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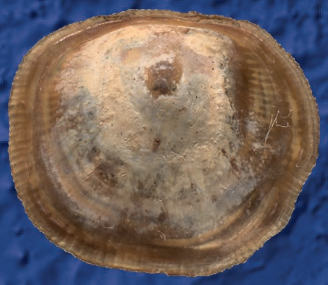
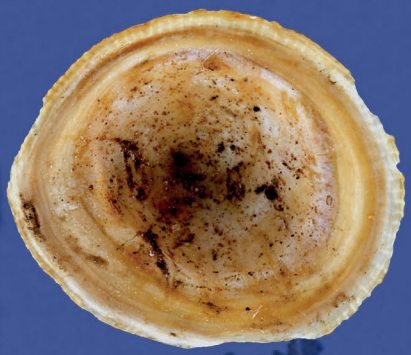
Alfréd DULAI & J. G. M. (Han) RAVEN





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Couverture / *Cover* :
Photos of two syntypes of *Discradisca semicornea* (Preston, 1908) in dorsal and ventral views.

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ABSTRACT
Brachiopods are one of the minor phyla of marine invertebrates, and representatives of the superfamily Discinoidea Gray, 1840 are rare. To date, six species of the genus *Discradisca* Stenzel, 1964 are known, mainly from coastal waters around the world. A new species of *Discradisca* is described here from northwestern Borneo: *Discradisca borneensis* n. sp., widely distributed in shallow waters of the South China Sea, in Sarawak, Sabah (East Malaysia) and Brunei Darussalam. The low conical dorsal valve of the new species is ornamented by 125-135 tuberculate radial costellae. The irregularly subhexagonal ventral valve has an elongated, ovoid pedicle foramen, and rounded, smooth and white pedicle area. The outer part of the ventral valve is ornamented by numerous (about 180) closely spaced radial costellae without tuberculated appearance. During this work, it was noted that *Acmaea semicornea* Preston, 1908, a little-known gastropod species described from the Andaman Islands (India), also belongs to the genus *Discradisca*. Examination of the type material shows that it is a senior synonym of *Discradisca indica* Dall, 1920, a species widely distributed in South Asia. Although the name *semicornea* was previously unused by researchers specialising in brachiopods, it has priority over the name *indica*, which has been used for a long time but does not meet the criteria of the *International Code of Zoological Nomenclature* (Art. 23.9) for a reversal of precedence.

KEY WORDS
Discinide brachiopods,
Sarawak,
Sabah,
Brunei,
India,
revision,
senior synonym,
new species.

RÉSUMÉ

Nouvelles données sur les Discradisca *Stenzel, 1964 (Brachiopoda, Discinoidea) d'Asie du Sud et du Sud-Est : description de* D. borneensis *n. sp. de N-O de Bornéo et statut taxonomique de* D. semicornea *(Preston, 1908).*

Les brachiopodes sont un des phylums mineurs d'invertébrés marins et les représentants de la superfamille Discinoidea Gray, 1840 sont rares. À ce jour, six espèces sont connues dans le genre *Discradisca* Stenzel, 1964, principalement dans les eaux côtières du monde entier. Une nouvelle espèce de *Discradisca* est décrite ici du nord-ouest de Bornéo : *Discradisca borneensis* n. sp., largement répandue dans les petits fonds de la mer de Chine méridionale, à Sarawak, Sabah (Malaisie orientale) et Brunei Darussalam. La valve dorsale conique basse de la nouvelle espèce est ornée de 125-135 côtes radiales perlées. La valve ventrale irrégulièrement hexagonale est pourvue d'une région pédiculaire allongée, ovoïde et lisse. La partie externe de la valve ventrale est ornée de nombreux (environ 180) costules radiaux étroitement espacés, sans aspect perlé. Au cours de ce travail, il a été noté qu'*Acmaea semicornea* Preston, 1908, une espèce de gastéropode méconnue, décrite des îles Andaman (Inde), appartient en fait également au genre *Discradisca*. L'examen du matériel type montre qu'il s'agit d'un synonyme plus ancien de *Discradisca indica* Dall, 1920, une espèce largement répandue en Asie du Sud. Bien que le nom *semicornea* n'était pas auparavant utilisé par des chercheurs spécialistes des brachiopodes, il a la priorité sur le nom *indica*, utilisé depuis longtemps mais ne satisfaisant pas aux critères du *Code de nomenclature zoologique* (Art. 23.9) pour un renversement de préséance.

MOTS CLÉS
Brachiopodes discinides,
Sarawak,
Sabah,
Brunei,
Inde,
révision,
synonyme principal,
espèce nouvelle.

INTRODUCTION

Brachiopods usually have a distinctive, easily recognisable bivalve skeleton with a dorsal and a ventral valve; however, some groups are more difficult to identify. These groups belong to the former "Inarticulata" class of brachiopods, now classified in the Linguliformea and Craniiformea subphyla (Kaesler 2000). Both in the Discinoidea superfamily of Linguliformea brachiopods and in the Craniiformea brachiopods the dorsal valves have cap-shaped forms, which at first glance can be confused with some similar-looking Gastropoda (Mollusca) groups ("limpets"). Craniide brachiopods, however, can be distinguished from gastropods by the distinctive muscle attachment scars on the internal side of their valves. Discinide brachiopods are even easier to distinguish, as the brownish-reddish-blackish chitinophosphatic material of their shells is even more striking than the muscle attachment scars. Nevertheless, until recently there is still some mixing between groups of similar appearance.

Such a mistake was recently revealed when Raven (2021) recognised that a species of the genus *Acmaea* Eschscholtz, 1833, described by Preston (1908) and classified as a snail for more than 100 years, is actually a discinide brachiopod. Amongst the shells the second author collected in NW Borneo during the 1990's there are several lots of a "limpet" with very characteristic shape and largely corneous. After a long time, a figure in a paper (Preston 1908: pl. 16, fig. 46) on molluscs from the Andaman Islands, India, was found representing a similar shell (Fig. 1): *Acmaea semicornea* Preston, 1908. The following literature search showed several authors struggled with this shell, which was subsequently placed in various mollusc families. Eventually it was realised they are brachiopods (Raven 2021), belonging to the chitinophosphatic family Discinidae Gray, 1840, circular to subcircular in outline, with a conical dorsal valve and a thin and fragile ventral valve, which lives attached to hard surfaces via short pedicle (Holmer & Popov 2000).

