

Two species of *Diplommatina* and a new species of *Palaina* (Gastropoda: Cyclophoroidea: Diplommatinidae) from Moti Island, North Moluccas, Indonesia

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Abstract. Diplommatinidae from Moti Island, North Moluccas are revised based on material collected in 2010 and 2022. Two species belonging to *Diplommatina* and a new species of *Palaina* have been recorded. *Diplommatina moluccensis* is endemic to the North Moluccas, while *Diplommatina radiiformis* is endemic to the Moluccan Archipelago. A new species (*Palaina motiensis*, new species) is described, which is known from a single site, and is most similar with *Palaina tanimbarensis* from Yamdena Island and *Palaina silvicultrix* from Waigeo, West Papua.

Key words. land snail, new species, Diplommatinidae, Maluku, Indonesia

INTRODUCTION

The North Moluccas are an archipelago comprising at least 1,474 islands located in the eastern part of Indonesia. The archipelago developed around 25 Ma after the Philippines-Halmahera tectonic plate collided with the northern Australia plate and moved west along the New Guinea plate (Hall, 2013). The archipelago lies between 3°40'S to 3°0'N and 123°50'E to 129°50'E. In terms of administration, the archipelago was formerly part of the Maluku Province of Indonesia but belongs to the province of Maluku Utara (North Moluccas) since 1999. Biogeographically, the archipelago is grouped with Sulawesi and the Philippines forming the Wallacea region (Ung et al., 2016).

Studies on land snails in the North Moluccas archipelago were conducted by van Benthem Jutting (1941, 1959). The studies were based on specimens collected from several expeditions by H. Th. De Booy in 1926 and 1928, H. J. Lam in 1926, P. Groenhart in 1951 and A. M. R. Wegner in 1953. van Benthem Jutting also examined the specimen collections belonging to the Naturalis Biodiversity Center (formerly Amsterdam Zoological Museum (ZMA) and Rijksmuseum

van Natuurlijke Historie of Leiden (RMNH)), Senckenberg Museum Frankfurt (SMF), and the British Museum (Natural History). There were at least 207 malacofauna species recorded from these islands. It was highlighted by van Benthem Jutting (1959) that this list is far from complete because of the absence of many snail groups, including Diplommatinidae. Only three diplommatinids were included, i.e. *Diancta constricta* (von Martens, 1864) recorded from Ternate I., *Diancta multiplicata* Möllendorff, 1902 from Obi I., and *Diancta torta* O Boettger, 1891 from Bacan (formerly Batjan) I. Greke (2012) published a malacofauna species list of Gebe I. in the North Moluccas where she described two new species. However, among the 18 species of molluscs, there was no record of Diplommatinidae.

There are 979 valid species of Diplommatinidae worldwide (MolluscaBase, 2022). Given that many diplommatinid species have restricted geographic distributions resulting in high endemism (Nurinsiyah & Hausdorf, 2017), this number is likely an underestimate. Greke (2012) studied more than 500 specimens of Diplommatinidae based on museum collections and field work in the Wallacea and Papua regions covering Lombok, Sumbawa, Flores, Sumba, Timor, the Alor Archipelago and Tanimbar I. (Wallacea region), and the Moluccas archipelago and the north and east of New Guinea, excluding Sulawesi (Papuan region). The study recorded 121 species of diplommatinids with 54 new species, of which 15 species were recorded from the North Moluccas (Greke, 2017). Three genera occur in the North Moluccas, i.e., *Diancta* Martens 1864, *Diplommatina* Benson 1849, and *Palaina* Semper 1865. Two important conclusions of the study from Greke (2017) were that (1) almost all diplommatinids from the region are regional and local endemics with restricted distribution; and (2) there are likely four times more diplommatinids in the Moluccas than are currently known.

