

LIST OF LAND SNAILS IN JAVA AND SEVERAL ADJACENT ISLANDS

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ABSTRACT

The malacofauna of Java has been most studied among the Indonesian islands, but the list of land snails in the area remains outdated. This study presents an updated check list of land snails in Java and its adjacent islands. This list is a compilation data from field work in Java conducted in 2013-2016, records from various museums in Europe and Indonesia, collections from private collectors, data from citizen sciences, and literatures. In total, 263 land snail species were recorded in Java and its adjacent islands. The number comprises of 36 families i.e. Subclass Neritimorpha (2 families), Caenogastropoda (6 families), and Heterobranchia (28 families). About 40% are species endemic to Java and among them have restricted distribution to certain areas. In addition, 5% or 13 introduced species were recorded in Java.

Key words: biodiversity, Gastropoda, Indonesia, Mollusca, terrestrial

INTRODUCTION

Java is among the main islands in Indonesia which covers 129km² or 6.7% of the whole of archipelago (BPS, 2017). Administratively, Java is divided into six provinces: Banten, DKI Jakarta, West Java, Central Java, DI Yogyakarta, and East Java. It is located between 6° 37'18" S (Panaitan Island, Banten) to 7°11'18" S (Kangean Islands, East Java) and 112° 38'47" E (Bawean Island, East Java) to 114°31'34" E (Alas Purwo, East Java). The island is covered by volcanic features, alluvial sediments, and areas of uplifted coral limestone. During the Quaternary period, the size of Java's land coverage changed due to the sea-level fluctuations. Nevertheless, the lowland and montane forest in the area were larger in the Last Glacial Maximum (LGM) compared to the present condition (Cannon et al., 2009). The forest present today in Sumatra, Borneo, Peninsular Malaysia, and Java are believed to be refugia for the region's biodiversity.

Java is the most populous island in the world and, accordingly, most of its area has been strongly modified by man. The island has suffered massive land use change throughout time. The area was divided into several land use types where only 5% of the island is covered by natural forest (Whitten et al., 1997; Purba et al., 2014). Forest in Java covers a total of 3,086,200 ha, consisting of 74,100 ha of primary forest, 788,200 ha of secondary forest and 2,240,000 ha of plantations (KLHK, 2016). The greatest threat to forest areas in Java today comes from anthropogenic factors, i.e. land conversions (forest destruction). In addition to

habitat loss, the existence of forest inhabitants is also endangered by hunting/trade, invasive alien species, and climate change (Hughes, 2017).

There are 27,474 described land snails in the world (Molluscabase.org, 2021). Yet, the scientific knowledge of the species diversity is scarce. Land snail species tend to have very small ranges, sensitive to changes associated with human disturbance, and are, thus, especially prone to extinction by habitat destruction (Schilthuizen et al., 2005; Douglas et al., 2013).

The work of land snails in Java is the most complete compared to other islands in the Indonesian archipelago. The earliest recorded discovery of land snail in Java was conducted by Johan Coenraad van Hasselt (JC van Hasselt) in 1821-1823 and recorded 40 land snail species (Martens, 1867). The most comprehensive systematic work on land snails in Java was by Möllendorf (1897) and van Benthem Jutting (1941, 1948, 1950, 1952) who described 71 species and 171 species respectively. In addition, Vermeulen (1996) discovered four new species and added the list.

The number of land snail research in Java are also growing in the 21st century (Dharma, 2005; Heryanto et al., 2003; Heryanto, 2008, 2011, 2012, 2017; Marwoto, 2011; Nurinsiyah, 2015; Nurinsiyah et al., 2016; Nurinsiyah & Hausdorf, 2019; Mujiono & Priawandiputra, 2020; Nurinsiyah & Hausdorf, 2020; Nurhayati et al., 2021). In addition, discoveries of new land snail species in Java are rising (Dharma, 2007, 2014; Nurinsiyah & Hausdorf, 2017a, 2017b; Greke, 2019; Nurinsiyah et al., 2019). In this paper, I aim to provide an updated checklist of land snails in Java and its adjacent islands, which administratively belong to the provinces in Java.

MATERIALS AND METHODS

The study is based on the material collected from field survey in Java and surrounding islands including Sempu and Madura Islands in 2013-2016. The list was also based on the examination of land snail collections from the Museum Zoologicum Bogoriense, Bogor, Indonesia (MZB), the Natural History Museum, London, United Kingdom (NHM), the Naturalis Biodiversity Center, formerly Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands (RMNH), the Senckenberg Museum, Frankfurt, Germany (SMF), the former Zoologisch Museum, Amsterdam, The Netherlands (ZMA; now in the RMNH), the Museum für Naturkunde, Berlin, Germany (ZMB), and the Zoological Museum of the University of Hamburg, Germany (ZMH). Finally, the list was completed with literature study. The checklist covers land snails from the Java mainland as well as its adjacent islands for instance the Panaitan, Peucang, and Dua islands (Banten), thousand islands in Jakarta Bay, Nusa Kambangan (Central Java), Sempu, Nusa Barung, Madura, Bawean and Kangean islands

(East Java). I excluded the list of land snails from Krakatau Islands because administratively they belong to Lampung Province (Sumatra).

