LIST OF MARINE ISOPODS RECORDED FROM INDONESIAN WATERS

Conni Margaretha Sidabalok

Research Center for Biology - Indonesian Institute of Sciences
Jln. Raya Jakarta-Bogor Km 46, Cibinong 16911, Indonesia
E-mail: sidabalok_conni@yahoo.com

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ABSTRACT

A list of marine isopods recorded from Indonesia has been compiled from the literature published between 1857 and 2012 as well as from Museum Zoologicum Bogoriense's collections and current expeditions. To date, 225 marine species from 97 genera and 19 families have been recorded from Indonesia with two parasitic families Cymothoidae and Bopyridae showing the largest number of species: 63 and 41, respectively. As for the sampling sites, waters surrounding Java, Maluku and Sulawesi have been investigated most intensively with 55, 51, and 40 records, respectively. The most comprehensive publication of marine isopods in Indonesia has been that by Nierstrasz (1931). In terms of role as bioindicators, *Sphaeroma* and *Dynamenella* have been discovered to survive in polluted waters in Jakarta Bay, suggesting their potential use as bioindicators of water pollution. Future research on basic taxonomy of isopods in Indonesia as well as their ecological functions are recommended.

Keywords*:* marine isopods, Indonesia, free-living, parasites, bioindicator.

INTRODUCTION

Research on marine isopods in Indonesia has received little attention for decades, the most recent overview being that of Nierstrasz (1931) in the reports of Siboga Expedition. Few publications or collected specimens have been available for this region. For the last three decades, there are only less than twenty publications on Indonesian marine isopods (e.g. Bruce, 2008; Cookson et al*.,* 2012; Negoescu, 1997; Yuniar and Palm, 2007). Similarly, the isopod collection held by the Museum Zoologicum Bogoriense (MZB) only consists of less than twenty registrations. They mostly come from either old expeditions or current collections. In addition, most of the available collections has not been identified to the species level.

Marine isopod demonstrates both important ecological roles and anthropocentric potentials. Their ecological roles have been discussed in relation to their diverse feeding modes, including their roles as detritus feeders, browsers, carnivores (micropredators, predators and scavengers), parasites and filter feeders (Poore and Bruce, 2012). Species of Sphaeromatidae are considered to be detritus feeders or browsers, while most species of Cirolanidae are scavengers and used for commercial purpose to clean shark carcasses to get its cartilage (Poore and Bruce, 2012; Bruce, 2004). Isopods are also potential bioindicators of water pollution and coral reef health (Lee, 1977; Jameson et al*.*, 1998).

Indonesia is a region with great marine faunal diversity, for example, eastern Indonesia which is a major part of the Coral Triangle (CT). The highest richness in the CT has been recorded in the Bird's Head Peninsula of Indonesian Papua with 574 out of 605 species of zooanthellate coral species (Veron et al*.*, 2009). The CT is also the epicenter for many other marine organisms (Hoegh-Guldberg et al., 2009), including very high numbers of undescribed species of crustaceans (De Grave, 2001 and Meyer et al*.*, 2005 in Veron et al*.*, 2009). Isopods whose several families are associated with coral reefs are

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expected to demonstrate the trend as well, as has been found in Papua New Guinea at Madang (e.g. Bruce, 1995; 1997).

The objective of this paper is to provide list of marine isopod species recorded from the Indonesian waters with a brief review and to identify areas in need of future research.

MATERIAL AND METHODS

All data were compiled from primary sources, i.e. current expeditions (e.g. Cookson et al., 2012) and MZB's collections (Sidabalok, unpublished data) and secondary sources, i.e. the literature from 1857 to 2012 and records from Smithsonian Institution (Schotte et al., 1995) and World Register of Marine Species (WoRMS: Schotte et al., 2008). The species identification in the primary sources was mostly based on the author's own examination, referring to the papers, e.g. Bruce (1986, 1987, 1995), and Harrison and Ellis (1991). As for the literature from 1857 to 2012, the species names and synonymies were verified on the WoRMS database to get the current valid names. All the species names on the list were accepted to be correct by the end of 2012.

RESULTS

A total of 225 isopod species from 97 genera and 19 families had been recorded throughout the Indonesian waters (Fig. 1 and Table 1). Of these, 45 records were with uncertain localities, particularly those from the Smithsonian list. From the 209 locality records of 7 major islands, the highest percentage of records to the total was found in Java (26%), followed by Maluku and adjacent waters (24%), Sulawesi (19%), Sumatera (10%), Lesser Sunda Islands (10%), Papua (9%), and Kalimantan (2%). The highest species number had been recorded from the family Cymothoidae (63),

Figure 1. Map of marine isopod distribution in Indonesian waters. Each dot represents record(s) either from one species or more at the particular locality (Map: http://www.geographicguide.com/asia/maps/indonesia.htm).

