandrana* (colour variety), O *Chelidonura varians*.

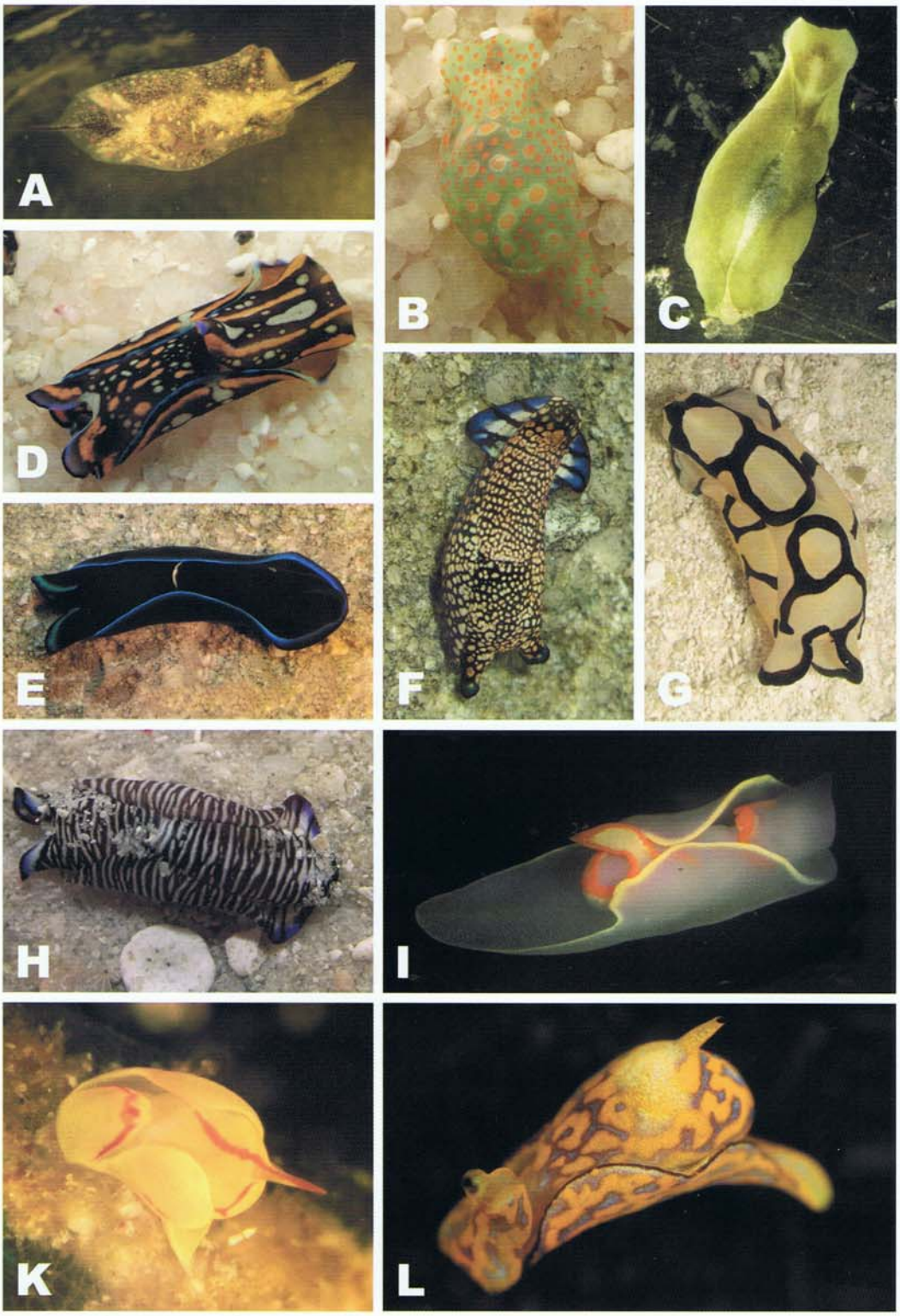


Figure 7 Cephalaspidea: A *Gastropteron bicornutum*, B *Haminoea cymbalum*, C *Phanerophthalmus smaragdinus*, D *Philinopsis cyanea*, E *Philinopsis gardineri*, F *Philinopsis reticulata*, G *Philinopsis pilsbryi*, H *Philinopsis lineolata*, I *Sagaminopteron ornatum*, K *Siphopteron quadrispinosum*, L *Siphopteron tigrinum*

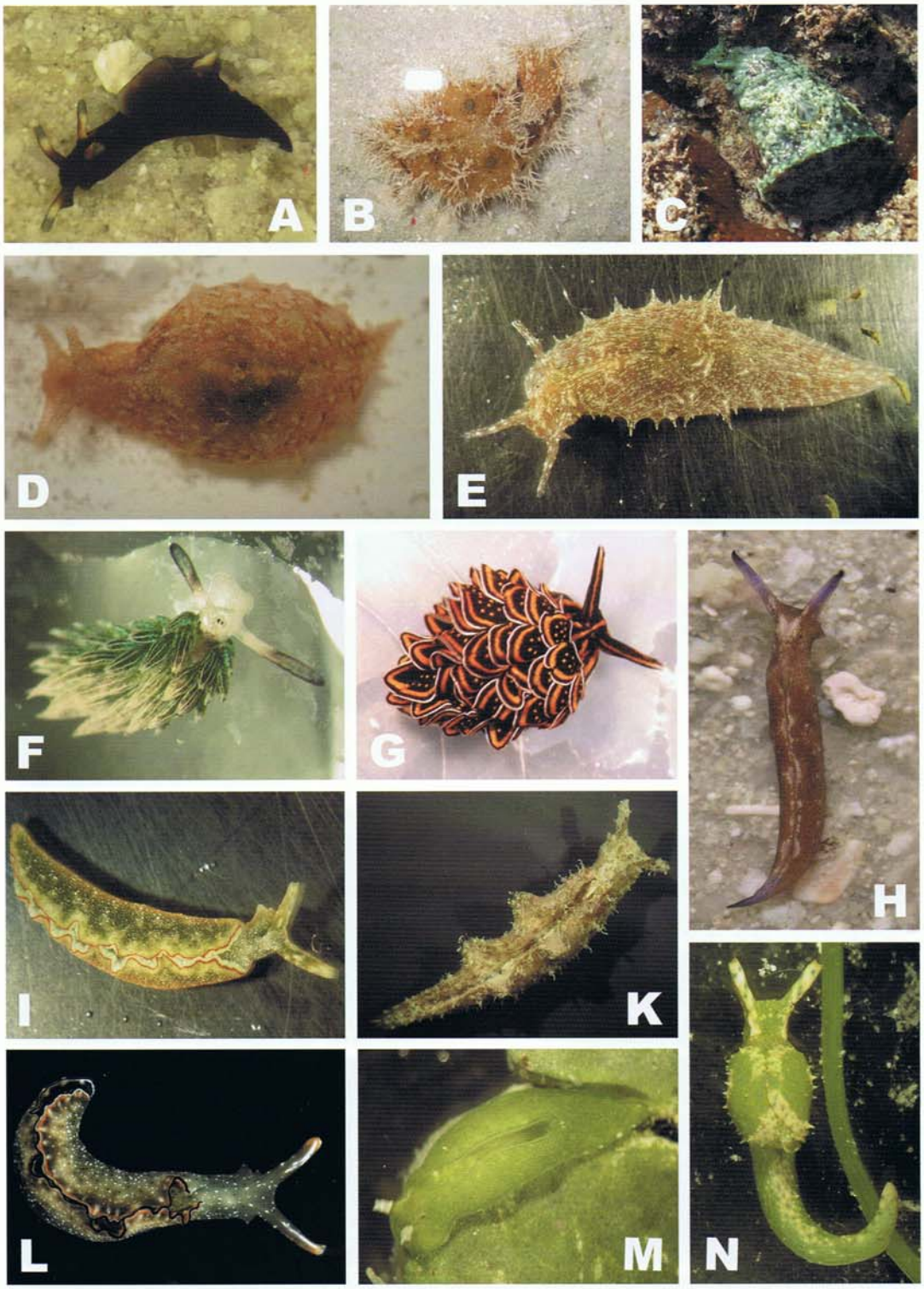


Figure 8 Anaspidea (A–E), Sacoglossa (F–N): A *Aplysia parvula*, B *Bursatella leachii*, C *Dolabella auricularia*, D *Notarchus indicus*, E *Stylocheilus striatus*, F *Costasiella usagi*, G *Cyerce nigricans*, H *Elysia amakusana*, I *Elysia bennettae*, K *Elysia tomentosa*, L *Elysia ornata*, M *Elysiella pusilla*, N *Oxynoe viridis*