Identification and validation processes referred to van Benthem Jutting (1948, 1950, 1952), Loosjes (1953), Butot (1955), Winter (1983), Dharma (1992, 2007, 2014), Winter & Vermeulen (1998), Vermeulen & Whitten (1998), Gomes & Thomé (2004), Heryanto (2011), and Páll-Gergely et al. (2020). The systematic arrangement and taxonomy status of the determined gastropods follows the classification of Bouchet et al. (2017) and Molluscabase.org.

RESULTS

A total of 263 land snail species of 36 families, i.e. Subclass Neritimorpha (2 families), Caenogastropoda (6 families), and Heterobranchia (28 families) were recorded in Java and adjacent islands (Table 1). Among them, 246 species were recorded in the main island of Java. Seventeen species were recorded only in the adjacent islands and not on the main island of Java. About 40% (104 species) of the 263 land snail species recorded were endemic to Java and its adjacent islands.

Table 1. Land snail of Java (*endemic species to Java and its adjacent islands; **introduced species to Java) The presence is indicated with (+)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
1	Neritimorpha	Helicinidae	<i>Geophorus oxytropis</i> (Gray, 1839)	+	
2	Neritimorpha	Helicinidae	<i>Geophorus rollei</i> (Sykes, 1901)*		+
3	Neritimorpha	Helicinidae	<i>Sulfurina biconical</i> (Martens, 1867)	+	
4	Neritimorpha	Hydrocenidae	<i>Georissa javana</i> Möllendorff, 1897	+	+
5	Neritimorpha	Hydrocenidae	<i>Georissa laeviuscula</i> Möllendorff, 1897	+	
6	Caenogastropoda	Alycaecidae	<i>Chamalycaeus fruhstorferi</i> (Möllendorff, 1897)*	+	+
7	Caenogastropoda	Alycaecidae	<i>Chamalycaeus reticulatus</i> (Möllendorff, 1897)*	+	
8	Caenogastropoda	Alycaecidae	<i>Dicharax candrakirana</i> Nurinsiyah & Hausdorf, 2017*		+
9	Caenogastropoda	Alycaecidae	<i>Dicharax longituba</i> (Martens, 1864)	+	
10	Caenogastropoda	Alycaecidae	<i>Pincerna crenilabris</i> (Möllendorff, 1897)	+	
11	Caenogastropoda	Alycaecidae	<i>Stomacosmethis jagori</i> (Martens, 1860)	+	+
12	Caenogastropoda	Cyclophoridae	<i>Cyclophorus kibleri</i> Fulton, 1907*	+	
13	Caenogastropoda	Cyclophoridae	<i>Cyclophorus perdix</i> (Broderip & Sowerby, 1830)	+	+
14	Caenogastropoda	Cyclophoridae	<i>Cyclophorus rafflesi</i> (Broderip & Sowerby, 1830)	+	+

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
15	Caenogastropoda	Cyclophoridae	<i>Cyclotus discoideus</i> Sowerby, 1843	+	
16	Caenogastropoda	Cyclophoridae	<i>Cyclotus kangeanus</i> Schepman, 1909*		+
17	Caenogastropoda	Cyclophoridae	<i>Ditropopsis fruhstorferi</i> (Möllendorff, 1897)*	+	
18	Caenogastropoda	Cyclophoridae	<i>Japonia ciliocincta</i> (Martens, 1865)	+	
19	Caenogastropoda	Cyclophoridae	<i>Japonia trochulus</i> (Martens, 1867)		+
20	Caenogastropoda	Cyclophoridae	<i>Lagocheilus ciliferus</i> (Mousson, 1849)	+	+
21	Caenogastropoda	Cyclophoridae	<i>Lagocheilus convexus</i> Möllendorff, 1897*	+	
22	Caenogastropoda	Cyclophoridae	<i>Lagocheilus grandipilus</i> Böttger, 1891	+	
23	Caenogastropoda	Cyclophoridae	<i>Lagocheilus humilis</i> Möllendorff, 1897*	+	
24	Caenogastropoda	Cyclophoridae	<i>Lagocheilus macromphalus</i> Möllendorff, 1897*	+	
25	Caenogastropoda	Cyclophoridae	<i>Lagocheilus obliquistriatus</i> Bullen, 1904	+	+
26	Caenogastropoda	Cyclophoridae	<i>Leptopoma altum</i> Möllendorff, 1897	+	
27	Caenogastropoda	Cyclophoridae	<i>Leptopoma perlucidum</i> (Grateloup, 1840)	+	+
28	Caenogastropoda	Cyclophoridae	<i>Opisthoporus corniculus</i> (Mousson, 1849)*	+	+
29	Caenogastropoda	Cyclophoridae	<i>Pterocyclos sluiteri</i> O. Böttger, 1890*	+	
30	Caenogastropoda	Diplommatinidae	<i>Arinia yanseni</i> Nurinsiyah & Hausdorf, 2017	+	
31	Caenogastropoda	Diplommatinidae	<i>Diplommatina auriculata</i> Möllendorff, 1897	+	+
32	Caenogastropoda	Diplommatinidae	<i>Diplommatina baliana</i> Fulton, 1899	+	+
33	Caenogastropoda	Diplommatinidae	<i>Diplommatina calcarata</i> Möllendorff, 1897*	+	
34	Caenogastropoda	Diplommatinidae	<i>Diplommatina canaliculata</i> Möllendorff, 1887	+	
35	Caenogastropoda	Diplommatinidae	<i>Diplommatina cyclostoma</i> Möllendorff, 1897*	+	
36	Caenogastropoda	Diplommatinidae	<i>Diplommatina diplostoma</i> Rensch, 1931	+	
37	Caenogastropoda	Diplommatinidae	<i>Diplommatina halimunensis</i> Nurinsiyah & Hausdorf, 2017*	+	
38	Caenogastropoda	Diplommatinidae	<i>Diplommatina heryantoi</i> Nurinsiyah & Hausdorf, 2017*	+	