Table 1. List of marine isopod species recorded from Indonesia

No	Species	Province/Island	Habitat	Publication
Family Corallanidae Hansen, 1890				
1	*Argathona macronema* (Bleeker, 1857)	West Papua, North Sulawesi, Jakarta	Parasite on the gill filament of landok (*Lethrinus* sp.) (Papua specimen); 2-16 m	Bleeker, 1857; Richardson, 1910; Nierstrasz, 1931; Bruce, 1982B; WORMS
2	*Argathona similis* Richardson, 1910	North Sulawesi		Richardson, 1910; Smithsonian
3	*Argathona stebbingi* Nierstrasz,1931	North Maluku	shallow	Nierstrasz, 1931; Delaney, 1989; WORMS
4	*Argathona rhinoceros* (Bleeker, 1857)	Banten, Jakarta, East Java	sandy beach (East Java)	Bleeker, 1857; Nierstrasz, 1931; Delaney, 1989
5	*Tachaea* sp 1.	West Papua		Lengguru-Kaimana Expedition (unpublished)
6	*Tachaea* sp 2.	West Papua	Dead coral on the shore	Lengguru-Kaimana Expedition (unpublished)
7	*Tachaea* lacustris Weber, 1892	West Sumatra, Java, Central Sulawesi	In alluvial gravel of river (Central Sulawesi)	Nierstrasz, 1931; Smithsonian
8	*Corallana estuaria* Jones, Icely & Cragg, 1983	West Papua; West Nusa Tenggara; East Nusa Tenggara; Southeast Sulawesi	Dead coral on the shore (West Papua); experimental wooden panels *Rhizophora stylosa* (Southeast Sulawesi)	Nierstrasz, 1931
9	*Corallana glabra* Nierstrasz, 1931	West Papua, Maluku	Dead coral on the shore (West Papua)	Nierstrasz, 1931; Bruce, 1982B; Delaney, 1989
10	*Corallana leopoldi* (Nierstrasz, 1930)	Maluku, East Nusa Tenggara		Bruce, 1982B; Delaney, 1989; Nierstrasz, 1931
11	*Corallana* sp 1.	Southeast Sulawesi	experimental wooden panels *Rhizophora stylosa*	
12	*Corallana* sp 2.	Southeast Sulawesi	experimental wooden panels *Rhizophora stylosa*	
13	*Alcirona papuana* Nobili, 1905	Papua		Nobili, 1905
14	*Alcirona indica* Nierstrasz, 1931	West Nusa Tenggara		Nierstrasz, 1931
15	*Alcirona niponia* Richardson, 1909	North Sulawesi	108 m	Nierstrasz, 1931; WORMS
16	*Lanocira rotundicauda* Stebbing, 1904	Jakarta	shallow	Bruce, 1980; Jones, 1982; Delaney, 1989
17	*Lanocira gardineri* Stebbing, 1904	Aceh		Smithsonian

Family Cirolanidae Dana, 1852				
18	*Anopsilana pustulosa* (Hale)	Southeast Sulawesi	experimental wooden panels *Rhizophora stylosa*	
19	*Excirolana orientalis* (Dana, 1853)	West Papua; West Nusa Tenggara; East Nusa Tenggara	Fine sand, caught by sieving and human skin bait; shallow (WORMS)	Nierstrasz, 1931; Bruce, 1986; WORMS
20	*Cirolana* cf. *oeronota* Bruce, 1986	West Papua	Dead coral on the shore; shallow (WORMS)	Lengguru-Kaimana Expedition (unpublished)
21	*Cirolana* cf. *stenoura* Bruce, 1986	West Papua	Dead coral on the shore; shallow (WORMS)	Lengguru-Kaimana Expedition (unpublished)
22	*Cirolana halei* Bruce, 1981	West Papua	Dead coral on the shore; shallow (WORMS)	Lengguru-Kaimana Expedition (unpublished)
23	*Cirolana* cf. *improceros* Bruce, 1986	West Papua	Dead coral on the shore	
24	*Cirolana indica* Nierstrasz, 1931	East Nusa Tenggara		Nierstrasz, 1931
25	*Cirolana pumicea* Hale	Riau		
26	*Cirolana vanhoeffeni* Nierstrasz, 1931	North Sulawesi	1155-1264 m	Nierstrasz, 1931; Smithsonian
27	*Cirolana parva* Hansen, 1890	West Papua; Sulawesi; Maluku	scavenger and shallow (WORMS)	Nierstrasz, 1931
28	*Cirolana lineata* Potts, 1915	Maluku		Nierstrasz, 1931
29	*Cirolana epimerias* Richardson, 1910	South Sulawesi	400 fathoms = 731.52 m	Richardson, 1910; Nierstrasz, 1931; Smithsonian
30	*Cirolana arafurae* Bruce, 1986	Maluku		Bruce, 1986
31	*Cirolana marosina* Botosaneanu, 2003	South Sulawesi	subterranean river of cave	Smithsonian
32	*Cirolana stebbingi* Nierstrasz, 1931 Incertae sedis	South Sulawesi	1301 m	Nierstrasz, 1931; Smithsonian
33	*Aatolana schioedtei* (Miers, 1884)	Papua; Palembang		Nierstrasz, 1931; Bruce 1986
34	*Dolicholana elongata* (Milne Edwards, 1840)	Jakarta, Central Java, West Nusa Tenggara, Sumatra	284-310 m (WORMS); Night light + net hand	Nierstrasz, 1931, Bruce 1986; Smithsonian
35	*Natatolana albicaudata* (Stebbing, 1900)	Java; North Sulawesi	Light Electric (Lembe Strait)	Nierstrasz, 1931; Richardson, 1910; Keable, 2006 (syn); Smithsonian
36	*Natatolana amplocula* Bruce, 1986	Maluku		Bruce, 1986
37	*Eurydice orientalis* Hansen, 1890	South Sulawesi; East Nusa Tenggara; Maluku; Jakarta; Papua	22 m	Richardson, 1910; Nierstrasz, 1931; Bruce 1986; WORMS