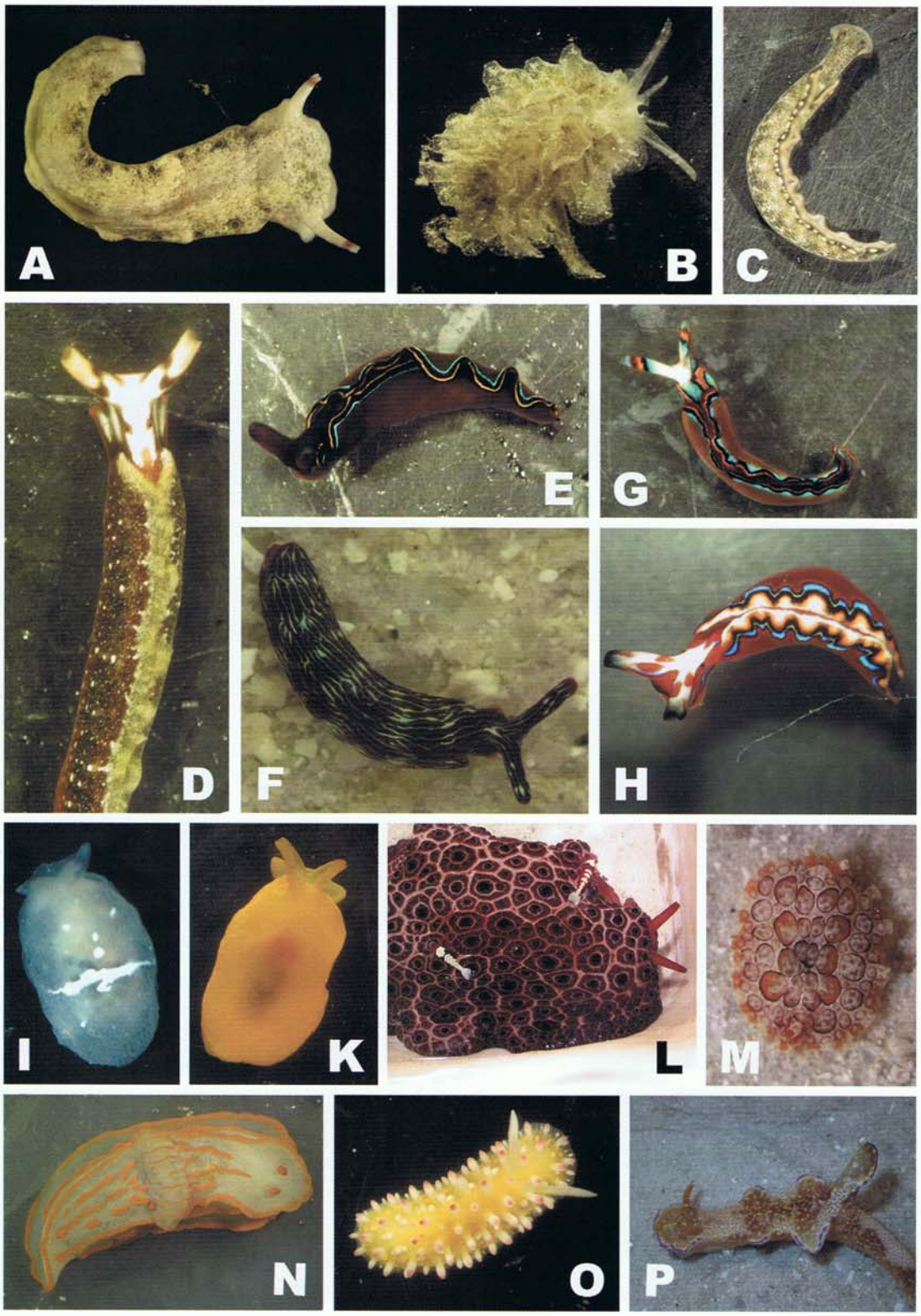


Figure 9 Sacoglossa (continuation, A–H), Pleurobranchoidea (I–M), Nudibranchia, Doridoidea (N–P): A *Placobranchus ocellatus*, B *Polybranchia orientalis*, C *Thuridilla carlsoni*, D *Thuridilla kathae*, E *Thuridilla livida*, F *Thuridilla gracilis*, G *Thuridilla neona*, H *Thuridilla multimarginata*, I *Berthella stellata*, K *Berthellina citrina*, L *Pleurobranchus grandis*, M *Pleurobranchus forskalii*, N *Analogium striatum*, O *Cadlinella ornatissima*. P *Ceratosoma tenue*

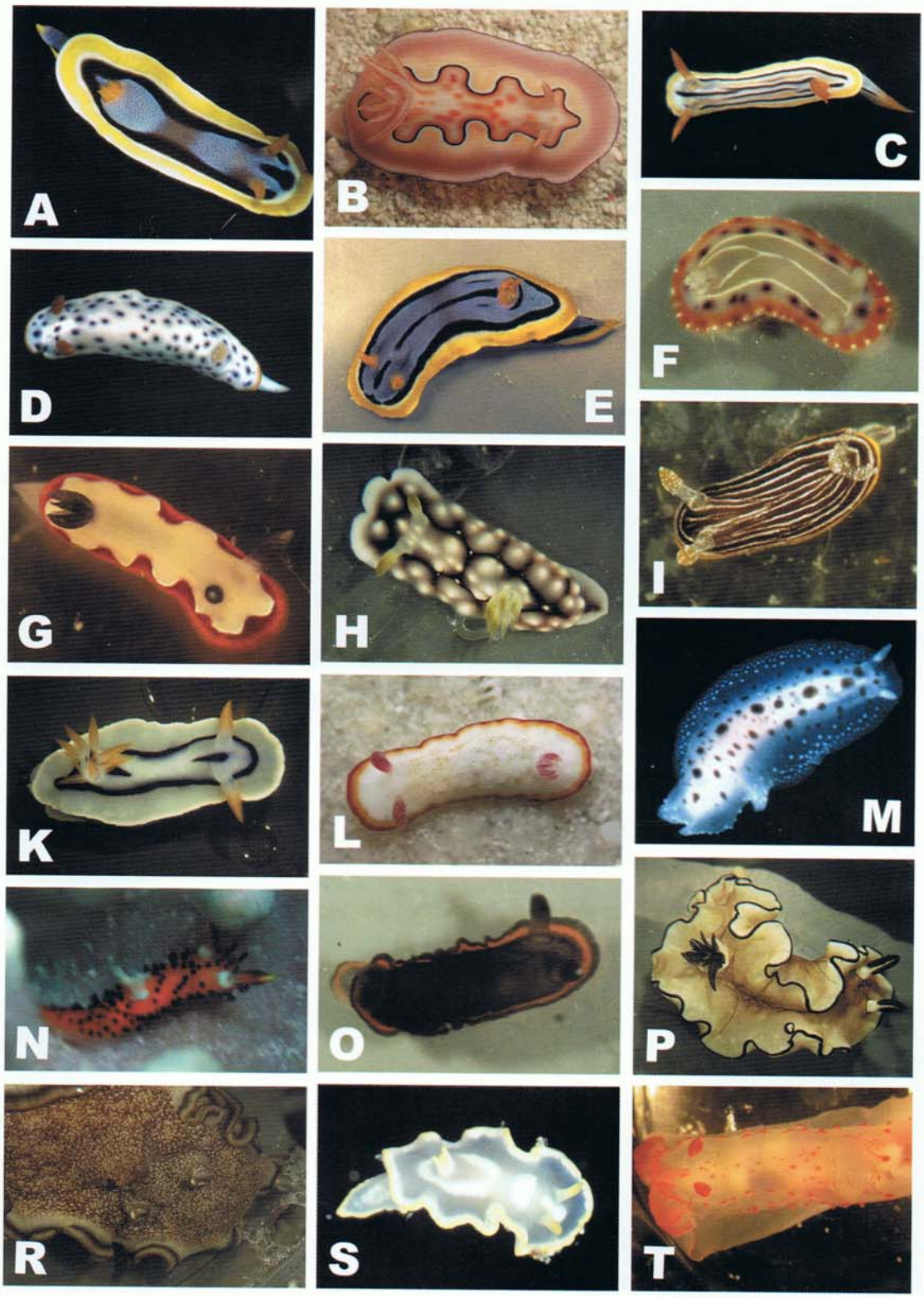


Figure 10 Doridoidea (continuation): A *Chromodoris annae*, B *Chromodoris coi*, C *Chromodoris colemani*, D *Chromodoris daphne*, E *Chromodoris elizabethina*, F *Chromodoris decora*, G *Chromodoris fidelis*, H *Chromodoris geometrica*, I *Chromodoris lineolata*, K *Chromodoris lochi*, L *Chromodoris verrieri*, M *Dendrodoris elongata*, N *Crimora lutea*, O *Dendrodoris nigra*, P *Glossodoris atromarginata*, R *Glossodoris hikuerensis*, S *Glossodoris pallida*, T *Gymnodoris alba*.