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
39	Caenogastropoda	Diplommatinidae	<i>Diplommatina heteroglypha</i> van Benthem Jutting, 1948*	+	
40	Caenogastropoda	Diplommatinidae	<i>Diplommatina javana</i> Möllendorff, 1897	+	
41	Caenogastropoda	Diplommatinidae	<i>Diplommatina kakenca</i> Nurinsiyah & Hausdorf, 2017*	+	
42	Caenogastropoda	Diplommatinidae	<i>Diplommatina majapahit</i> Greke, 2019*	+	
43	Caenogastropoda	Diplommatinidae	<i>Diplommatina nevillei</i> (Crosse, 1879)	+	+
44	Caenogastropoda	Diplommatinidae	<i>Diplommatina perpusilla</i> Möllendorff, 1897*	+	
45	Caenogastropoda	Diplommatinidae	<i>Diplommatina planicollis</i> Möllendorff, 1897*	+	
46	Caenogastropoda	Diplommatinidae	<i>Diplommatina ristiae</i> Nurinsiyah & Hausdorf, 2017*	+	
47	Caenogastropoda	Diplommatinidae	<i>Diplommatina sulcicollis</i> Möllendorff, 1897*	+	
48	Caenogastropoda	Diplommatinidae	<i>Diplommatina tetragonostoma</i> Möllendorff, 1897*	+	
49	Caenogastropoda	Diplommatinidae	<i>Opisthostoma javanicum</i> van Benthem Jutting, 1932	+	+
50	Caenogastropoda	Diplommatinidae	<i>Opisthostoma uranoscopium</i> van Benthem Jutting, 1932*	+	
51	Caenogastropoda	Diplommatinidae	<i>Palaina gedeanae</i> Möllendorff, 1897	+	
52	Caenogastropoda	Diplommatinidae	<i>Palaina nubigena</i> Möllendorff, 1897*	+	
53	Caenogastropoda	Pupinidae	<i>Pupina bivalatalis</i> Böttger, 1890*	+	
54	Caenogastropoda	Pupinidae	<i>Pupina compacta</i> Möllendorff, 1897*	+	
55	Caenogastropoda	Pupinidae	<i>Tylotoechus junghuhni</i> Martens, 1867*	+	
56	Caenogastropoda	Pupinidae	<i>Tylotoechus treubi</i> Böttger, 1890	+	
57	Caenogastropoda	Pupinidae	<i>Tylotoechus verbeeki</i> Möllendorff, 1897*	+	
58	Caenogastropoda	Assimineidae	<i>Anaglyphula tiluana</i> (Möllendorff, 1897)*	+	
59	Caenogastropoda	Assimineidae	<i>Omphalotropis columellaris</i> Quadras & Möllendorff, 1893	+	+
60	Heterobranchia	Ellobiidae	<i>Carychium javanum</i> Möllendorff, 1897	+	+
61	Heterobranchia	Ellobiidae	<i>Auriculastra semiplicata</i> (Adams & Adams, 1854)	+	
62	Heterobranchia	Ellobiidae	<i>Ellobium aurisjudae</i> (Linnaeus, 1758)	+	+

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
63	Heterobranchia	Ellobiidae	<i>Ellobium aurismidae</i> (Linnaeus, 1758)	+	+
64	Heterobranchia	Ellobiidae	<i>Ellobium tornatelliforme</i> (Petit de la Saussaye, 1843)	+	
65	Heterobranchia	Ellobiidae	<i>Ellobium scheepmakeri</i> (Petit de la Saussaye, 1850)	+	+
66	Heterobranchia	Ellobiidae	<i>Melampus castaneus</i> Megerle von Mühlfeld, 1816	+	
67	Heterobranchia	Ellobiidae	<i>Melampus cumingianus</i> (Récluz, 1846)	+	+
68	Heterobranchia	Ellobiidae	<i>Melampus fasciatus</i> (Deshayes, 1830)	+	+
69	Heterobranchia	Ellobiidae	<i>Melampus granifer</i> (Mousson, 1849)	+	
70	Heterobranchia	Ellobiidae	<i>Melampus luteus</i> (Quoy & Gaimard, 1832)	+	+
71	Heterobranchia	Ellobiidae	<i>Cassidula aurisfelis</i> (Bruguère, 1789)	+	+
72	Heterobranchia	Ellobiidae	<i>Cassidula faba</i> (Pfeiffer, 1853)	+	
73	Heterobranchia	Ellobiidae	<i>Cassidula nucleus</i> (Gmelin, 1791)	+	+
74	Heterobranchia	Ellobiidae	<i>Cassidula sowerbyana</i> (Pfeiffer, 1853)	+	
75	Heterobranchia	Ellobiidae	<i>Cassidula sulculosa</i> (Mousson, 1849)		+
76	Heterobranchia	Ellobiidae	<i>Laemodonta monilifera</i> (Adams & Adams, 1854)		+
77	Heterobranchia	Ellobiidae	<i>Laemodonta siamensis</i> (Morelet, 1875)	+	
78	Heterobranchia	Ellobiidae	<i>Laemodonta typica</i> (Adams & Adams, 1854)	+	
79	Heterobranchia	Ellobiidae	<i>Pythia castanea</i> (Lesson, 1831)		+
80	Heterobranchia	Ellobiidae	<i>Pythia imperforata</i> (Adams, 1850)	+	+
81	Heterobranchia	Ellobiidae	<i>Pythia pantherina</i> (Adams, 1850)	+	+
82	Heterobranchia	Ellobiidae	<i>Pythia plicata</i> (Gray, 1825)	+	+
83	Heterobranchia	Ellobiidae	<i>Pythia scarabaeus</i> (Linnaeus, 1758)	+	+
84	Heterobranchia	Ellobiidae	<i>Pythia trigona</i> (Troschel, 1838)	+	+
85	Heterobranchia	Ellobiidae	<i>Pythia undata</i> (Lesson, 1831)	+	+
86	Heterobranchia	Veronicellidae	<i>Filicaulis bleekeri</i> (Keferstein, 1865)	+	

