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The Australian Museum Lord Howe Island Expedition 2017—Marine Invertebrates

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Abstract. Despite less than perfect oceanic conditions generated by tropical cyclone *Debbie* in 2017, a field team from the Australian Museum Research Institute sampled marine invertebrates from multiple habitat types around Lord Howe Island. Collections were made during two weeks in March–April 2017 from intertidal sand-flats and reefs, and from subtidal habitats using SCUBA. Hand collecting was supplemented with limited use of traps. Protocols emphasized fixation and preservation methods that favour molecular approaches to systematics. One hundred and thirteen samples were collected from 16 sites. The samples contain multiple phyla, with the predominant taxa targeted being Mollusca, Crustacea and Polychaeta. Many samples still need to be sorted and analysed in detail. Lysiosquilloid mantis shrimps and axiidean ghost shrimps, the isopod taxa *Cirolana*, Joeropsididae and Stenetriidae, polychaete species of *Hydroides, Serpula*, and *Vermiliopsis*, and the blanket octopus *Tremoctopus gracilis* (Eydoux & Souleyet, 1852) are recorded for the first time from Lord Howe Island.

Keywords. Mollusca; Crustacea; Polychaeta; biogeography

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From 26 March to 6 April 2017, a field team from the Australian Museum Research Institute sampled invertebrates from a range of marine habitats around Lord Howe Island (Fig. 1) by hand collecting intertidally and also using scuba to depths of 18 m (Figs 2–4). Within the limited time available the sampling attempted to cover a diverse cross-section of previously recognized habitats and substrates (Marine Parks Authority, 2010). These included the inner lagoon, outer fringing reefs, beaches, rock platforms, seagrass, coral rubble, sediment, and algal turf. To supplement the main collection methods, attempts were also made to collect specimens using baited traps (Keable, 1995) and octopus pots, but unfortunately there was little opportunity to deploy these successfully due to unfavourable weather.

The Lord Howe Island Group (including the adjacent Balls Pyramid) are the only emergent features on the Lord Howe Rise in the Tasman Sea between Australia and New Zealand. Lord Howe Island includes the southernmost coral reef, but given its isolated southerly position, also supports a mixture of tropical and temperate species, many of them endemic.

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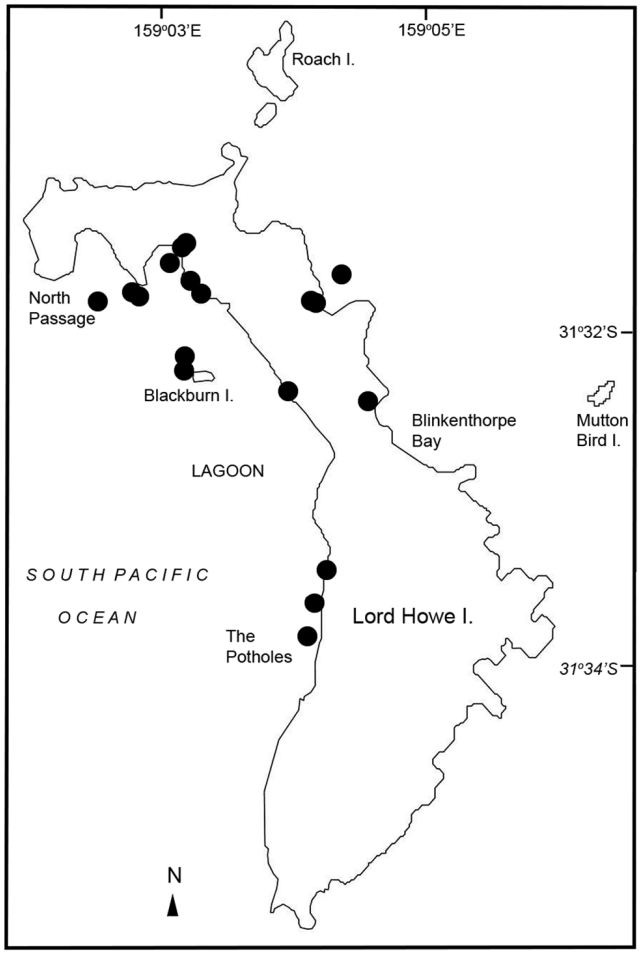


Figure 1. Map of Lord Howe Island showing collection sites indicated by black dots (Balls Pyramid not shown).

Taxonomic groups targeted were selected to support research projects underway at the Australian Museum and the Western Australian Museum, as well as build collections for future study and fill knowledge gaps for Lord Howe Island. For example, in a recent summary describing the Lord Howe Island Marine Park it has been noted that, "A lack of systematic surveys of many invertebrate groups, such as the crustaceans, means that the extent of their diversity is likely to be greatly underestimated" (Marine Parks Authority, 2010). Focus taxa for the 2017 expedition were principally Mollusca, Crustacea and Polychaeta.