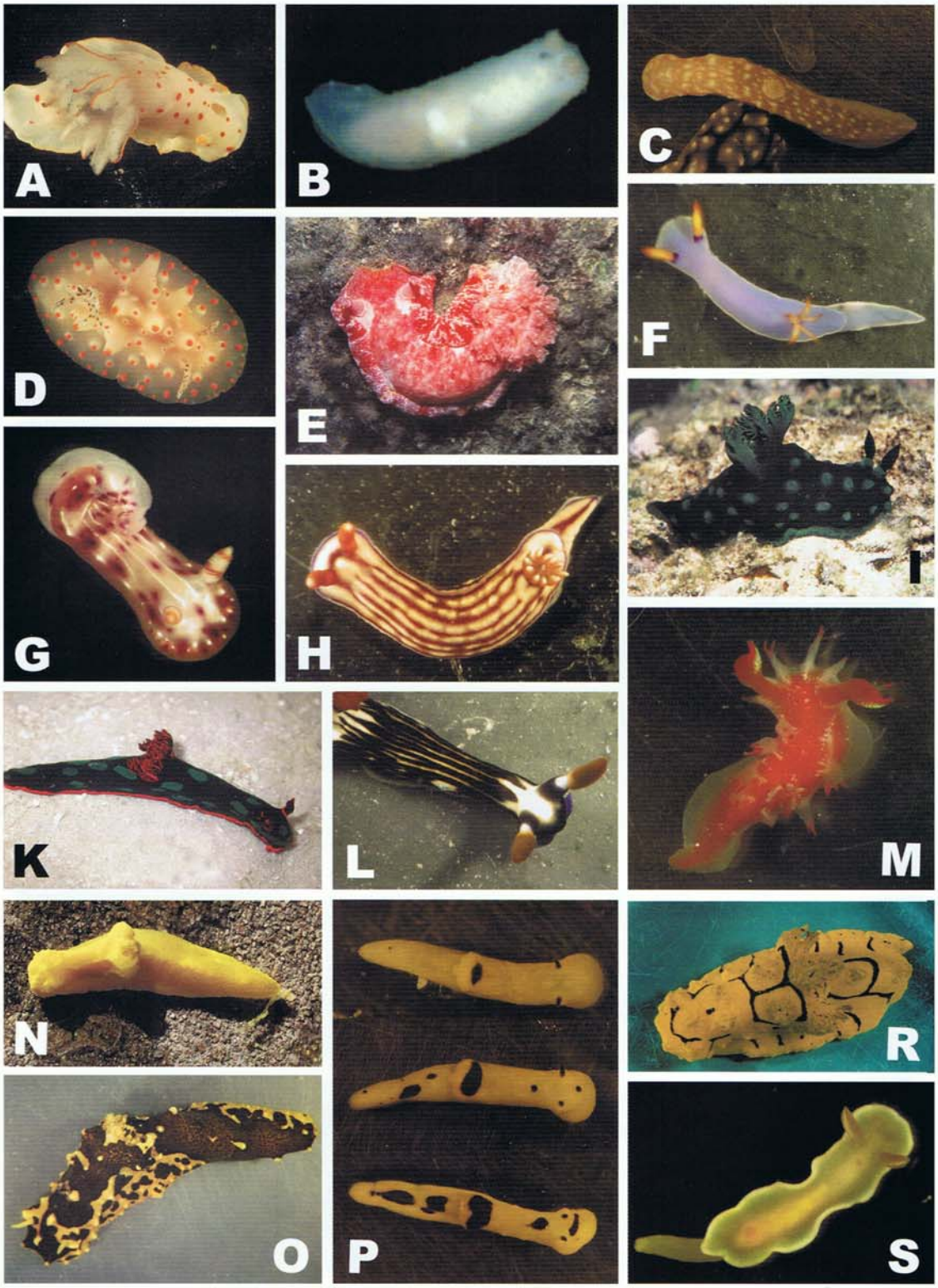


Figure 11 Doridoidea (continuation): A *Gymnodoris ceylonica*, B *Gymnodoris citrina*, C *Gymnodoris okinawae*, D *Halgerda batangas*, E *Hexabranchus sanguineus*, F *Hypselodoris bullocki*, G *Hypselodoris maculosa*, H *Hypselodoris whitei*, I *Nembrotha cristata*, K *Nembrotha kubarayana*, L *Nembrotha lineolata*, M *Kaloplocamus acutus*, N *Notodoris citrina*, O *Notodoris gardineri*, P *Notodoris gardineri* (juveniles), R *Notodoris minor*, S *Noumea crocea*

