

An overview of the marine Isopoda (Crustacea) of Singapore

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Abstract. The marine isopod fauna of Singapore is reviewed on the basis of specimens collected during the Comprehensive Marine Biodiversity Survey of Singapore between 2010 and 2014. Museum collections and accepted literature records were also included. A total of 117 species in 64 genera and 19 families was documented. Of these 117 species, there were 37 new records for Singapore (including specimens representing 15 genera recorded for the first time from Singapore which were not identified to species) and a further 15 species possibly new to science. The 22 species that were identified and determined as new records for Singapore comprised eight families: one species of Aegidae, three species of Cirolanidae, three species of Cymothoidae, 11 species of Sphaeromatidae, one species of Stenetriidae, one species of Arthuridae, one species of Bopyridae and one species of Janiridae.

Key words. Johor Straits, Singapore Strait, Isopoda, Comprehensive Marine Biodiversity Survey.

INTRODUCTION

The isopod fauna of Singapore has been little documented despite its position as a major shipping, cultural and educational hub. Prior to 2010 (the start of the Comprehensive Marine Biodiversity Survey) only 37 species of Isopoda had been recorded. Singapore lies at the northern reaches of the ‘Indo-Malaysian triangle’ (Wallace et al., 2003, Hoeksema, 2007), but lacks oceanic waters and associated oceanic reefs. Inshore reefs, with a relatively high silt load, have lower isopod diversity than clear-water reefs with high water circulation. Notwithstanding, the intertidal and shallow subtidal shores can be expected to have the typical assemblage of families and species of Isopoda associated with tropical and coral reef shores. The results of this survey, though far from comprehensive, show that this is indeed the case.

The principle source of knowledge for Isopoda of the greater region is still the *Siboga* reports of Nierstrasz (1931a, b) and publications of Harriet Richardson (notably Richardson, 1910). Most of these historic accounts are based on subtidal sampling, and there a few comparable collections from shallow-water. In recent history, isopods from Southeast Asia have been minimally documented with contributions by Bruce & Olesen (2002), and Kussakin & Malyutina (1993), Müller (1992a–d, 1993a–c) and Malyutina (1995).

Despite its relatively small territory, Singapore does have a wide variety of marine habitats, and being placed within the ‘coral triangle’ can be expected to have a high diversity. Equal-area comparisons of diversity are difficult to make from the taxonomic literature, but the tropical and subtropical coast of Queensland, Australia is moderately well known. Queensland has a total recorded marine fauna of 360 species, the great majority of these species being from shallow water on the coast and coral reefs. Heron Island and Lizard Island have recorded isopod totals of 64 species and 62 respectively. Recent research under the Census of Marine Life CReefs (Australia) Project indicates that the isopod fauna from these two sites is three to four times as many species (personal estimations based on field collecting over three years), exceeding 200 species. In the short period of this Singapore survey the minimal total of species identified to OTU (identification is still ongoing) is 117 species, indicative of a marine isopod fauna of comparable diversity to that of the larger and more thoroughly researched Queensland coast.

MATERIAL AND METHODS

Specimens were collected during the Comprehensive Marine Biodiversity Survey between 2010 and 2014. The collection was supplemented by material obtained during two international workshops held in 2012 and 2013, the first which surveyed the northern shores of Singapore and Johor Straits, and the second which surveyed the southern islands of Singapore and Singapore Strait. Additional material obtained from pre-survey collections held at the Lee Kong Chian Natural History Museum (formerly the Raffles Museum of Biodiversity Research), and collections made in 2003 by Regina Wetzer (Natural History Museum of Los Angeles County) and the author were also examined and incorporated into the preliminary list. Collection methods comprised direct intertidal collecting, dredges, trawl, small Ockelmann sled and isopod traps (Keable, 1995); collections made in 2003

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used SCUBA, but in 2012 and 2013, SCUBA specimens were incidentally collected by general collectors.

Classification follows Brandt & Poore (2003). Literature cited includes authorities for all genus and species names. Key literature is cited in the family or superfamily text.

Species marked with ** are literature records, not collected during the two surveys. All species considered as undescribed are indicated by “sp. nov.”; species indicated by sp. could not be identified as a named or new species without further research; “cf.” is used to indicate similarity to a known species.

All specimens are deposited in the Lee Kong Chian Natural History Museum (LKCNHM), National University of Singapore (NUS) and Museum of Tropical Queensland (MTQ).

SINGAPORE ISOPODA SPECIES LIST

Information on isopods collected from the Comprehensive Marine Biodiversity Survey is provided in Tables 1, 2 and 3. The locations of intertidal and subtidal sites in the Singapore and Johor Straits where isopods were collected are indicated in Figures 1 and 2 respectively.

Suborder Cymothoidea Wägele, 1989

Aegidae White, 1850

The Aegidae is a small family, comprehensively reviewed by Bruce (2009). In Singapore the most commonly encountered genus is *Rocinela* Leach, 1818, all specimens belonging to a group of morphologically uniform species most similar to and probably including *Rocinela orientalis* Schioedte & Meinert, 1879b.

1. *Aega antennata* Richardson, 1910.
2. ***Aegiochus vigilans* (Haswell, 1881). (see Bruce 2009)
3. *Alitropus* cf. *typus* Milne Edwards, 1840.
4. *Rocinela* sp.
5. *Rocinela* sp. 1.
6. *Rocinela* sp. 2.
7. *Rocinela* sp. 3.

Cirolanidae Dana, 1852

The family Cirolanidae is well represented, with an assemblage of species typical of tropical waters and coral reefs throughout the Indo-West Pacific. *Cirolana* Leach, 1818 is represented by several species of both the ‘nodulose-group’ and ‘parva-group’ (Bruce, 1986a, 1995, 2004a) as well as genera such as *Aatolana* Bruce, 1993 (see also Keable, 1998) and *Dolichana* Bruce, 1986a (see also Keable, 1999), *Neocirolana* Hale, 1925 and miscellaneous species of no obvious affinity such as *Cirolana indica* Nierstrasz, 1931. The well-known genus and species *Excicrolana orientalis* (Dana, 1852) is present in suitable habitats, and while the genera *Eurydice* Leach, 1814 and *Metacirolana* Kussakin,

1979 were each collected only once, targeted collecting would yield more specimens and species.