38	*Cartetolana integra* (Miers, 1884)	Maluku	shallow	Keable, 1997; WORMS
39	*Cartetolana lineata* (Potts)	Maluku		Nierstrasz, 1931
Family Limnoriidae White, 1850				
40	*Limnoria sellifera* Cookson, Cragg, & Hendy 2012	Southeast Sulawesi	weathered wood in mangrove, wood borers	Cookson et al. 2012
41	*Limnoria pfeferri*	Southeast Sulawesi	weathered wood in mangrove, wood borers	Cookson et al. 2012
42	*Limnoria unicornis*	Southeast Sulawesi	weathered wood in mangrove, wood borers	Cookson et al. 2012
43	*Limnoria insulae*	Southeast Sulawesi	weathered wood in mangrove, wood borers	Cookson et al. 2012
44	*Limnoria foveolata* Menzies, 1957	Maluku	52 m	Menzies, 1957; Smithsonian
45	*Limnoria multipunctata* Menzies, 1957	Maluku	sand, 13 m	Menzies, 1957; Smithsonian
Family Sphaeromatidae Latreille, 1825				
46	*Cilicaeopsis* cf. *lepida* Kussakin & Malyutina, 1992	West Papua	on oyster clumps and rocks on the beach	Lengguru-Kaimana Expedition (unpublished)
47	*Cilicaeopsis whiteleggei* (Stebbing, 1905)	Maluku		Nierstrasz, 1931
48	*Cilicaeopsis laevis* Nierstrasz, 1931	Maluku		Nierstrasz, 1931; Smithsonian
49	*Sphaeroma triste* Heller, 1868	West Papua	porous clay on the beach	Nierstrasz, 1931
50	*Sphaeroma terebrans* Bate, 1866			Harrison and Holdich 1984
51	*Sphaeroma exosphaeroma* Boone, 1918	East Nusa Tenggara; Maluku		Nierstrasz, 1931
52	*Sphaeroma* cf. *intermedium*	East Kalimantan	sandy beach	Transborder Expedition (unpublished)
53	*Sphaeroma* sp.	Banten	Dead coral on the shore	PKPP Project (unpublished)
54	*Exosphaeroma laeviusculum* (Heller, 1868)	Java		Nierstrasz, 1931
55	*Hemisphaeroma pulchrum* Hansen, 1905	West Java		Nierstrasz, 1931; Harrison and Ellis, 1991
56	*Isocladus indicus* Nierstrasz, 1930	East Nusa Tenggara; Maluku		Nierstrasz, 1931
57	*Cymodoce tribullis* Harrison & Holdich, 1984	Sumatra		
58	*Cymodoce longistylus* Miers	East Nusa Tenggara; Maluku; South Sulawesi; North Sulawesi		Nierstrasz, 1931

59	*Paracilicaea pubescens* (H. Milne Edwards, 1840)	East Nusa Tenggara	shallow	Nierstrasz, 1931; Harrison and Holdich, 1984; WORMS
60	*Paracilicaea fimbriata* Kussakin, Malyutina, & Rostomov, 1990	Java Sea	shallow	Smithsonian
61	*Cilicaea latreillei* Leach, 1818	Maluku	26-104 m	Nierstrasz, 1931, WORMS
62	*Botryias fructiger* Richardson, 1910	East Nusa Tenggara; South Sulawesi	180 fathoms = 329 m	Richardson, 1910; Nierstrasz, 1931; Harrison and Ellis, 1991; Smithsonian
63	*Cassidinidea* sp.	Maluku		Smithsonian
64	*Chitonopsis hanseni* Nierstrasz, 1931	East Nusa Tenggara		Nierstrasz, 1931
65	*Dynamenella alveolata* Schotte & Kensley, 2005	North Sumatra		Schotte & Kensley, 2005; WORMS
66	*Dynamenella trachidermata* Harrison & Holdich, 1982	Java		Kussakin & Malyutina, 1993
67	*Dynamenella* sp.	Banten	on red algae on the beach	PKPP Project (unpublished)
68	*Naesicopea abyssorum* (Beddard, 1886)	Papua	deep water (1958 m) on mud	Beddard, 1886; Harrison and Ellis, 1991; WORMS
69	*Pseudosphaeroma*	Maluku	stones on the beach	Unpublished data
70	*Oxinasphaera obregonia* Bruce, 1997	Selat Sunda	54 m, numerous sponges (Sigsbee trawl)	Bruce, 1997; Smithsonian
71	*Oxinasphaera tual* Bruce, 1997	Maluku	2m from sponges	Bruce, 1997; Smithsonian
Family Cymothoidae Leach, 1818				
72	*Aegathoa elongata* Monod, 1976	Maluku		WORMS
73	*Aegathoa buitendijki* Nierstrasz	Jakarta; Central Java		Nierstrasz, 1931
74	*Nerocila* sp 1.	East Java	host *Stolephorus* sp.	PKPP Project (unpublished)
75	*Nerocila* sp 2.	Papua		Smithsonian
76	*Nerocila* sp 3.	Java Sea		Trilles, 1979
77	*Nerocila* sp 4.	Merauke		Trilles, 1979
78	*Nerocila congener* Miers, 1880	West Kalimantan		Bruce and Harrison-Nelson, 1988
79	*Nerocila depressa* Milne Edwards, 1840	Riau	host *Coilia dussumieri*	Bruce and Harrison-Nelson, 1988
80	*Nerocila exocoeti Pillai*	North Sumatra		
81	*Nerocila monodi Hale*	South Sulawesi		Smithsonian