Major historical collections of marine invertebrates that are available from Lord Howe Island are typically composed of dry or formalin-fixed specimens, and while there have been some recent breakthroughs in DNA extraction methodologies, in most cases this remains an obstacle to readily utilizing genetic analysis in contemporary systematic studies (Schander & Halanych, 2003; Hykin *et al.*, 2015). To address this, the field protocols of the 2017 expedition emphasized fixation and preservation methods that favour molecular systematic approaches. Operculate gastropods and bivalves were treated using the *Niku-nuki* method (Fukuda *et al.*, 2008) prior to fixation. This method involves rapid immersion in hot water so the animal dies rapidly with the operculum or valves open, thus enabling subsequent penetration by fixative. The majority of specimens were fixed in 80% or full strength ethanol and/or small samples of tissue were taken for long-term storage at -80°C. For some taxa, additional specimens were fixed in 7–10% formalin, primarily for morphological examination. All collected material is deposited in the Australian Museum.

Near perfect weather conditions for fieldwork were encountered during the initial four days of the sampling period, before the effects of tropical cyclone *Debbie* made subtidal collecting impractical until the circumstances improved again on the final day. Overall, 113 samples were collected (not including an opportunistic sample received from another group at Balls Pyramid) most of which require further sorting prior to identification. The sampled sites, all outside designated Sanctuary Zones, are shown in Fig. 1.

Preliminary results

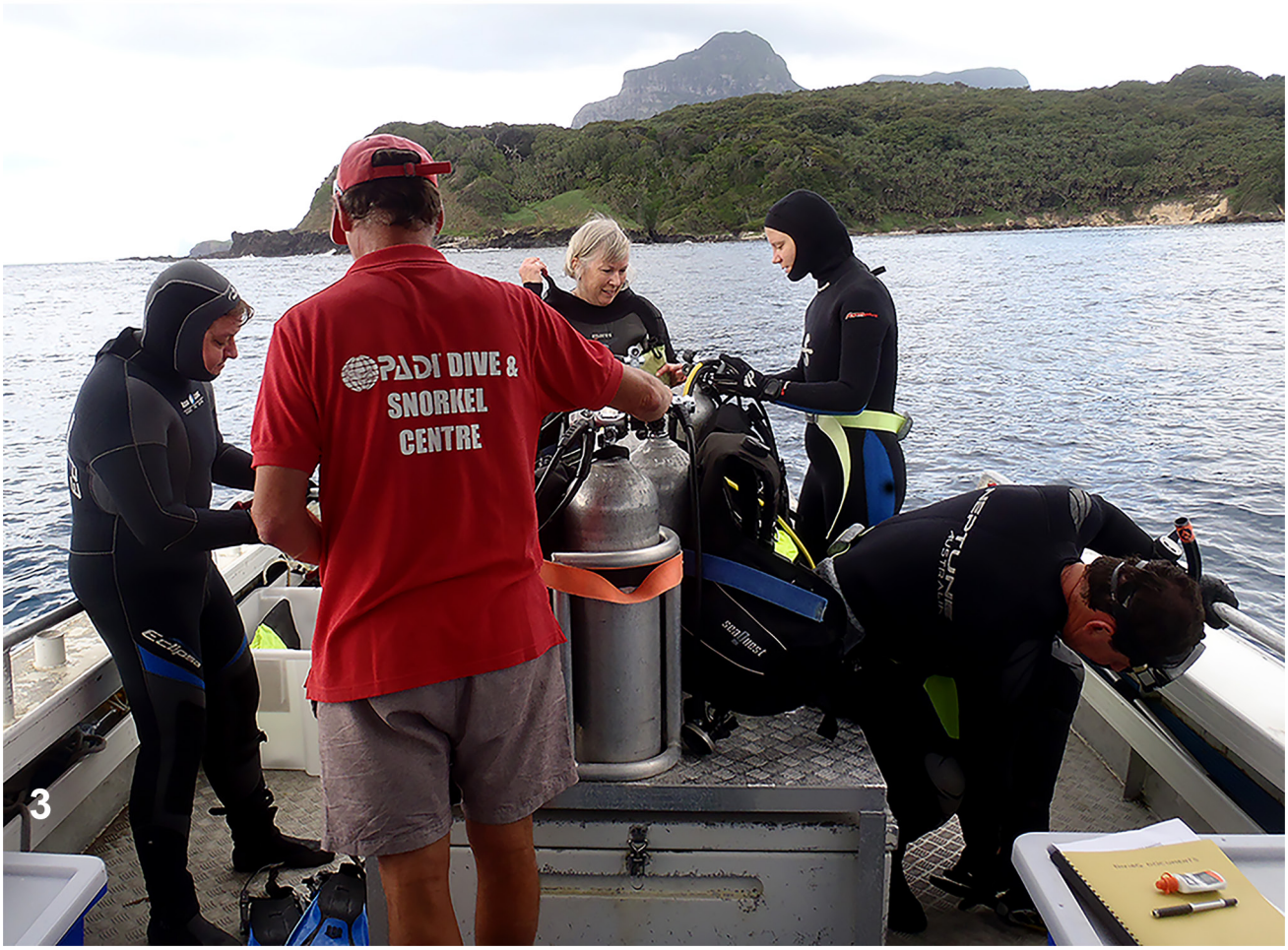
Table 2 summarizes the taxa recognized in the marine invertebrate collections made during the expedition and the current number of specimen "lots" (each with one or more specimen(s) identified to a particular taxonomic category) that have been separated for each. Comments are restricted here to the target groups Mollusca, Crustacea and Polychaeta. Approximately ten samples have residual substrate material that may retain further specimens, sorting of this remainder is ongoing.