Twenty-four species in nine genera of Cirolanidae were recorded during the Comprehensive Marine Biodiversity Survey, indicative of high diversity in the Singapore region. Trapping in deeper water (maximum depth for the survey was c. 40 m) and further off shore from the island would significantly increase the total. When this total is compared to the totals for other regions such as Heron Island (17 species in 7 genera), Lizard Island (19 species in 8 genera) or even South Africa (34 species in 9 genera), all regions with a longer history of collection and research on marine isopods, Singapore’s high diversity is unambiguous. The only region of comparable high diversity is Madang in Papua New Guinea, with 27 species in 11 genera, all within a site of about 6 km radius (Bruce, 1993; see Bruce 2004b, Table 1).

Unusual, particularly in the trap samples, is the near total absence of any species of *Natatolana* Bruce, 1981 (see also Keable, 2006), a world-wide marine genus, albeit with apparent low diversity in the northern Indo-West Pacific; only one specimen, taken in follow-up collecting in 2014.

8. ***Annina fustis* Bowman & Iliffe, 1991. Mangroves.
9. *Odysseylana* sp. 3 sp. nov.; ‘smooth dorsum’.
10. *Odysseylana* sp. 6 sp. nov.; smooth, truncate pleotelson.
11. *Odysseylana* sp. nov.
12. *Aatolana* sp. nov.
13. *Cirolana* sp. ‘parva-group’ #1.
14. *Cirolana* sp. ‘parva-group’ #2.
15. *Cirolana* sp. ‘parva-group’ #3.
16. *Cirolana indica* Nierstrasz, 1931.
17. *Cirolana willeyi* Stebbing, 1904. (Cai & Teo, 2012).
18. *Cirolana* sp. 1 sp. nov. ‘nodule tail small’.
19. *Cirolana* sp. 2 sp. nov. ‘nodule tail large’.
20. *Cirolana* sp. 4 sp. nov. ‘nodule tail smallest’.
21. *Cirolana* sp. 5 sp. nov. ‘smooth, rounded’.
22. *Cirolana* sp. 7 sp. nov. ‘nodule tail wide rami’.
23. *Cirolana* sp. 8 sp. nov. ‘pointed head’.
24. *Dolicholana porcellana* (Barnard, 1936).
25. *Dolicholana elongata* (Milne Edwards, 1840) (see Keable, 1999)
26. *Eurydice* sp. ‘orientalis-group’
27. *Excicrolana orientalis* (Dana, 1852).
28. ***Hansenolana anisopous* Stebbing, 1900. (see Bruce, 1986).
29. *Metacirolana* sp. (‘serrata group’)
30. *Natatolana* sp. nov.
31. *Neocirolana obesa* Hale, 1925.

Corallanidae Hansen, 1890

The Corallanidae is a small family with a strongly tropical distribution (Delaney, 1989). All genera except *Alcirona* Hansen, 1890 were represented in the collections, the two most commonly encountered being *Argathona* Stebbing, 1905 and *Lanocira* Hansen, 1890. *Tachaea* Schioedte & Meinert, 1879 is present in both marine and freshwater; in freshwater the genus is an ectoparasite of shrimps, such as *Macrobrachium*.