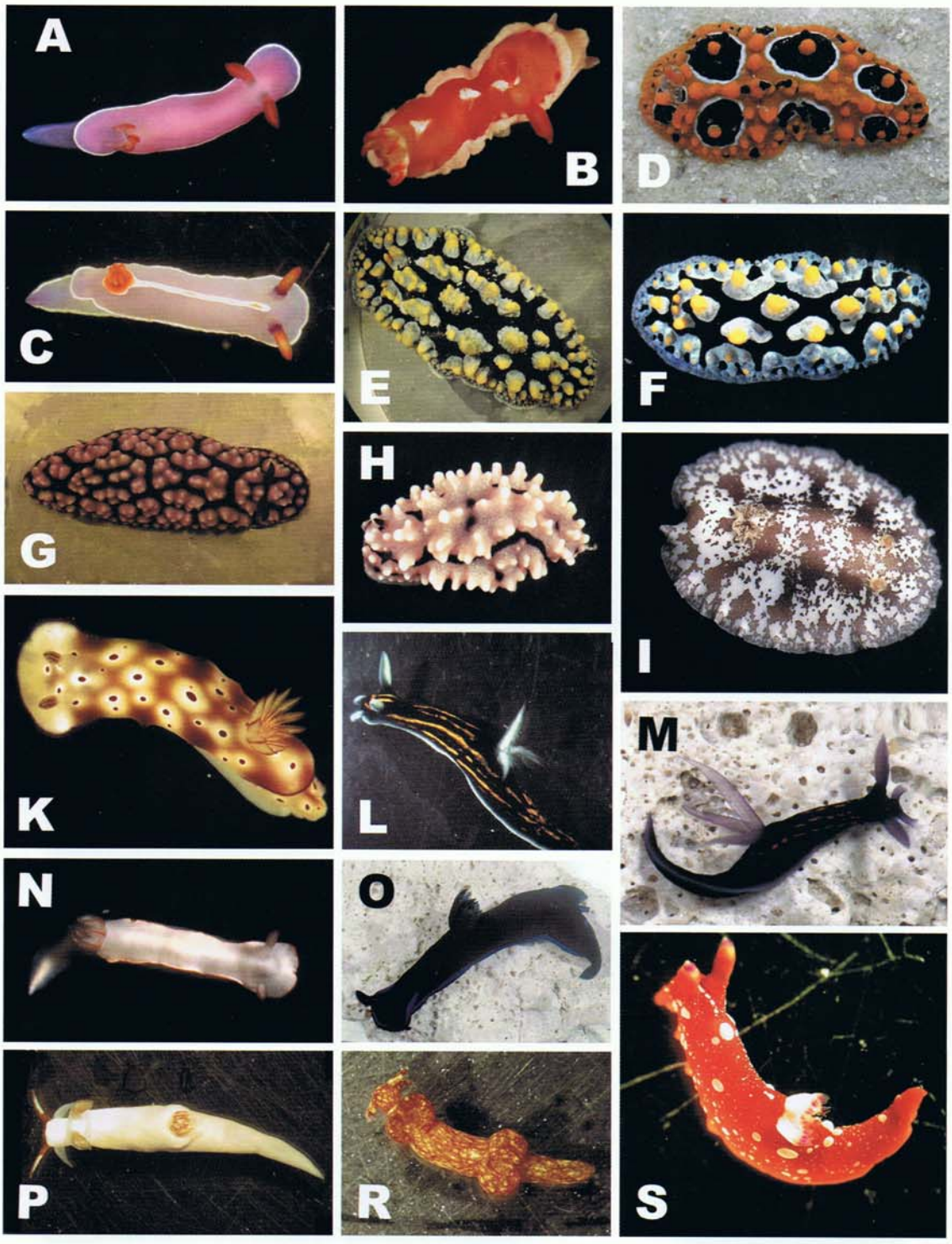


Figure 12 Doridoidea (continuation): A *Noumea romeri*, B *Noumea varians*, C *Pectenodoris trilineata*, D *Phyllidia ocellata*, E *Phyllidia coelestis*, F *Phyllidia varicosa*, G *Phyllidiella pustulosa*, H *Phyllidiella lizae*, I *Platydoris scabra*, K *Risbecia tryoni*, L *Roboastra gracilis*, M *Roboastra gracilis* (colour variation), N *Thorunna fortiva*, O *Tambja morosa*, P *Trapania* cf. *aurata*, R *Trapania reticulata*, S *Tambja limaciformis*

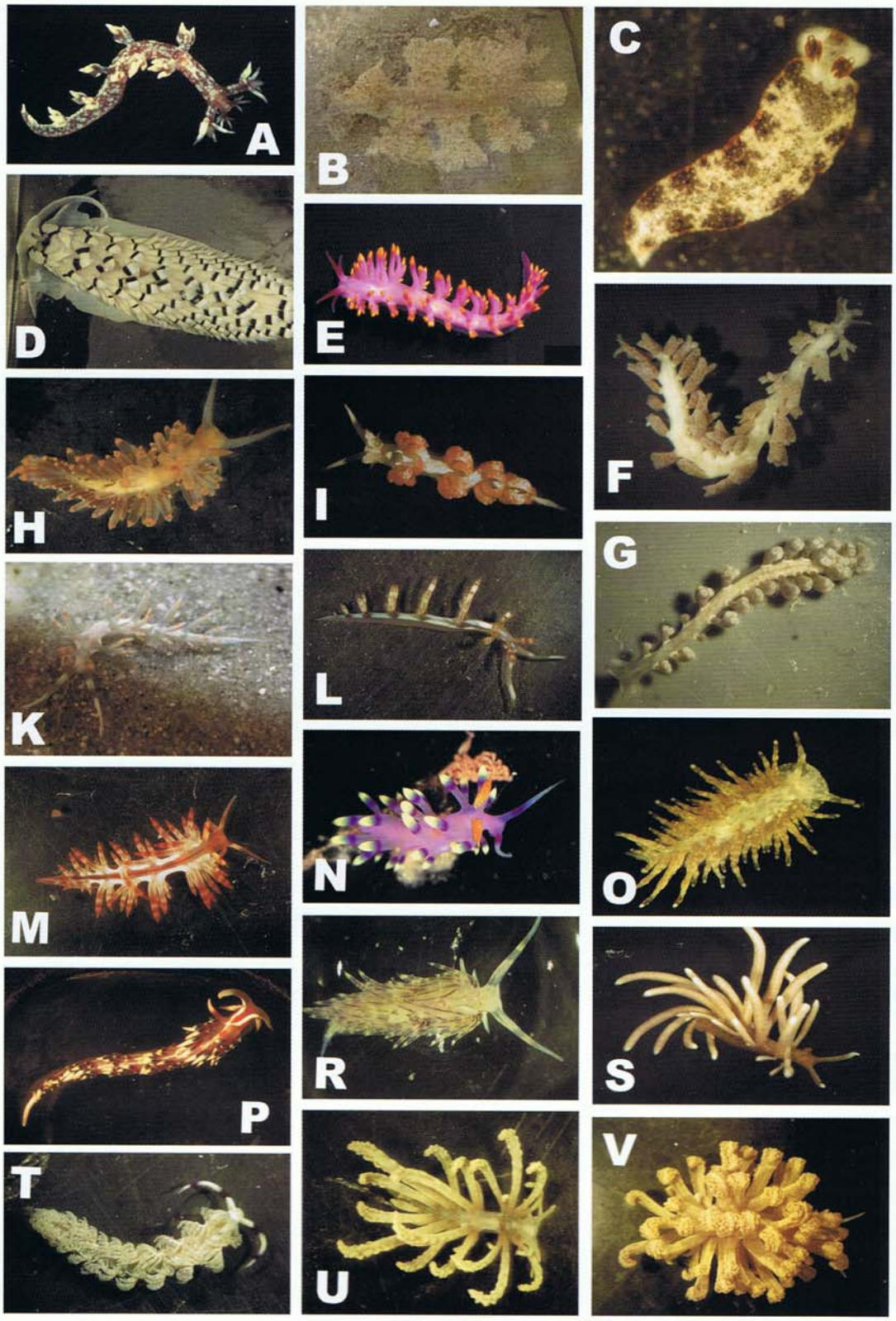


Figure 13 Cladobranchia: A *Bornella stellifer*, B *Melibe mirifica*, C *Dermatobranchus fortunata*, D *Cerberilla annulata*, E *Cuthona sibogae*, F *Embletonia gracilis*, G *Embletonia gracilis*, H *Facelina rhodopos*, I *Favorinus japonicus*, K *Flabellina bicolor*, L *Flabellina bilas*, M *Flabellina rubrolineata*, N *Flabellina exoptata*, O *Phestilla lugubris*, P *Phidiana indica*, R *Godiva quadricolor*, S *Phyllodesmium briareum*, T *Pteraeolidia ianthina*, U *Phyllodesmium cf hyalinum*, V *Phyllodesmium hyalinum*.

Table 1 Species list of Lizard Island's opisthobranchs. HW and GB during July 1999 and July 2002, AKK in July 1999, IB during July to September 2002 and August to September 2004, NA during January to February 2003 and October 2003 to February 2004, and JE during July 2003. The species collected in the aquaria of the research station were probably sucked in by the seawater system, which is supplied via an inlet pipe in front of the research station (Casuarina Beach) in a depth of about 1 to 2 m. The last column indicates further published information on the material. Some species are described with a general Indo Pacific distribution but only localities north of the GBR. When no literature is known to us with the GBR explicitly mentioned as locality, we consider the findings on Lizard Island as new to the GBR, despite the general assumption of broad distribution. This is indicated with a +. R+ indicates, that this species is mentioned in Bill Rudman's sea slug forum at the Australian Museum in Sydney (www.seaslugforum.net) to occur in the GBR. For the new species, a question mark indicates that distribution is not known, but this species is probably new to the GBR