For Mollusca (snails, clams etc.), the number of new marine registered lots presently stands at 465. Of these, 363 tissue samples have been added to the Australian Museum frozen tissue collection. This tally will rise considerably as further identifications are made. Ninety-six mollusc taxa have so far been identified, including a new record of the octopod *Tremoctopus gracilis* (Eydoux & Souleyet, 1852) that was given to NSW DPI from a local fisherman prior to our visit to the island.

A total of 321 micromollusc specimens were collected, live-imaged, and preserved specifically for current and future DNA work (Figs 5–6). The Australian micromollusc fauna is incredibly diverse (Middelfart *et al.*, 2016) and the least known of the mollusc fauna with many endemic taxa thought to exist at Lord Howe Island. To date 66 families from four classes of mollusc are represented in the 2017 collections, and the discovery of several new species is expected. Some micromolluscs were retrieved from sand and gravel samples that were elutriated in seawater, others were collected from rock scrubbings and coral rubble, and some were found on algae (the latter tend to crawl off the algae when it is left to soak in trays for several hours without aeration). These collections represent a small survey of Lord Howe Island's micromollusc community and will be invaluable for future research.

Crustacean specimens sorted to date are from several major orders or higher level groupings including: Amphipoda, Cirripedia, Copepoda, Decapoda (Figs 8–9), Isopoda, Ostracoda, Stomatopoda and Tanaidacea. Comments are restricted here to the decapods, isopods and stomatopods, the only groups where there has been a limited amount of more than superficial examination at this point.

Stomatopoda (mantis shrimps) comprise a modest component of the crustaceans collected (6 specimens; 3 species). Among these, however, a new species of the genus *Acaenosquilla* was collected from intertidal sand-flats using a suction pump (also known as a bait or "yabby" pump; Hailstone & Stephenson, 1961). Significantly, this new species of *Acaenosquilla* also represents the first record of the family and superfamily from Lord Howe Island, and is morphologically most closely related to *A. brazieri* from eastern Australia (Ahyong, 2001). The genus *Acaenosquilla* is most closely related to *Pariliacantha* from New Zealand (Ahyong, 2012), so the discovery of a species of *Acaenosquilla* on the southern Lord Howe Rise, at an intermediate locality between mainland Australia and New Zealand, is biogeographically parsimonious.



Figures 2–3. The team at work: *(2)* Kara Layton exiting a scuba dive assisted by Darcie Bellanto, Lord Howe Island lagoon 2017, prior to weather influenced by tropical cyclone *Debbie* (photo by S. Keable); *(3)* preparing for a SCUBA dive east of Middle Beach (from left: Elena Kupriyanova, Brian Busteed, Mandy Reid, Kara Layton, Steve Keable) (photo by A. Miller).

Figure 4. Intertidal marine invertebrate collecting site, Signal Point, as weather influenced by tropical cyclone abates (Alison Miller and Alex Hegedus at the right of the scene) (photo by S. Keable).