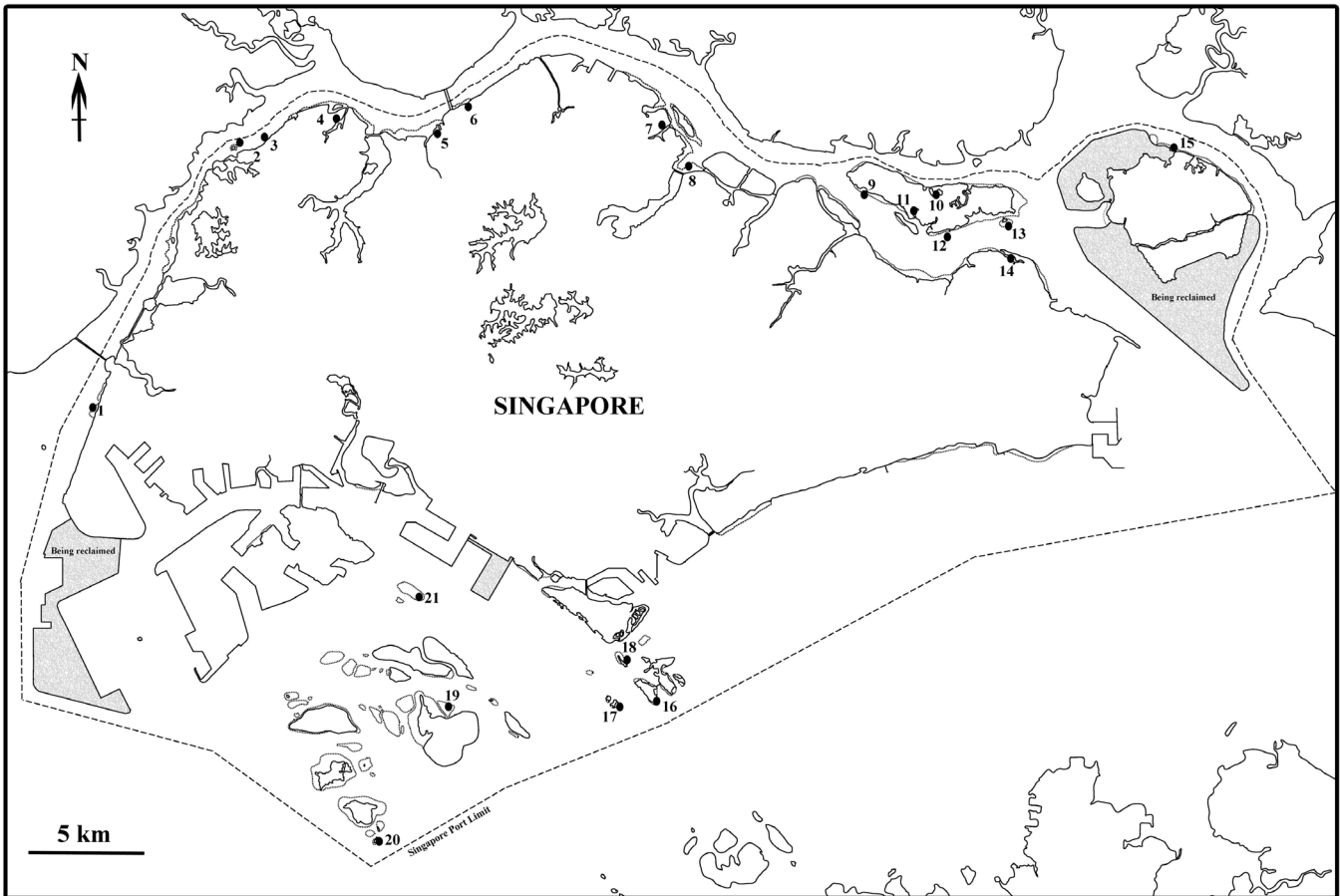


Fig. 1. Intertidal collecting sites; details in Table 2.

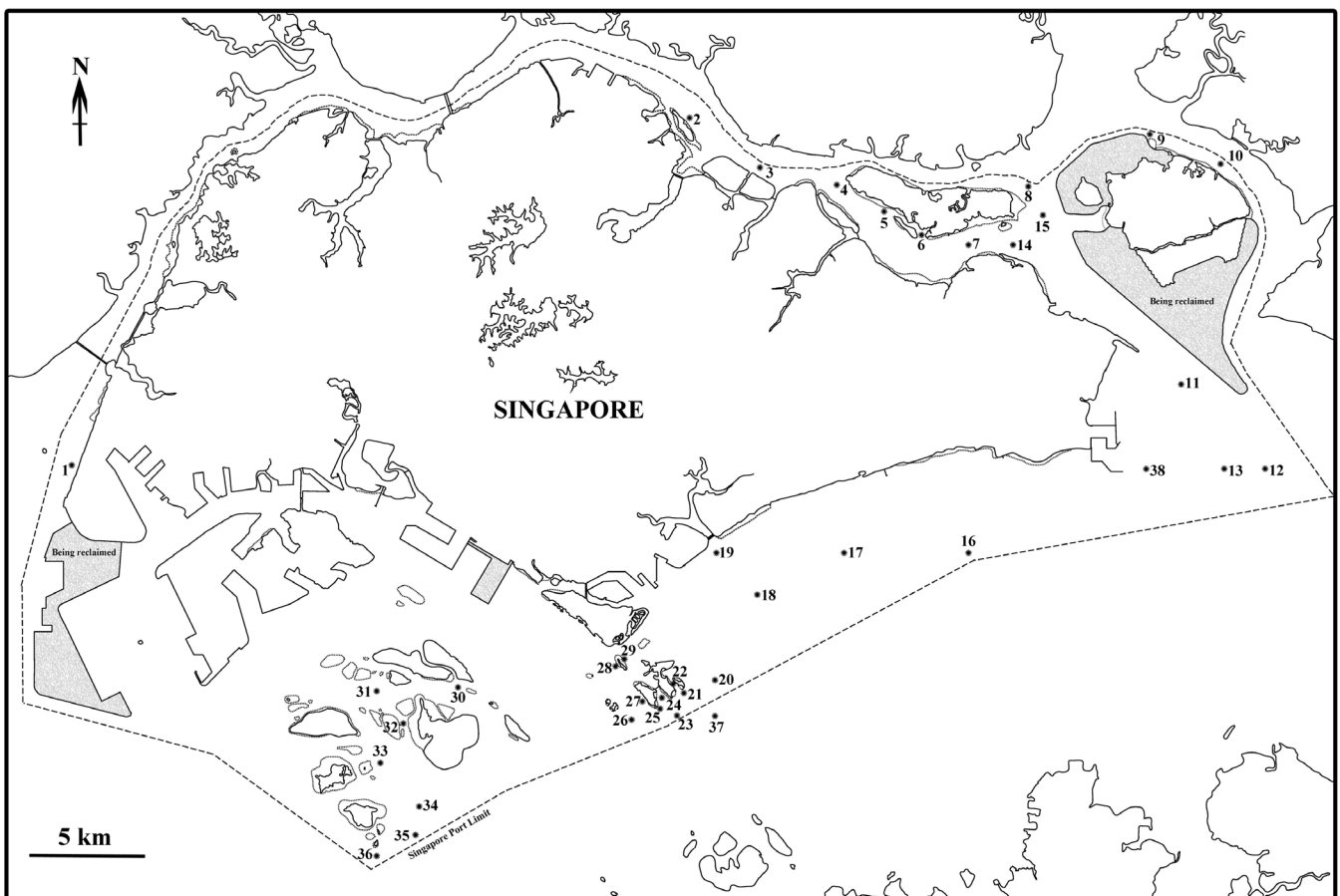


Fig. 2. Subtidal collecting sites; details in Table 3.

Table 1. List of isopods collected during the Comprehensive Marine Biodiversity Survey.