The aim of this paper is to establish the taxonomic status of *Acmaea semicornea* and to describe a new *Discradisca* species based on material from NW Borneo (numerous localities in Sarawak, Brunei and Sabah; Fig. 1) collected by one of the authors (HR). This NW Bornean species is different from that of India and is herein described as a new taxon. These steps may help to clarify the presence of the genus *Discradisca* in South Asia – North Australia, which is one of the most important distribution areas of recent Discinidae brachiopods. We also discuss shortly the problem that the future identification of the new species may be difficult, as its ventral valve has valuable information to differentiate between species, but due to its delicate nature is not always preserved.

MATERIAL AND METHODS

The new species from NW Borneo is based on material collected by the second author (who lived in Miri, Sarawak from 1992-1997 and repeatedly returned to the area), mostly by sampling intertidal rocks, dredged sediments, and collecting sediment while snorkelling or scuba diving.

Acmaea semicornea material was studied based on literature data, as well as online available museum specimens and types. Syntypes of the species were located in the Indian Museum (J. Warneford collection), which later were moved to the National Zoological Collection (Zoological Survey of India). Photographs of the type material were published online, including the specimen figured by Preston (Fig. 5B-D). Three juvenile *semicornea* specimens from the Andaman Islands are in the Natural History Museum in London (L. Worthington Wilmer collection; NHMUK 1888.12.3.1-3) seen also by Preston. As no holotype had been assigned by Preston (1908), these juveniles can also be considered syntypes. Two additional *semicornea* syntypes are in the Dautzenberg collection at the Royal Belgian Institute of Natural Sciences (Brussels,

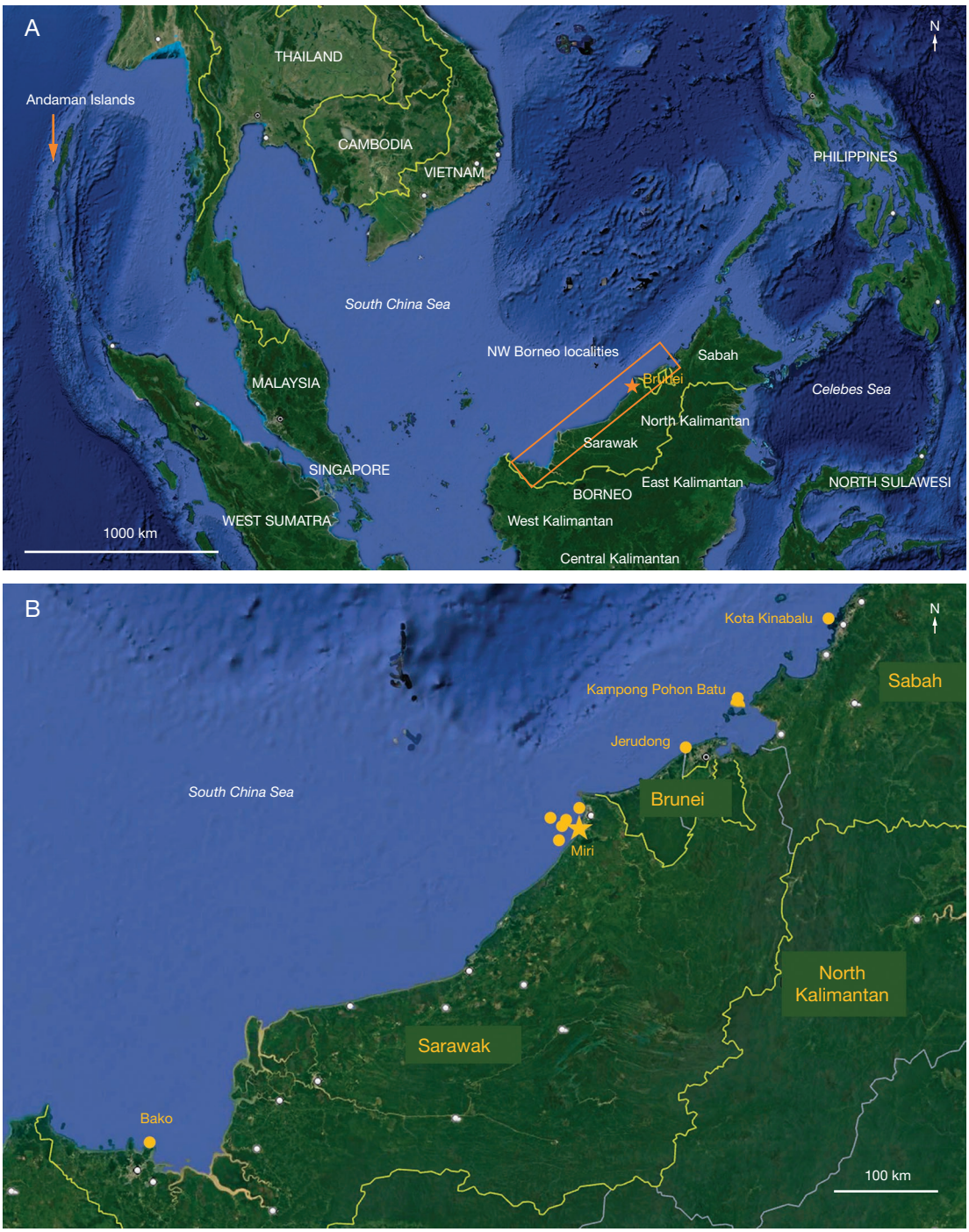

FIG. 1. — **A**, map of SE Asia showing Andaman Islands (*Discradisca semicornea* (Preston, 1908)) and NW Borneo (*Discradisca borneensis* n. sp.), with the **asterisk** representing the type locality of the latter, and the rectangle representing the known distribution area; **B**, collection points of *Discradisca borneensis* n. sp., the **asterisk** represents the type locality (Tanjong Lobang, Miri, Sarawak, Malaysia), the yellow dots indicate the other collecion points (background from Google Earth Pro).

Belgium) of which photographs and a 3D model are also available online (RBINS Virtual Collections) (Fig. 5E-G).

Light photographs were taken using a Leica stereomicroscope with stacking software. SEM images were taken without coating in a JEOL JSM-6480 LV using low vacuum, 10 KV voltage and 30 Pa pressure. Sizes recorded are based on measurements (digital calliper) on material studied.

ABBREVIATIONS

Institutions

NHMUK	Natural History Museum, London;
RBINS	Royal Belgian Institute for Natural Sciences, Brussels;
RMNH	Rijksmuseum van Natuurlijke Historie, now part of Naturalis Biodiversity Center, Leiden.

Measurements
H height;
L length;
W width.

SYSTEMATICS

Phylum BRACHIOPODA Duméril, 1805
Subphylum LINGULIFORMEA Williams, Carlson, Brunton, Holmer & Popov, 1996
Class LINGULATA Gorjansky & Popov, 1985
Order LINGULIDA Waagen, 1885
Superfamily DISCINOIDEA Gray, 1840
Family DISCINIDAE Gray, 1840

Genus *Discradisca* Stenzel, 1964

Discradisca Stenzel, 1964: 627.