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
87	Heterobranchia	Veronicellidae	<i>Laevicaulis alte</i> (Férussac, 1822)**	+	
88	Heterobranchia	Veronicellidae	<i>Semperula maculata</i> (Templeton, 1858)	+	+
89	Heterobranchia	Veronicellidae	<i>Semperula wallacei</i> (Issel, 1874)	+	
90	Heterobranchia	Veronicellidae	<i>Valiguna siamensis</i> (Martens, 1867)*	+	+
91	Heterobranchia	Rathouisiidae	<i>Atopos ouwensi</i> Collinge, 1908*	+	
92	Heterobranchia	Achatinidae	<i>Allopeas clavulinum</i> (Potiez & Michaud, 1838)**	+	+
93	Heterobranchia	Achatinidae	<i>Allopeas gracile</i> (Hutton, 1834)**	+	+
94	Heterobranchia	Achatinidae	<i>Geostilbia aperta</i> (Swainson, 1840)**	+	+
95	Heterobranchia	Achatinidae	<i>Glessula sumatrana</i> (Martens, 1864)	+	
96	Heterobranchia	Achatinidae	<i>Lissachatina fulica</i> (Bowdich, 1822)**	+	+
97	Heterobranchia	Achatinidae	<i>Paropeas achatinaceum</i> (Pfeiffer, 1846)	+	+
98	Heterobranchia	Achatinidae	<i>Paropeas acutissimum</i> (Mousson, 1857)	+	
99	Heterobranchia	Achatinidae	<i>Subulina octona</i> (Bruguière, 1789)**	+	+
100	Heterobranchia	Streptaxidae	<i>Gulella bicolor</i> (Hutton, 1834)**	+	+
101	Heterobranchia	Charopidae	<i>Corinomala baliana</i> (Rensch, 1930)	+	
102	Heterobranchia	Charopidae	<i>Discocharopa aperta</i> (Möllendorff, 1888)	+	+
103	Heterobranchia	Charopidae	<i>Philalanka micromphala</i> van Benthem Jutting, 1952	+	
104	Heterobranchia	Charopidae	<i>Philalanka nannophya</i> Rensch, 1932	+	+
105	Heterobranchia	Charopidae	<i>Philalanka setifera</i> Vermeulen, 1996	+	
106	Heterobranchia	Charopidae	<i>Philalanka thienemanni</i> Rensch, 1932	+	+
107	Heterobranchia	Charopidae	<i>Philalanka tjibodasensis</i> (Leschke, 1914)	+	
108	Heterobranchia	Charopidae	<i>Thysanota conula</i> (Blanford, 1865)	+	
109	Heterobranchia	Endodontidae	<i>Beilania philippinensis</i> (Semper, 1874)	+	
110	Heterobranchia	Helicodiscidae	<i>Stenopylis coarctata</i> (Möllendorff, 1894)	+	+