Family	Species	Remarks	Intertidal Collection Site (see Table 2 and Figure 1)	Subtidal Collection Site (see Table 3 and Figure 2)	Specimen Reference Number
Suborder Cymothoidea Wägele, 1989					
Aegidae White, 1850	<i>Aega antennata</i> Richardson, 1910	New record of species			AT10 (or FT107)
	<i>Alitropus</i> cf. <i>typus</i> Milne Edwards, 1840	Not determined	5		SW97
	<i>Rocinela</i> sp.	New record of genus		8, 10, 15	CMBS606; CMBS20028
	<i>Rocinela</i> sp. 1	New record of genus		13, 34	SS0494; SS0859
	<i>Rocinela</i> sp. 2	New record of genus		20	SS1872
	<i>Rocinela</i> sp. 3	New record of genus	5		SW97
Cirolanidae Dana, 1852	<i>Odysseylana</i> sp. 3 sp. nov.	Potential new species		24, 25, 27	SS4940; SS4942; SS4934; SS4941; SS0854; OTC-0061; OTC-0051
	<i>Odysseylana</i> sp. 6 sp. nov.	Potential new species		18, 24	SS4941; SEA-1881
	<i>Odysseylana</i> sp. nov.	Potential new species		25	SS4942; SS4934
	<i>Atololana</i> sp. nov.	Potential new species		24, 27	SS4940; OTC-0108; OTC-0063; OTC-0067
	<i>Cirolana</i> sp. 'parva-group' #1	Not determined	18, 20	6, 15, 20, 24, 25, 28	SS4942; IT140; SS0853; SS4940; SW147; SS4934; SS0842; SS0849; SS0839; SS0856; CMBSD06; SS4938; SS0843; SS0839; SS0838
	<i>Cirolana</i> sp. 'parva-group' #2	Not determined	20	29	SS0846; OTC-0039
	<i>Cirolana</i> sp. 'parva-group' #3	Not determined	17	27, 29, 31	SS1931; OTC-0072; OTC-0081; SS5400
	<i>Cirolana indica</i> Nierstrasz, 1931	New record of species		24, 27, 30, 33, 35, 36	SS4940; SS4941; SEA-0064; SEA-1524; OTC-0069; SS4248; OTC-0070; SEA-2023

Family	Species	Remarks	Intertidal Collection Site (see Table 2 and Figure 1)	Subtidal Collection Site (see Table 3 and Figure 2)	Specimen Reference Number
	<i>Cirolana willeyi</i> Stebbing, 1904	Previously recorded	3, 5, 6		CMBS43065–43113; CMBS46001–46002; CMBS46004–46013; CMBS46015; CMBS46244- 46264; CMBS46394; CMBS48104–48144; CMBS6343
	<i>Cirolana</i> sp. 1 sp. nov.	Potential new species		24	SS4942; SS4940; SS4934; SS4941
	<i>Cirolana</i> sp. 2 sp. nov.	Potential new species		24, 25, 27	SS4942; SS0853; SS4940; SW147; SS4934; SS4941; SS4931; OTC-0053; SS4169
	<i>Cirolana</i> sp. 4 sp. nov.	Potential new species		25	SS4934; SS0842
	<i>Cirolana</i> sp. 5 sp. nov.	Potential new species		25	SS0842
	<i>Cirolana</i> sp. 7 sp. nov.	Potential new species		24	SS4942
	<i>Cirolana</i> sp. 8 sp. nov.	Potential new species		9, 24, 38	SEA-1273; SEA-6139; OTC- 0103
	<i>Dolicholana porcellana</i> (Barnard, 1936)	New record of species		17, 19, 24	SS4942; SS0820; DR14; SS2010
	<i>Dolicholana elongata</i> (Milne Edwards, 1840)	Previously recorded		22	SS4250
	<i>Eurydice</i> sp. 'orientalis- group'	New record of genus		11	SW130
	<i>Excirolana orientalis</i> (Dana, 1852)	New record of species		16	SS0811; SS0815
	<i>Metacirolana</i> sp. ('serrata group')	New record of genus		16	SS4938
	<i>Natatolana</i> sp. nov.	Potential new species		1	SEA-4274
	<i>Neocirolana obesa</i> Hale, 1925	New record of species		21	SB132
Corallanidae Hansen, 1890	<i>Argathona</i> cf. <i>rhinoceros</i> (Bleeker, 1857)	New record of genus		24	SS1917; SS0828

Family	Species	Remarks	Intertidal Collection Site (see Table 2 and Figure 1)	Subtidal Collection Site (see Table 3 and Figure 2)	Specimen Reference Number
	<i>Argathona</i> sp. 1	New record of genus		12, 13, 15, 32, 37	SS5379; CMBS-D06; SS1968; SS1970; SS1967; SS1966; SS5382; SS4153
	<i>Argathona</i> sp. 2	New record of genus		25	SS0858
	<i>Argathona</i> cf. <i>setosa</i> (Richardson, 1910)	New record of genus		12, 32, 37	SS5382; SS4153; SS1971
	<i>Corallana</i> sp.	New record of genus	17		SS1933
	<i>Corallana</i> sp. 1	New record of genus		9, 15	JS2675; CMBS-D06
	<i>Lanocira</i> cf. <i>gardineri</i> Stebbing, 1904	New record of genus	20, 21	23, 25, 28	SS4931; SS1972; SD100; SS4392; SS0839; SS0821
	<i>Lanocira</i> sp. nov.	Potential new species	20	22, 26	DR112; SI10002; SS0845
	<i>Tachaea crassipes</i> Schioedte & Meinert, 1879	Previously recorded		16	SS0827
	<i>Tachaea</i> sp.	Not determined			SITE 1?
Gnathiidae Leach, 1814	<i>Elaphognathia</i> sp.	New record of genus	13	2, 10	JS1288; DW65; DW81
	<i>Gnathia</i> sp.1	Not determined	13		JS1288
Cymothoidae Leach, 1814	<i>Catoessa</i> sp.	New record of genus	14		JS1524
	<i>Cymothoa pulchrum</i> Lanchester, 1902.	New record of species		4, 5, 9	JS1997-1999; JS2001; JS2003; JS2004; JS2318; JS2375
	<i>Cymothoa rhina</i> Schioedte & Meinert, 1884.	New record of species		25	SS0841
	<i>Joryma</i> sp.	New record of genus		4	SW76
	<i>Nerocila</i> cf. <i>sundaica</i> Bleeker, 1857	Not determined	2, 13	3, 7	CMBS66142; CMBS66162; JS1284; DW120; DW66
Superfamily Anthuroidea Leach, 1814					
	Anthuroidea sp. 3	Not determined		2	DW65
	Anthuroidea sp. 4	Not determined		2	DW65
	Anthuroidea sp. 5	Not determined		7	DW121
	Anthuroidea sp. 6	Not determined		14	DW118