TYPE SPECIES. — *Orbicula antillarum* d'Orbigny, 1845: by original designation (Stenzel 1964: 627).

REMARKS

Discradisca was introduced by Stenzel (1964) as a subgenus of *Discinisca* Dall, 1871 when he wanted to distinguish those species having radial costellae on the dorsal valve from those lacking costellae. Later Cooper (1977) elevated *Discradisca* to generic rank. In the revised Treatise, Holmer & Popov (2000) distinguished *Discradisca* and *Discinisca* on the basis of the ventral valve: "similar to *Discinisca*, but with wide, transversely suboval pedicle track, closed apically by semicircular, gently concave listrium". However, fossil assemblages generally contain mostly dorsal valves (some exceptions were mentioned by Radwańska & Radwański 2003) and ventral valves are not always known even in the case of recent materials. Therefore, it is expedient to return to Stenzel's original definition that distinguishes *Discradisca* based on radial costellae on the dorsal valve, especially if only dorsal valves are available (e.g., Dulai 2013; Bitner & Cahuzac 2013; Ishizaki & Shiino 2023, 2024). Regarding the radial ridges on discinide valves, Williams *et al.* (1997) distinguished primary radiated ridges (costae) from secondarily branched ridges (costellae). In this paper we follow the work of Ishizaki & Shiino (2023) who did not distinguish between primary and secondary ridges, but referred to them uniformly as costellae.

Discinide species are traditionally subdivided into three types (A, B, and C) based on dorsal valve characteristics (Dall 1920; Radwańska & Radwański 1984; Ishizaki & Shiino 2024: fig. 10): Type A: large, lamellose shell without radial costellae; Type B: large, weakly lamellose shell with faint irregular costellae; Type C: small, non-lamellose shell, with regular radial costellae. Taking into account the abovementioned criteria, species of type B and C are classified in the genus *Discradisca* (although it may be argued that type B might deserve to be placed in a separate genus). The painful lack of knowledge about the ventral valve of the fossil species of *Discinisca* and *Discradisca* is excellently illustrated by the carefully compiled summary figure by Ishizaki & Shiino (2024: fig. 10). They show that among the nine known Palaeogene and Neogene *Discradisca* species, we have no information at all on the ventral valve, and even among the *Discinisca* species, only three of the twelve species have a fossilised ventral valve: *D. singewaldi* (Scuchert in Berry 1917); *D. elslooensis* (Radwańska & Radwański 2003) and *D. messii* (Pérez *et al.* 2023). The ventral valve was also described and illustrated by Hertlein & Grant (1944) for the species *D. perrini* Loel & Corey, 1932 from Miocene strata in western North America.

Currently six extant *Discradisca* species are known characterised by a warm-temperate to tropical, cosmopolitan distribution mainly over the continental shelves (Emig 1997a, b):

D. antillarum (d'Orbigny, 1845): the Atlantic coast of America from Cuba to Brazil; the Caribbean Sea at the coasts of Mexico, Cuba, Nicaragua, and Jamaica (d'Orbigny 1841-1853; Reeve 1862; Davidson 1888; Dall 1920; Cooper 1977; Tunnell 1982; Zezina 1985, 2010; Emig 2017: p. 33).

D. cumingii (Broderip, 1834): the Pacific coasts of America from California Peninsula to 40°S (Mexico, Guatemala, Panama, Ecuador, Peru), Antarctic Peninsula, from the low tide line to 15 m of depth (Broderip 1834; Reeve 1862; Davidson 1888; Dall 1920; Zezina 1985, 2010; Zezina & Pakhnevich 1998; Gaspard 2001; Álvarez *in* Álvarez *et al.* 2016; Emig 2017).

D. indica (Dall, 1920): India, Sri Lanka, Philippines, the Persian Gulf, and Indonesia (as *Discinisca keiensis* by Jackson & Stiasny 1937) at a depth of 51-68 and (?)329 m (Dall 1920; Cooper 1973; Zezina 1985, 2010; Bitner *et al.* 2008).

D. sparselineata (Dall, 1920): the coasts of Japan from Hakodate to Tokyo Bay (unknown depth) and French Polynesia (96-300 m) (Dall 1920; Hatai 1940; Kato 1983; Zezina 1985, 2010; Bitner 2014; Ogiso *et al.* 2014, 2019).

D. stella (Gould, 1862): the Pacific coasts of Asia from Tokyo Bay to Hong Kong and to New Caledonia; Northern Australia and the seas of the Malay Archipelago at a depth of 31-141 m (Reeve 1862; Davidson 1888; Dall 1920; Hatai 1940; Zezina 1985, 2010; Richardson *et al.* 1989; Harper 1997; Bitner 2010; Emig 2017: 33; Otani 2019; Ogiso *et al.* 2019; Ishizaki & Shiino 2023).

D. strigata (Broderip, 1834): the Pacific coasts of America from California to Panama at a depth of 5-33 m (Broderip 1834; Dall 1920; LaBarbera 1985; Zezina 1985, 2010; Emig 2009).

So far, no *Discradisca* remains are known from Mesozoic formations (Ishizaki & Shiino 2024: fig. 1). The oldest extinct species of the genus is *D. littigensis* Stenzel, 1964 from the Lower Palaeocene (Danian) of Texas, USA (Stenzel 1964). Several extinct species of the genus are known from the Eocene to Miocene of Europe (e.g., Dreger 1889; Dollfus & Dautzenberg 1901; de Morgan 1915; Muir-Wood 1939; Čtyroký & Fejfar 1963; Radwańska & Radwański 1984, 1989; Popiel-Barczyk 1996; Kroh 2003; Kocsis *et al.* 2012; Bitner & Cahuzac 2013; Dulai 2013, 2015, 2017). Also, the genus is known from the Palaeogene (Hertlein & Grant 1944) and Neogene (Dall 1909; Portell & Harper 2005) of North America and from the Pleistocene, and possibly the Pliocene of Japan (Yabe & Hatai 1935; Hatai 1940; Hatai & Hayasaka 1965).