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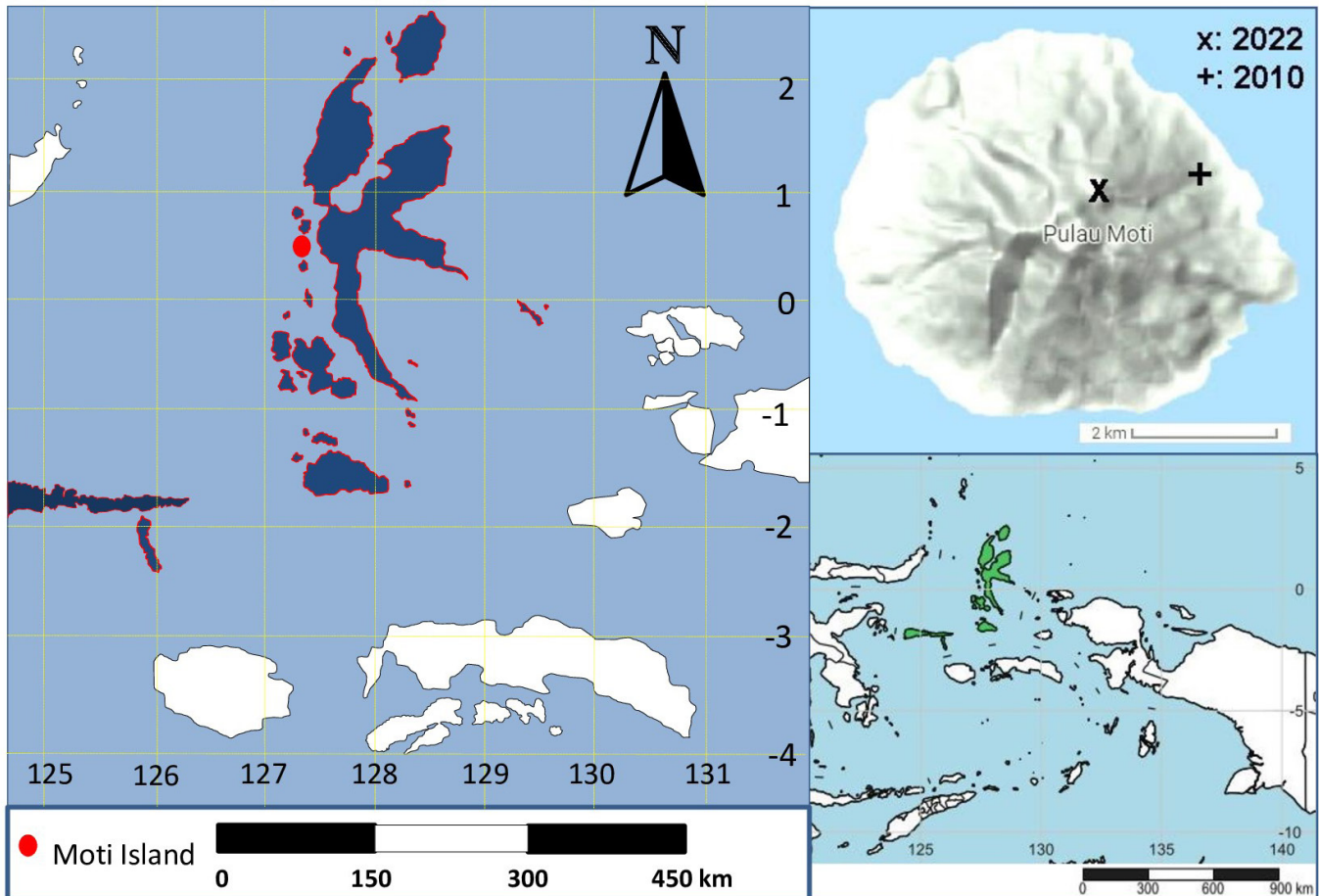


Fig. 1. Map of Moti I. in the North Moluccas Archipelago, with the insertion of the North Moluccas in Indonesia and the studied area in Moti I.

