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Two new species of the carnivorous snail genus *Discartemon* from Thailand and Myanmar (Eupulmonata: Streptaxidae)

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Abstract. Two new species of the carnivorous snail genus *Discartemon* are described based on their shell morphology: *D. sagitticallosum*, from Thailand, which has a unique flattened shell, arrowhead aperture, and tall parietal lamella, and *D. tonywhitteni*, from Southeastern Myanmar, which has a circular shell, angular last whorl, and one parietal lamella. Three nominal species show identical shell characters with described species, which we propose as junior synonyms: *D. pallgergelyi* is a junior synonym of *D. discus*, *D. huberi* is a junior synonym of *D. discamaximus*, and *D. szekeresi* is a junior synonym of *D. moolenbeeki*. *Discartemon moolenbeeki* has a strong peripheral keel and transverse ridges, and so it is recognised as a valid species.

Key words. limestones, Pulmonata, endemism, conservation, Southeast Asia

INTRODUCTION

The land snail family Streptaxidae sensu lato has a worldwide distribution (van Bruggen, 1967; Schileyko, 2000). These snails usually have a bright yellow to dark orange-coloured soft body, and are well known as "carnivorous" or "hunter" snails because of their predatory feeding mode, with an apparent preference for smaller snails and earthworms (Blanford & Godwin-Austen, 1908; van Benthen Jutting, 1954; Herbert & Kilburn, 2004). Molecular phylogenetic analysis of Southeast Asian samples confirmed that the small and cylindrical shells belong to the family Diapheridae, and are the sister group to the large and helicoid shells of the family Streptaxidae sensu stricto (Rowson et al., 2010; Sutcharit et al., 2010). The Southeast Asian streptaxids exhibit a high level of diversity, in terms of the number of species and shell morphology, with a peculiar eccentric shell and complicated apertural barriers (van Benthem Jutting, 1954; Schileyko, 2000; Siriboon et al., 2013, 2014a, 2014b).

The genus *Discartemon* Pfeiffer, 1856, is comprised of 28 nominal species (Siriboon et al., 2014a; Maassen, 2016). Most of the recognised species have a quite narrow distribution and the genus is restricted to southern Thailand and Peninsular Malaysia. Only five species are known from outside, being found in Vietnam, Cambodia, and the Greater Sunda Islands (van Benthem Jutting, 1959; Siriboon et al., 2014a, 2014b). Their unique shell morphology (not axially distorted from the columella axis and flattened to globose-heliciform shape) makes *Discartemon* different from all other genera in this region (van Benthem Jutting, 1954; Schileyko, 2000; Siriboon et al., 2013, 2014b). Traditional classification of the genus is based mainly on the shell shape, shell sculpture, and variation in the apertural dentition (van Benthem Jutting, 1954, 1959; Schileyko, 2000; Siriboon et al., 2014a). The genus was revised by Siriboon et al. (2014a), who included illustrations of the type specimens and anatomy for most of the species. This revision also revealed the congruence in species recognition using shell morphology and genitalia structures, and further demonstrated that genitalia structures are important for demarcating species that have a very similar shell morphology, such as in the *D. roebeleni*-species group (Siriboon et al., 2014a). Therefore, shell morphology alone may be informative and significant in recognising species at least in the genus *Discartemon*.

Surveys of karstic-associated land snails in Southern Thailand and Southeastern Myanmar revealed two undescribed *Discartemon* species. Although without genitalia information, they are clearly different from all others species in a number of shell characters described herein. In addition, the status of four additional, recently described species, is discussed: *D. moolenbeeki* Maassen, 2016, *D. huberi* Thach, 2017, *D. pallgergelyi* Thach, 2017 and *D. szekeresi* Thach & Huber, 2018.