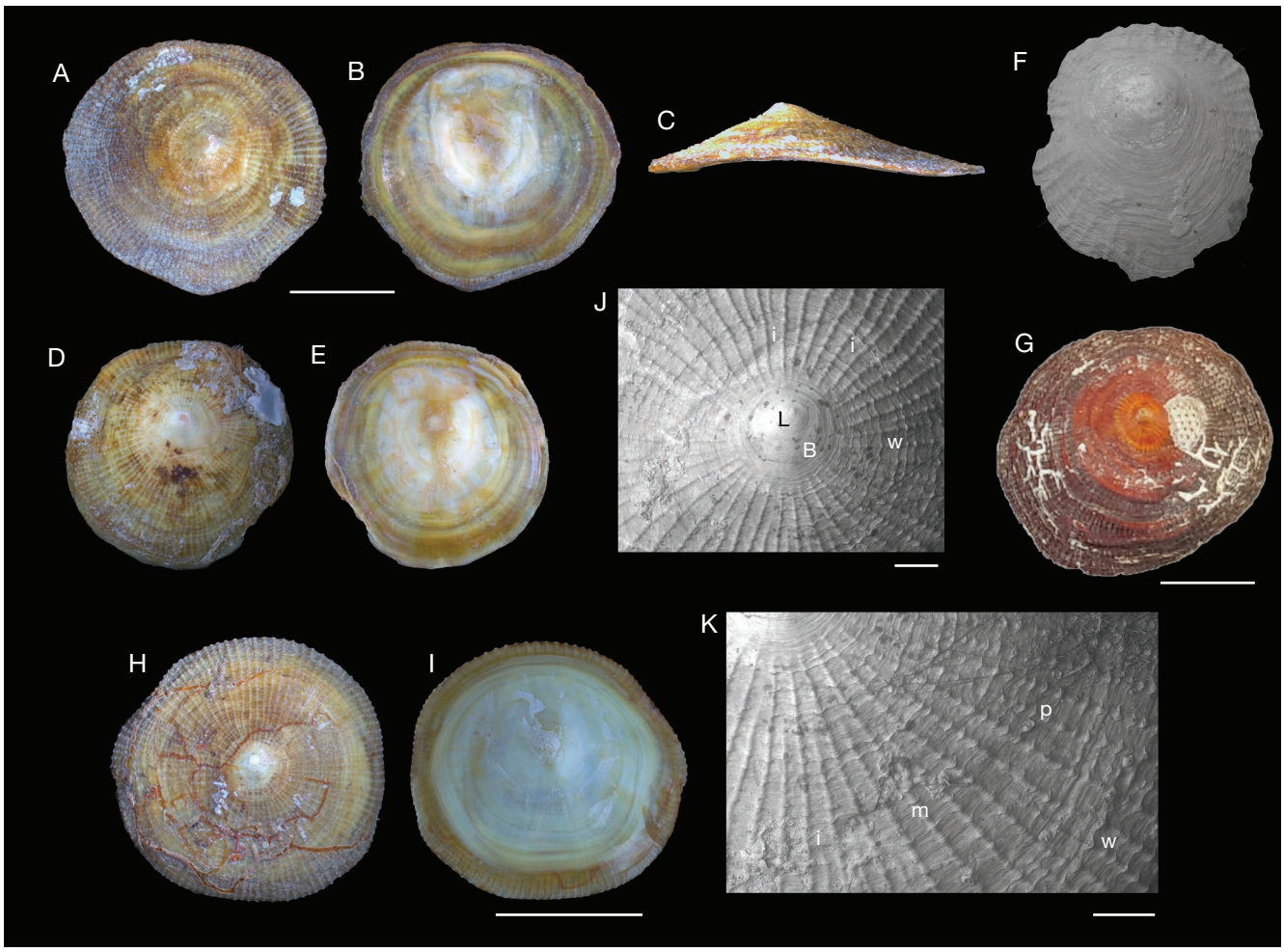

FIG. 2. — *Discradisca borneensis* n. sp., dorsal valves: **A**-**C**, holotype, Tanjong Lobang, Miri, Sarawak, Malaysia (RMNH.BRA.923), external, internal, and lateral views; **D**, **E**, paratype 1, Tanjung Aru beach, Kota Kinabalu, Sabah, Malaysia, (RMNH.BRA.924), external and internal views; **F**, juvenile dorsal valve, Azam's Place, Miri, Sarawak, Malaysia, (RMNH.BRA.928), external view (SEM image); **G**, grouper Patch, SW of Tanjong Lobang, Miri, Sarawak, Malaysia, (RMNH.BRA.927; specimen broken after photograph was taken), external view; **H**-**K**, paratype 2, Atago Maru wreck, offshore from Lutong, Sarawak, Malaysia, (RMNH.BRA.925), external and internal view, detail of central part of shell and detail of sculpture (SEM images). Abbreviations: **L**, larval shell; **B**, brephic shell; **m**, fine concentric micro-ornamentation; **i**, intercalated new radial costellae; **p**, elongated pustules at the intersection of growth lines and radial costellae; **w**, wavy concentric growth lines. Scale bars: A-F, H-I, 5 mm; G, J, K, 0.5 mm.

Discradisca borneensis n. sp.
(Figs 2; 3; 4)

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Discradisca spec. – Raven 2021: 11-13, fig. 2, pl. 1.

TYPE MATERIAL. — **Holotype**. **Malaysia** • 1 specimen; Sarawak, Miri, Tanjong Lobang; intertidal zone; Raven leg.; alive on rocks; RMNH.BRA.923 (Figs 2A-C; 3; 4).
Paratypes. Malaysia • 1 specimen; Sabah, Kota Kinabalu, Tanjung Aru beach; 1-2 m b.s.l.; Raven leg.; collected snorkelling; living attached to the bivalve *Malleus malleus* (Linnaeus, 1758) on rocks; RMNH.BRA.924 (Fig. 2D-E) • 1 specimen; Sarawak, offshore from Lutong, Atago Maru wreck; 12 m b.s.l.; Raven leg; alive on wreck; RMNH.BRA.925 (Fig. 2H-K).