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
111	Heterobranchia	Succineidae	<i>Succinea gracilis</i> (Lea, 1841)*		+
112	Heterobranchia	Succineidae	<i>Succinea listeri</i> (Smith, 1889)*	+	+
113	Heterobranchia	Succineidae	<i>Succinea minuta</i> (Martens, 1867)	+	
114	Heterobranchia	Succineidae	<i>Succinea obesa</i> (Martens, 1867)	+	+
115	Heterobranchia	Achatinellidae	<i>Elasmias manilense</i> (Dohrn, 1863)	+	+
116	Heterobranchia	Achatinellidae	<i>Elasmias sundanum</i> (Möllendorff, 1897)	+	
117	Heterobranchia	Achatinellidae	<i>Lamellidea cylindrica</i> (Sykes, 1900)		+
118	Heterobranchia	Achatinellidae	<i>Lamellidea subcylindrica</i> (Möllendorff & Quadras, 1894)	+	+
119	Heterobranchia	Achatinellidae	<i>Truncatella guerinii</i> Villa & Villa, 1841	+	+
120	Heterobranchia	Pupillidae	<i>Pupoides coenopictus</i> (Hutton, 1834)		+
121	Heterobranchia	Cerastidae	<i>Rhachis zonulata</i> (Pfeiffer, 1846)**	+	+
122	Heterobranchia	Enidae	<i>Apoecus alticola</i> (Dharma, 1996)*	+	
123	Heterobranchia	Enidae	<i>Apoecus apertus</i> (Martens, 1863)		+
124	Heterobranchia	Enidae	<i>Apoecus glandula</i> (Mousson, 1848)	+	
125	Heterobranchia	Enidae	<i>Apoecus prillwitzi</i> (Möllendorff, 1897)*	+	
126	Heterobranchia	Enidae	<i>Apoecus tenggericus</i> (Möllendorff, 1897)	+	
127	Heterobranchia	Enidae	<i>Apoecus tenuiliratus</i> (Möllendorff, 1897)*	+	
128	Heterobranchia	Enidae	<i>Apoecus thraustus</i> (Möllendorff, 1897)	+	
129	Heterobranchia	Gastrocoptidae	<i>Gastrocopta euryomphala</i> Pilsbry, 1934		+
130	Heterobranchia	Gastrocoptidae	<i>Gastrocopta pediculus</i> (Shuttleworth, 1852)	+	+
131	Heterobranchia	Gastrocoptidae	<i>Gastrocopta recondita</i> (Tapparone-Canefri, 1883)	+	
132	Heterobranchia	Gastrocoptidae	<i>Gastrocopta servilis</i> (Gould, 1843)**	+	+
133	Heterobranchia	Gastrocoptidae	<i>Gyliotrachela fruhstorferi</i> (Möllendorff, 1897)*	+	
134	Heterobranchia	Gastrocoptidae	<i>Paraboysidia boettgeri</i> (Möllendorff, 1897)	+	

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
135	Heterobranchia	Pyramidulidae	<i>Pyramidula javana</i> (Möllendorff, 1897)*	+	
136	Heterobranchia	Truncatellinidae	<i>Truncatellina insulivaga</i> (Pilsbry & Hirase, 1904)*	+	
137	Heterobranchia	Valloniidae	<i>Pupisoma perpusillum</i> (Möllendorff, 1897)*	+	
138	Heterobranchia	Valloniidae	<i>Pupisoma circumlitum</i> Hedley, 1897	+	+
139	Heterobranchia	Valloniidae	<i>Pupisoma dioscoricola</i> (Adams, 1845)	+	+
140	Heterobranchia	Valloniidae	<i>Pupisoma moleculina</i> (van Benthem Jutting, 1940)	+	
141	Heterobranchia	Valloniidae	<i>Pupisoma orcella</i> (Stoliczka, 1873)	+	
142	Heterobranchia	Vertiginidae	<i>Insulipupa malayana</i> (Issel, 1874)	+	+
143	Heterobranchia	Vertiginidae	<i>Nesopupa nannodes</i> (Quadrans & Möllendorff, 1898)	+	+
144	Heterobranchia	Vertiginidae	<i>Nesopupa novopommerana</i> Rensch, 1932	+	
145	Heterobranchia	Clausiliidae	<i>Juttingia fucosa</i> (Loosjes, 1963)*	+	
146	Heterobranchia	Clausiliidae	<i>Oospira cornea</i> (Küster, 1844)*	+	+
147	Heterobranchia	Clausiliidae	<i>Oospira fruhstorferi</i> (Möllendorff, 1897)*	+	
148	Heterobranchia	Clausiliidae	<i>Oospira javana</i> (Pfeiffer, 1841)*	+	+
149	Heterobranchia	Clausiliidae	<i>Oospira junghuhni</i> (Küster, 1844)	+	
150	Heterobranchia	Clausiliidae	<i>Oospira nubigena</i> (Möllendorff, 1897)*	+	
151	Heterobranchia	Clausiliidae	<i>Oospira orientalis</i> (Pfeiffer, 1842)*	+	
152	Heterobranchia	Clausiliidae	<i>Oospira salacana</i> (Böttger, 1890)*	+	
153	Heterobranchia	Clausiliidae	<i>Oospira schepmani</i> (Möllendorff, 1897)*	+	
154	Heterobranchia	Clausiliidae	<i>Phaedusa corticina</i> (Pfeiffer, 1842)	+	+
155	Heterobranchia	Clausiliidae	<i>Phaedusa moluccensis</i> (Martens, 1864)	+	
156	Heterobranchia	Phylomycidae	<i>Meghimatium bilineatum</i> (Benson, 1842)*	+	
157	Heterobranchia	Phylomycidae	<i>Meghimatium striatum</i> van Hasselt, 1824	+	
158	Heterobranchia	Agriolimacidae	<i>Deroceras laeve</i> (Müller, 1774)**	+	