MATERIAL AND METHODS

We conducted rapid assessment surveys of karst-associated land snails from southern Thailand and the Tanintharyi Region of Southeastern Myanmar in 2015 and 2016. The

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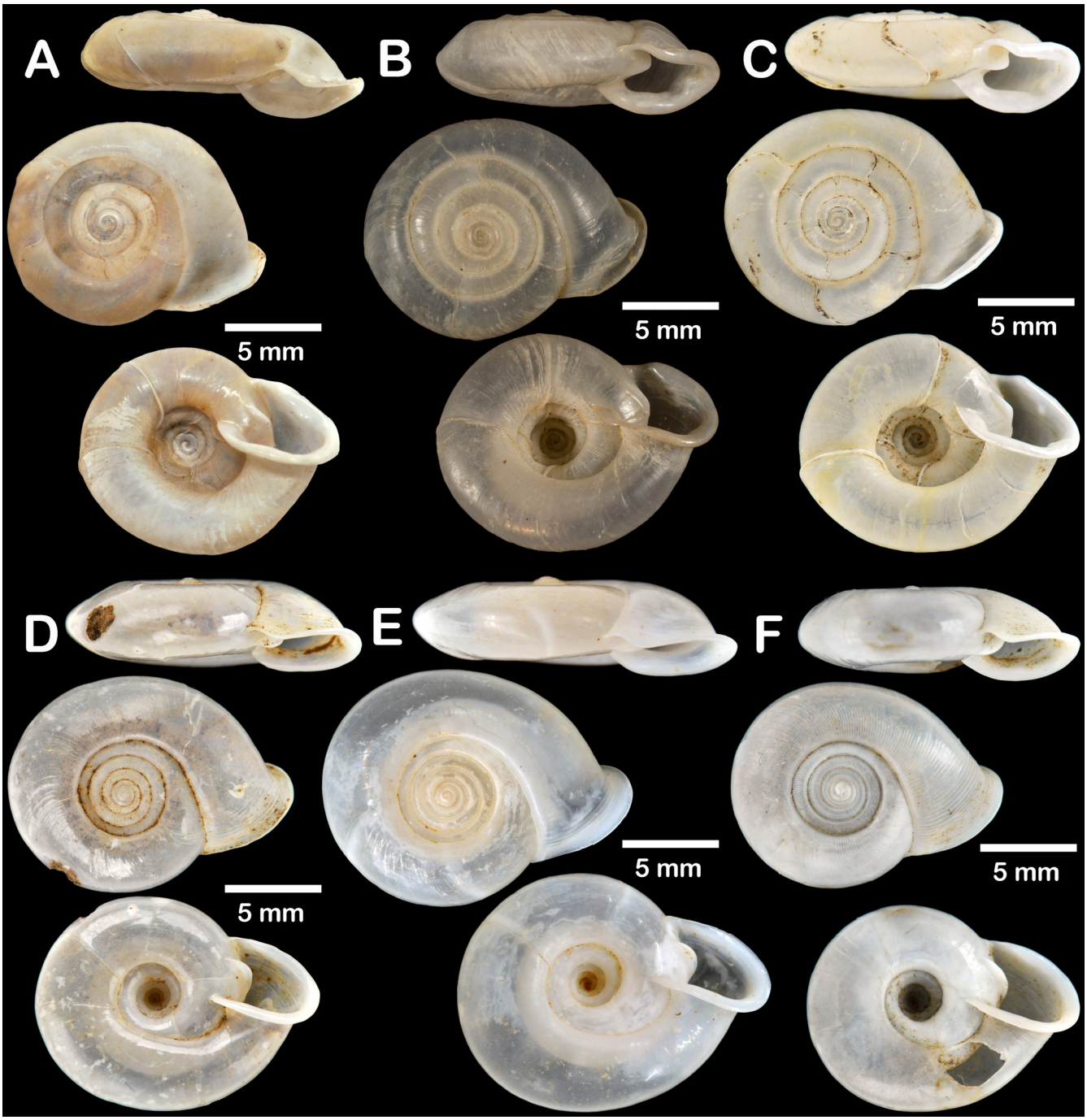