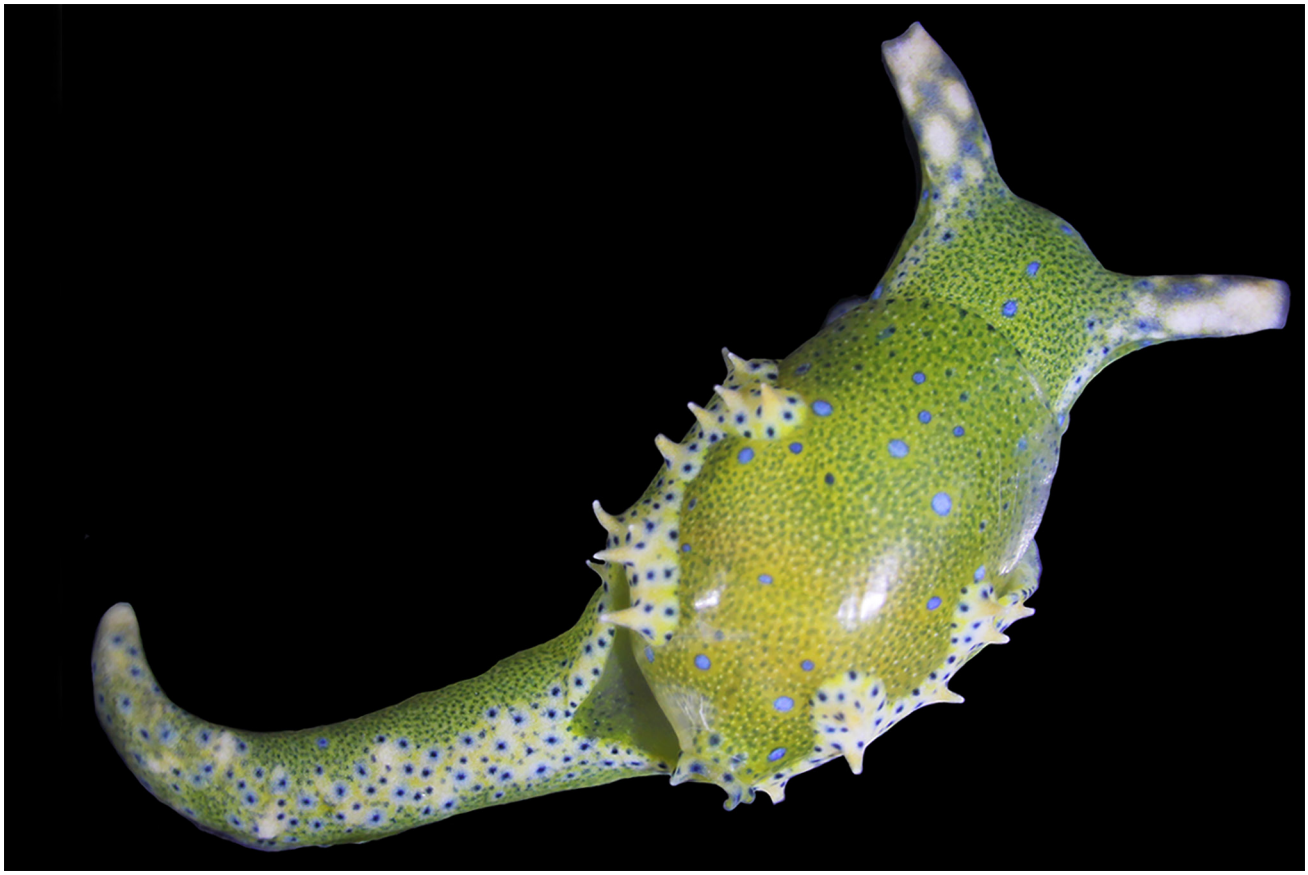


Figure 5. Collected during 2017 Australian Museum Expedition to Lord Howe Island, this bubble snail, Oxynoidae, *Oxynoe* sp., is camouflaged among the algae on which it feeds. (Photo by K. Layton).

Figures 6–7. Marine invertebrates from 2017 Australian Museum Expedition to Lord Howe Island: *(6)* Columbellidae, *Aesopus* sp. (photo by K. Layton); *(7)* serpulid polychaete, *Spirobranchus taeniatus*, partly removed from its calcareous tube (photo by A. Reid).

The Decapoda (crabs, shrimps, lobsters) collected includes at least 129 registered lots spanning at least 16 families. Collections were dominated by reef crabs and hermit crabs taken by hand directly from substrate or taken together with sampled habitat, such as algal turf and rubble. Smaller numbers of the fast moving caridean shrimps were also collected, primarily by netting. The decapod collection awaits detailed taxonomic evaluation, but immediately noteworthy specimens include a possibly new species of ghost shrimp, *Calliaxina* (Eucalliacidae). These ghost shrimp specimens were collected from deep sand-flat burrows by suction pump together with the new species of mantis shrimp (*Acaenosquilla* sp.), and represent the first records of axiidean shrimp from Lord Howe Island.

Terrestrial and littoral isopods of Lord Howe Island have received attention in several publications (Lewis, 1998; Lillemets & Wilson, 2002), and a high diversity and degree of endemicity has been noted. The shallow water marine isopods have not received the same attention but are recorded as one of the more widespread and common components of lagoon sediments (Marine Parks Authority, 2010). Isopods from the 2017 expedition are yet to be

Figures 8–9. Marine invertebrates from 2017 Australian Museum Expedition to Lord Howe Island: *(8)* crab, *Caphyra laevis* on host soft coral, *Heteroxenia* (photo by A. Reid); *(9)* marbled cleaner shrimp *Saron marmoratus* (photo by K. Layton).