Family	Species	Remarks	Intertidal Collection Site (see Table 2 and Figure 1)	Subtidal Collection Site (see Table 3 and Figure 2)	Specimen Reference Number
	Anthuroidea sp. 7	Not determined		14	DW118
	Anthuroidea, unidentified	Not determined	16, 18, 20	6	SS0843; CMBSD09; CMBS010; IT140; SS4938
Anthuridae Leach, 1814	Anthuridae sp. 1, Mesanthura sp.	Not determined	1		SW16
Expanathuridae Poore, 2001	Expanathuridae? sp.	Not determined		10	DW81
Suborder Sphaeromatidea Wägele, 1989					
Sphaeromatidae Latreille, 1825	cf. <i>Apemosphaera</i> sp. nov.	Potential new species	16		SS0825
	<i>Cassidinidea</i> sp. nov.	Potential new species	5, 6, 9		CMBS43045–43064; CMBS46003; SW100
	<i>Cerceis pravinpalma</i> Harrison & Holdich, 1982a	New record of species	16, 20	32	SS0830; SS0845; SS4938
	<i>Cerceis sinensis</i> Kussakin & Malyutina, 1993	New record of species		24, 28	SS0826; SS0840
	<i>Cilicæa crassicaudata</i> Haswell, 1881	New record of species	11	15	CMBS-M02; CMBS-D06
	<i>Cilicæopsis</i> cf. <i>whiteleggei</i> (Stebbing, 1905)	New record of genus	19		SS0382
	<i>Cymodoce bipapilla</i> Harrison & Holdich, 1984	New record of species	20		SS0845
	<i>Cymodoce longistylis</i> Miers, 1884	New record of species	16, 21		SS0822; SS4938
	<i>Cymodoce tribullis</i> Harrison & Holdich, 1984	New record of species	20, 21	28	SS0850; SS0845; SS0837
	<i>Dynoides amblysinus</i> (Pillai, 1954)	Previously recorded	20		SS0860
	<i>Oxinasphaera</i> sp.	New record of genus		23	SS4392
	<i>Paraleptosphaeroma brucei</i> Kussakin & Malyutina, 1993	New record of species	20	4	SS0856; SS0843; SW68

Family	Species	Remarks	Intertidal Collection Site (see Table 2 and Figure 1)	Subtidal Collection Site (see Table 3 and Figure 2)	Specimen Reference Number
	<i>Sphaeroma</i> cf. <i>intermedium</i> (Baker, 1926)	Not determined	10		SW95
	<i>Sphaeroma terebrans</i> Bate, 1866	Previously recorded	5, 8		CMBS6216-6342; CMBS6441; CMBS43035- 43044; CMBS45404; SW97
	<i>Sphaeroma triste</i> Heller, 1868	New record of species	4, 7, 15		CMBS34080; CMBS44198; CMBS49020
	<i>Sphaeroma walkeri</i> Stebbing, 1905 (Cai & Teo, 2012)	Previously recorded		24	SS0826
Suborder Asellota Latreille, 1802					
Stenetriidae Hansen, 1905	<i>Liocoryphe siamense</i> (Hansen, 1905)	New record of species	20		SS0843
	<i>Liocoryphe</i> sp. nov.	Potential new species	20		SS0843
Janiriidae Sars, 1897	<i>Carpias</i> sp. 1	New record of genus	16		SS4938
	<i>Carpias</i> sp. 2	New record of genus	20		SS0843
	Janiriidae sp.	Not determined	20		SS0843
Joeropsididae Nordenstam, 1933	<i>Joeropsis</i> sp. 1	New record of genus	16		SS4938
	<i>Joeropsis</i> sp. 2	New record of genus	20		SS0843
Munnidae Sars, 1897	cf. <i>Paramunna</i> sp.	Not determined	20		SS0843
Santiidae Wilson, 1987	<i>Santia</i> sp.	New record of genus	16		SS4938
Suborder Valvifera Sars, 1882					
Idoteidae Samouelle, 1819	<i>Synidotea poorei</i> Cai & Teo, 2012	Previously recorded	5		CMBS43317
Arcturidae Dana, 1849	<i>Arcturinoidea gibbosus</i> Müller, 1989	New record of species		10	DW130; DW81
Suborder Oniscidea Latreille, 1802					
Ligiidae Leach, 1814	<i>Ligia</i> sp.	Not determined	1, 12		CMBS24023; CMBS24047- 24048; JS2327

Table 2. Singapore Isopoda. Intertidal collection sites (see also Fig. 1).

Intertidal Collection Site	Area Description	Johor / Singapore Straits	Habitat
1	Tuas	West Johor Straits	Sandy shore with mud
2	Pulau Sarimbun	West Johor Straits	Mudflat
3	Sarimbun Shore	West Johor Straits	Mudflat
4	Sungei Buloh	West Johor Straits	Mudflat
5	Sungei Mandai	West Johor Straits	Mudflat
6	Sungei Cina	East Johor Straits	Mudflat
7	Sungei Simpang	East Johor Straits	Mudflat
8	Seletar	East Johor Straits	Mudflat
9	Pulau Ubin, shore near Outward Bound School	East Johor Straits	Mudflat
10	Pulau Ubin, Sungei Besar	East Johor Straits	Mudflat
11	Pulau Ubin, Sungei Puaka	East Johor Straits	Mudflat
12	Pulau Ubin, on pontoon of fish farm	East Johor Straits	NA
13	Pulau Sekudu	East Johor Straits	Sandy and rocky shore
14	Changi Creek	East Johor Straits	Mudflat
15	Pulau Tekong	East Johor Straits	Mudflat
16	Saint John Island	Singapore Strait	Sandy and rocky shore
17	Pulau Subar Laut (The Sisters Island)	Singapore Strait	Rocky reef
18	Pulau Tekukor	Singapore Strait	Rocky reef
19	Terumbu Semakau	Singapore Strait	Sandy and rocky shore
20	Pulau Satumu (Raffles Lighthouse)	Singapore Strait	Sandy and rocky shore
21	Terumbu Pandan (Cyrene Reef)	Singapore Strait	Rocky reef