Among the areas studied by van Benthem Jutting (1959) and Greke (2017), Moti I. was never included. An expedition to Moti I. was conducted in 2010, which resulted in a list of 31 malacofauna species (Heryanto, 2011). Among them, three diplommatinids were discovered (listed as *Diplommatina* spp.). Moti I. belongs to the North Moluccas Archipelago (Fig 1) and lies at 0.45°N 127.40°E (Heryanto, 2011). The largest island of the archipelago, Halmahera I., is located off the east side of Moti I. The islands of Mare and Tidore are located to the north of Moti I., while Makian I. is located to its south. Moti I. has a total size of 24.78 km^2 . Geologically, Moti I. consists of volcanic rock with andesite composition. The highest elevation of the island is the peak of Mount Tuanane ranging from $930\text{--}950\text{ m a.s.l.}$ and located at the centre of the island (Roemantyo, 2010). The island was covered by primary forest (12.35%), mainly located at higher elevations, old secondary forest (1.90%), secondary forest (23.52%), plantations, open fields, and human settlements (Roemantyo, 2010; Utamingrum & Roemantyo, 2011). In recent years, the forest coverage has decreased due to the growth of nutmeg plantations (*Myristica fragrans* Houtt.), which now cover about 11.02 km^2 in area (BPS Kota Ternate, 2022). Moti I. is divided into six villages: Moti, Figur, Takofi, Tafaga, Tadenas, and Tafamutu. The human population of the island was 4,371 in 2009 and increased by 10% in 2021 (BPS Kota Ternate, 2022).

Based on the lack of diplommatinid collections in 2010, we revisited Moti I. in 2022 and studied the systematics of diplommatinids in this area. Due to the potential diversity in Moti I. and the unique habitat for land snails in the North Moluccas, further studies are required to unveil the land snail diversity in the area.

MATERIAL AND METHODS

This study is based on material from field surveys conducted in May 2010 (H) and in May 2022 (H, NM, IWL). Direct visual search and hand collection were used to collect the specimens. The collected specimens were preserved in 1.5 ml vials with 96% ethanol. Identification and validation processes referred to the publications of Diplommatinidae from the Moluccas Archipelago by van Benthem Jutting (1959) and Greke (2012, 2017) as well as from nearby large islands such as Sulawesi (Maassen, 2003). In total, 55 specimens of diplommatinids from Moti I. were examined. In addition, we also compared the diplommatinids from Moti I. with the diplommatinids collected from Ternate and Tidore islands in 2022, which are stored in the Museum Zoologicum Bogoriense (MZB). We photographed and measured the shells (Table 1, Fig. 2) using a DMC5400 camera with L.A.S V4.13.0 software adapted to a Z6 APO

Table 1. Shell measurements of diplommatinid species on Moti Island (in mm). Abbreviations: sd = shell diameter; sh = shell height; da = diameter of the aperture; ha = height of the aperture; W = number of whorls; n = number of measured specimens; min = minimum; max = maximum; std = standard deviation.

	sd	sh	da	ha	W
<i>Diplommatina moluccensis</i>, n=8					
Min	1.1	2.3	0.5	0.3	5.0
Max	1.3	3.1	0.8	0.5	7.0
Mean	1.2	2.7	0.6	0.5	6.1
Std	0.1	0.2	0.1	0.0	0.6
<i>Diplommatina radiiformis</i>, n=1					
	1.2	2.7	0.9	0.8	7.5
<i>Palaina motiensis</i>, new species, n=3					
Min	1.6	3.0	1.4	1.3	5.0
Max	1.9	3.3	1.5	1.5	5.5
Mean	1.8	3.2	1.5	1.4	5.2
Std	0.1	0.1	0.1	0.1	0.3

(Leica Microsystems, Heerbrugg, Switzerland). We followed characters and positional terms defined by Nurinsyah & Hausdorf (2017). All material (holotype and paratypes) is deposited in the Museum Zoologicum Bogoriense (MZB), National Research and Innovation Agency, Indonesia.