OTHER MATERIAL EXAMINED. — **Malaysia** • 1 specimen; Sarawak, near Bako, Telok Pandar Besar beach; tidal flat; J. J. Vermeulen leg.; in fine shell grit in an area with rocks, mangroves and wide silty tidal flat; RMNH.BRA.937 • 1 juvenile specimen; Sarawak, Miri, 26.4 km W of Tanjong Lobang, Tukau reef; 20 m b.s.l.; Raven leg.; collected scuba diving; between coral rubble on coral bank; RMNH.BRA.926 • 1 specimen; Sarawak, Miri, SW of Tanjong Lobang, Grouper Patch, 30 km from shore; 16 m b.s.l.; Raven leg.; collected scuba diving; between coral rubble on coral bank; RMNH.BRA.927 (Fig. 2G) • 3 juvenile specimens; Sarawak, Miri, 11.6 km SW of Tanjong Lobang, Azam's Place; 20 m b.s.l.; Raven leg.; collected scuba diving; between coral rubble on coral bank; RMNH.BRA.928 (Fig. 2F) • 1 specimen + 2 juveniles; Sarawak, Miri, 6 km WNW of Tanjong Lobang, Shipwreck No. 1; 14 m b.s.l.; Raven leg.; collected scuba diving; living on shells on shipwreck; RMNH.BRA.929 • 2 specimens; Sarawak, Miri, WSW of Tanjong Lobang, 10.1 km offshore, Outer reef; 6 m b.s.l.; Raven leg.; collected scuba diving; between coral rubble on coral bank; RMNH.BRA.930 • 10 specimens; Sarawak, Miri, Tanjong Lobang; intertidal zone; Raven leg.; alive on rocks; RMNH.BRA.931 • 1 specimen, 2 juveniles; Sarawak, offshore from Lutong, Atago Maru wreck; 12 m b.s.l.; Raven leg.; collected scuba diving; alive on shells on shipwreck; RMNH.BRA.932 • 1 specimen; Sabah, Labuan, Kampong Pohon Batu; Raven leg.; RMNH.BRA.935 • 1 specimen, 2 juveniles; Sabah, Kota Kinabalu, Tanjung Aru beach; 1-2 m b.s.l.; Raven leg.;

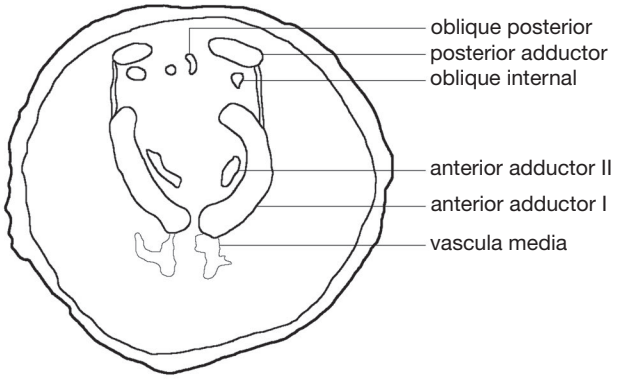

Fig. 3. — *Discradisca borneensis* n. sp. Muscle scars on the internal side of dorsal valve of the holotype (see also Fig. 2B).

collected snorkelling; living attached to *Malleus malleus* (Linnaeus, 1758) on rocks; RMNH.BRA.936.
Brunei • 5 specimens; Muara, Jerudong beach; 15 m b.s.l.; Raven leg.; sediment dredged; RMNH.BRA.933 • 5 juveniles, 2 fragments; Muara, Jerudong beach; J. J. Vermeulen & K. Orr leg; RMNH. BRA.934.

Etymology. — Refers to the island of Borneo where all available specimens were found.

Type locality. — Tanjong Lobang, Miri, Sarawak, Malaysia; intertidal zone.

Diagnosis. — *Discradisca* with low conical dorsal valve, ornamented by 125-135 tuberculate radial costellae. Irregularly subhexagonal ventral valve with elongated ovoid pedicle foramen, smooth white pedicle area. Outer part of the ventral valve ornamented by numerous (*c.* 180), closely spaced radial costellae, without tuberculated appearance.

Distribution. — Apparently endemic to the southern South China Sea in NW Borneo. Known from Sarawak and Sabah (East Malaysia) and Brunei Darussalam. The records from NW Borneo are about 2500 km to the East from the Andaman Islands, from where *D. semicornea* was described by Preston (1908).

Description

Dorsal valve

Slightly irregular, chitinophosphatic thin shell with subcircular outline (Fig. 2A, D, F-H). Small to medium sized (holotype: L: 12.8 mm, W: 12.1 mm, H: 2.2 mm), low-conical in profile (Fig. 2C). Posterior slope straight, anterior slope slightly concave. Smooth apex in subcentral position (Fig. 2A, D, F-H), slightly posterior to centre; often eroded in adults. Circular larval shell (protegulum) smooth, without growth lines, about 0.4 mm in diameter (Fig. 2J). Post-larval (brephic) shell (L: *c.* 1 mm, W: *c.* 0.7 mm) elliptical, nearly smooth with some fine concentric growth lines and a few incipient radial costellae (Fig. 2J). External surface of adult shell with numerous (up to 125-135 at 12 mm diameter) fine, well-pronounced but slightly irregular, tuberculate radial costellae, and relatively strong, somewhere faintly wavy concentric growth lines (Fig. 2A, D, G, H). Costellae continuous and densely spaced, interspaces wider than ridges (Fig. 2J-K). Irregular elongated pustules at the intersection of growth lines and radial costellae (Fig. 2K). Number of costellae increasing by intercalation towards the edges (Fig. 2A, H, J, K). Micro ornamentation of numerous very fine concentric grooves, both in interspaces and over grooves and pustules (Figs 2J, K). Internal side smooth, but traces of external costellae sometimes on the internal surface (Fig. 2B, E). Only anterior adductors well visible in smaller specimens, other muscle scars hardly detectable (Fig. 2E, I). Muscle scars with concentric arrangement in fully grown valves (like the holotype) (Figs 2B; 3). Anterior adductor I located laterally to internal side of apex, longitudinally elongated, narrow, curved anteriorly in a horseshoe-like shape, but not reaching each other. Posterior adductors narrow, laterally slightly elongated, situated near to the limbus. Lateral ends of posterior adductors connected to outer edge of anterior adductor I by a thin ridge. Anterior adductor II along inner side of anterior adductor I shorter, longitudinally elongated and slightly curved. Short elliptical oblique internal muscle scars situated between posterior adductor and posterior end of anterior adductor I. Oblique posterior muscle scars located between left and right posterior adductors, left one small subcircular, right one elongated, bean-shaped. Faint impressions of vascula media situated at anterior end of anterior adductor I and bend laterally. Possible vascula lateralia very uncertain and blurred at outer middle part of anterior adductor I (Fig. 2B). Shell edge finely crenulate (Fig. 2H-I). Limbus poorly and unevenly developed. Colour inside and outside pale yellowish.

Ventral valve

Corneous, thin, and flexible, with irregularly subhexagonal outline (Fig. 4). Pedicle area subcircular, smooth and white, with thickened brown border. Posteriorly placed pedicle foramen elongated ovoid, wider posteriorly and narrower anteriorly. A relatively small depressed area (*sensu* Ishizaki & Shiino 2024) seen only around the posterior third of the pedicle area. A short and low median septum situated between anterior end of pedicle foramen and border of pedicle area, however, possibly extending as in a very low ridge in outer, costellated part of shell. Outer part of ventral valve ornamented by closely spaced, slightly irregular radial costellae, without tuberculated appearance. Number of radial costellae increasing by both intercalation and bifurcation towards the shell margin, up to 180 at outer edge. All costellae pointing towards the central part of ventral shell, causing costellae on the posterior part of shell to fit into the rim of pedicle area.