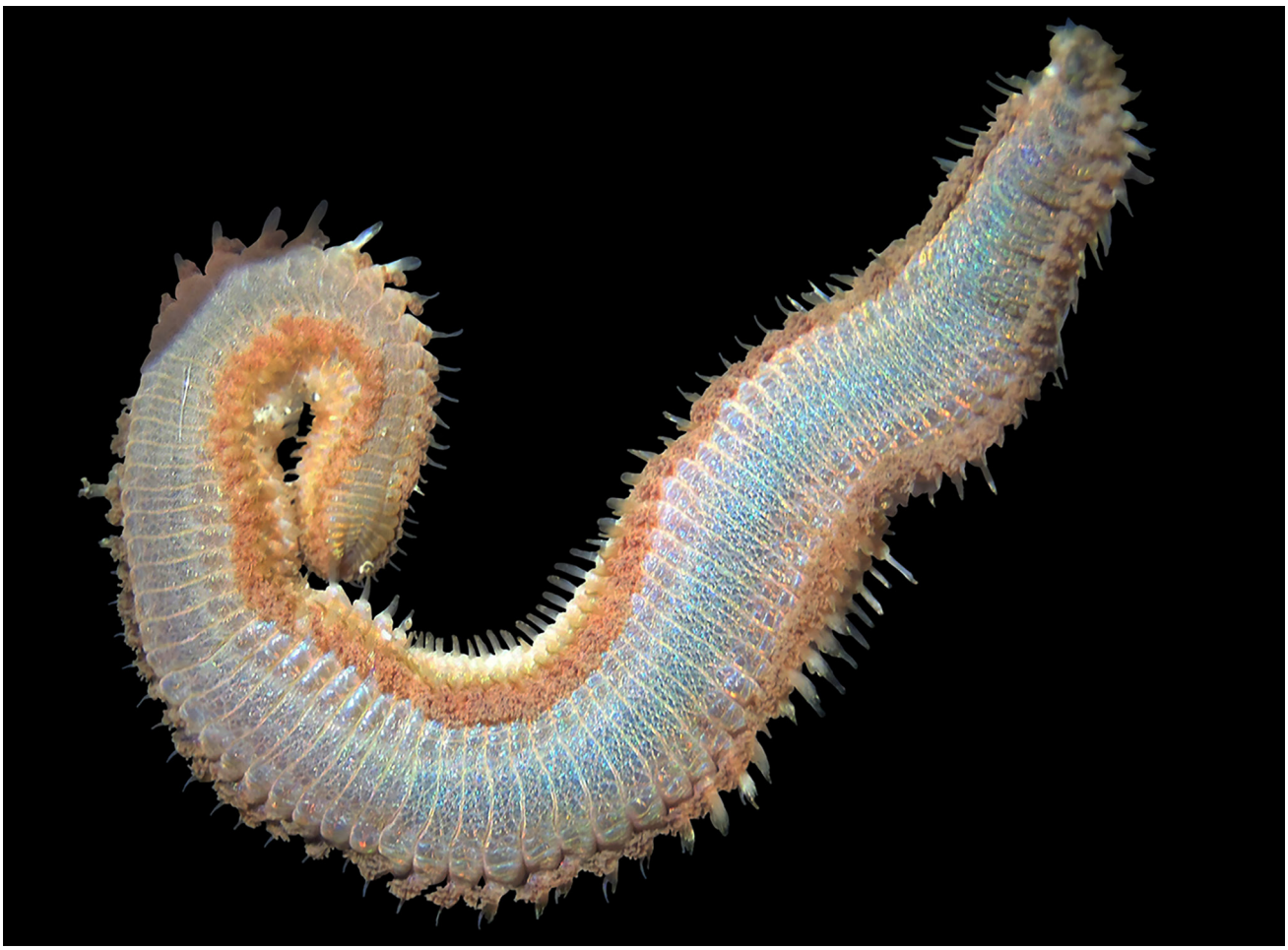


Figure 10. Fireworm, Amphinomidae, *Eurythoe* (photo by A. Reid).

extracted from all samples but over 30 lots have been sorted into the suborders Asellota (including families Joeropsididae, Munnidae and Stenetriidae), Cymothoida (including species of the superfamily Anthuroidea, *Cirolana* and Infraorder Epicaridea), Oniscidea and Sphaeromatoidea (family Sphaeromatidae), following the classification recognized in WoRMS (2017). Sphaeromatidae occur in over 25% of the total samples collected, including a wide range of intertidal and subtidal substrates. Asellota occur in at least 15% of the samples whereas other isopod taxa have been found in less than 10% of the sorted collection. Several specimens of *Cirolana* were obtained in two baited trap samples set in 3–10 m depth in the lagoon and an additional specimen was found in intertidal algae. A single small sample of the oniscidean *Actaecia bipleura* Lewis and Green, 1994 was collected from the supralittoral area of Lagoon Beach, adjacent to Signal Point, under rocks, and marine and terrestrial plant debris. Reference to the Australian Faunal Directory (ABRS, 2017) and the Atlas of Living Australia (2017) shows *Cirolana*, Joeropsididae and Stenetriidae to be previously unreported from Lord Howe Island.