A key to Diplommatinidae of Moti Island

1. Shell with conical and spindle shape, aperture with visible columellar lamella *Diplommatina* (2)
 - Shell with cylindrical shape, aperture without visible lamella *Palaina* (3)
2. Shell with low spired apex and appears as if decollated *Diplommatina moluccensis*
 - Shell with spire apex *Diplommatina radiiformis*
3. Sinistral shell with angular whorls *Palaina motiensis*, new species

SYSTEMATICS

Family Diplommatinidae Pfeiffer, 1856

Diplommatina Benson, 1849

Diplommatina moluccensis Greke, 2017

(Figs. 1, 2a; Table 1)

Diplommatina moluccensis Greke, 2017: 181, pl. 25: fig. 1–5 (Tidore I., North Moluccas).

Diplommatina sp.1—Heryanto, 2011: 123.

Material examined. Specimen MZB.Gst. 22495/7, Indonesia, North Moluccas, Moti Island, Tadenas Village, forest near nutmeg plantation, 480 m a.s.l., 0°27'42.7"N 127°25'40.8"E, coll. Heryanto, May 2010; specimen MZB.Gst. 22496/41, Moti Village, 65 m a.s.l., 0°27'42.78"N 127°24'52.47"E, coll. Heryanto, Nova Muijono, Ibnu W. Laitupa, May 2022.

Diagnosis. *Diplommatina moluccensis* is characterised by a small, dextral shell with a spindle shaped body whorl, first few whorls are low spired, making the shell look decollated, distinct columellar lamella. The species from Moti I. is similar to *D. moluccensis* collected from the type locality (Tidore I.).

Description. Shell dextral; spindle-shaped with smooth low spired apex, body whorl narrow, and penultimate whorl is the widest; with 5 to 7 whorls separated by deep suture; protoconch with ribs; teleoconch with oblique ribs; there are more ribs on penultimate whorl than body whorl; without discernible spiral striae between ribs; whitish; subtranslucent; aperture subangular, columello-basal part of aperture is pointed; upper insertion of peristome distinctly ascending towards aperture; insertions of peristome connected by a weak callus; peristome expanded and thickened, slightly doubled on the basal side; aperture with a distinct columellar lamella; laterally right inside the body whorl with a long spiral palatal fold and dorsolaterally right with radial palatal fold along the whorl; umbilicus closed. Shell height 2.3–3.1 mm, shell diameter 1.1–1.3 mm.

Habitat. The specimen was found in secondary forest, in a nutmeg plantation, on a large boulder of volcanic rock covered with herbaceous layers and moss, and in between leaf litter. The species occurs from 0 to 500 m a.s.l.

Distribution. *Diplommatina moluccensis* is endemic to the North Moluccas, where it has been found so far only on Tidore I., Ternate I., and Moti I. The distribution in Moti I. is a new record.

Diplommatina radiiformis Preston, 1913

(Figs. 1, 2b; Table 1)

Diplommatina radiiformis Preston, 1913: Island of Beilan-beilan (Belangbelang); Greke, 2017: 183, Plate 25: fig. 15–24. *Diplommatina* sp. 2—Heryanto, 2011: 123.