82	*Nerocila phaiopleura* Bleeker, 1857	West Java; Central Java; North Sumatra; Jakarta; Maluku		Bleeker, 1857; Nierstrasz, 1931; Smithsonian
83	*Nerocila loveni* Bovallius, 1887	Jakarta		Nierstrasz, 1931; WORMS
84	*Nerocila sundaica* Bleeker, 1857	Jakarta; East Kalimantan		Bleeker, 1857; Nierstrasz, 1931; WORMS; Smithsonian
85	*Nerocila serra* Schiödte et Meinert, 1881	Java; South Sumatra		Nierstrasz, 1931; WORMS
86	*Nerocila trivittata* Bleeker, 1857	Maluku		Bleeker, 1857; Nierstrasz, 1931; WORMS
87	*Nerocila laevinota* Miers, 1880	West Kalimantan		Nierstrasz, 1931
88	*Norileca indica* (H. Milne Edwards, 1840)	Papua		Trilles, 1979
89	*Renocila ovata* Miers, 1880	Maluku; South Sulawesi; West Nusa Tenggara; East Nusa Tenggara		Richardson, 1910; Nierstrasz, 1931; Smithsonian
90	*Renocila indica* Schiödte et Meinert, 1884	Java		Nierstrasz, 1931; WORMS; Smithsonian
91	*Renocila limbata* (Schiödte et Meinert, 1881)	Maluku	host: *Scorpaena picta* (Nierstrasz 1931), *Sebastopsis polylepis* (Trilles, 1979)	Trilles, 1979; Bruce, 1987
92	Anilocra dimidiata Bleeker, 1857	Jakarta; South Sulawesi	58 m	Bleeker, 1857; Nierstrasz, 1931; WORMS; Smithsonian
93	*Anilocra alloceraea* Koelbel	Maluku	host: *Stolopherus*	Bruce and Harrison-Nelson, 1988
94	*Anilocra gigantea* (Herklots, 1870)	Indonesia		Smithsonian
95	*Anilocra koolanae* Bruce, 1987	Jakarta		Bruce & Harrison-Nelson 1988; Smithsonian
96	*Anilocra rhodotaenia* Bleeker, 1857	Jakarta		Bleeker, 1857; Smithsonian; WORMS
97	*Anilocra leptosoma* Bleeker, 1857	Jakarta; North Sumatra		Bleeker, 1857; Nierstrasz, 1931
98	*Anilocra recta* Nierstrasz, 1915	Java		Nierstrasz, 1931; WORMS
99	*Anilocra marginata* (Bleeker, 1857)	Jakarta		Bleeker, 1857; Nierstrasz, 1931; WORMS
100	*Anilocra capensis* Leach, 1818	Java		Nierstrasz, 1931
101	*Anilocra amboinensis* Schiödte et Meinert, 1881	Maluku; North Sulawesi	Bottom: rock dead and live coral, sandy between lat/long approx	Nierstrasz, 1931; Smithsonian
102	*Anilocra cavicauda* Richardson, 1910	Kalimantan		Smithsonian
103	*Anilocra longicauda* Schiödte et Meinert, 1881	West Sumatra		Nierstrasz, 1931

104	*Lobothorax typus* Bleeker, 1857	Jakarta		Bleeker, 1857; Nierstrasz, 1931, WORMS
105	*Rhexanella verrucosa* (Schiödte et Meinert)	East Nusa Tenggara		Nierstrasz, 1931
106	*Ceratothoa imbricata* (Fabricius, 1775)	Java		Nierstrasz, 1931; WORMS
107	*Ceratothoa retusa* (Schioedte & Meinert, 1883)	Papua		WORMS; Smithsonian
108	*Ceratothoa trigonocephala* (Leach, 1818)	Java		WORMS
109	*Ceratothoa* sp 1	Papua		Trilles, 1979
110	*Cymothoa edwardsi* Bleeker	Jakarta		Nierstrasz, 1931
111	*Cymothoa elegans* Bovallius, 1885	Java Sea		Nierstrasz, 1931
112	*Cymothoa eremita* (Brunnich, 1783)	Jakarta Bay; Cirebon		Trilles, 1979
113	*Cymothoa eximia* Schioedte & Meinert, 1884	Indonesia		Schioedte & Meinert, 1884; Smithsonian
114	*Cymothoa marginata* Bleeker, 1857	Jakarta		Bleeker, 1857; Miers, 1880; Smithsonian
115	*Cymothoa pulchrum* Lanchester, 1902	Indonesia		Smithsonian
116	*Cymothoa stromatei* Bleeker	Jakarta; North Sulawesi		Richardson, 1910; Smithsonian
117	*Cymothoa truncata* Schioedte & Meinert, 1884	Jakarta Bay; Cirebon		Trilles, 1979
118	*Cymothoa* sp 1.	Central Java	parasite on the gill rakers and mouth cavity of *Scatophagus argus*	Yuniar et al 2007
119	*Cymothoa* sp 2.	West Java		
120	*Cymothoa* sp 3	Manokwari		Trilles, 1979
121	*Enispa irregularis* (Bleeker, 1857)	Jakarta; Maluku		Bleeker, 1857; Nierstrasz, 1931; WORMS
122	*Ichthyoxenus jellinghausi* Herklots, 1870	Sumatra; West Java		Nierstrasz, 1931; WORMS; Smithsonian
123	*Catoessa scabricauda* Schiödte et Meinert, 1884	East Nusa Tenggara		Nierstrasz, 1931
124	*Catoessa boscii* (Bleeker, 1857)			Bleeker, 1857; Nierstrasz, 1931; Trilles, 1979
125	*Elthusa emarginata* (Bleeker, 1857)	Jakarta; Maluku; North Maluku		Nierstrasz, 1931
126	*Elthusa parva* (Nierstrasz, 1915)	Indonesia		Smithsonian
127	*Livoneca intermedia* Nierstrasz, 1931	East Java		Nierstrasz, 1931; Trilles, 1979

