

The slug genus *Atopos* Simroth, 1891 (Systellommatophora: Rathouisiidae) from Myanmar with description of a new species

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Abstract. We report on the carnivorous rathouisiid slugs in Myanmar, including one new record, *Atopos laidlawi* Collinge, 1902, from Tanintharyi Region, and describe one new species, *Atopos transversus*, new species, from Shan State. Previously, only *Atopos graveleyi* Ghosh, 1915 from Kayin State had been documented from Myanmar. Detailed descriptions along with illustrations of the external morphology and genital characters are provided herein. Among the distinguishing features, *A. transversus*, new species, has a Simroth gland with the evaginable part slightly shorter than the penis length, a short-interconnected duct, and a cylindrical secretory part, whereas *A. laidlawi* possesses a Simroth gland in which the evaginable part is similar in length to the penis, has a long-interconnected duct, and a bulbous secretory part.

Key words. anatomy, carnivorous slug, limestone, morphology, Southeast Asia

INTRODUCTION

Myanmar ranks as the largest country in mainland Southeast Asia and boasts diverse terrestrial ecosystems, including tropical, subtropical, alpine, and semi-arid areas (MCRB, 2018). These varied ecosystems support a wide range of species and make it a biodiversity hotspot (MECF, 2014; Murray et al., 2020). In the past two decades, there has been a growing interest in studying Myanmar biodiversity, including the various groups of vertebrates (i.e., MECF, 2014; Grismer et al., 2016, 2018), as well as invertebrates, such as arthropods (i.e., Yasunaga et al., 2016; Oo et al., 2020; Choi et al., 2021), earthworms (i.e., Blakemore, 2006; Csuzdi et al., 2015), and land snails, which are predominantly stylommatophorans (i.e., Páll-Gergely et al., 2020a, 2020b, 2020c, 2022, 2023; Pholyotha et al., 2020; Sutcharit et al., 2020; Grego et al., 2021; Man et al., 2022, 2023; Tongkerd et al., 2024). Nevertheless, there is a severe lack of data regarding carnivorous rathouisiid slugs.

Carnivorous slugs of the family Rathouisiidae Heude, 1885 currently comprise four genera, of which *Atopos* Simroth, 1891 has the highest species diversity and is the only genus

with a known distribution across South Asia, Southeast Asia to New Guinea, and in the north of Australia (Barker, 2001; Schilthuizen & Liew, 2008; Manganelli et al., 2023). In contrast, the other genera are either monotypic or known from only a few species, and have narrow distribution ranges (Wu et al., 2006; Kimura et al., 2020; Manganelli et al., 2023; MolluscaBase eds., 2024). The genus *Atopos* is characterised by the following: cross-section of the body resembles an isosceles triangle, prominent mid-dorsal keel, anterior body (about 1/3 of total length) thicker than posterior, and presence of ditrematous genitalia (two genital pores) (Simroth, 1891; Ghosh, 1912; Manganelli et al., 2023). In addition, they are predominantly carnivorous, feeding on terrestrial snails and semi-slugs, although they occasionally feed on fungi and plants (Collinge, 1902; Barker, 2001; Tan & Chan, 2009; Liew & Schilthuizen, 2014; Vermeulen & Liew, 2022). So far, only one species, *Atopos graveleyi* Ghosh, 1915, has been recorded in Myanmar, but this was over a century ago.

During land snail expeditions in collaboration with the Forest Department of Myanmar and Fauna & Flora International (FFI) in 2015 and 2016, *Atopos* specimens were discovered in Tanintharyi Region and Shan State of Myanmar. This study describes one new species based on external morphology and genitalia. Additionally, a redescription of a newly recorded species, *Atopos laidlawi* Collinge, 1902, is provided. These data reinforce the expanding understanding of the diverse terrestrial malacofauna in Myanmar.

MATERIAL AND METHODS

Specimen sampling and morphological studies. The rathouisiid slug specimens were collected from limestone

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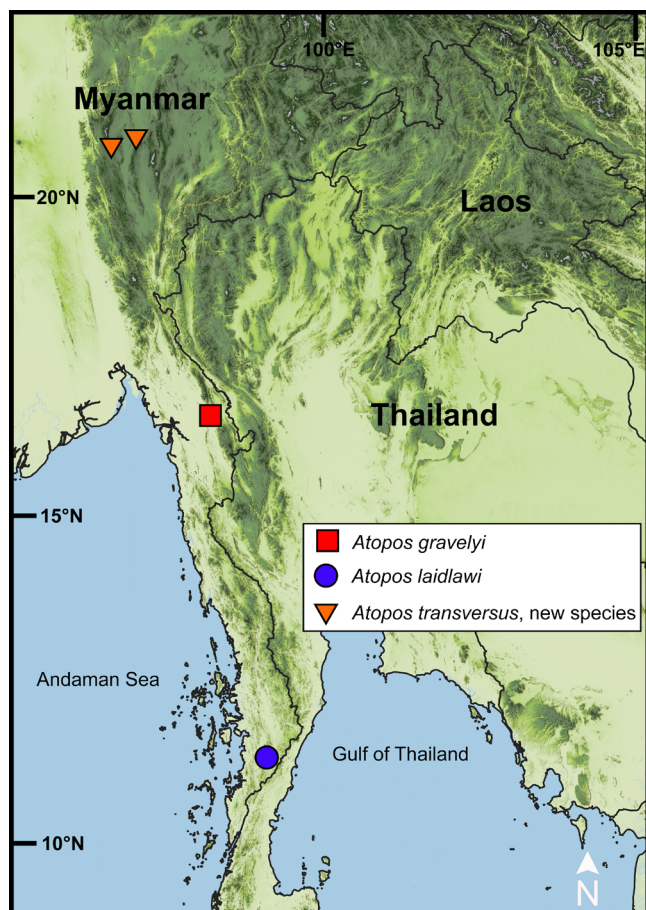