Fig. 1. A–C, *Discartemon discus*. A, NHMUK 20130684, lectotype, unknown locality; B, MNHN-IM 2000-33217, holotype of *D. pallgergelyi*, Hoi An City, Quang Nam, Vietnam; C, CUMZ 6001, specimen, Marble Mountain, Da Nang, Vietnam. D–F, *D. discamaximus*: D, CUMZ 6245, holotype, Tam Namphud, Phangnga, Thailand; E, NHMUK 20170284, holotype of *D. huberi*, Krabi, Thailand; F, CUMZ 5112, specimen, Tam Kobe, Phangnga, Thailand.

fieldwork in Myanmar was conducted under the MOU between the Ministry of Natural Resources and Environmental Conservation of Myanmar and Fauna & Flora International (FFI). We searched for streptaxids in karst outcrops, caves and rock crevices at various sites in limestone formations. The collected specimens were initially identified following Kobelt (1905–1906, 1910), van Benthem Jutting (1954, 1959) and Siriboon et al. (2014a), and then compared with the type specimens of *Discartemon* species. The adult shells were measured for shell height (H) and shell width (W).

Institutional abbreviations. CUMZ, Chulalongkorn University Museum of Zoology, Bangkok; MNHN, Muséum National Histoire Naturelle, Paris; NHMUK, The Natural History Museum, London; SMF, Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main; ZRC, Zoological Reference Collection of the Lee Kong Chian Natural History Museum, National University of Singapore, Singapore.

SYSTEMATICS

Family Streptaxidae Gray, 1860

Discartemon Pfeiffer, 1856

Type species. *Streptaxis discus* Pfeiffer, 1853, by subsequent designation by Ancey (1884).

Remarks. *Discartemon* was revised by Siriboon et al. (2014a). At present, there are 30 recognised valid species, comprised of 27 species in Siriboon et al. (2014a), one species by Maassen (2016), and two new species described in this study.

Discartemon discus (Pfeiffer, 1853)
(Fig. 1A–C)

Streptaxis discus Pfeiffer, 1853 [1851]: 252. Type locality: unknown. Pfeiffer, 1854: 394, 395, pl. 145, figs. 15–17.
Streptaxis (*Discartemon*) *paradiscus* Möllendorff, 1900: 117. Type locality: Phucson bei Touranne, Annam.
Discartemon discus – Siriboon et al., 2014a: 53–55, figs. 4a–c, 11a–c, 22a. Inkhavilay et al., 2019: 146, fig. 59a.
Discartemon pallgergelyi Thach, 2017: 31, figs. 370–372, 373 (top). Type locality: Hoi An City, Quang Nam Province, Vietnam.

Material examined. Lectotype of *D. discus*, NHMUK 20130684 (Fig. 1A), holotype of *D. pallgergelyi*, MNHN-IM 2000-33217 (Fig. 1B), specimen of *D. discus*, CUMZ 6001 (39 shells, Fig. 1C) from Marble Mountain, Da Nang Province, Vietnam.

Remarks. The complete list of synonyms and usage of the taxon name are provided in Siriboon et al. (2014a). The recent revision of the genus treated this species as being present in central Vietnam. However, the record of *D. discus* from "Laos" by Schileyko (2000, 2011) is still uncertain until new material confirms its distribution.

Siriboon et al. (2014a) examined the types of *D. discus*, and the radula and genitalia have been described based on the specimens from Marble Mountain (about 15 km north of Hoi An City) in central Vietnam. They treated *Streptaxis paradiscus* Möllendorff, 1900 from Vietnam as a junior synonym. *Discartemon pallgergelyi* was described from almost the same geographical area as *D. discus*. However, Thach (2017) indicated a brief diagnostic character as "presence of basal lamella". Nevertheless, the type specimens of *D. discus*, *Streptaxis paradiscus* and *D. pallgergelyi* are identical in all shell characters and the basal lamella can vary from absent to very weakly present both within and between populations (see Siriboon et al., 2014a). Therefore, we treat *D. pallgergelyi* Thach, 2017 as a junior subjective synonym of *D. discus*.