32. *Argathona* cf. *rhinoceros* (Bleeker, 1857). May be two species.
33. *Argathona* sp. 1; 'striped'.
34. *Argathona* sp. 2; 'wide frontal lamina, spotted, setose'.
35. *Argathona* cf. *setosa* (Richardson, 1910) (from fish gill).
36. *Corallana* sp. 'hirsute pleon and pleotelson'.
37. *Corallana* sp. 1; 'fine, not hirsute'. Subtidal.
38. *Lanocira* cf. *gardineri* Stebbing, 1904.
39. *Lanocira* sp. nov. 'not *gardineri*, setose pleotelson'.
40. *Tachaea crassipes* Schioedte & Meinert, 1879a.
41. *Tachaea* sp. From *Macrobrachium*. Freshwater

Gnathiidae Leach, 1814

Gnathiids are known from most marine habitats, and are a typical component of the coral-reef isopod fauna (e.g., Farquharson et al. 2012, Svavarsson, 2002; Svavarsson & Bruce, 2012; Svavarsson & Gísladóttir, 2002; Müller, 1993b). Represented in Singapore by at least three species.

42. *Elaphognathia* sp.
43. ***Gnathia philogona* Monod, 1926.
44. *Gnathia* sp. 1
45. *Gnathia* sp. 2; St John's Island, intertidal

Cymothoidae Leach, 1814

Cymothoid isopods have a long taxonomic history (see Smit et al., 2014), with the family being one of the first isopod families to be monographed (Schioedte & Meinert,

1881, 1883, 1884). Many of the historical records originated from collections made in the then East Indies, with early significant contributions by Bleeker (1857), Heller (1868), Haller (1880) and Miers (1880, 1884). Consequently the family is well represented in the region, though there are few records from Singapore. Bruce & Harrison-Nelson (1988) is the most recent regional account. The primary source for the extensive literature on this family is Trilles (1994).

All cymothoids are obligate parasites of fishes, and thorough sampling of this family relies on working together with fish collectors and other fish parasitologists. Certain genera are commonly encountered, such as *Anilocra*, *Nerocila*, *Cymothoa*, *Ceratothoa* and *Elthusa*. Specialist targeted collecting would reveal more species than here recorded.

46. ***Anilocra alloceraea* Koelbel, 1879 (Bruce & Harrison-Nelson, 1988).
47. ***Anilocra longicauda* Schioedte & Meinert, 1881 (Bruce, 1987).
48. *Catoessa* sp.
49. *Cymothoa pulchrum* Lanchester, 1902. Host *Tetraodon* sp. (Tetraodontidae).
50. *Cymothoa rhina* Schioedte & Meinert, 1884. Host *Lutjanus carponotatus* (Lutjanidae).
51. *Joryma* sp. Host *Sardinella albella* (Clupeidae).
52. ***Mothocya colletei* Bruce, 1986b.
53. *Nerocila depressa* Milne Edwards, 1840. Host *Pennahia anea* (Sciaenidae).
54. ***Nerocila loveni* Bovallius, 1887 (Bruce & Harrison-Nelson 1988).

Table 3. Singapore Isopoda: Subtidal collection sites (see also Fig. 2)

Subtidal Collection Site	Area Description	Depth (m)	Collection Method	Johor / Singapore Straits	Substratum
1	Tuas	7.2–7.5	Rectangular dredge	West Johor Straits	Sand, mud and shell
2	North of Pulau Seletar	7.8–8.6	Epibenthic sled	East Johor Straits	Fine mud
3	North of Pulau Punggol	13.9	Otter trawl	East Johor Straits	Fine mud
4	Pulau Ubin, near Tanjong Tajam	5.0	Triangular dredge and lift net	East Johor Straits	Sand and rock
5	Pulau Ubin, mouth of Sungei Teris	2.0	Gill net	East Johor Straits	Mud
6	Pulau Ubing, Ketam channel	10.0	Rectangular dredge	East Johor Straits	Mud
7	Between Changi and Pulau Ubin	20.6–21.7	Beam trawl and epibenthic sled	East Johor Straits	Sand and mud
8	Northeast of Chek Jawa, Pulau Ubin	10.0–20.0	Rectangular dredge	East Johor Straits	Mud
9	Beting Bronok, Pulau Tekong	6.4–8.7	Rectangular dredge, gill net and tangle net	East Johor Straits	Mud
10	Northeast of Pulau Tekong	9.9–10.7	Epibenthic sled	East Johor Straits	Fine mud and shell
11	Between Changi and Pulau Tekong	18.5–18.7	Epibenthic sled	Singapore Strait	Sand
12	Eastern bunkering A	26.7–33.7	Beam trawl	Singapore Strait	Silt
13	Eastern bunkering A	22.4–25.1	Beam trawl	Singapore Strait	Clay
14	North of Changi beach	11.3–11.4	Epibenthic sled	East Johor Straits	Mud
15	Between Pulau Ubin and Pulau Tekong	16.0	Dredge	East Johor Straits	Sand and mud
16	South of Tenah Merah	38.7–39.9	Beam trawl	Singapore Straits	Mud
17	Eastern Fairway	15.8–18.0	Rectangular dredge	Singapore Straits	Silt and gravel
18	South of Tanjong Rhu	9.9–11.1	Rectangular dredge	Singapore Straits	Marine clay and mud
19	Outside Marina Barrage	17.1–19.1	Beam trawl	Singapore Straits	Mud and gravel
20	Eastern Boarding Ground A	98.0–103.0	Beam trawl	Singapore Straits	Gravel and rock
21	South of Kusu Island	8.0	Scuba dive	Singapore Straits	Reef
22	South west of Kusu Island	7.8–16.3	Scuba dive	Singapore Straits	Reef
23	St John's Island, South, near Singapore port limit	41.2–44.4	Rectangular dredge	Singapore Straits	Gravel
24	Between St John's Island and Lazarus Island	13.5–45.0	Trap and scuba dive	Singapore Straits	Rock and sand
25	South of St John's Island	2.0–15.0	Trap, gill net and scuba dive	Singapore Straits	Sand and mud
26	Southern Fairway	33.6–34.4	Rectangular dredge	Singapore Straits	Shells and coral rubble
27	West of St John's Island	36.4	Trap	Singapore Straits	Rock and sand
28	South west of Pulau Tekukor	4.5	Scuba dive	Singapore Straits	Reef