Remarks

Three *Discradisca* species are known from the shallow waters of South Asia and Northern Australia: *D. indica*, *D. stella*, and *D. sparselineata*. The latter species can be distinguished by its strongly irregular dorsal valve with sparse radial costellae and very long setae (Dall 1920; Hatai 1940; Bitner 2014). *Discradisca stella* and *D. indica* are very similar in size, shape and ornamentation of the dorsal valve, however, they differ in the characters of the costellae, which are distinctly tuberculate and more widely spaced in *D. indica* (Cooper 1973; Bitner *et al.* 2008), while fine radial and not tuberculate in *D. stella*

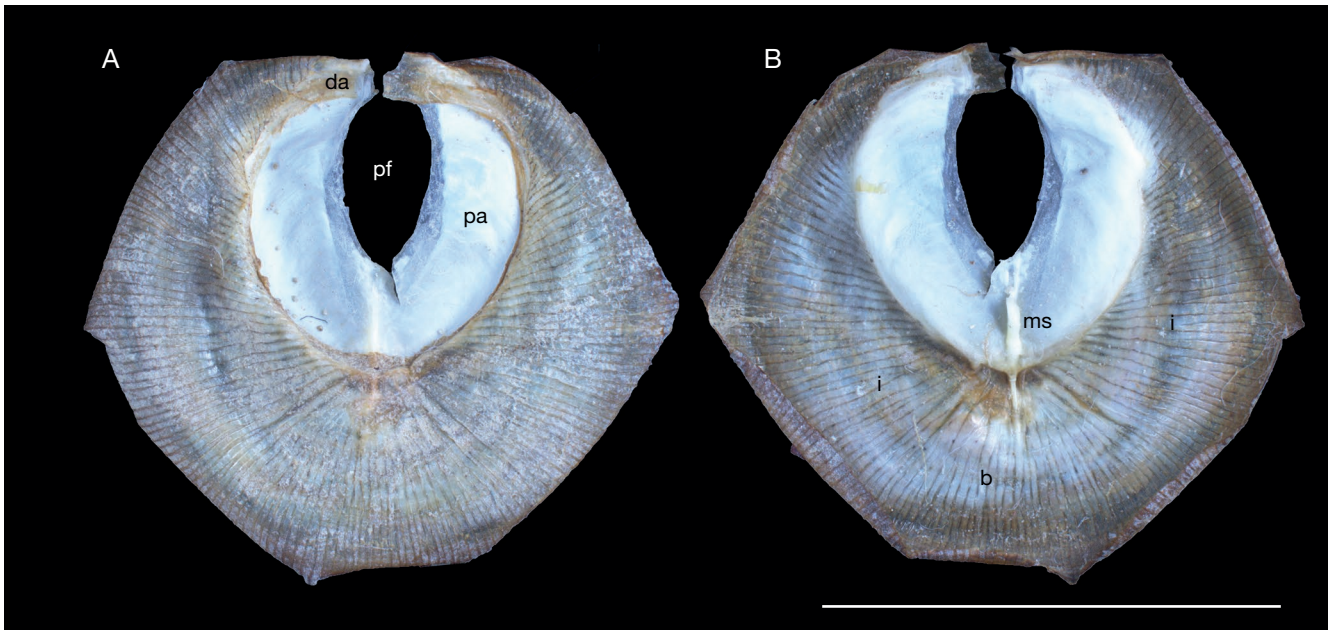

Fig. 4. — *Discradisca borneensis* n. sp.: ventral valve of the holotype. **A**, **B**, external view and internal view. Abbreviations: **b**, bifurcated costellae; **da**, depressed area; **ms**, median septum; **pa**, pedicle area; **pf**, pedicle foramen; **i**, intercalated new costellae. Scale bar: 1 cm.

(Bitner 2010). In this regard, *D. borneensis* n. sp. from the South China Sea, located between the Indian and Pacific Oceans, definitely is more similar to *D. indica*.

If we have only dorsal valves, we may conclude that the studied material from NW Borneo is within the intraspecific variability of *D. indica*. Some smaller differences can be found in the size (*D. borneensis* n. sp. seems to be larger), in number of costellae (125-135 in *D. borneensis* n. sp. vs 140-155 in *D. indica*), in position of apex (more central in *borneensis* n. sp., and more posteriorly situated in *D. indica*) and in the outline (more regular in *D. borneensis* n. sp., and more irregular in *indica*, especially in Bitner *et al.* 2008 material). However, if we also have the ventral valves, both species can be clearly distinguished as separate species. *Discradisca indica* ventral valve is irregular in outline, with subcircular to heart-shaped pedicle area, and ornamented by a few (30-35 in Cooper 1973 and 15-20 in Bitner *et al.* 2008), widely spaced, straight or slightly arched, tuberculate radial costellae. On the contrary, the ventral valve of *D. borneensis* n. sp. is subhexagonal in outline, its pedicle area is subcircular, and its surface is ornamented by numerous (about 180), closely spaced radial costellae without tuberculate appearance.

Having a generally pale yellow, pale straw colour, some colour patterns can be observed on the dorsal valves, in the form of a more pronounced concentric pattern and a slightly uncertain radial pattern. Some specimens show a lighter, almost white colour around the apex (Fig. 2D, H), followed by a less defined central part, and alternating concentric lighter and darker bands at the edges of the specimens (Fig. 2A, H). Darker patches with irregular outlines are also observed in the middle part of the Figure 2D specimen. The darker colour is mostly confined to the interspaces of the costellae, the costellae themselves being uniformly lighter in colour (Fig. 2A, D, H); a similar observation was mentioned by Ishizaki & Shiino (2023) for *Discradisca* sp. cf. *D. stella*. In another specimen, the apex area is orange, turning dark brown towards the shell margin (Fig. 2G). The inner side of the dorsal valves also shows lighter (yellowish) and darker (brownish) irregular concentric bands at the shell margin (Fig. 2B, I), but some valves also show a more indistinct yellow-orange radial pattern (Fig. 2E). Surface of muscle attachment scars is brightly coloured, almost white (Fig. 2B, E). On the ventral valve, the pedicle area is white, with a narrow dark brown band marking the outer margin on the external side. The area outside the pedicle area is pale brown, with a much less distinct concentric pattern at the edge than in the dorsal valve. On the internal side, the colours are brighter and the costellae are more defined. Here the concentric pattern is also more visible, but sometimes the concentric colour pattern is not continuous. The discolouration again occurs in the interspaces of costellae, but here the costellae are darker than the colour pattern, unlike in the dorsal valve.