An interesting collection of marine Annelida (known as Polychaeta) was made during the expedition. The main methods of polychaete collecting were gathering substrate (mostly pieces of dead corals and algal tuft) by scuba divers or intertidally. In the laboratory, the coral substrate was broken into pieces and left for several hours before being washed through a set of sieves and sorted under the microscope to extract the animals. Conspicuous, large-bodied polychaetes, such as representatives of the families Amphinomidae (fireworms) (Fig. 10) or Eunicidae (blood worms) were hand-collected from the underside of intertidal rocks. The large serpulid, *Spirobranchus corniculatus*, a common associate of corals throughout the Indo-West Pacific, was not observed or collected in the lagoon, but collection of smaller serpulid polychaetes (e.g., Fig. 7) included at least the first records for Lord Howe Island for the genera *Hydroides, Serpula*, and *Vermiliopsis*. Further taxonomic assessment using molecular techniques will determine whether any of these constitute new species. There has never before been a published study describing the biodiversity of marine annelids of Lord Howe Island and current historical collections of the Australian Museum include 123 registered lots from 12 families. When the smaller infaunal polychaetes are fully analysed, we expect our understanding of the polychaete biodiversity of Lord Howe Island to be significantly improved. We also plan to compare these findings with more extensive collections made at nearby Elizabeth and Middleton reefs in the late 1980s during a two-week intensive Australian Museum Expedition which revealed several endemic species for some other invertebrate groups.

Conclusion

When curation of the 2017 expedition material is complete and further identifications have been made, it is planned to combine the new records with existing information from the Australian Museum collection registration database and other sources, to produce a checklist of the marine invertebrates of Lord Howe Island as a resource for future ecological, taxonomic, biogeographic and conservation research.

Table 2. Taxa recognized in the marine invertebrate collections made during the expedition and the number of samples that have been separated for each to date.

		No. of registered lots to date	No. of unregistered lots sorted to date
Annelida	Polychaeta	41	c.126
Arthropoda			
	Crustacea: Amphipoda	2	c.70
	Crustacea: Cirripedia	3	—
	Crustacea: Copepoda	23	—
	Crustacea: Decapoda	126	—
	Crustacea: Isopoda	—	c.37
	Crustacea: Ostracoda	12	—
	Crustacea: Stomatopoda	6	—
	Crustacea: Tanaidacea	24	—
	Pycnogonida	10	—
Bryozoa		3	—
Chordata	Ascidiacea	7	—
Cnidaria		37	—
Echinodermata		37	—
Hemichordata		1	—
Mollusca		—	c.176
	Bivalvia	43	—
	Cephalopoda	4	—
	Gastropoda	412	—
	Polyplacophora	6	—
Nemertea		1	—
Platyhelminthes		7	—
Porifera		21	—
Sipuncula		8	—

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Table 1. Sample collection sites and substrates. Abbreviations: *BT*, baited trap; *DN*, dip net and night light; *E*, east; *HC*, hand-collected, *HCS*, hand-collected on scuba; *N,* north; *SN*, sweep net; *SW*, southwest; *W*, west; *YP*, yabby pump. Depths are in metres. * Sample numbers correspond to *Collection Event* records. They are catalogued in the Australian Museum *EMu* database in the format LHI2017mmmdd_nnn, where *mmm* refers to month (abbreviation), *dd* refers to day, and *nnn* refers to the sample number (for example, the full *Collection Event* code for the first record is LHI2017Mar26_001). (Sample 23 has been omitted as it refers to a terrestrial sample.)