128	*Livoneca lunelli* Haller, 1880	South Sulawesi		Nierstrasz, 1931
129	*Mothocya melanosticta* (Schiödte et Meinert, 1884)	Central Java		Nierstrasz, 1931
130	*Mothocya renardi* (Bleeker, 1857)	Jakarta; North Maluku		Bleeker, 1857; Nierstrasz, 1931; WORMS; Smithsonian
131	*Mothocya* sp 1.	Jakarta		Trilles, 1979
132	*Irona vatia* Schiödte et Meinert	Jakarta		Nierstrasz, 1931
133	*Cterissa pterygota* (Koelbel, 1878)	Maluku		Nierstrasz, 1931
134	*Telotha indica* Nierstrasz, 1915	Java Sea		Smithsonian
Family Aegidae White, 1850				
135	*Aega vigilans* (Haswell)	West Papua		Nierstrasz, 1931
136	*Aega magnoculis* Richardson	South Sulawesi	960 fathoms	Richardson, 1910; Nierstrasz, 1931
137	*Aega antennata* Richardson, 1910	North Maluku	265 fathoms	Richardson, 1910
138	*Aega whanui* Bruce, 2009	Maluku	1058-1084 m	Bruce, 2009
139	*Aegapheles banda* (Bruce, 2004)	Maluku	290-416 m	Bruce, 2009
140	*Aegiochus coroo* (Bruce, 1983)	Maluku	184-186 m; 246 m	Bruce, 2009
141	*Aegiochus weberi* (Nierstrasz, 1931)	Celebes Sea	450 m	Bruce, 2009
142	*Rocinela typus* (H. Milne Edwards)	West Kalimantan; West Sumatra		Nierstrasz, 1931
143	*Rocinela media* Nierstrasz, 1931	Southeast Sulawesi	75-94 m	Bruce, 2009
144	*Rocinela richardsonae* Nierstrasz, 1931	Maluku	560 m	Bruce, 2009
145	*Alitropus typus* H. Milne Edwards, 1840	Kalimantan; Sumatra	low-salinity estuarine (9ppt) and freshwater	WORMS
146	*Syscenus infelix* Harger	North Maluku	272-298 fathoms; Previous records: Japan, Atlantic coast	Richardson, 1910
147	*Syscenus intermedius* Richardson, 1910	Maluku	356-368 m	Bruce, 2009
148	*Syscenus latus* Richardson, 1909	Maluku		Bruce, 2009
Family Tridentellidae Bruce, 1984				
149	*Tridentella memikat* Bruce, 2008	Maluku	620–666 m	Bruce, 2008
150	*Tridentella tanimbar* Bruce, 2008	Maluku	413–410 m	Bruce, 2008
151	*Tridentella brandtae* Bruce, 2008	Maluku	417–425 m	Bruce, 2008
Family Leptanthuridae Poore, 2001				

152	*Accalathura sladeni* (Stebbing, 1910)	Sumatra	48-51; intertidal -90 m	WORMS; Smithsonian
153	*Accalathura barnardi* (Nierstrasz, 1941)	Indonesia	19-113 m	Smithsonian; WORMS
154	*Accalathura normani* (Nierstrasz, 1941)	Indonesia	16-23 m	Smithsonian; WORMS
155	*Accalathura indica* (Nierstrasz, 1941)	Java Sea		Smithsonian
156	*Leptanthura laevigata* (Simpson, 1855)	Aceh		Smithsonian
157	*Leptanthura baliensis* Negoescu, 1992	Bali	Sand with Thalassia and coral rubble, 3-4 m	Negoescu, 1997
Family Anthuridae Leach, 1814				
158	*Apanthura sandalensis* Stebbing, 1900	Sumatra	shallow	WORMS
159	*Apanthura indonesiensis* Negoescu, 1997	North Sulawesi	coarse sand and dead corals, 4.5 m	Negoescu, 1997
160	*Apanthura pariensis* Negoescu, 1997	Jakarta	fine sand with much mud, 1-1.5 m	Negoescu, 1997
161	*Apanthuropsis* sp.	Jakarta	bottom with mud, algae, 1.5-2 m	Negoescu, 1997
162	*Caenanthura Negoescui* Negoescu, 1997	Jakarta	fine sand with much mud, 1-1.5 m	Negoescu, 1997
163	*Pendanthura* sp.	South Sulawesi	Sand with *Thalassia*, 3m	Negoescu, 1997
164	*Mesanthura javensis* Wägele, 1984	Java	intertidal	Smithsonian
Family Paranthuridae Menzies & Glynn, 1968				
165	*Colanthura kensleyi* Poore, 1984	North Sulawesi	0-6 m	Smithsonian
166	*Paranthura bunakenensis* Negoescu, 1997	North Sulawesi	4.5 m	Negoescu, 1997
167	*Paranthura setigera* Negoescu, 1997	Bali	coarse sand with *Thalassia* and coral rubble, 3-4 m	Negoescu, 1997
168	*Paranthura* sp.	Jakarta	bottom with sand and algae, 1.5 m	Negoescu, 1997
169	*Pseudanthura albatrossae* Kensley, 1978	South Sulawesi	1380 m	Smithsonian
Family Bopyridae Rafinesque, 1815				
170	*Aporobopyrina javaensis* Bourdon, 1972	Java Sea		Smithsonian
171	*Bopyrina gigas* Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
172	*Allorbimorphus haigae* Bourdon, 1976	Indonesia		Smithsonian
173	*Allorbimorphus lamellosus* (Nierstrasz & Brender à Brandis, 1923)	Indonesia		Smithsonian
174	*Anacepon sibogae* Nierstrasz & Brender à Brandis, 1931	Indonesia		Smithsonian; WORMS