The shells adapt to the surfaces to which they live attached, resulting in irregular shapes. The animals have been found attached to rocks and shells from the intertidal zone to –20 m. They occur on hard substrates in siliciclastic depositional environments (such as rocky intertidal at Tanjong Lobang and the shipwrecks resting on sandy bottom, both near Miri, Sarawak, Malaysia), in shallow water coral areas (Labuan and Kota Kinabalu, both Sabah, Malaysia) and subtidal coral banks (Outer Reef, Grouper Patch, Azam's Place near Miri, Sarawak, Malaysia).

Several specimens were found alive, but none was preserved as at the time (1992-1997) locally methanol was not available to the general public. From a single large specimen (collected from intertidal rocks in the southern part of Tanjong Lobang,

Miri, Sarawak, Malaysia), besides the dorsal valve, the corneous thin ventral valve was preserved, which according to the field sketch was present between the animal and the rock on which it lived (Fig. 4).

The dorsal valves provide a substratum for a variety of epibionts, including barnacles, bryozoans, calcareous algae and other organisms. No single specimen was seen with substantial overgrowth.

Discradisca semicornea (Preston, 1908) (Fig. 5)

Acmaea semicornea Preston, 1908: 203, fig. 46, pl. 16.

Discinisca indica Dall, 1920: 279. — Cooper 1973: 5, figs 18-25, pl. 1. — Bitner *et al.* 2008: 281-282, figs 2B-H, **n. syn.**

Sutura fluviatilis – Grant 1937: 322.

Trimusculus semicornea – Lindberg 1990: 311 (erroneous identification).

Discradisca semicornea – Raven 2021: 11-13, fig. 1, pl. 1.

Pilosabia trigona – Ravinesh *et al.* 2021: fig. 3t (erroneous identification).

non *Trimusculus semicornea* – Van Gemert 2010: 45-46, fig. 1 (= *Trimusculus mauritianus* (E. von Martens, 1880); see Van Gemert 2024).

Type material illustration. — 2021 online photographs, syntypes National Zoological Collection (Zoological Survey of India); 2021 online photographs, syntypes RBINS Virtual Collections, Brussels.

Original description (Preston 1908). — *"Shell semicorneous, depressedly conical, irregularly subquadrate, pale yellowish brown, sculptured with fine radiating transverse ribs crossed by concentric striae, presenting a very finely cancellate appearance; edge of peristome finely crenulate; apex simple, placed slightly to one side: anterior end of shell shortened; posterior end broadly produced. Altitude 2 mm. Diam, major 9, minor 7.75."*

Emended description. — Outline of subcircular dorsal valves (8-9 mm in diameter) more irregular than in *D. borneensis* n. sp. Asymmetrically low-conical in profile (3 mm high) (Figs 5D, G), posterior slope straight, anterior slope slightly convex (Fig. 5G). Smooth apex in subcentral position (Figs 5B, E), shifted posteriorly. Apex area eroded on both specimens (details of larval shell and brephic shell cannot be observed well); larval shell (protegulum) apparently smooth. External surface of dorsal valve with numerous (140-145) fine, well-pronounced but slightly irregular, tuberculate radial costellae and relatively strong, concentric growth lines. Costellae continuous and densely spaced, interspaces wider than ridges. Small irregular granules on radial costellae, more pronounced on RBINS specimen (Fig. 5E). Number of costellae increasing by intercalation towards the edges (Figs 5B, E). RBINS specimen bearing traces of survived physical damage or predation, where the growth lines blurred and radial costellae broken (Figs 5E, G). Shell edge finely crenulate (Fig. 5B, E). Internal side smooth, but traces of external costellae on the internal surface, especially along the edge of valves (Figs 5C, F). On lectotype muscle scars covered by thin white chalky deposit; on RBINS specimen lighter colour of ring-shaped muscle scars faintly visible. Shell of variable, generally pale straw colour. Lectotype lighter in colour around the apex, with alternating concentric bands of lighter and darker colours towards the edge (Fig. 5B).

Distribution. — India, Sri Lanka, Philippines, Persian Gulf, and Indonesia.

Remarks

The species has long been considered a mollusc after the original description by Preston (1908), but subsequent authors placed it in various genera belonging to widely differing families of gastropods:

Acmaea Eschscholz, 1833 (Acmaeidae Forbes, 1850, Patellogastropoda Lindberg, 1986) (Preston 1908);

Potomacmaea Peile, 1922 (Lottiidae J. E. Gray, 1840, Patellogastropoda Lindberg, 1986) (Grant 1937);

Gadiniidae J. E. Gray, 1840 (now considered a junior synonym of Trimusculidae J. Q. Burch, 1945, Heterobranchia Burmeister, 1837) (Lindberg 1990);

Pilosabia Iredale, 1929 (Hipponicidae Troschel, 1861, Caenogastropoda L. R. Cox, 1960) (Ravinesh *et al.* 2021).

Syntypes of *Acmaea semicornea* were deposited in the Indian Museum in Kolkata (India) and subsequently moved to the National Zoological Collection (Zoological Survey of India). The specimen illustrated online appears to be the same as the specimen figured by Preston and is here selected as lectotype. Three juveniles, also from the Andaman Islands and seen by Preston are in the Natural History Museum (London, UK; NHM 1888.12.3.1-3), considered paratypes by Lindberg (1990: 314) but not assigned such status in the original paper (Preston 1908). Two additional syntypes were apparently exchanged with Dautzenberg and are kept in RBINS (Brussels, Belgium, RBINS/Dautz-Types/525910). All these syntypes are here assigned as paralectotypes.

The *semicornea* specimens published as gastropods are all dorsal valves; there is no information about the ventral valve in these materials. The dorsal valve characteristics of *semicornea* fit into the variation range of *Discradisca indica* Dall, 1920 (compare Dall 1920; Cooper 1973; Bitner *et al.* 2008).