Higher hierarchy	Species	Date of observation	Loc. of material	Site and habitat	New to GBR	Figured and/or published in:
Acteonoidea						
	Micromelo undata (Bruguiere, 1792)	July 2002	HW	North Point		Fig. 6A Wägele and Klussmann-Kolb, 2005
	Pupa nitidula (Lamarck, 1816)	July 2002 Jan 2004	HW	Mangrove Beach intertidal Casuarina Beach intertidal		Fig. 6B
	Pupa solidula (Linnaeus, 1758)	July 2002	HW	Mangrove Beach intertidal		Fig. 6C Wägele and Klussmann-Kolb, 2005
	Pupa sulcata (Gmelin, 1791)	July 2002	HW	Mangrove Beach intertidal		Fig. 6D
Cephalaspidea						
	Aglajidae spec. 1	Oct. – Dec. 2003	NA	Casuarina Beach	?	Fig. 3A
	Aglajidae spec. 2	Dec. 2003 – Jan. 2004	NA	Casuarina Beach	?	Fig. 3B
	Aglajidae spec. 3	Aug.–Sept. 2004	IB	Horseshoe Reef	?	Fig. 3C
	Atys spec.	Nov. 2003	NA	Coconut Beach	?	Fig. 3D
	Atys cylindrica (Helbling, 1779)	July 2002	HW	Mangrove Beach intertidal One Tree		Fig. 6E
	Bulla vernicosa	Dec. 2003		Casuarina Beach		Fig. 6F
	Cephalaspidea spec.	Dec. 2003	NA	Casuarina Beach	?	Fig. 3G
	Chelidonura electra Rudman, 1970	Jan. 2003, Nov. 2003, Jan. 2004	NA	Blue Lagoon, Horseshoe Reef		Fig. 6G
	Chelidonura fulvipunctata Baba, 1938	Dec. 2003 – Jan. 2004	NA	Casuarina Beach		Fig. 6H
	Chelidonura hirundinina (Quoy and Gaimard, 1833)	Jan./Feb. 2003 Oct. 2003–Feb. 2004	NA	Mangrove Beach, Casuarina Beach, Loomis Beach		Fig. 6I Anthes *et al.* 2005
	Chelidonura inornata Baba, 1949	July 1999 July 2002 Sept. 2002 Jan. 2003 June 2003 Oct. 2003–Jan. 2004	HW NA	Mermaid Cove, Coral rubble in Blue Lagoon (bommies) North Point Blue Lagoon Mangrove Beach Various reefs		Fig. 6K Wägele *et al.* 2003 Vonnemann *et al.* 2005
	Chelidonura pallida Risbec, 1951	July 1999 Nov. 2003 Jan. 2004	HW NA	Mermaid Cove Watson Bay, Blue Lagoon		Fig. 6L

Table 1 (cont.)

Higher Hierarchy	Species	Date of Observation	Loc. of material	Site and Habitat	New to GBR	Figured and/or published in:
	Chelidonura sandrana Rudman, 1973	Jan. 2003 Oct. 2003 – Feb. 2004 Aug.–Sept. 2004	NA IB	Blue lagoon, Casuarina Beach Loomis Reef, Casuarina Beach	+	Fig. 6M, N Anthes and Michiels 2005 Anthes *et al.* 2006
	Chelidonura varians Eliot, 1903	July 1999 June 2003 Nov. 2003 – Jan. 2004	HW NA	Coral rubble in Blue Lagoon Ghost Beach, Cobia Hole Blue lagoon	R+	Fig. 6O
	Gastropteron bicornutum Baba and Tokioka, 1965	Jan. 2004	NA	Casuarina Beach coral sand	+	Fig. 7A
	Gastropteron spec.	July 2002	HW	Bird Island inside the Blue Lagoon	?	Fig. 3E
	Haminoea cymbalum (Quoy and Gaimard, 1833)	Jan. 2003 Dec. 2003		Off Casuarina Beach		Fig. 7B
	Melanochlamys spec.	Jan. 2003, Oct. 2003 – Jan. 2004	NA	Horseshoe Reef, coral sand Blue Lagoon, Casuarina Beach	?	Fig. 3F *Melanochlamys* spec.1 in Marshall and Willan 1999
	Phanerophthalmus smaragdinus (Rüppell and Leuckart, 1830)	July 1999 Aug.–Sept. 2004	HW IB	Ghost Beach intertidal Coconut Beach		Fig. 7C Vonnemann *et al.* 2005 Wägele and Klussmann-Kolb, 2005
	Philinopsis cyanea (Martens, 1879)	Jan./Feb. 2003 Oct. 2003 – Jan. 2004	NA	Off Casuarina Beach, Loomis Reef, Mangrove Beach Blue Lagoon, Casuarina Beach		Fig. 7D
	Philinopsis gardineri (Eliot, 1903)	Jan./Febr. 2003 June 2003 Nov. 2003 – Jan. 2004	NA	Coconut Beach, South Island Off Casuarina Beach, Palfrey Island Blue Lagoon		Fig. 7E Wägele and Klussmann-Kolb, 2005
	Philinopsis lineolata (H. and A. Adams, 1854)	Dec. 2003 – Jan. 2004	NA	Casuarina Beach, Osprey Islet coral rubble		Fig. 7H
	Philinopsis pilsbryi (Eliot, 1900)	Jan. 2004	NA	Bird Islet, coral rubble		Fig. 7G
	Philinopsis reticulata (Eliot, 1903)	Jan. 2003 June 2003 Nov. 2003 – Jan. 2004 Aug.–Sept. 2004	NA IB	Off Casuarina Beach, Loomis Reef, Mangrove Beach, Watson Bay South Island, Bird Island, Palfrey Island, Casuarina Beach	R+	Fig. 7F
	Sagaminopteron ornatum Tokioka and Baba, 1964	July 1999, July 2002 Jan. 2004	HW NA	Off Bird Island outer reef, Coral rubble in Blue Lagoon (bommies), Coral head Blue Lagoon		Fig. 7I Wägele and Klussmann-Kolb, 2005

Higher Hierarchy	Species	Date of Observation	Loc. of material	Site and Habitat	New to GBR	Figured and/or published in:
	Siphopteron cf. *pohnpei*	Oct. 2003 – Jan. 2004	NA	Casuarina Beach, Watson Bay		Fig. 3H
	Siphopteron quadrispinosum Gosliner, 1989	Oct. 2003 – Jan. 2004	NA	Casuarina Beach	+	Fig. 7K
	Siphopteron cf. *tigrinum* Gosliner, 1989	Sept. 2002	HW	North Point		Fig. 7L
Anaspidea						
	Aplysia dactylomela Rang, 1828	July 2002	HW	Coconut Beach intertidal		
	Aplysia parvula Guilding in Morch, 1863.	Jan. 2004		Horseshoe Reef		Fig. 8A
	Bursatella leachii de Blainville, 1817	Dec. 2003		North Point		Fig. 8B
	Dolabella auricularia (Lightfoot, 1786)	July 2002 June 2003 Dec. 2003	HW	Coconut Beach intertidal Coconut Beach Lizard Aquarium		Fig. 8C
	Notarchus indicus Schweigger, 1820	Feb 2003		LIRS, Aquarium		Fig. 8D
	Stylocheilus striatus (Quoy and Gaimard, 1832)	Sept. 2002 Jan. 2003 June 2003 Dec. 2003		LIRS, Aquarium Off Casuarina Beach		Fig. 8E We follow the discussion in Rudman (seaslugforum) and consider the species found here as *S. striatus*
Sacoglossa						
	Costasiella usagi Ichikawa, 1993	Dec. 2003 – Jan. 2004	NA	Watson Bay	+	Fig. 8F
	Costasiella cf *ocelligera*	Dec. 2003 – Jan. 2004	NA	Watson Bay, Casuarina Beach	?	Fig. 4F
	Cyerce nigricans (Pease, 1866)	July 1999 Aug. 2002 Jan. 2004	HW	Coconut Beach intertidal Casuarina Beach coral sand		Fig. 8G Wägele and Johnson 2001 Vonnemann *et al* 2005
	Cyerce spec. 1	July 2002	HW	Coconut Beach intertidal	?	Fig. 4A
	Cyerce spec. 2	Sept. 2002 Aug.–Sept. 2004	HW IB	Between Bird and South Island intertidal	?	Fig. 4B
	Elysia cf. *amakusana* Baba, 1955	Dec. 2003 Jan. 2004	NA	Blue Lagoon Mangrove Beach	+	Fig. 8H

Table 1 (cont.)