*	Location	Latitude	Long.	Depth	Date	Method	Substrate
1	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	encrusted rocky reef
2	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	rocky ledge on reef
3	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	rocky ledge on reef
4	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	sand and coral rubble under reef ledge
5	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	mixed sponges and soft coral
6	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	coral rubble from crevices
7	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	green sponges
8	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	encrusted hard substrate with some sponge and gelatinous green algae
9	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	sponge
10	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	red algae
11	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	sediment and rubble
12	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	black Crinoidea
13	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	purple Bryozoa
14	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	under ledge
15	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	tube sponge
16	southern end of Old Settlement Beach	-31.52	159.06	0–1	26 Mar	HC	rock
17	southern end of Old Settlement Beach	-31.52	159.06	1.5	26 Mar	DN	seagrass
18	southern end of Old Settlement Beach	-31.52	159.06	0	26 Mar	HC	seagrass
19	southern end of Old Settlement Beach	-31.52	159.06	0	26 Mar	HC	under rocks
20	southern end of Old Settlement Beach	-31.52	159.06	0	26 Mar	HC	floating seagrass and algae
21	southern end of Old Settlement Beach	-31.52	159.06	0.5–1.5	26 Mar	HC	sediment at base of seagrass
22	E of Middle Beach	-31.52	159.08	16–18	26 Mar	HCS	algae *Caulerpa*
24	Kings Beach	-31.56	159.08	0	27 Mar	HC	clumps of red algae from consolidated beach rock
25	Kings Beach	-31.56	159.08	0	27 Mar	HC	green algal turf from consolidated beach rock
26	Kings Beach	-31.56	159.08	0	27 Mar	HC	brown algal turf from consolidated beach rock
27	Kings Beach	-31.56	159.08	0	27 Mar	HC	gelatinous green algae from consolidated beach rock
28	Kings Beach	-31.56	159.08	0–1.5	27 Mar	HC	under and on rock boulders
29	Kings Beach	-31.56	159.08	0–1.5	27 Mar	HC	under and on rock boulders
30	Kings Beach	-31.56	159.08	0–1.5	27 Mar	HC	*Caulerpa* on rock boulders
31	Kings Beach	-31.56	159.08	0–1.5	27 Mar	HC	red algae on rock boulders
32	Kings Beach	-31.56	159.08	0–1.5	27 Mar	HC	sediment from around rock boulders
33	Middle Beach, intertidal rock platform	-31.53	159.07	0	27 Mar	HC	on and under rocks
34	Middle Beach, intertidal rock platform	-31.53	159.07	0	27 Mar	HC	on echinoderms
35	Middle Beach, intertidal rock platform	-31.53	159.07	0	27 Mar	HC	algae *Caulerpa*
36	lagoon, W of Old Settlement Beach	-31.52	159.06	3	27 Mar	BT	
37	lagoon, SW of Dawsons Point	-31.53	159.05	10	27 Mar	BT	
38	lagoon, north E of Blackburn (Rabbit) Island	-31.53	159.06	3	27 Mar	BT	
39	Middle Beach, intertidal rock platform	-31.53	159.07	0	27 Mar	HC	brown algae with masses of small brown ascidians
40	Kings Beach	-31.56	159.08	0–1.5	27 Mar	HC	soft coral *Xenia elongata* from rock
41	Kings Beach	-31.56	159.08	0–1.5	27 Mar	HC	brown algae under and on rock boulders
42	lagoon under jetty	-31.52	159.06	2	28 Mar	HCS	pylon and tape wrapped around it
43	lagoon under jetty	-31.52	159.06	2–3	28 Mar	HCS	under and on rocks
44	lagoon under jetty	-31.52	159.06	2–3	28 Mar	HCS	sand
45	lagoon under jetty	-31.52	159.06	2–3	28 Mar	HCS	brown algae
46	lagoon under jetty	-31.52	159.06	2–3	28 Mar	HCS	plastic wrapping on pylons
47	lagoon, 'The Potholes'	-31.56	159.07	3	28 Mar	HCS	sand
48	lagoon, 'The Potholes'	-31.56	159.07	3	28 Mar	HCS	coral rubble
49	lagoon, 'The Potholes'	-31.56	159.07	3	28 Mar	HCS	algae growing over coral
50	lagoon, 'The Potholes'	-31.56	159.07	3	28 Mar	HCS	under coral rubble
51	lagoon, 'The Potholes'	-31.56	159.07	3	28 Mar	HCS	sediment
52	Old Settlement Beach	-31.52	159.06	0.5–1.5	28 Mar	SN	seagrass
53	lagoon, north of Blackburn (Rabbit) Island	-31.53	159.06	3	28 Mar	BT	patchy sand near reef
54	lagoon ... Blackburn (Rabbit) Island[a]	-31.53	159.06	4	29 Mar	HCS	coral rubble
55	lagoon ... Blackburn (Rabbit) Island[a]	-31.53	159.06	4	29 Mar	HCS	red algae
56	lagoon ... Blackburn (Rabbit) Island[a]	-31.53	159.06	4	29 Mar	HCS	sediment from gully next to seagrass
57	lagoon ... Blackburn (Rabbit) Island[a]	-31.53	159.06	4	29 Mar	HCS	green algae
58	lagoon ... Blackburn (Rabbit) Island[a]	-31.53	159.06	4	29 Mar	HCS	seagrass
59	Old Settlement Beach	-31.52	159.06	0	29 Mar	YP	intertidal sand
60	Old Settlement Beach	-31.52	159.06	0	29 Mar	HC	sand

... / continued

Table 1 (continued).