Discartemon discamaximus Siriboon & Panha, 2014
(Fig. 1D–F)

Discartemon discamaximus Siriboon & Panha in Siriboon et al., 2014a: 62, fig. 5a, b. Type locality: Tam Namphud, Phangnga, Thailand.
Discartemon huberi Thach, 2017: 30, 31, figs. 365–368, 373 (bottom). Type locality: Suburb of Krabi Town, Krabi Province, South Thailand.

Material examined. Holotype of *D. discamaximus*, CUMZ 6245 (Fig. 1D), holotype of *D. huberi*, NHMUK 20170284 (Fig. 1E), specimen of *D. discamaximus*, CUMZ 5112 (2 shells, Fig. 1F) from Tam Kobe, Thap Put District, Phangnga Province, Thailand.

Remarks. The type locality of *D. huberi* (Krabi Province) is situated about 55 km southeast of the type locality of *D. discamaximus*. The original description of *D. huberi* was compared with *D. deprima* Siriboon & Panha, 2014, but not with *D. discamaximus*. The type specimen of *D. huberi* is identical to that of *D. discamaximus*, except for only a slightly larger shell diameter (shell width ranged from 14 to 16 mm) than *D. discamaximus* (shell width ranged from 12 to 14 mm). This difference in the shell size is only a minor shell character and insufficient for species distinction. Therefore, we treat *D. huberi* Thach, 2017 as a junior subjective synonym of *D. discamaximus*.

Discartemon moolenbeeki Maassen, 2016

Discartemon moolenbeeki Maassen, 2016: 139, 140, fig. 1. Type locality: rocks near the river mouth, Noppharat Thara Beach along Andaman Sea, Krabi Province, Thailand.
Discartemon szekeresi Thach & Huber in Thach, 2018: 38, 39, figs. 507–510. Type locality: Ao Luc, between Krabi and Phang Nga, South Thailand [Ao Luek District, Krabi Province].

Remarks. *Discartemon moolenbeeki* was known only from the holotype from Krabi Province, Thailand. None of the specimens collected in the nearby areas in Trang, Suratthani and Nakhon Sri Thammarat Provinces are identical to this species. *Discartemon moolenbeeki* has prominent transverse ridges, strong peripheral keel; apertural dentition with one parietal, one palatal, one basal and one columellar lamellae. The strong peripheral keel on the last whorl makes *D. moolenbeeki* differ from all other congeners, particularly the *D. roebeleni*-species group (see Siriboon et al., 2014a). We agree with Maassen's view in recognising this as a distinct species.

Recently, Thach (2018) introduced the name *D. szekeresi* based on two shells, whose type locality is situated near that of *D. moolenbeeki*. The diagnostic characters of the conical spire, strong peripheral keel, parietal lamella and transverse ridges are identical to the holotype of *D. moolenbeeki*. Thus, we consider them to be conspecific and formally treat