Higher Hierarchy	Species	Date of Observation	Loc. of material	Site and Habitat	New to GBR	Figured and/or published in:
	Elysia bennettae Thompson, 1973	July 1999 July 2002	HW	Ghost Beach intertidal		Fig. 8I Wägele and Johnson 2001 as *E. expansa*
	Elysia ornata (Swainson, 1840)	Apr. 1990 July 1999, July 2002 Aug. 2002 June 2003 Jan. 2004 Aug.–Sept. 2004	HW IB	Blue Lagoon, Osprey Islet, Bird Island inside of Blue Lagoon Palfrey Island, Loomis Reef, Horseshoe Reef, North Point		Fig. 8M
	Elysia spec.	Aug. 2002 Aug.–Sept. 2004	HW IB	Blue Lagoon, Bird Island, Horseshoe Reef	?	Fig. 4C, D (2 pictures)
	Elysia tomentosa Jensen, 1997	Sept. 2002 Aug.–Sept. 2004	HW IB	LIRS, aquarium Loomis Reef, Horseshoe Reef	?	Fig. 8K
	Elysiella pusilla Bergh, 1872	July 1999 July 2002 June 2003	HW	South Island intertidal, coral rubble in Blue Lagoon, Coconut Beach intertidal, Casuarina Beach		Fig. 8M Wägele and Klussmann-Kolb, 2005
	Oxynoe viridis (Pease, 1861)	June 2003 Jan. 2004		Coconut Beach, Casuarina Beach		Fig. 8N Wägele and Klussmann-Kolb, 2005
	Plakobranchus ocellatus Hasselt, 1824	July 1999 July 2002 June 2003 Dec. 2003 – Jan. 2004 Aug.–Sept. 2004	HW IB	Coral rubble in Blue Lagoon, bommies in Blue Lagoon, Mangrove Beach intertidal, Loomis Beach Casuarina Beach, Mangrove Beach, Palfrey Island Blue Lagoon, Casuarina Beach, Coconut Beach Loomis, Horseshoe Reef		Fig. 9A Wägele and Johnson 2001 Wägele and Klussmann-Kolb, 2005 Wägele 2004
	Polybranchia orientalis (Kelaart, 1858)	July 1999 July 2002 Sept. 2002	HW IB	South Island intertidal Coral rubble in Blue		Fig. 9B
	P. cf. orientalis	Aug.–Sept. 2004		Lagoon off Bird Island Coconut Beach intertidal Coconut Beach		
	Thuridilla carlsoni Gosliner, 1995	July 2002 Jan. 2004 Aug.–Sept. 2004	HW IB	Coral rubble in Blue Lagoon Horseshoe Reef Loomis Reef, Bird Is		Fig. 9C

Higher Hierarchy	Species	Date of Observation	Loc. of material	Site and Habitat	New to GBR	Figured and/or published in:
	Thuridilla gracilis (Risbec, 1928)	July 1999 Jan./Feb. 2003 June 2003 Jan. 2003 Aug.–Sept. 2004	HW IB	Ghost Beach intertidal, Off Casuarina Beach, Mermaid Cove, Ghost Beach, Casuarina Beach, Coconut Beach, Mangrove Beach Blue Lagoon, Horseshoe Reef Loomis Reef, Coconut Beach, Bird Island, Horseshoe Reef, Washing Machine, North Point		Fig. 9F Wägele and Johnson 2001 as *T. ratna;*
	Thuridilla kathae Gosliner 1995	Aug.–Sept. 2004	IB	Loomis Reef		Fig. 9D
	Thuridilla livida (Baba, 1955)	Aug.–Sept. 2004	IB	Bird Island	+	Fig. 9E
	Thuridilla multimarginata Gosliner, 1995	Jan. 2004		Blue lagoon patch reef		Fig. 9H
	Thuridilla neona Gosliner, 1995	Aug.–Sept. 2004	IB	Bird Island		Fig. 9G
	Thuridilla spec. Coleman 2001	Jan. 2004	NA	Horseshoe Reef	?	Fig. 4E
Pleurobranchoidea						
	Berthellina citrina (Rüppell and Leuckart, 1828)	July 1999 Aug.–Sept. 2004	HW IB	Ghost Beach intertidal, Coconut Beach, Bird Island		Fig. 9K Wägele and Klussmann-Kolb, 2005
	Berthella stellata (Risso, 1826)	July 1999	HW	Intertidal, coral rubble in Blue Lagoon		Fig. 9I
	Pleurobranchus forskalii (Ruppell and Leuckart, 1828)	Jan. 2004		Casuarina Beach coral rubble		Fig. 9M
	Pleurobranchus grandis Pease, 1868	Nov. 2003		Watson Bay		Fig. 9L
Nudibranchia						
Doridoidea						
	Analogium striatum (Eliot, 1908)	Aug. 2002	HW	Blue Lagoon		Fig. 9N
	Ardeadoris egretta Rudman, 1984	July 2002	HW	North Point		
	Cadlinella ornatissima (Risbec, 1928)	Aug.–Sept. 2004	IB	Loomis		Fig. 9O
	Ceratosoma sinuata (van Hasselt, 1824)	July 2002	HW	Coral rubble in Blue Lagoon off Bird Island		

Table 1 (cont.)

Higher Hierarchy	Species	Date of Observation	Loc. of material	Site and Habitat	New to GBR	Figured and/or published in:
	Ceratosoma tenue Abraham, 1876	Dec. 2003 / Jan. 2004		Watsons Bay		Fig. 9P
	Chromodoris annae Bergh, 1877	July 2002	HW	Coconut Bay intertidal, Mermaid Cove, North Point		Fig. 10A
	Chromodoris coi (Risbec, 1956)	Jan. 2003		Blue Lagoon		Fig. 10B
	Chromodoris colemani Rudman, 1982	July 1999, July 2002 Jan. 2004	HW	Off Bird Island outer reef, Coral rubble Bird Islet		Fig. 10C
	Chromodoris daphne (Angas, 1864)	July 1999	HW	Ghost Beach intertidal		Fig. 10D
	Chromodoris decora (Pease, 1860)	July 2002 Aug. 2002 Aug.–Sept. 2004	HW IB	South Island intertidal, Coconut Beach intertidal, Bird Island		Fig. 10F
	Chromodoris elizabethina Bergh, 1877	July 2002 Jan. 2004	HW	North Point, Lizard Head outer crest		Fig. 10E
	Chromodoris fidelis (Kelaart, 1858)	July 1999 Jan. 2004 Aug.–Sept. 2004	HW IB	Coral rubble in Blue Lagoon, Wickies Reef Loomis Reef		Fig. 10G
	Chromodoris geometrica Risbec, 1928	July 2002 Aug.–Sept. 2004	HW IB	Cobia Hole Bird Island		Fig. 10H
	Chromodoris lineolata (Hasselt, 1824)	July 1999 Aug.–Sept. 2004	HW IB	Ghost Beach intertidal, Horseshoe Reef		Fig. 10I
	Chromodoris lochi Rudman, 1982	Sept. 2002 Nov. 2003 / Jan. 2004	HW	North Direction Island, Coconut Beach outer crest		Fig. 10K
	Chromodoris rubrocornuta Rudman, 1985	July 1999	HW	Coral rubble in Blue Lagoon		
	Chromodoris verrieri (Crosse, 1875)	Dec. 2003		Watsons Bay		Fig. 10L
	Crimora lutea Baba, 1949	Jan. 2003		Horseshoe Reef		Fig. 10N
	Dendrodoris cf. *elongata* Baba, 1936	July 1999		locality not noted		Fig. 10M
	Dendrodoris nigra (Stimpson, 1855)	July 1999 July 2002 Sept. 2002 Aug.–Sept. 2004	HW IB	Ghost Beach intertidal, coral rubble in Blue Lagoon, Blue Lagoon Loomis Reef		Fig. 10O