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
159	Heterobranchia	Trochomorphidae	<i>Geotrochus bicolor</i> (Martens, 1864)	+	
160	Heterobranchia	Trochomorphidae	<i>Geotrochus conus</i> (Pfeiffer, 1841)*	+	
161	Heterobranchia	Trochomorphidae	<i>Geotrochus multicarinatus</i> (Böttger, 1890)*	+	
162	Heterobranchia	Trochomorphidae	<i>Trochomorpha concolor</i> Böttger, 1890*	+	
163	Heterobranchia	Trochomorphidae	<i>Trochomorpha froggatti</i> (Iredale, 1941)	+	+
164	Heterobranchia	Trochomorphidae	<i>Trochomorpha strubelli</i> Böttger, 1890*	+	+
165	Heterobranchia	Chronidae	<i>Kaliella barrakporensis</i> (Pfeiffer, 1853)	+	
166	Heterobranchia	Chronidae	<i>Kaliella dendrophila</i> (van Benthem Jutting, 1950)	+	
167	Heterobranchia	Chronidae	<i>Kaliella doliolum</i> (Pfeiffer, 1846)	+	+
168	Heterobranchia	Chronidae	<i>Kaliella microconus</i> (Mousson, 1865)	+	+
169	Heterobranchia	Chronidae	<i>Kaliella micula</i> (Mousson, 1857)	+	
170	Heterobranchia	Chronidae	<i>Kaliella platyconus</i> Möllendorff, 1897	+	+
171	Heterobranchia	Chronidae	<i>Kaliella scandens</i> (Cox, 1872)	+	+
172	Heterobranchia	Chronidae	<i>Vitrinopsis fruhstorferi</i> (Möllendorff, 1897)	+	
173	Heterobranchia	Dyakiidae	<i>Dyakia clypeus</i> (Mousson, 1857)	+	
174	Heterobranchia	Dyakiidae	<i>Dyakia rumphii</i> (Pfeiffer, 1842)	+	
175	Heterobranchia	Dyakiidae	<i>Elaphroconcha bataviana</i> (Pfeiffer, 1842)	+	+
176	Heterobranchia	Dyakiidae	<i>Elaphroconcha javacensis</i> (Férussac, 1821)	+	+
177	Heterobranchia	Dyakiidae	<i>Elaphroconcha patens</i> (Martens, 1898)*	+	
178	Heterobranchia	Dyakiidae	<i>Inozonites imitator</i> Möllendorff, 1897*	+	
179	Heterobranchia	Euconulidae	<i>Coneuplecta macrostoma</i> (Möllendorff, 1897)*	+	
180	Heterobranchia	Euconulidae	<i>Coneuplecta olivacea</i> Vermeulen, 1996	+	+
181	Heterobranchia	Euconulidae	<i>Coneuplecta sitaliformis</i> (Möllendorff, 1897)	+	+
182	Heterobranchia	Euconulidae	<i>Guppya gundlachi</i> (Pfeiffer, 1840)**	+	

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
183	Heterobranchia	Euconulidae	<i>Liardetia acutiuscula</i> (Möllendorff, 1897)	+	
184	Heterobranchia	Euconulidae	<i>Liardetia convexiconica</i> (Möllendorff, 1897)	+	+
185	Heterobranchia	Euconulidae	<i>Liardetia densetorta</i> (Möllendorff, 1897)	+	
186	Heterobranchia	Euconulidae	<i>Liardetia javana</i> (Böttger, 1890)	+	
187	Heterobranchia	Euconulidae	<i>Liardetia pisum</i> (Möllendorff, 1897)*	+	
188	Heterobranchia	Euconulidae	<i>Liardetia reticulata</i> van Benthem Jutting, 1950	+	
189	Heterobranchia	Euconulidae	<i>Liardetia viridula</i> (Möllendorff, 1897)	+	
190	Heterobranchia	Euconulidae	<i>Lamprocystis gedeani</i> Möllendorff, 1897*	+	
191	Heterobranchia	Helicarionidae	<i>Durgella pusilla</i> (Martens, 1867)	+	
192	Heterobranchia	Helicarionidae	<i>Durgella sundana</i> Rensch, 1930	+	
193	Heterobranchia	Helicarionidae	" <i>Helicarion</i> " <i>albellus</i> Martens, 1867	+	+
194	Heterobranchia	Helicarionidae	" <i>Helicarion</i> " <i>perfragilis</i> Möllendorff, 1897	+	
195	Heterobranchia	Helicarionidae	" <i>Helicarion</i> " <i>radiatulus</i> (Möllendorff, 1897)	+	
196	Heterobranchia	Ariophantidae	<i>Hemiplecta humphreysiana</i> (Lea, 1840)	+	+
197	Heterobranchia	Ariophantidae	<i>Hemiplecta kangeanensis</i> Schepman, 1913*		+
198	Heterobranchia	Ariophantidae	<i>Macrochlamys amboinensis</i> (Martens, 1864)**	+	
199	Heterobranchia	Ariophantidae	<i>Macrochlamys infans</i> (Reeve, 1854)	+	
200	Heterobranchia	Ariophantidae	<i>Macrochlamys spiralifer</i> Vermeulen, 1996	+	
201	Heterobranchia	Ariophantidae	<i>Microcystina chionodiscus</i> Vermeulen, 1996	+	+
202	Heterobranchia	Ariophantidae	<i>Microcystina circumlineata</i> (Möllendorff, 1897)	+	+
203	Heterobranchia	Ariophantidae	<i>Microcystina exigua</i> (Möllendorff, 1897)	+	
204	Heterobranchia	Ariophantidae	<i>Microcystina fruhstorferi</i> (Möllendorff, 1897)*	+	
205	Heterobranchia	Ariophantidae	<i>Microcystina gratilla</i> van Benthem Jutting, 1950	+	+
206	Heterobranchia	Ariophantidae	<i>Microcystina muscorum</i> van Benthem Jutting, 1959	+	+