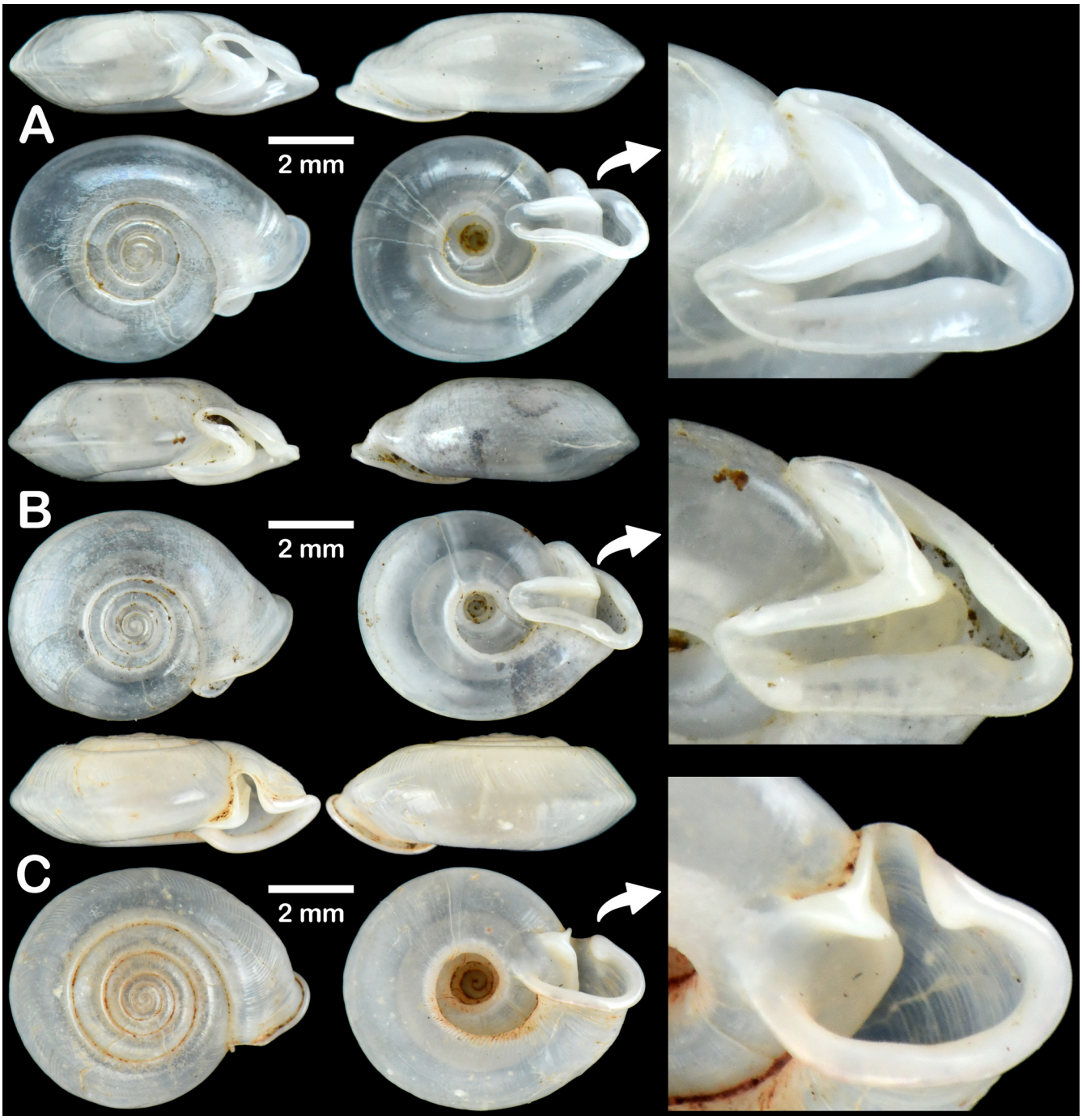

Fig. 2. A, B, *Discartemon sagitticallosum*, new species. A, CUMZ 5111, holotype, Khao Tam Ting (Cave), Pa-Lian, Trang, Thailand; B, CUMZ 5110, paratype, Khao Tam Ting (Cave), Pa-Lian, Trang, Thailand; C, *D. nummus*, CUMZ 3783, Khao Ok Taru, Patthalung, Thailand. Insets: apertural dentition.

D. szekeresi Thach & Huber, 2018 as a junior subjective synonym of *D. moolenbeeki*.

***Discartemon sagitticallosum*, new species**
(Fig. 2A, B)

Material examined. Holotype CUMZ 5111 (Fig. 2A); paratypes CUMZ 5110 (4 shells), NHMUK (1 shell), SMF (1 shell), and ZRC (1 shell), all from the limestone outcrops at Khao Tam Ting (Cave), Li Phang Sub-district, Pa-Lian District, Trang Province, Thailand (7°09'30"N 99°48'10"E).