Higher Hierarchy	Species	Date of Observation	Loc. of material	Site and Habitat	New to GBR	Figured and/or published in:
	Dendrodoris tuberculosa (Quoy and Gaimard, 1832)	Aug.–Sept. 2004	IB	Bird Island		
	Discodoris spec.	Aug. 2002	HW	Coconut Beach intertidal	?	Fig. 4G
	Glossodoris atromarginata (Cuvier, 1804)	July 2002 Aug. 2002 Aug.–Sept. 2004	HW	Ghost Beach, Coconut Beach		Fig. 10P
	Glossodoris cincta (Bergh, 1888)	July 2002 Aug.–Sept. 2004	HW IB	Blue Lagoon off South Island, intertidal Off Casuarina Beach		
	Glossodoris hikuerensis (Pruvot-Fol, 1954)	July 2002	HW	Loomis Reef		Fig. 10R
	Glossodoris pallida (Rüppell and Leuckart, 1830)	July 1999	HW	Off Bird Island outer reef		Fig. 10S
	Goniodoris spec.	Aug.–Sept. 2004	IB	Loomis Reef	?	Fig. 5A
	Gymnodoris alba (Bergh, 1877)	July 1999 Dec. 2003 Aug.–Sept. 2004	HW IB	Mermaid Cove, Casuarina Beach, Blue Lagoon, Loomis Reef, Bird Island, Horseshoe Reef, North Point		Fig. 10T
	Gymnodoris ceylonica (Kelaart, 1858)	Dec. 2003 Aug.–Sept. 2004	IB	Casuarina Beach, Off Casuarina Beach		Fig. 11A
	Gymnodoris okinawae Baba, 1936	July 2002	HW	Mermaid Cove North Point		Fig. 11C
	Gymnodoris citrina	July 2002	HW	North Point	?	Fig. 11B
	Gymnodoris spec. 1	July 2002	HW	North Point	?	Fig. 5C
	Gymnodoris spec. 2	July 1999 Dec. 2003	HW	Ghost Beach intertidal, Horseshoe Reef	?	Fig. 5D Coleman 2001
	Halgerda aurantiomaculata	June 2003		Cobia Hole		
	Halgerda cf. *batangas* Carlson and Hoff, 2000	Aug.–Sept. 2004	IB	North Point	?	Fig. 11D
	Hexabranchus sanguineus (Rüppell and Leuckart, 1830) (egg clutch)	Aug. 2002 June 2003 Jan. 2004 Aug.–Sept. 2004	HW NA IB	Coconut Beach intertidal, Casuarina Beach, Watson Bay, Horseshoe Reef		Fig. 11E
	Hypselodoris bullocki (Collingwood, 1881)	July 2002 Nov. 2003	HW	North Point, Mangrove Beach		Fig. 11F
	Hypselodoris maculosa Pease, 1871	July 1999 Aug.–Sept. 2004	HW IB	Off Bird Island outer reef, Horseshoe Reef		Fig. 11G

Table 1 (cont.)

Higher Hierarchy	Species	Date of Observation	Loc. of material	Site and Habitat	New to GBR	Figured and/or published in:
	Hypselodoris whitei (Adams and Reeve, 1850)	Aug.–Sept. 2004	IB	Coconut Beach, Bird Island		Fig. 11H
	Kaloplocamus acutus Baba, 1949	Jan. 2004		Reef inside Bird islet		Fig. 11M
	Nembrotha cristata Bergh, 1877	Apr. 1990 July 1999 Sept. 2002 June 2003 Jan. 2004 Aug.–Sept. 2004	HW IB	Loomis Beach, Horseshoe Reef, Bird Island Reef, Blue Lagoon, Casuarina Beach, Loomis Reef, Bird Island		Fig. 11I
	Nembrotha kubaryana Bergh, 1877	July 1999, July 2002 Aug./Sept. 2002 Jan. 2003 June 2003 Nov. 2003 Aug.–Sept. 2004	HW IB	Ghost Beach, Horseshoe Reef, off Bird Island outer reef, North Point, Blue Lagoon, Loomis Reef, Bird Island inner reef, Washing Machine, Palfrey Island, Coconut Beach, Bird Island, Horseshoe Reef		Fig. 11K Wägele and Johnson 2001
	Nembrotha lineolata Bergh, 1905	Aug. 2002	HW	Bird Island Reef		Fig. 11L
	Nembrotha milleri Gosliner and Behrens, 1997	Nov./Dec. 2003		Casuarina Beach		
	Notodoris citrina Bergh, 1875	Aug.–Sept. 2004	IB	Horseshoe Reef		Fig. 11N
	Notodoris gardineri Eliot, 1903	July 1999 July 2002 Jan. 2003 June 2003 Jan. 2004	HW	Osprey Islet, Mermaid cove, off Bird Island outer reef, North Point, Turtle Beach, Horseshoe Reef, South Island, Coconut Beach, Blue Lagoon		Fig. 11O,P
	Notodoris minor Eliot, 1904	July 2002 Jan. 2003 Mar. 1990 June 2003 Jan. 2004 Aug.–Sept. 2004	HW IB	Off Bird Island outer reef, Mermaid Cove Horseshoe Reef, Blue Lagoon, North Point		Fig. 11R
	Noumea crocea Rudman, 1986	Aug.–Sept. 2004	IB	Bird Island		Fig. 11S
	Noumea romeri Risbec, 1928	July 1999	HW	Osprey Islet		Fig. 12A
	Noumea varians (Pease, 1871)	Aug.–Sept. 2004	IB	Horseshoe Reef		Fig. 12B
	Pectenodoris trilineata (Adams and Reeve, 1850)	Aug.–Sept. 2004	IB	Bird Island		Fig. 12C

Higher Hierarchy	Species	Date of Observation	Loc. of material	Site and Habitat	New to GBR	Figured and/or published in:
	Phyllidia coelestis Bergh, 1905	July 2002	HW	Bird Island outer reef, Blue Lagoon		Fig. 12E
	Phyllidia ocellata Cuvier, 1804	July 2002 Jan. 2004	HW	Cobia Hole, Osprey islet		Fig. 12D
	Phyllidia varicosa Lamarck, 1801	Oct. 2001 June 2003 Nov. 2003 Aug.–Sept. 2004	IB	Mac's Reef, Horseshoe Reef, Blue Lagoon, Loomis Reef, Coconut Beach		Fig. 12F
	Phyllidiella lizae Brunckhorst, 1993	July 1999 Aug.–Sept. 2004	HW IB	Ghost Beach intertidal, Loomis Reef, off Casuarina Beach		Fig. 12H
	Phyllidiella pustulosa (Cuvier, 1804)	July 1999, July 2002 Jan./Feb. 2003 June 2003 Nov. 2003 – Jan. 2004 Aug.–Sept. 2004	HW IB	Palfrey Island, Mac's Reef, Ghost Beach intertidal North Point, Mermaid Cove, Blue Lagoon, South Island outer reef crest, North Point		Fig. 12G
	Platydoris scabra (Cuvier, 1804)	July 1999, July 2002 Aug./Sept. 2002	HW	Coconut Beach intertidal,		Fig. 12I
	Risbecia tryoni (Garrett, 1873)	July 1999 Jan. 2003 June 2003 Nov. 2003 Aug.–Sept. 2004	HW IB	South Island intertidal Blue Lagoon, Palfrey Island, Mangrove Beach, Loomis Reef		Fig. 12K
	Roboastra gracilis (Bergh, 1877) *R. cf gracilis*	July 1999 Aug. 2002 Jan. 2003 Nov. 2003 – Jan. 2004 Aug.–Sept. 2004	HW IB	Osprey Islet, Loomis Reef, Off Bird Island, North Point, Osprey Island, Palfrey Island, Horseshoe Reef		Fig. 12L,M Wägele and Johnson 2001
	Roboastra luteolineata (Baba, 1936)	Dec. 2003		Off South Island outer Reef		
	Tambja limaciformis (Eliot, 1908)	Oct. 2003		Horseshoe Reef		Fig. 12S
	Tambja morosa (Bergh, 1877)	July 1999	HW	Off Bird Island outer reef		Fig. 12O
	Thecacera spec.	Aug. 2002	HW	Cobia Hole	+	Fig. 5B
	Thorunna furtiva Bergh, 1878	July 1999, July 2002	HW	North Point Blue Lagoon		Fig. 12N
	Trapania cf. *aurata* Rudman, 1987	July 2002	HW	North Point		Fig. 12P
	Trapania reticulata Rudman, 1987	Aug. 2002	HW	Bird Island Reef		Fig. 12R

Table 1 (cont.)