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
207	Heterobranchia	Ariophantidae	<i>Microcystina nana</i> (Möllendorff, 1897)	+	+
208	Heterobranchia	Ariophantidae	<i>Microcystina sinica</i> Möllendorff, 1885	+	+
209	Heterobranchia	Ariophantidae	<i>Microcystina subglobosa</i> (Möllendorff, 1897)*	+	+
210	Heterobranchia	Ariophantidae	<i>Microcystina vitreiformis</i> (Möllendorff, 1897)	+	+
211	Heterobranchia	Ariophantidae	<i>Microparmarion austeni</i> Simroth, 1893*	+	
212	Heterobranchia	Ariophantidae	<i>Microparmarion strubelli</i> Simroth, 1893	+	
213	Heterobranchia	Ariophantidae	<i>Parmarion martensi</i> Simroth, 1893	+	
214	Heterobranchia	Ariophantidae	<i>Parmarion pupillaris</i> (Humbert, 1829)	+	
215	Heterobranchia	Camaenidae	<i>Amphidromus alticola</i> Fulton, 1896*	+	
216	Heterobranchia	Camaenidae	<i>Amphidromus banksi</i> Butot, 1954*		+
217	Heterobranchia	Camaenidae	<i>Amphidromus filozonatus</i> (Martens, 1867)*	+	+
218	Heterobranchia	Camaenidae	<i>Amphidromus furcillatus</i> (Mousson, 1849)	+	+
219	Heterobranchia	Camaenidae	<i>Amphidromus heerianus</i> (Pfeiffer, 1871)*	+	+
220	Heterobranchia	Camaenidae	<i>Amphidromus javanicus</i> (Sowerby, 1833)*	+	
221	Heterobranchia	Camaenidae	<i>Amphidromus jeffabbasorum</i> Thach, 2016*	+	
222	Heterobranchia	Camaenidae	<i>Amphidromus palaceus</i> (Mousson, 1849)	+	
223	Heterobranchia	Camaenidae	<i>Amphidromus perversus</i> (Linnaeus, 1758)	+	+
224	Heterobranchia	Camaenidae	<i>Amphidromus porcellanus</i> (Mousson, 1849)*	+	
225	Heterobranchia	Camaenidae	<i>Amphidromus sancangensis</i> Dharma, 2007*	+	
226	Heterobranchia	Camaenidae	<i>Amphidromus winteri</i> (Pfeiffer, 1849)*	+	
227	Heterobranchia	Camaenidae	<i>Bradybaena similaris</i> (Férussac, 1821)**	+	+
228	Heterobranchia	Camaenidae	<i>Chloritis crassula</i> (Philippi, 1844)*	+	
229	Heterobranchia	Camaenidae	<i>Chloritis fruhstorferi</i> Möllendorff, 1897*	+	+
230	Heterobranchia	Camaenidae	<i>Chloritis helicinoides</i> (Mousson, 1848)*	+	+

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
231	Heterobranchia	Camaenidae	<i>Chloritis transversalis</i> (Mousson, 1857)	+	+
232	Heterobranchia	Camaenidae	<i>Ganesella bantamensis</i> (Smith, 1887)*	+	
233	Heterobranchia	Camaenidae	<i>Landouria abdidalem</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
234	Heterobranchia	Camaenidae	<i>Landouria ciliocincta</i> (Möllendorff, 1897)*	+	
235	Heterobranchia	Camaenidae	<i>Landouria conoidea</i> (Leschke, 1914)	+	
236	Heterobranchia	Camaenidae	<i>Landouria davini</i> Dharma, 2015*	+	
237	Heterobranchia	Camaenidae	<i>Landouria dharmai</i> Nurinsiyah, Neiber & Hausdorf, 2019	+	
238	Heterobranchia	Camaenidae	<i>Landouria epiplatia</i> (Möllendorff, 1897)*	+	
239	Heterobranchia	Camaenidae	<i>Landouria intumescens</i> (Martens, 1867)*	+	
240	Heterobranchia	Camaenidae	<i>Landouria kangeanensis</i> (Schepman, 1913)*		+
241	Heterobranchia	Camaenidae	<i>Landouria leucochila</i> (Gude, 1905)*	+	
242	Heterobranchia	Camaenidae	<i>Landouria madurensis</i> Nurinsiyah, Neiber & Hausdorf, 2019*		+
243	Heterobranchia	Camaenidae	<i>Landouria menorehensis</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
244	Heterobranchia	Camaenidae	<i>Landouria monticola</i> van Benthem Jutting, 1950*	+	
245	Heterobranchia	Camaenidae	<i>Landouria moussoniana</i> (Martens, 1867)*	+	
246	Heterobranchia	Camaenidae	<i>Landouria naggsi</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
247	Heterobranchia	Camaenidae	<i>Landouria nodifera</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
248	Heterobranchia	Camaenidae	<i>Landouria nusakambangensis</i> Nurinsiyah, Neiber & Hausdorf, 2019*		+
249	Heterobranchia	Camaenidae	<i>Landouria pacitanensis</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
250	Heterobranchia	Camaenidae	<i>Landouria pakidulan</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	+
251	Heterobranchia	Camaenidae	<i>Landouria parahyangensis</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
252	Heterobranchia	Camaenidae	<i>Landouria petrukensis</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
253	Heterobranchia	Camaenidae	<i>Landouria rotatoria</i> (Pfeiffer, 1842)*	+	
254	Heterobranchia	Camaenidae	<i>Landouria schepmani</i> (Möllendorff, 1897)*	+	