Other material examined. Tam Khantiphon Cave, Thung Wa Sub-district, Thung Wa District, Satun Province, Thailand (7°05'12"N 99°47'54"E): CUMZ 5109 (1 shell).

Etymology. The species name *sagitticallosus*, *-a*, *-um* is derived from the Latin words *sagitta*, meaning arrow, and *callus*, and refers to the prominent arrowhead shape of the parietal callus. An adjective.

Diagnosis. *Discartemon sagitticallosum* is a typical streptaxid with discoidal and flattened shell, smooth surface.

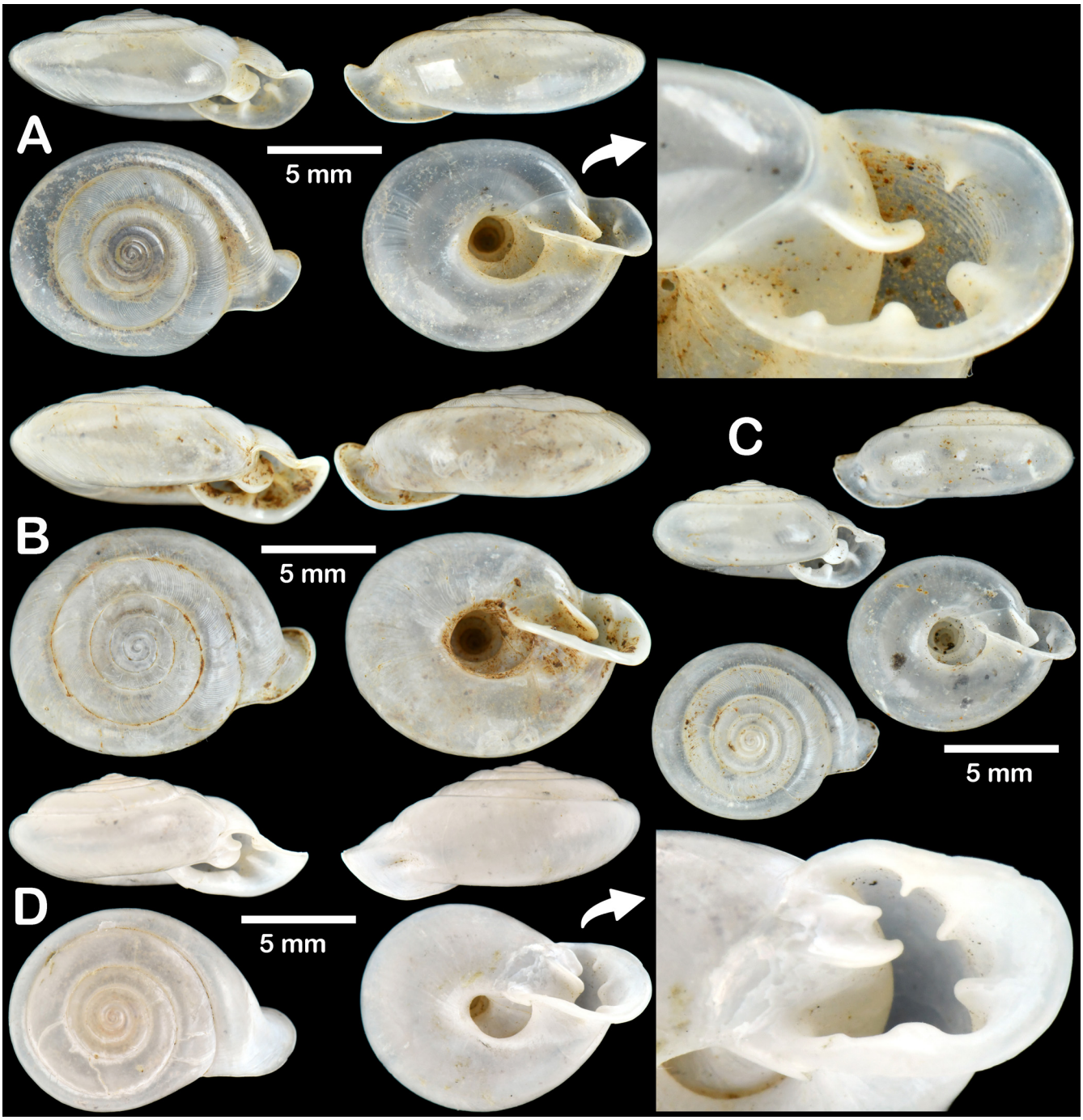

Fig. 3. A–C, *Discartemon tonywhitteni*, new species. A, CUMZ 5108, holotype, Lenya National Park, Tanintharyi, Myanmar; B, CUMZ 5107, paratype, Lenya National Park, Tanintharyi, Myanmar; C, paratype CUMZ 5107 of small-shell, Lenya National Park, Tanintharyi, Myanmar. D, *Discartemon flavacandida*, CUMZ 6251, holotype, Tam Phra Khayang, Ranong, Thailand. Insets: apertural dentition.

and widely opened umbilicus. It belongs to the *D. discus*-species group which comprise of *D. discus*, *D. planus* (Fulton, 1899), *D. sykesi* (Collinge, 1902), *D. nummus* (Laidlaw, 1929), *D. khaosokensis* Panha & Burch, 1998, *D. circulus* Siriboon & Panha, 2014, *D. discadentus* Siriboon & Panha, 2014, *D. discamaximus* Siriboon & Panha, 2014, *D. deprima* Siriboon & Panha, 2014, and *D. expandus* Siriboon & Panha, 2014. *Discartemon sagitticallosum* differs from the species of this group by strong peripheral keel on last whorl, and impression area and constriction located behind expanded apertural lip. Aperture narrow; parietal callus thickens and elevated with V-shape (sagittiform callus). Apertural dentition with a solely strong, tall, and sinuous parietal lamella.

Description. Shell small (width 4.5 to 7.3 mm, height 1.8 to 2.5 mm) flattened, whitish, and semi-transparent; whorls 4–5½, spire flattened with distinct suture. Shell surface glossy, nearly smooth with thin irregular growth line and varices present. Embryonic shell large about two whorls with smooth surface; following whorls regularly coiled. Last whorl angular with strong peripheral keel, intermediately