175	*Bopyrophryxus branchiabdominalis* Codreanu, 1965	North Maluku		Smithsonian
176	*Cardiocepon pteroides* Nobili,1906	Indonesia		Smithsonian
177	*Epicepon indicum* Nierstrasz & Brender à Brandis, 1931	Indonesia		Smithsonian
178	*Epipenaeon georgei* Devi, 1982	Indonesia	Host: *Parapenaeus longipes* (Markham, 1994)	WORMS
179	*Gigantione giardi* Nobili, 1906	Indonesia		Smithsonian
180	*Hypocepon enoeensis* Nierstrasz & Brender à Brandis, 1930	Indonesia		Smithsonian
181	*Megacepon pleopodatopus* Bourdon, 1981	Indonesia		Smithsonian
182	*Metacepon pleopodata* Bourdon & Stock, 1979	Indonesia		Smithsonian
183	*Parabopyrella distincta* (Nierstrasz & Brender à Brandis, 1923)	Indonesia		Smithsonian
184	*Parabopyrella intermedia* (Nierstrasz & Brender à Brandis, 1923)	Indonesia		Smithsonian
185	*Paracepon stebbingi* Nierstrasz & Brender à Brandis, 1931	Indonesia		Smithsonian
186	*Paragigantione indica* (Nierstrasz & Brender à Brandis, 1923)	Indonesia		Smithsonian
187	*Parapenaeon expansa* Bourdon, 1979	Indonesia		WORMS
188	*Parapenaeon japonica* (Thielemann, 1910)	Indonesia	Host: *Metapenaeopsis sinica*	WORMS
189	*Parapenaeon tertium* Nierstrasz & Brender à Brandis, 1932	Indonesia		Smithsonian
190	*Parione ischyrandra* Bourdon, 1976	Indonesia		Smithsonian
191	*Parionella elegans* Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
192	*Parionella richardsonae* Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
193	*Parionella astridae* Nierstrasz & Brender à Brandis, 1930	Indonesia		Smithsonian

194	*Pauperella rotunda* Nierstrasz & Brender à Brandis, 1929	Indonesia		Smithsonian
195	*Pleurocryptina indica* Nierstrasz & Brender à Brandis, 1929	Indonesia		Smithsonian
196	*Parathelges weberi* Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
197	*Pleurocryptella infecta* Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
198	*Pleurocrypta keiensis* Nierstrasz & Brender à Brandis, 1931	Indonesia		Smithsonian
199	*Pleurocrypta macrocephala* Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
200	*Pleurocrypta latimellaris* (Nierstrasz & Brender à Brandis, 1931)	Indonesia		Smithsonian
201	*Pseudione nobilii* Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
202	*Pseudione subcrenulata* Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
203	*Pseudione tattersalli* Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
204	*Probopyrus buitendijki* (Horst, 1910)	Java; North Maluku	Host: *P. carcinus* (Chopra, 1930); 1 km up freshwater stream (North Maluku)	WORMS
205	*Probopyrus ascendens* (Semper)	Maluku		Richardson, 1910; Smithsonian
206	*Probopyrus borrei* (Giard & Bonnier)	North Maluku		Smithsonian
207	*Probopyrus marinus* (Nierstrasz & Brender à Brandis, 1923)	Indonesia		Smithsonian
208	*Onychocepon giard*i Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
209	*Orbione halipori* Nierstrasz & Brender à Brandis, 1923	Indonesia		Smithsonian
210	*Schizobopyri brachytelson* (Nierstrasz & Brender à Brandis, 1923)	Indonesia		Smithsonian
Family Idoteidae Samouelle, 1819				
211	*Idotea brevicorna* Milne Edwards, 1840	Papua		WORMS
Family Dajidae Giard & Bonnier, 1887				

212	*Paradajus tenuis* Nierstrasz & Brender à Brandis, 1923	Sulawesi	adult: parasitic: ectoparasitic	WORMS
213	*Zonophryxus trilobus* Richardson	North Maluku	On carapace of host	Smithsonian
Family Barybrotidae Hansen, 1890				
214	*Barybrotes agilis* Schiödte et Meinert	Java Sea		Richardson, 1910
Family Gnathiidae Leach, 1814				
215	*Gnathia*	Maluku	Dead coral on the shore, pH= 8	
216	*Elaphognathia rangifer* Monod, 1926	Indonesia	shallow	Smithsonian; WORMS
Family Arcturidae Dana, 1849				
217	*Naesicopeaabyssorum* (Beddard, 1886)	North Sulawesi; North Maluku	1.18 km	Richardson, 1910; Smithsonian
218	*Arcturus hirsutus* Richardson	North Sulawesi	1.18 km	Richardson, 1910; Smithsonian
219	*Chaetarcturus myops* (Beddard, 1886)	South Sulawesi	731.52 m	Richardson, 1910; Smithsonian
220	*Arcturus parvus* Richardson	Maluku		Smithsonian
Family Austrarcturellidae Poore & Bardsley, 1992				
221	*Dolichiscus cornutus* (Beddard, 1886)	North Sulawesi; North Maluku	1.18 km	Richardson, 1910; Smithsonian
222	*Dolichiscus kai* Poore, 1998	Indonesia	620-666 m	Smithsonian
223	*Dolichiscus tanimbar* Poore, 1998	Indonesia	410-413 m	Smithsonian
Family Munnopsidae Lilljeborg, 1864				
224	*Paropsurus* sp.	South Sulawesi		Smithsonian
Family Macrostylidae Hansen, 1916				
225	*Macrostylis porrecta* Mezhov, 1988.	Sumatra	6433 m	Kensley, 2001