Subtidal Collection Site	Area Description	Depth (m)	Collection Method	Johor / Singapore Straits	Substratum
29	North east of Pulau Tekukor	1.6	Trap	Singapore Straits	Rock and sand
30	South of Pulau Bukom	24.3–27.6	Rectangular dredge	Singapore Straits	Mud, sand and gravel
31	South of Pulau Busing	20.6–22.6	Rectangular dredge	Singapore Straits	Sand
32	West of Pulau Semakau	5.0	Scuba dive	Singapore Straits	Coral rubbles and rock
33	North east of Pulau Berkas	17.3–18.7	Rectangular dredge	Singapore Straits	Sand and shell
34	Raffles reserve	38.5–38.3	Rectangular dredge	Singapore Straits	Gravel and shell
35	East of Raffles Lighthouse	33.8–40.5	Rectangular dredge	Singapore Straits	Sand and shell
36	South of Raffles Lighthouse	39.7–42.1	Rectangular dredge	Singapore Straits	Rock, sand, shell and gravel
37	Outside Singapore port limit	113.0–128.0	Beam trawl	Singapore Straits	Rock
38	Near Changi Naval Base	19.2–23.2	Rectangular dredge	Singapore Straits	Mud and sand

55. *Nerocila phaiopleura* Bleeker, 1857 (Bruce & Harrison-Nelson 1988).

56. *Nerocila* cf. *sundaica* Bleeker, 1857.

Bopyrididae Rafinesque, 1815

No attempt was made to identify Bopyridae, other than as OTU. Markham (2009) recorded 11 species in 11 genera from Singapore.

57. *Parathelges enoshimensis* Shiino, 1950 (From hermit crab; photo identification by John Markham)

58. *Apocepon digitatum* Stock, 1960.

59. *Asymmetrione sallyae* Williams & Schuerlein, 2005.

60. *Athelges takonoshimensis* Ishii, 1914.

61. *Hypophryxus pikei* Bruce, 1968.

62. *Metaphrixus intutus* Bruce, 1965.

63. *Parabopyrella bonnieri* (Nierstrasz & Brender à Brandis, 1923).

64. *Parapenaeon bonnieri* (Nobili, 1906).

65. *Pleurocrypta macrocephalon* Nierstrasz & Brender à Brandis, 1923.

66. *Pseudione kensleyi* Williams & Schuerlein, 2005.

67. *Pseudostegias dulcilacuum* Markham, 1982.

68. *Schizobopyrina brachytelson* (Nierstrasz & Brender à Brandis, 1923).

Superfamily Anthuroidea Leach, 1814

Anthuroids rely on mouthparts and statocysts for identification in many keys (e.g., Poore, 2001a) and while an attempt has been made to identify specimens to OTU on the basis of gross morphology and colour pattern (usually lost post-

mortem except *Mesanthura*), the following list is, at best, only indicative.

69. Anthuroidea sp. 3.

70. Anthuroidea sp. 4.

71. Anthuroidea sp. 5. Stout body, short pleon.

72. Anthuroidea sp. 6. No eyes, no chromatophores.

73. Anthuroidea sp. 7. Weak chromatophores.

74. Anthuroidea, unidentified.

Anthuridae Leach, 1814

75. Anthuridae sp. 1, *Mesanthura* sp.

76. *Exallanthura sexpes* Kensley, 1980.

77. *Mesanthura albolineata* Barnard, 1925 (Wägele, 1984).

Expanathuridae Poore, 2001

78. Expanathuridae? sp.

Leptanthuridae Poore, 2001

79. *Leptanthura orientalis* Barnard, 1925.

Suborder Limnoridea Brandt & Poore, 2002

The suborder contains three families, the dominant family being the wood-boring Limnoridae; the small families Hadromastacidae Bruce & Müller, 1991 and Keuphyliidae Bruce, 1980 have not been recorded from Singapore. One species is previously known from Singapore (Cookson & Cragg, 1991), but more species are present.

80. ***Limnoria cristata* Cookson & Cragg, 1991.

Suborder Sphaeromatidea Wägele, 1989

Sphaeromatidae Latreille, 1825

The Sphaeromatidae is the largest family of free-living marine isopods, currently with 100 genera and in excess of 700 species. Surprisingly only one species has been recorded from Singapore itself (Cai & Teo, 2012), though regionally the family is relatively well documented (Kussakin & Malyutina, 1993). Holdings in museums indicate that there are still many undescribed genera and uncounted species remain to be documented. In addition the generic taxonomy is likely to remain unstable as many of the large genera are clearly not monophyletic and numerous species are incorrectly placed. The family reaches its greatest diversity in the Southern Hemisphere with South Africa, New Zealand and southern Australia all having a rich sphaeromatid fauna. Contrary to many isopod families, diversity decreases towards the tropics, but none the less remains high. Generic representation is regionally not highly consistent across the Indo-West Pacific in comparison to the Cirolanidae and Asellota; some genera show clear habitat preferences, for example both *Cilicæa* Leach, 1814, *Cymodoce* Leach, 1814 and *Cerceis* Milne Edwards, 1840 occupy inshore habitats, while genera such as *Neonaesa* Harrison & Holdich, 1982 and *Cilicæopsis* Hansen, 1905 are more strongly associated with coral reef habitats; *Cassidinidea* Hansen, 1905 is specifically associated with muddy and estuarine habitats.

The much larger region of the eastern Queensland coast, including the Great Barrier Reef has 61 species of Sphaeromatidae (in 34 genera) with a further eight known undescribed species. The relatively limited collecting effort in Singapore has yielded 22 species in 15 genera, a figure that will unquestionably increase with further research.