expanded and descending near aperture. Below periphery of last whorl with strong constriction just behind apertural lip; upper periphery with impression area close to apertural lip. Aperture narrow V-shaped with a sinulus on the palatal side. Peristome continuous, very thick, expanded, and reflected. Parietal callus (sagittiform) very thick and elevated, arrowhead-shaped. Apertural dentition with very strong, tall, and curved parietal lamella adjoining at sinulus. Umbilicus open very wide, deep, and showing all preceding whorls.

Distribution. *Discartemon sagitticallosum* is known from two localities along the same karst formation. A single shell from Tam Khantipon, about 8 km south of the type locality, is identical with the type specimens. The empty shells were collected among decayed leaf litter in limestone rock crevices.

Remarks. No living specimen was available for anatomical study. However, the prominent and unique aperture, parietal callus and parietal lamella is sufficient to discriminate *D. sagitticallosum*.

Discartemon sagitticallosum differs from all members of the *D. discus*-species group, except for *D. nummus*, by a small shell (shell width ranged from 4 to 7 mm). Whereas, the others species have a large shell (shell width ranged from 8 to 14 mm). *Discartemon sagitticallosum* has a similar shell size as *D. nummus* (Fig. 2C), but with the distinct characters of a smooth shell surface, very thick and elevated sagittiform parietal callus, very narrow V-shaped aperture, parietal lamella very strong, tall, and curved, and strong constriction just behind the apertural lip. Whereas, *D. nummus* has thin transverse ridges, Y-shaped parietal callus, wider triangular aperture, weak parietal lamella, and very weak or no constriction behind the apertural lip (Siriboon et al., 2014a).