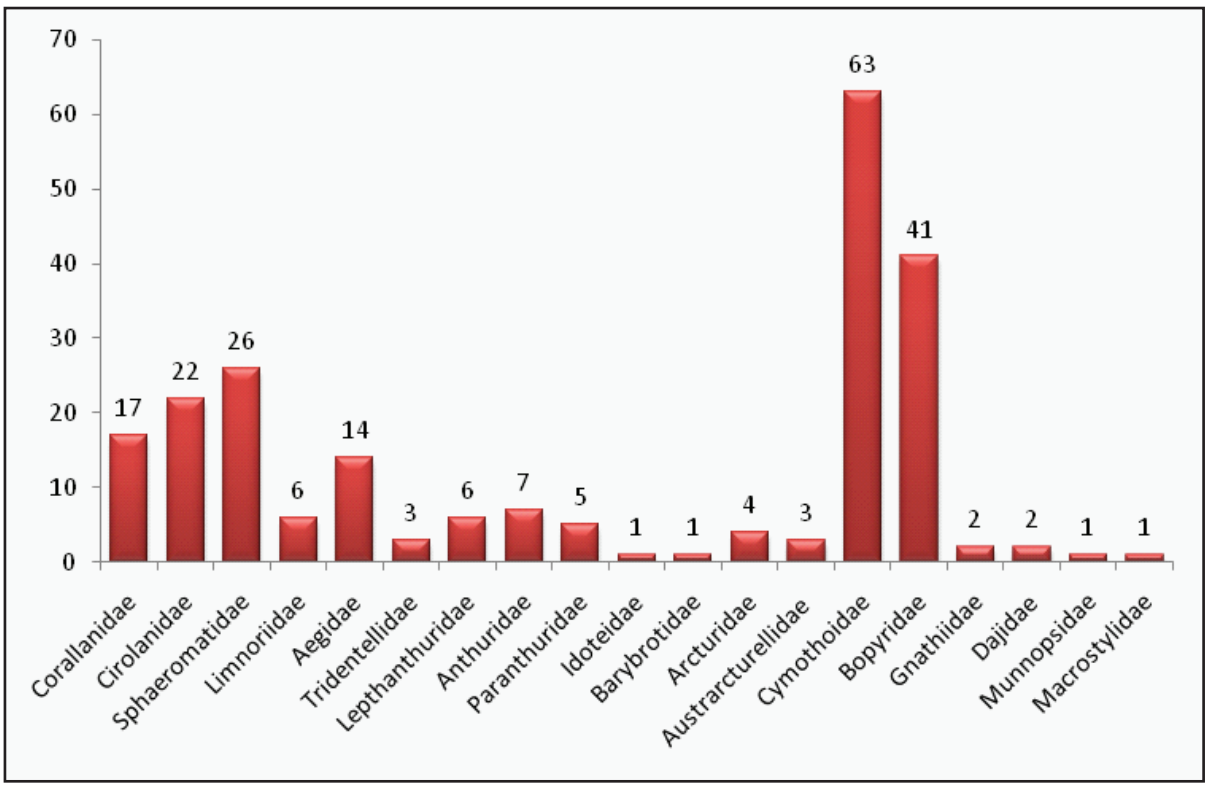

Figure 2. Number of species of marine isopod families found in Indonesia to date.

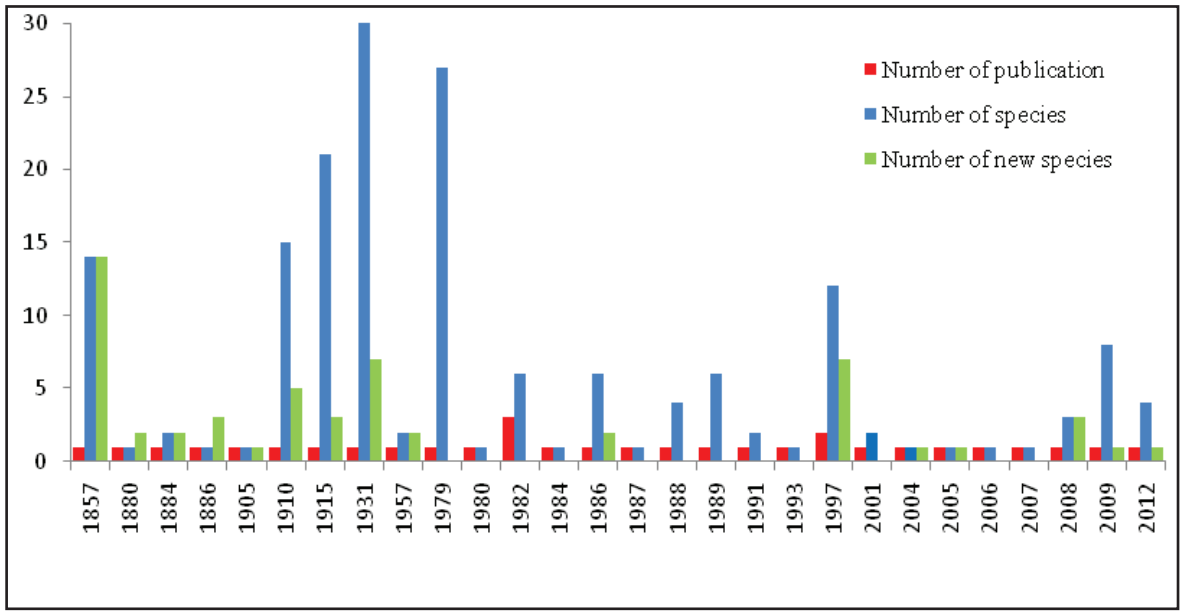

Figure 3. Number of species and related publications on marine isopods found in Indonesia to date.

followed by Bopyridae (41) and Sphaeromatidae (26) (Fig. 2).

The number of publications from 1857 to 2012 was only few (1−2) throughout the period and peaked in 1982 with 3 publications, while the number of species within those publications slightly varied among years (mostly under 10) with a significant exception in 1931 wherein 60 species were described (Fig. 3). A considerable number of new species had been described from this region, particularly between 1857 and 1931 (Fig. 3), with the largest number of 14 in 1857 (Bleeker, 1857). There has been fewer new species described per

Table 2. Expedition and fieldwork incorporating marine isopod sampling in Indonesia between 2010 and 2012.

Expedition	Location	Year	New Species	New Record	Common Record
Operation Wallacea	Wakatobi, Southeast Sulawesi	2010 - current	1	3	4
Lengguru– Kaimana Expedition	Kaimana, West Papua	2010	1 (suspected)	10	
Dikti	Jakarta Bay	2011		2	
Transborder	East Kalimantan	2011		1	
-	Ambon, Maluku	2011		5	
-	Raja Ampat, West Papua	2011			1
PKPP	East Java	2012		2	
PKPP	Sumbawa Besar, West Nusa Tenggara	2012			1

Note: Transborder is a top-down project from Indonesian government; Dikti and PKPP are research projects granted by Ministry of Research and Technology Indonesia.

year afterwards, with the highest number of 7 in 1997 (Bruce, 1997; Negoescu, 1997). Currently there were 8 expeditions and fieldworks involving marine isopod samplings 2010−2012 (Table 2).