*	Location	Latitude	Long.	Depth	Date	Method	Substrate
61	Kings Beach	-31.56	159.08	0	29 Mar	BT	intertidal rock boulders and consolidated beach rock
62	South Reef	-31.56	159.07	0	29 Mar	HC	under intertidal rocks
63	either side of Jetty	-31.52	159.06	0	29 Mar	HC	under rocks on sand
64	boat ramp ... Old Settlement Beach[b]	-31.52	159.06	0	29 Mar	HC	under rocks on sand
65	creek ... Old Settlement Beach[c]	-31.52	159.06	0.1	29 Mar	DN	water column
66	creek ... Old Settlement Beach[c]	-31.52	159.06	0	29 Mar	HC	intertidal sand beach
67	Balls Pyramid	-31.75	159.25	0	29 Mar	HC	intertidal rocks
68	Old Settlement Beach	-31.52	159.06	0	29 Mar	HC	intertidal rocks
69	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	red algae
70	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	green finger sponge
71	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	green algae
72	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	coral rubble
73	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	
74	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	algae *Caulerpa*
75	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	sediment
76	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	encrusted rock
77	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	encrusted flat reddish/brown algae
78	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	reddish/brown low encrusting sponge
79	outer reef slope S side of North Passage[d]	-31.53	159.05	10–17	30 Mar	HCS	red algae
80	Kings Beach	-31.56	159.08	0	30 Mar	BT	intertidal consolidated beach rock and boulders
81	creek at south end of Old Settlement Beach	-31.52	159.06	0	30 Mar	HC	debris under mangroves
82	Old Settlement Beach	-31.52	159.06	0	01 Apr	HC	sediment
83	Old Settlement Beach	-31.52	159.06	0	01 Apr	HC	seagrass and sediment
84	Middle Beach	-31.53	159.07	0	01 Apr	HC	around and under upper intertidal rocks
85	Blinky Beach	-31.54	159.08	0	01 Apr	HC	on and under rocks
86	Blinky Beach	-31.54	159.08	0	01 Apr	HC	on sand
87	Old Settlement Beach	-31.52	159.06	0.5–1	01 Apr	DN	seagrass and sediment
88	Old Settlement Beach	-31.52	159.06	0	01 Apr	HC	mixed algae washed up on beach
89	Old Settlement Beach	-31.52	159.06	0	01 Apr	HC	sediment next to seagrass
90	Signal Point	-31.53	159.06	0	02 Apr	HC	sand off rocky point
91	Signal Point	-31.53	159.06	0	02 Apr	HC	on and under rocks, algal scrapings
92	Middle Beach	-31.53	159.07	0–0.5	04 Apr	HC	red/brown algae
93	Middle Beach	-31.53	159.07	0–0.5	04 Apr	HC	*Caulerpa* / green algae
94	Middle Beach	-31.53	159.07	0–0.5	04 Apr	HC	green algae
95	Middle Beach	-31.53	159.07	0–0.5	04 Apr	HC	sediment
96	Signal Point	-31.53	159.06	0	04 Apr	HC	intertidal rocks and rockpools, supralittoral, under rocks, and marine and terrestrial plant debris
97	Signal Point	-31.53	159.06	0	04 Apr	HC	intertidal rocks and rockpools, coralline algae
98	Signal Point	-31.53	159.06	0	04 Apr	HC	intertidal rocks and rockpools, algae washings and rock scrapings
99	Signal Point	-31.53	159.06	0	04 Apr	HC	intertidal rocks and rockpools, in, on, and under rocks and coral rubble
100	Signal Point	-31.53	159.06	0	04 Apr	HC	intertidal rocks and rockpools, sediment from under rocks in rockpool
101	Settlement Beach	-31.52	159.06	0	04 Apr	YP	intertidal sand
102	breakwall near runway	-31.54	159.07	0–0.5	05 Apr	HC	off rocks
103	breakwall near runway	-31.54	159.07	0–0.5	05 Apr	HC	brown algae
104	Signal Point	-31.53	159.06	0.5–1	05 Apr	HC	*Caulerpa*
105	Signal Point	-31.53	159.06	0.5–1	05 Apr	HC	brown algae off rocks
106	Signal Point	-31.53	159.06	0.5–1	05 Apr	HC	coral rubble
107	Signal Point	-31.53	159.06	0.5–1	05 Apr	HC	soft coral
108	lagoon, off snorkelling mooring	-31.52	159.05	2–2.7	06 Apr	HCS	sediment from sandy seagrass
109	lagoon, off snorkelling mooring	-31.52	159.05	2–2.7	06 Apr	HCS	sediment from under coral rubble
110	lagoon, off snorkelling mooring	-31.52	159.05	2–2.7	06 Apr	HCS	under coral rubble
111	lagoon, off snorkelling mooring	-31.52	159.05	2–2.7	06 Apr	HCS	*Caulerpa* (even branched)
112	lagoon, off snorkelling mooring	-31.52	159.05	2–2.7	06 Apr	HCS	branching coral
113	lagoon, off snorkelling mooring	-31.52	159.05	2–2.7	06 Apr	HCS	*Caulerpa* (bubble-like)
114	lagoon, off snorkelling mooring	-31.52	159.05	2–2.7	06 Apr	HCS	seagrass and base of seagrass
115	lagoon, off snorkelling mooring	-31.52	159.05	2–2.7	06 Apr	HCS	algae, *Chlorodesmis major*

[a] lagoon, N of moorings on N side of Blackburn (Rabbit) Island
[b] either side of boat ramp at Old Settlement Beach
[c] mouth of creek at south end of Old Settlement Beach
[d] outer reef slope southern side of North Passage