Fig. 1. Distribution map of the three recognised *Atopos* species in Myanmar based on current literature and specimens examined herein.

areas in southeastern (Tanintharyi Region) and eastern (Shan State) parts of Myanmar by members of the Animal Systematics Research Unit Chulalongkorn University (ASRU CU), Bangkok, Thailand (Fig. 1). These field surveys took place as part of a Memorandum of Understanding (MOU) established between the Forest Department under the Ministry of Natural Resources and Environmental Conservation, Myanmar, and the FFI, as documented by Letter No. 0092. Specimens were euthanised by the two-step method (AVMA, 2020) and preserved in 70% (v/v) ethanol. Preserved specimens were photographed using a Nikon camera (DSLR D850). Microphotographs were captured under a stereomicroscope (ZEISS Stemi 508) equipped with a camera (ZEISS Axiocam 208 color) and image processing was conducted using the ZEISS Labscope software. Measurements were taken of the body length, body height, body width, foot width, and distance between the male and female genital pores. Species were identified based on the original descriptions and by comparing with the relevant species descriptions.

Scanning electron microscopy. A square centimetre of skin from the right side of the notum at approximately $\frac{1}{3}$ of the body length from the head of each specimen was excised and preserved in 95% (v/v) ethanol. Subsequently, each specimen underwent dehydration through an ethanol series until the concentration reached 100% (v/v) ethanol. The specimens were then dried using a Critical Point Dryer (LEICA EM

CPD300). The dried specimens were mounted on aluminum stubs with double-sided carbon tape and coated with gold for 210 seconds using a Sputter Coater (BALZERS UNION SCD 040). Finally, the skin surfaces were imaged using a scanning electron microscopy (SEM; JEOL JSM-6610LV) at the Scientific and Technological Research Equipment Centre at Chulalongkorn University (STREC CHULA).

Anatomical abbreviations. The following abbreviations were used in this study: ag, albumen gland; an, anal pore; es, evaginable part of the Simroth gland; f, foot; fg, female genital pore; hg, hermaphrodite gland; lsg, left Simroth gland; ov, oviduct; p, penis; pg, prostate gland; po, pulmonary orifice; pr, penial retractor muscle; rs, receptaculum seminis; rsg, right Simroth gland; sp, secretory part of the Simroth gland; sr, Simroth gland retractor muscle; vd, vas deferens; vg, vagina.

Institutional abbreviations. CUMZ, Chulalongkorn University, Museum of Zoology, Bangkok, Thailand.

TAXONOMY

Family Rathouisiidae Heude, 1885

Genus *Atopos* Simroth, 1891

Atopos Simroth, 1891: 596, 597; Sarasin & Sarasin, 1899: 104–106; Collinge, 1902: 84–87; Heynemann, 1906: 37–38; Ghosh, 1912: 182; Ghosh, 1914: 111–113; Thiele, 1931: 489; Schilthuizen & Liew, 2008: 293, 294; Manganeli et al., 2023: 91–94.

Type species. *Atopos semperi* Simroth, 1891 by subsequent designation in Thiele (1931: 489).

Diagnosis. The animal has an isosceles triangle cross-section and a short base (formed by the foot). Mid-dorsal region with more or less prominent mid-dorsal keel. Anterior body (about $\frac{1}{3}$ of total length) thickest, gradually tapering to posterior end. Head with two pairs of tentacles: upper pair contractile and with dark eye spot on tip; lower pair short and bifid. Genitalia ditrematous: male pore opened behind right lower tentacle; female pore located near anal pore and pulmonary orifice in right pedal groove.

Remarks. Although Simroth gland(s) have been reported in *Atopos*, there have been no studies or direct observations, so its function is still being studied. However, Laidlaw (1940) and Barker (2001) hypothesised that it probably has a role in the copulatory process because it connects to the male genital organ and is close to the genital opening.

At present, the genus *Atopos* comprises approximately 30 nominal species. They have a broad distribution, mainly being found in Southeast Asia, but have also been documented in Australia, Papua New Guinea, and India (Souleyet, 1852; Heynemann, 1876; Simroth, 1891, 1914, 1920; Sarasin & Sarasin, 1899; Babor, 1900; Collinge, 1902, 1903, 1908; Ghosh, 1912, 1913, 1915; De Wilde, 1984; Tan & Chan, 2009; Vermeulen & Liew, 2022).