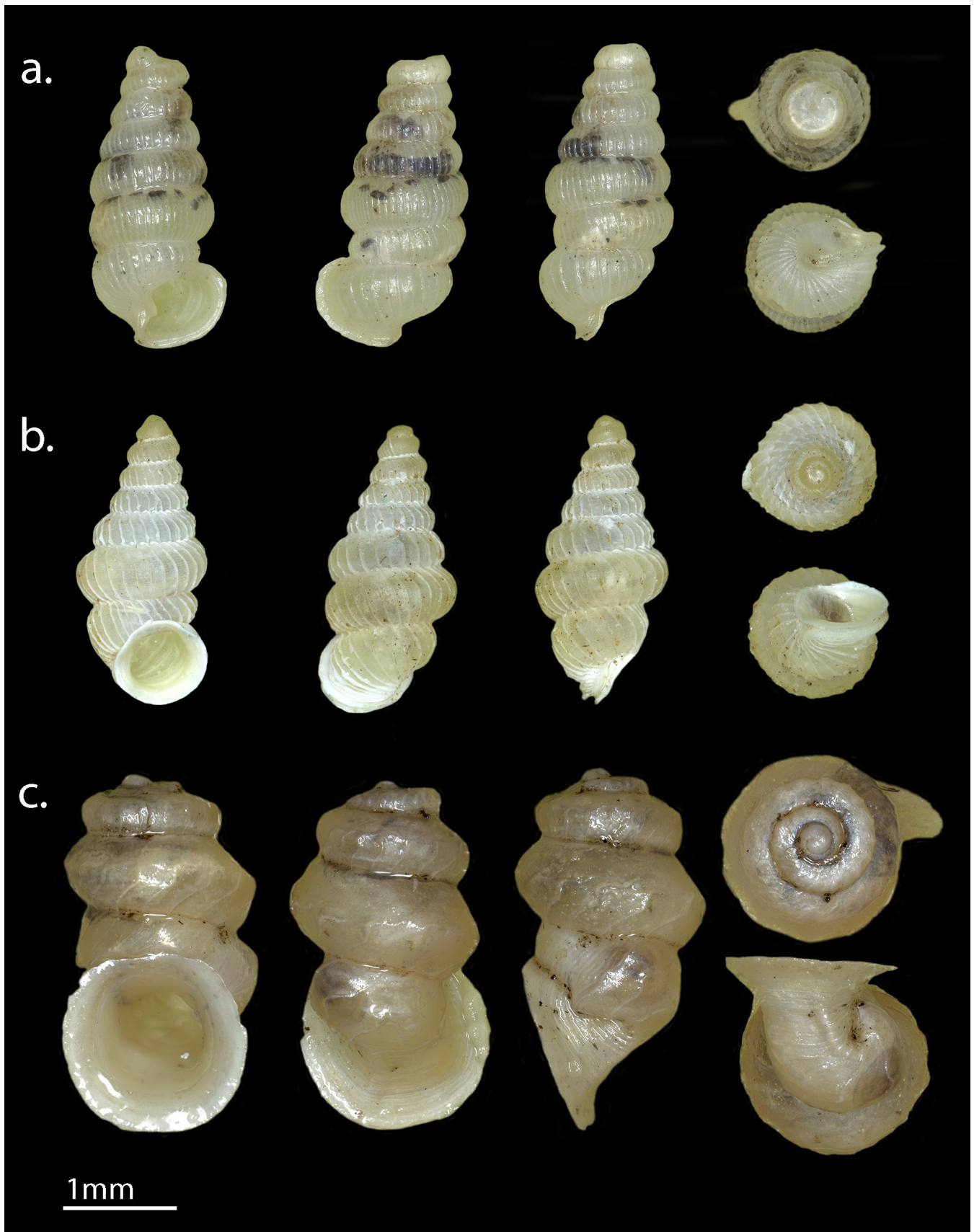


Fig. 2. Shells of Diplommatinidae described from Moti I. a, *Diplommatina moluccensis* Greke, 2017, (MZB.Gst. 22496). b, *Diplommatina radiiformis* Preston, 1913, (MZB 22497). c, *Palaina motiensis*, new species (Holotype, MZB 22493). Scale bars = 1.0 mm.

Material examined. Specimen MZB.Gst. 22497/2, Indonesia, North Moluccas, Moti Island, Tadenas Village, forest near nutmeg plantation, 480 m a.s.l., 0°27'42.7"N 127°25'40.8"E, coll. Heryanto, May 2010.

Diagnosis. *Diplommatina radiiformis* is characterised by a closely ribbed and spiral striae in between ribs, small dextral shell with a convex body whorl with two spiral palatal folds inside the body whorl and distinct columellar lamella. The species from Moti I. has similar morphological characters with *D. radiiformis* described and figured by Greke (2017), especially with the distinct and dense spiral striae and the longitudinal palatals on the ultimate whorl. The specimen from Moti I. differs by having a slightly larger shell.