DISCUSSION

Java had been the island with the highest number of marine isopod species recorded for the last century. It was apparently due to intensive collecting activities in this region, which may have been contributed by easy access. The presence of many big harbors in the given area facilitated in providing transportation modes for exploring the waters surrounding Java. Maluku and the adjacent waters were the second region with a large number of recorded species partly owing to the report of Siboga Expedition by Nierstrasz (1931) who described 40 isopod species from the eastern Indonesia. The same reason also assigns Sulawesi as the third island in terms of the number of recorded species, in which some records came from nearby straits such as Lembeh Strait which was rich in benthic crustacean species (Shirayama, 2011) and Makassar Strait (e.g. Richardson, 1910; Nierstrasz, 1931).

The two most speciose families, Cymothoidae and Bopyridae, were families composed of parasitic members, while the third-most speciose family, Sphaeromatidae, was a free-living one. The large number of parasitic species in Indonesia, particularly in Cymothoidae, ectoparasites of fishes, was conformable with the fact that Cymothoidae showed the highest diversity in the tropical marine environment (Trilles et al., 2011). Moreover, the Cymothoidae species number in Indonesia was 19.6% (55/280) of the global total (Poore and Bruce, 2012). This was quite remarkable considering not much research had been designated in the diversity of Indonesian marine isopod especially since Siboga Expedition in 1899–1900 (Nierstrasz, 1931). The fewer species number of the speciose and abundant free-living families such as Sphaeromatidae and Cirolanidae may indicate lack of research on the free-living families throughout Indonesia. Higher species number was expected considering the large tropical marine area in Indonesia, i.e. 6.279 million km^2 (Anonymous, 2012). Other possibilities that may add up to the diversity number could be the presence of undescribed and even unsorted specimens stored in overseas museums and future opportunity to explore more various ecosystems and remote habitats.

The number of marine isopod families in Indonesian waters was more than a half (19/37) of the global total (excluding Asellota and crustacean symbionts) (Poore and Bruce, 2012), whereas the total number of marine isopod species in Indonesia was only 3.6% (225/6,250) of the global total (Poore and Niel, 2012), suggesting existence of a large number of still-undescribed species.

In terms of habitat depth, 87.6% (197/225) of the recorded species were from shallow water, while 12.4% (28/225) were from the deep-sea (below 100 m) (Table 1). This suggests the necessity of more exploration to the deep-sea region. In terms of the distribution across the oceans, all records have extended distributions in either Indian or Pacific Oceans except for *Syscenus infelix* Harger, 1880 that reached Atlantic Ocean (Richardson, 1910; Schotte et al., 2008).

Most of the subsequent records came from the small-scale explorations in many specific areas of Indonesia, e.g. Operation Wallacea in Wakatobi Marine National Park, Southeast Sulawesi which discovered one new species (Cookson et al., 2012) and Lengguru-Kaimana Expedition in West Papua (Sidabalok, unpublished data). These and other current expeditions were subjected to discover biodiversity, but isopod collecting was only the minor part. Yet, there has been an important finding from these expeditions, i.e. the possibility to utilize isopods as bioindicators of environmental changes (Sidabalok, unpublished data). This was finding of a research on heavily polluted water in Tanjung Pasir, Jakarta Bay where *Sphaeroma* sp., was found to be able to survive and even reproduce in such environment. This species was observed inhabiting dead corals on the shore with high exposure of the polluted water. Another species, *Dynamenella* sp., was found to live in Rambut Island which was only 6.4 km from Tanjung Pasir but with visible clearer water. This species may also be of potential use for bioindicator of pollution in a body of water and its surrounding environment.

Isopods are also potential bioindicators of coral reef diversity as they demonstrates various environmental sensitivity, easy to collect, slow movers, not migrating and not exploited by human. Nevertheless, coral reef isopods are very poorly known in Indonesia while this is the only region that covers both Indian and Pacific Ocean zoogeographic systems (Bruce, pers. comm.), which also forms the Coral Triangle harboring the highest number of coral reef species in the world (Veron et al., 2009). While several species of Corallanidae, Cirolanidae, and Sphaeromatidae have been reported to inhabit dead corals on the shore (Table 1), there has been no record of species associated with live corals. The main constraint of the current expeditions has been the exclusion of SCUBA diving from the sampling activity which limited the opportunity to collect coral-reef associated isopods. Future collaboration with coral reef scientists with proper collection method of associated isopods is recommended. To obtain rich representation of coral-reef associated isopods, it is necessary to prioritize more exploration to the eastern part of Indonesia, e.g. Raja Ampat as part of Coral Triangle with the highest coral species (Veron et al., 2009).

Lastly, in addition to morphological approach as the only current approach to assess isopod diversity in Indonesia, application of molecular technique as an additional approach to clarify the exact diversity of existing and future records is worthy considered. Molecular technique will be particularly useful in revealing cryptic species complex (Poore and Bruce, 2012). For example, some species of the *Cirolana parva*-group with currently 27 similar species (Poore and Bruce, 2012) are distributed in Indonesia, i.e. *Cirolana arafurae* Bruce, *C. parva* Hansen, *Cirolana* cf. *stenoura* Bruce, *Cirolana* cf. *improceros* Bruce. It is also important to conduct future studies to identify the contribution of Indonesian isopod to marine zoogeography of Indonesia, marine fish parasitology, and bioindicator potentials.

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