DISCUSSION

Raven (2021) recognised that the scarcely known snail species *Acmaea semicornea*, described by Preston (1908) from the Andaman Islands of India, belongs to the Discinidae brachiopods. By checking the rare literature items mentioning the species, and the collection materials available online (Zoological Survey of India, Kolkata; Natural History Museum, London; Royal Belgian Institute for Natural Sciences, Brussels) including type specimens, it became clear that the known dorsal valves of *D. semicornea* fit without exception into the variation range of *Discradisca indica* Dall, 1920, demonstrating that it is a senior synonym of *D. indica*. Although the name *semicornea* is completely unknown to brachiopod researchers, as over the past 100 years this taxon has been classified in various Gastropoda families, it has priority over the name *indica*, which has been used for a long time but does not meet the criteria of the International Code of Zoological Nomenclature (ICZN 1999: Art. 23.9) for a reversal of precedence (23.9.1.1. the senior synonym or homonym has not been used as a valid name after 1899, and 23.9.1.2. the

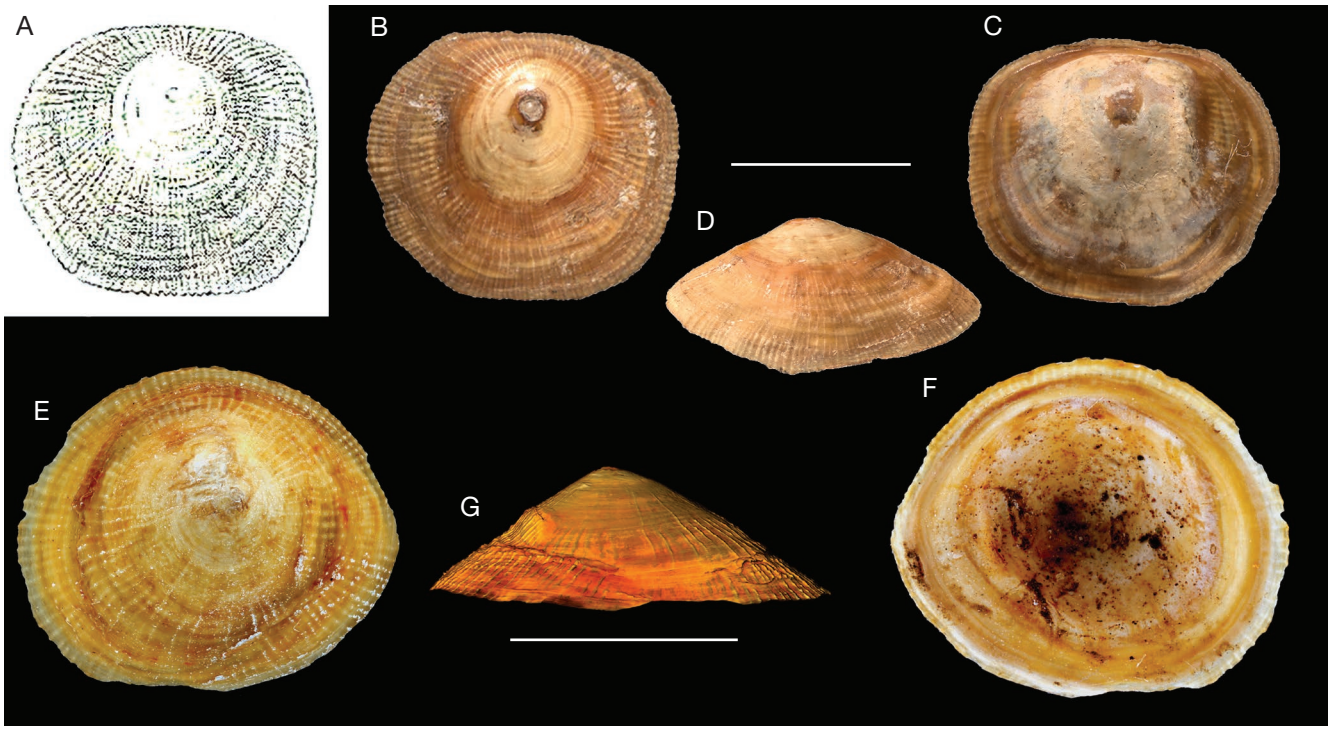

FIG. 5. — *Discradisca semicornea* (Preston, 1908): **A**, drawing of a syntype in Preston (1908: pl. 16, fig. 46), external view; **B**-**D**, photos of the same specimen, herein selected as lectotype (Photo by National Zoological Collection, India), external, internal, and oblique lateral views; **E**-**G**, syntype from the Dautzenberg collection in Brussels (Photo by Royal Belgian Institute of Natural Sciences, Brussels, Belgium), external, internal, and lateral views. Scale bars: 5 mm.

junior synonym or homonym has been used for a particular taxon, as its presumed valid name, in at least 25 works, published by at least 10 authors in the immediately preceding 50 years and encompassing a span of not less than 10 years). Since the present study on *D. semicornea* is based solely on dorsal valve information, future discoveries of ventral valve data could lead to further taxonomic revisions related to *semicornea* and *indica*.

Discinide specimens collected at several points along the NW coast of Borneo in the South China Sea (Sabah, Sarawak, Brunei) are here described as a new species, mainly based on the ventral valve characteristics (irregularly hexagonal outline; subcircular pedicle area with thickened border; ovoid pedicle foramen; closely spaced, slightly irregular radial costellae up to 180). With the addition of *Discradisca borneensis* n. sp. seven extant species of *Discradisca* are known. *Discradisca* records are concentrated in two areas: along the tropical-subtropical coasts of the Americas (*D. antillarum*, *D. cumingii*, and *D. strigata*) and in the waters of South Asia – Northern Australia (*D. stella*, *D. sparselineata*, and *D. semicornea*). *Discradisca borneensis* n. sp. fits well into this distribution pattern, adding to the number of *Discradisca* species known from South Asia. Identification of the new species may be difficult, as its dorsal valve is similar to *D. semicornea*, and mainly its ventral valve has valuable information to differentiate between the species. However, due to its delicate nature it is not always preserved and available for studies.

Discradisca brachiopods have been found at numerous locations along the coasts of the Sea of Japan, but almost always in small numbers. However, Yoshioka (2020) described an exceptionally rich accumulation in the Hamakurosaki beach of Toyama Bay. The construction of a new breakwater in the area significantly altered the pattern of materials drifting ashore. Related research revealed a significant increase in the number of *Discradisca* shells, which had previously been found only sporadically. The radically different fossilisation potential of the dorsal and ventral valves is well illustrated by the fact that during approximately one and a half years of research, only one ventral valve was found among 6328 dorsal valves (Yoshioka 2020). The original habitat of the brachiopods has not been found, but the thousands of washed-up shells suggest that they may occur in large numbers in certain areas. *Discradisca borneensis* n. sp., described here, has been found at numerous sites along the northern coast of Borneo (Sarawak, Sabah, Brunei), but we have not observed its mass occurrence anywhere. It was most common at the Tanjong Lobang site in Miri (10 specimens). However, based on the Japanese example published by Yoshioka (2020), it is conceivable that patchy populations could also develop along the coast of Borneo.

A general conclusion of our paper, beyond brachiopods, that if the taxonomic identification of a species cannot be satisfactorily resolved within a century, it is worth looking at some similar-looking forms, even in other phyla. Adaptation to the environment and habitat can cause very similar morphological appearances in completely different taxonomic groups.

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