Description. Shell dextral; spindle shaped with a conical top and narrowed body whorl; with 7.5 whorls separated by deep suture; protoconch smooth; teleoconch with oblique ribs (penultimate and body whorl almost have same number of ribs); with spiral striae between ribs; whitish or corneous; subtranslucent; body whorl ventrally with constriction; aperture almost rounded, with a slight bend on upper insertion of peristome; insertions of peristome connected by strong callus; peristome expanded, thickened, doubled; aperture with distinct columellar lamella; ventrally inside body whorl with two spiral palatal folds close to suture; umbilicus closed. Shell height 2.7 mm, shell diameter 1.2 mm.

Habitat. The specimen was found in secondary forest, in a nutmeg plantation, on a large boulder of volcanic rock covered with herbaceous layers and moss, and in between leaf litter. On Moti I., the species was recorded at an elevation between 400 to 500 m a.s.l. However, on the other islands, the species can occur in both lower elevations (230 m a.s.l.) and higher elevations (530 m a.s.l.) (Greke, 2017).

Distribution. *Diplommatina radiiformis* is endemic to the Moluccas Archipelago (Maluku Islands), distributed from Belang-belang I. (Obi Islands), Tidore I., and Halmahera I. (Greke, 2017). The distribution in Moti I. is a new record.

Palaina Semper, 1865

Palaina motiensis, new species

(Figs. 1, 2c; Table 1)

Diplommatina sp. 3—Heryanto, 2011: 123.

Material examined. Holotype: specimen MZB.Gst. 22493 (D = 1.65 mm, H = 3.25 mm), Indonesia, North Moluccas, Moti Island, 480 m a.s.l., 0°27'42.8"N 127°24'52.5"E, coll. Heryanto, May 2010. Paratypes: MZB.Gst. 22494/4, same data as for holotype.

Diagnosis. *Palaina motiensis*, new species is characterised by an ovoid, distant ribbed, sinistral shell with an operculum with an indistinct spiral ridge on the outer surface.

Description. Shell sinistral; ovoid with pointed top; with 5–5.5 angular whorls separated by deep suture; protoconch smooth; teleoconch with curved and distant ribs; denser ribs appear on angular part of penultimate whorl and on body whorl towards peristome; without distinct spiral striae between ribs; whitish or corneous; subtranslucent; body whorl angular near lower margin; aperture rounded; upper insertion of peristome distinctly ascending towards aperture; insertions of peristome connected by a distinct callus; peristome expanded, thickened, but not doubled; without lamellae or folds. Shell height 3.0–3.3 mm, shell diameter 1.6–1.9 mm.

Remarks. Two known *Palaina* species, *P. tanimbarensis* Greke, 2017 and *P. silvicultrix* Greke, 2017, have a similar shell with this new species. *Palaina tanimbarensis* differs by the expanded and doubled peristome, as well as the protruding ribs. Moreover, it was recorded in Yamdena I., which is located in the far south, approximately 974 km from Moti I. and separated by deep sea. Most of the known taxa (98%) in this region are site endemic (Greke, 2017). Thus, it is unlikely that the two species are the same. *Palaina silvicultrix* from Waigeo, West Papua, located ~ 366 km away and separated by the Halmahera Sea, has a more expanded and doubled peristome, as well as denser ribs compared to this new species.

Habitat. The specimen was found in secondary forest, in a nutmeg plantation, on a large boulder of volcanic rock covered with herbaceous layers and moss, and in between leaf litter. The species was found at the elevation range of 400 to 500 m a.s.l.

Distribution. *Palaina motiensis*, new species is endemic to Moti Island, where it has been found so far only on the island.

Etymology. The species *Palaina motiensis* is named after the type locality, Moti Island where the holotype was found.

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AUTHOR CONTRIBUTIONS

Heryanto (H) conducted the first and second fieldwork and wrote the manuscript; Nova Mujiono (NM) conducted the second fieldwork and created the map; Ibnu Wahab Laitupa (IWL) conducted the second fieldwork; Ayu Savitri Nurinsiyah (ASN) analysed the specimens, described the new species, and wrote the manuscript.

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