Table 1. (continued)

No	Subclass	Family	Species	Distribution	
				Java	Adjacent Islands
255	Heterobranchia	Camaenidae	<i>Landouria sewuensis</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
256	Heterobranchia	Camaenidae	<i>Landouria smimensis</i> (Mousson, 1848)*	+	
257	Heterobranchia	Camaenidae	<i>Landouria sukoliloensis</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
258	Heterobranchia	Camaenidae	<i>Landouria tholiformis</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
259	Heterobranchia	Camaenidae	<i>Landouria tonywhitteni</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
260	Heterobranchia	Camaenidae	<i>Landouria winteriana</i> (Pfeiffer, 1842)	+	
261	Heterobranchia	Camaenidae	<i>Landouria zonifera</i> Nurinsiyah, Neiber & Hausdorf, 2019*	+	
262	Heterobranchia	Camaenidae	<i>Pseudopartula arborascens</i> Butot, 1955*	+	+
263	Heterobranchia	Camaenidae	<i>Pseudopartula galericulum</i> (Mousson, 1849)	+	

Many of the endemic species in Java are restricted to a small region. Among the total number of species that occur in Java, 53% (139 species) were recorded in karst areas. Twenty-five species occur exclusively in karst areas. Each of the fourteen of these karst-exclusive species were each found only in a single karst area. For instance, among 27 *Landouria* species in Java, 21 species have restricted distributions and are only recorded in small range areas in Java (Nurinsiyah et al., 2019). From 23 diplommatinids, 12 species were recorded only in non-karst (volcanic/mountain) areas. The records of these small range endemic forest species might indicate that small scale forest refugia probably existed during the glacial period.

DISCUSSION

Based on the extremely high species richness of plants and vertebrates, Indonesia is listed as one of the mega diversity countries (Reid, 1998). Furthermore, the country is also included among the 25 biodiversity hotspots (Sundaland) based on the number of endemic species and the degree of threat (Myers et al., 2000). Fourteen percent of the land snail species known in Indonesia occur in Java (Hausdorf, 2019). The number of land snail species in Java is slightly differ from Sumatra and Sulawesi, which have larger areas (Table 2). The land snail species diversity in the two latter islands might be underestimated due to

the lack of malacological study in these areas. This is the case not only for snails, but also for other invertebrate taxa that are often neglected.

Table 2. Land snail species diversity in the archipelago (source: adapted from Hausdorf, 2019)

Island	Area (km ²)	Number of Species
Sumatra	473,481	276
Java & adjacent islands	129,438	263
Bali & Nusa Penida	5,780	126
Borneo	743,330	558
Sulawesi	180,680	253

The 263 land species in Java and adjacent islands is a great increment from the previous comprehensive list which was 171 land snail species (van Benthem Jutting, 1941, 1948, 1950, 1952). The additional species came from new record of native species, new record of introduced species, and newly described species. In the past two decades there were 26 new species of Gastropods have been described from Java. There were also fossil species of Gastropods described (Dharma, 2007, 2021) but they are not included in the list. Whitten et al. (1997) listed seven introduced species from Java i.e. *Allopeas gracile*, *Lissachatina fulica*, *Subulina octona*, *Gulella bicolor*, *Rachis zonulata*, *Gastrocopta servilis*, and *Bradybaena similaris*. The number was added to 13 introduced species (Nurinsiyah & Hausdorf, 2019). The widely distributed introduced species occur mainly in the disturbed areas and modified habitats. The proportion of introduced species abundance in an area can be use as indicator for habitat disturbance (Nurinsiyah et al., 2016).

Among the 17 land snail species found on the adjacent islands (not in mainland), nine species are endemic to a particular island. The species of *Geophorus rollei*, *Cyclotus kangeanus*, *Hemiplecta kangeanensis*, and *Landouria kangeanensis* were found only in Kangean island (van Benthem Jutting, 1941). The island is located more than 120km from the mainland Java even though administratively belongs to the Province of East Java. There are also species endemic to adjacent island located less than 1km away from the mainland Java. *Dicharax candrakirana* is endemic to Sempu Is. and *Landouria nusakambangensis* is endemic to Nusa Kambangan Is. (Nurinsiyah & Hausdorf, 2017b; Nurinsiyah et al., 2019). The former island is a nature reserve, whereas the latter is a prison island which public have limited access to enter the area. However, there is a concession area for limestone quarry in the northern part of the Nusa Kambangan Is. Although more than 50% of the concession area is designated for conservation forest, land coverage and habitat sustainability for the forest inhabitants needs to be ensured.

Terrestrial mollusk is one of the fauna groups that is often overlooked and abandoned from the conservation spotlight. It was estimated that this group may have lost 7% of the total described species on Earth (Régnier et al., 2015). Although the work of land snails in Java is the most complete compared to other islands in the Indonesian archipelago, monitoring the sustain population in Java is crucial. Furthermore, there will always be a yet discovered taxa or systematically problematic taxa in this well-known island awaiting scientific discovery.

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