81. cf. *Apemosphaera* sp. nov.
 82. *Cassidias* sp. nov. (2003 collections).
 83. *Cassidinidea* sp. nov.
 84. *Cerceis* cf. *bicarinata* Barnard, 1936 (Singapore, collected 30 December 1986. Inshore, intertidal).
 85. ***Cerceis orientalis* Dana, 1853. Identity uncertain, based on immature specimens (Harrison & Holdich, 1982).
 86. *Cerceis pravipalma* Harrison & Holdich, 1982.
 87. *Cerceis sinensis* Kussakin & Malyutina, 1993.
 88. *Cilicæa crassicaudata* Haswell, 1881.
 89. *Cilicæopsis* cf. *whiteleggei* (Stebbing, 1905). There is a complex of undescribed species under this name.
 90. *Cymodoce bipapilla* Harrison & Holdich, 1984.
 91. *Cymodoce longistylis* Miers, 1884.
 92. *Cymodoce tribullis* Harrison & Holdich, 1984.
 93. *Dynamenella trachydermata* Harrison & Holdich, 1982. Kranji, 22 December 1986.
 94. *Dynoides amblysinus* (Pillai, 1954). See Harrison & Holdich (1984, p. 366), "*Clanella brucei*" = *D. amblysinus*.
 95. *Oxinasphaera* sp. In sponges.

96. *Paradella diana* (Menzies, 1962) (Harrison & Holdich, 1982b). (2003 collections). Intertidal, in crevices, algal turf etc.
 97. *Paraleptosphaeroma brucei* Kussakin & Malyutina, 1993.
 98. *Sphaeroma* cf. *intermedium* (Baker, 1926).
 99. *Sphaeroma terebrans* Bate, 1866.
 100. *Sphaeroma triste* Heller, 1868.
 101. *Sphaeroma walkeri* Stebbing, 1905 (Cai & Teo, 2012).
 102. *Zuzara* sp. (2003 collections).

Suborder Asellota Latreille, 1802

Coral reefs throughout the Indo-West Pacific present a consistent assemblage of characteristic genera and families. Most coral rubble and dead coral samples will contain Stenetriidae Hansen, 1905 (usually common, genera are diverse), Joeropsididae Nordenstam, 1933 (*Joeropsis* is common), Janiridae Sars, 1897 (*Carpas* Richardson, 1902 is common), Santiidae Wilson, 1987 (*Santia* Sivertsen & Holthuis, 1980 is common; also *Halacarsantia* Wolff, 1989), and less common are species of Gnathostenetroididae Kussakin, 1967, Munnidae Sars, 1897, Paramunnidae Vanhöffen, 1914 and Microparasellidae Karaman, 1933. Asellota in shallow-water tropics become less abundant as silt levels increase, and this is in evidence in the Singapore samples where the relevant families were represented by few specimens, although all the expected families are present.

Stenetriidae Hansen, 1905

Stenetriidae are well represented in tropical marine habitats, and in particular they can be abundant on coral reefs. The family was re-appraised by Serov & Wilson (1995, 1999), with more recent contributions from Kensley & Schotte (2002), Bruce & Buxton (2013) and Bruce & Cumming (2015). Recent collections from the Great Barrier Reef revealed the presence of at least six genera indicating that in suitable habitats the diversity can be high.

103. *Liocoryphe siamense* (Hansen, 1905).
 104. *Liocoryphe* sp. nov., large eye, round pseudorostrum.

Janiridae Sars, 1897

The genus *Carpas* is ubiquitous on coral reefs in the Indo-West Pacific.

105. *Carpas* sp. 1 (white).
 106. *Carpas* sp. 2 (red).
 107. *Iais singaporiensis* Menzies & Barnard, 1951 (Müller & Brusca, 1992) (Commensal of large sphaeromatids such as *Sphaeroma*).
 108. Janiridae sp.

Joeropsididae Nordenstam, 1933

The genus *Joeropsis* Koehler, 1885 is ubiquitous in coral reef habitats. Species are remarkably uniform body appearance and are primarily identified by differences in colour pattern.

Bruce (2015) recorded fifteen species from Lizard Island, indicating that diversity can be high in suitable habitats.

109. *Joeropsis* sp. 1, 'head band'.

110. *Joeropsis* sp. 2, speckled except pereonites 2–5.

Munnidae Sars, 1897

111. cf. *Paramunna* sp.

Santiidae Wilson, 1987

Santiids are common on coral reefs, principally the genus *Santia*. There are few recent accounts for tropical species of this family—see Kensley & Schotte (2002), Shimomura & Bruce (2012) and Wolff & Brandt (2000).

112. *Santia* sp.

Suborder Valvifera Sars, 1882

Valviferans reach their greatest diversity in Southern Hemisphere cool and temperate waters. In tropical shallow water representation is low, though subtidally more taxa will be encountered. To date two species have been identified from Singapore, while there will be more genera and species, the total will remain low. For an introduction to this family see Poore (2001b).

Idoteidae Samouelle, 1819

113. *Synidotea poorei* Cai & Teo, 2012.

Arcturidae Dana, 1849

114. *Arcturinoidea gibbosus* Müller, 1989.

Suborder Oniscidea Latreille, 1802

Oniscids are 'terrestrial isopods', but occur in the high intertidal and supra-littoral. The Ligiidae are the most familiar, in large part because of their relatively large size and impressive speed. *Ligia exotica* Roux, 1828 is believed to have been transported around the planet by wooden ships in historic times. Worldwide there are several families that occur on the upper shore, and in contrast to the Ligiidae are more cryptic or burrow in sand; these include the Actaeiidae Vandel, 1952, Scyphacidae Dana, 1852, Tylidae Dana, 1852 and Philosciidae Kinahan, 1857.

Ligiidae Leach, 1814

115. *Ligia* sp. Common to abundant on most shores.

116. *Ligia exotica* Roux, 1828 (see Ng et al., 2011)

117. *Ligia hawaiiensis* Dana, 1852 (see Ng & Sivasothi, 1999; we regard this record as unconfirmed)

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Bruce & Wong: Overview of Singapore isopods

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