***Discartemon tonywhitteni*, new species**
(Fig. 3A–C)

Material examined. Holotype CUMZ 5108 (Fig. 3A); paratypes CUMZ 5107 (14 shells; Fig. 3B, C), CUMZ 5101 (30 shells), CUMZ 5102 (25 shells), CUMZ 5104 (18 shells), CUMZ 5105 (30 shells), CUMZ 5106 (20 juvenile shells), NHMUK (5 shells), SMF (5 shells) and ZRC (5 shells), all from the limestone outcrop at Phra (Buddha) Cave, Lenya National Park, Tanintharyi Township, Tanintharyi Division, Myanmar (11°13'46"N 99°10'34"E).

Etymology. The species is named to honour Dr. Tony Whitten of Fauna & Flora International who invited our team to explore the karstic land snails in Myanmar in 2015 and 2016.

Diagnosis. *Discartemon tonywhitteni* is a typical streptaxid with a depressed-heliciform shell, fine transverse ridges and widely opened umbilicus. It belongs to the *D. plussensis*-species group, which comprises of: *D. plussensis* (de Morgan, 1885), *D. hypocrite* van Benthem Jutting, 1954, *D. leptoglyphus* van Benthem Jutting, 1954, *D. platymorphus* van Benthem Jutting, 1954, *D. afthonodontia* Siriboon & Panha, 2014, *D. epipedis* Siriboon & Panha, 2014, and *D. flavacandida* Siriboon & Panha, 2014. *Discartemon tonywhitteni* differs by the angular last whorl and with furrows behind expanded apertural lip. Apertural dentition with one strong and tall parietal lamella, and palatal, basal, columellar and supracolumellar lamellae present.

Description. Shell large (width 9.6 to 13.4 mm; height 3.5 to 5.2 mm), regularly coiled, depressed-heliciform, whitish and translucent; whorls 5–6½, spire low-conical to convex with wide and depressed suture. Shell surface glossy, with fine transverse ridges that are inconspicuous below periphery; varices present. Embryonic shell large, about 2½ whorls, with smooth surface; following whorls regularly coiled. Last whorl usually angular (sometimes narrowly rounded) with obtuse peripheral keel and regularly expanded. Below periphery with two shallow and short longitudinal furrows just behind apertural lip. Aperture trapezoid or obtusely trapezoid; peristome discontinuous, thickened, expanded and reflected; parietal callus thin and transparent. Apertural dentition: one strong and curved parietal lamella, one palatal, one basal, one large columellar, and one supracolumellar lamella; sometimes tiny upper palatal lamella present. Umbilicus open, wide, deep, and present all preceding whorls.

Distribution. *Discartemon tonywhitteni* is known only from the type locality, lowland and isolated limestone hills in Lenya National Park, Myanmar. The primary forest surrounding the karsts was a low disturbed, mature broad-leaved evergreen forest, and with patches of bamboo forest. This is the northernmost record of the genus *Discartemon* along the Malay Peninsula.

Remarks. *Discartemon tonywhitteni* belongs to the *D. plussensis*-species group and differs from all others species (except *D. flavacandida*) by a large shell (shell width ranged from 10 to 13 mm). Whereas, the other species have a small shell (shell width ranged from 6 to 10 mm). *Discartemon tonywhitteni* can be distinguished from *D. flavacandida* (Fig. 3D) by having a regularly coiled shell, with transverse ridges, conical shape of umbilical opening, angular last whorl, and with one parietal and one columella lamellae. Whereas, *D. flavacandida* displays an axially deflected, smooth shell surface, shouldered last whorl, oblique conical shape of umbilical opening, and with two parietals (parietal and upper parietal), two columella (columella and supracolumella), and one upper palatal lamellae (Siriboon et al., 2014a).

Shell variation occurs in the small-sized specimens that tended to have a rounded last whorl (Fig. 3C).

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