Higher Hierarchy	Species	Date of Observation	Loc. of material	Site and Habitat	New to GBR	Figured and/or published in:
Dendronotoidea						
	Bornella stellifer (A. Adams and Reeve in A. Adams, 1848)	July 1999, July 2002	HW HW	Ghost Beach intertidal, South Island intertidal		Fig. 13A
	Doto spec.	July 2002	HW	Coral rubble in Blue Lagoon	?	Fig. 5E
	Melibe mirifica (Allan, 1932)	Jan 2004		Watson Bay		Fig. 13B
"Arminoidea"						
	Dermatobranchus spec.	July 2002	HW	North Point		Fig. 5F Wägele and Johnson 2001
	Dermatobranchus fortunata Bergh, 1888	Sept. 2002 Aug.–Sept. 2004	HW IB	Coconut Beach intertidal, Horseshoe Reef	?	Fig. 13C Burghardt and Wägele 2006
	Lomanotus vermiformis Eliot, 1908	July 1999	HW	Off Bird Island outer reef		No picture
Aeolidoidea						
	Aeolid spec. 1	Dec. 2003	NA	Casuarina Beach	?	Fig. 5L
	Aeolid spec. 2	Aug. 2004	IB	Loomis		Fig. 5G
	Cerberilla annulata (Quoy and Gaimard, 1832)	Aug. 2002 Nov. / Dec. 2003	HW NA	Coconut Beach intertidal Loomies Reef sand flat	+	Fig. 13D
	Cerberilla spec.	Jan. 2004	NA	Casuarina Beach	?	Fig. 5M
	Cuthona sibogae (Bergh, 1905)	July 1999, July 2002	HW	Off Bird Island outer reef, Cobia Hole		Fig. 13E Wägele *et al.* 2003
	Embletonia gracilis Risbec, 1928	July 2002 Sept. 2002	HW	South Island intertidal, Coconut Beach	+	Fig. 13F, G
	Eubranchus rubropunctatus Edmunds, 1969	July 1999	HW	South Island intertidal		
	Eubranchus spec.	Nov. 2003		Casuarina Beach	?	Fig. 5H
	Facelina rhodopos Yonow, 2000	Sept. 2002	HW	Coconut Beach	+	Fig. 13H
	Favorinus japonicus Baba, 1949	Aug.–Sept. 2004	IB	Loomis Reef		Fig. 13I
	Flabellina bicolor (Kelaart, 1858)	July 2002 Sept. 2002 Nov. / Dec. 2003 Aug.–Sept. 2004	HW IB	North Point, Coconut Beach, Blue Lagoon, Bird Island		Fig. 13K
	Flabellina bilas (Gosliner and Willan, 1991)	Dec. 2003		Wickies Reef		Fig. 13L
	Flabellina exoptata Gosliner and Willan, 1991	July 1999 Febr. 2003 Nov. 2003 Jan. 2004	HW	Osprey Islet, off Bird Island outer reef, Horseshoe Reef, Reef crest Bird Islet, Watson Bay, Blue Lagoon		Fig. 13N Wägele and Johnson 2001

Higher Hierarchy	Species	Date of Observation	Loc. of material	Site and Habitat	New to GBR	Figured and/or published in:
	Flabellina rubrolineata (O'Donoghue, 1929)	July 2002 Jan. 2004 Aug.–Sept. 2004	HW IB	North Point, Coconut Beach, Washing Machine		Fig. 13M
	Godiva spec.	Jan. 2003 Oct. 2003 – Jan. 2004	NA	Casuarina Beach	?	Fig. 5K Wells and Bryce 2000
	Godiva cf. *quadricolor* (Barnard, 1927)	Jan. 2004		Casuarina Beach, Lizard Head	+	Fig. 13R
	Phestilla lugubris (Bergh, 1870)	Aug.–Sept. 2004	IB	Loomis Reef		Fig. 13O Burghardt and Wägele 2006
	Phidiana indica (Bergh, 1896)	Jan. 2004		Bird Islet		Fig. 13P
	Phyllodesmium briareum (Bergh, 1869)	July 1999, July 2002	HW	Cobia Hole, Cobia Hole, North Point		Fig. 13S Wägele and Johnson 2001 Wägele *et al.* 2003 Burghardt *et al.* 2005 Burghardt and Wägele 2006
	Phyllodesmium cf. *hyalinum* Ehrenberg, 1831	Aug.–Sept. 2004	IB	Loomis Reef, Horseshoe Reef		Fig. 13U,V
	Phyllodesmium longicirrum (Bergh, 1905)	Oct. 2001 Jan. 2003 June 2003 Nov. 2003 – Jan. 2004	NA	Washing Machine, Blue Lagoon, Horseshoe Reef, Wickies Reef		
	Phyllodesmium spec.	Aug.–Sept. 2004	IB	Bird Island	+	Fig. 5I
	Pteraeolidia ianthina (Angas, 1864)	July 1999, July 2002 Sept. 2002 June 2003 Nov. 2003 – Jan. 2004	HW	South Island, Osprey Islet, Coconut Beach intertidal, Blue Lagoon, Bird Island, Mangrove Beach, Palfrey Island, Bird Islet outer crest, crest, Watson Bay		Fig. 13T Wägele and Johnson 2001 Burghardt *et al.* 2005

Table 2 Comparison of the total number of opisthobranch species (data taken from literature) from different Indo-Pacific areas.

Area	Authors	Total number of species	Collection Time Period
Papua New Guinea	Gosliner 1992	538	Not indicated
Great Barrier Reef	Marshall and Willan 1999	414	18 years episodic
Heron Island	Marshall and Willan 1999	261	18 years episodic
Fiji Islands	Brodie and Brodie 1990	251	4 years continuous
Marshall Islands	Johnson and Boucher 1983	101	3 years continuous
Lizard Island	Present paper	158	5 years episodic

side of the Island were relatively under sampled because of rough weather conditions during many visits. Therefore, the species numbers presented here are preliminary in terms of the coverage of different habitat types.

Data of opisthobranch species richness from other tropical Pacific areas are available i.e. New Caledonia (Bouchet *et al.* 2002), Papua New Guinea (Gosliner 1992), Fiji (Brodie and Brodie 1990, 1995) and Marshall Islands (Johnson and Boucher 1983) (see Figure 2). Direct comparison is not possible, since these areas differ geographically and in size, and collection times were much longer in some studies than others (see table 2). E.g., collection on Heron Island (Great Barrier Reef) occurred over a period of 18 years with 27 field trips (Marshall and Willan 1999). Nevertheless, similar trends in the different opisthobranch subgroups are obvious for all investigated regions. All major groups of the Opisthobranchia are represented in comparable proportions and the Doridoidea are the species richest group.

Since Mikkelsen (1996, 2002) published her detailed phylogenetic analyses on the Cephalaspidea, the Acteonoidea are excluded from the Cephalaspidea, or even from the Opisthobranchia. For this reason Marshall and Willan (1999) did not include this taxon in their extensive studies on Heron Island. Therefore, in Figure 2, a zero is indicated in these two sections of their data (Great Barrier Reef column nr. 3, Heron Island column nr. 4), indicating lack of data, but not absence of this group. Gosliner (1992) did not list the Acteonoidea separately for Papua New Guinea, but the species numbers are added to the Cephalaspidea (71 species in total). All other checklists listed the Acteonoidea as a separate group as we do in this study.

Anaspidea are well represented on Lizard Island (33 % of all known Indo Pacific species – see Coleman 2001), but locality sites with high abundance of macroalgae have hardly been investigated, especially the *Halimeda* habitats in front of Bird Island.

58 sacoglossan species are recorded by Coleman (2001) from the Indo Pacific and Gosliner's (1992) numbers from Papua New Guinea are even higher. Twenty-one species are now recorded from Lizard Island with probably four undescribed species (Figure 4).

Tylodinoidea are only known from very few species (about 15 worldwide), and only two species (*Tylodina corticalis*, *Umbraculum umbraculum*) are recorded from Australian waters (Willan 1998). None of them were found on Lizard Island.

The highest species numbers in the Indo-Pacific are given for the Doridoidea (Coleman 2001: 420 species) and this taxon also shows the highest diversity on Lizard Island with 66 species, representing 16% of recorded Indo-Pacific dorids. Nevertheless, compared to other areas, this number is low. A thorough investigation of the sponge fauna might reveal many more species, especially cryptic ones.

The number of dendronotoidean (3) and arminoidean (3) species is low, whereas aeolidoideans are represented with more species (23). This is in line with the studies on other sites. Some *Dermatobranchus* species (Arminidae) are known to house zooxanthellae (Wägele and Johnsen 2001), and were specially looked for during one project on "solarpowered" seaslugs. The new *Dermatobranchus* species found in low depths down to 5 m was very small (less then 10 mm) and highly cryptical due to the stored zooxanthellae.

This study is the base for further investigation on the opisthobranch biodiversity on a site, which lies between well studied areas in the South of the Great Barrier Reef (Heron Island) and the tropical Islands north of Australia (e.g. Papua New Guinea).

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