In Myanmar, *A. graveleyi* was the first and only species discovered in Kayin State (Ghosh, 1915). From this study, we identified one new species, named here as *A. transversus*, new species, from Shan State, and also documented a new record of *A. laidlawi* Collinge, 1902 from Tanintharyi Region.

Atopos graveleyi Ghosh, 1915

Atopos graveleyi Ghosh, 1915: 153, pl. 16, figs. 1–7, pl. 17, figs. 8–17, pl. 18, figs. 18–26, pl. 19, figs. 27–29, type locality: Dawna Hills near Thingannyinaung [probably in the area of Myawaddy District, Kayin State, Myanmar]; Manganeli et al., 2023: 91, 93.

Diagnosis. Upper part of mid-lateral line sepia, decorated with dark brown blotches and small spots. Lower part of mid-lateral line blue, decorated with slaty-black blotches and spots. Mid-lateral line with pale buff blotches above and dark-clove brown band below. Mid-dorsal keel rounded and prominent. Dark clove-brown mid-dorsal line. Foot pale yellow. Right Simroth gland well-developed with evaginable part long, cylindrical, and longer than penis; interconnected duct and secretory part indistinguishable with a long slender shape.

Remarks. Unfortunately, no new specimens identified to this species were collected, and the type specimen could not be located.

Atopos graveleyi is superficially similar to *Atopos maximus* Collinge, 1903 from Thailand in terms of its colour pattern on the notum. However, *A. graveleyi* differs by possessing a prominent and dark clove-brown mid-dorsal line, pale buff blotches above and clove-brown band below the mid-lateral line, upper part of mid-lateral line sepia with dark brown blotches and spots, and lower part of mid-lateral line blue with slaty-black blotches and spots (Ghosh, 1915: pl. 16, fig. 1). In addition, *A. graveleyi* has only a right Simroth gland, with its evaginable part longer than penis length; interconnected duct and secretory part indistinguishable and long and slender in shape (Ghosh, 1915: pl. 19, fig. 27). In comparison, *A. maximus* possesses a yellowish-brown mid-dorsal line, a yellowish-brown band as the mid-lateral line with an irregular margin, slaty-blue mottling above the mid-lateral line, and a yellowish notum and decorated with scattered tiny black spots (Collinge, 1903: pl. 11, figs. 5, 6). Moreover, *A. maximus* has well-developed left and right Simroth glands, evaginable part short and about one-fourth of the penis length, thin interconnected duct, and secretory part a long cylindrical shape (Collinge, 1903: pl. 13, fig. 21). Therefore, we have retained this species as valid until new topotypic specimens as well as specimens from the other populations become available to verify the taxonomic status, intraspecific variation, and the relationship with *A. maximus*.

Atopos laidlawi Collinge, 1902

(Figs. 2, 4A, B, 5A–C)

Atopos laidlawi Collinge, 1902: 90, 91, pl. 5, figs. 53–55, type locality: Ban Kong Rah, District of Gaboing [in the area of Kabang District, Yala Province, Thailand].

Material examined. One ethanol-preserved specimen (Fig. 2A, B; length 21 mm, width and height 5 mm) (CUMZ 160201), Phra Cave (Site III), Ban Nam Yen, Tanintharyi Region, Myanmar, 11°14'01.5"N, 99°10'42.8"E. One ethanol-preserved specimen (Fig. 2C, D; length 25 mm, width and height 5 mm) (CUMZ 160205), same locality as specimen CUMZ 160201.

Diagnosis. Upper part of mid-lateral line pale yellow; lower part pale brown and separated by irregular brown band. Mid-dorsal keel rounded and fairly prominent. Clear white mid-dorsal line flanked by brown stripes. Perinotum and foot off-white. Anterior and posterior ends of notum white.

External characters. Preserved specimen (Fig. 2). Animal elongated elliptical, tapering at both ends, and anterior part thicker than posterior part. Dorsal side with fairly prominent mid-dorsal keel along its entire length. Notum rather smooth, and uniformly covered with small- to medium-sized and randomly scattered papillae. Papillae generally elliptical shaped and interconnected with rows of ridge (Fig. 4A, B). Anterior and posterior ends of notum white. Notum pale yellowish, off-white to pale brown; mid-dorsal line white and flanked by irregular brownish stripes; mid-lateral line with a broad dark brown band and irregular margins. Upper and lower parts of mid-lateral line yellowish, and sometimes lower part with darker colour than upper part. Perinotum narrow with off-white sharp keel; foot (f) narrow and about half of body width (Figs. 2, 5B). Anterior notum covers head region. Head and tentacles off-white; upper tentacles slightly long; lower tentacles short, stout, and bifid.

Genital organs. Male genital pore located at base of lower right tentacle. Atrium short; penis (p) long cylindrical shape and situated at base of right body cavity. Vas deferens (vd) thin tube, originating at base of hermaphroditic-prostate gland complex, bound with oviduct before penetrating body wall on right side of foot, and then emerging from body wall near male genital pore and inserting near distal end of penis (Fig. 5A, C). Penial retractor muscle (pr) inserted at distal end of penis. Simroth glands present on both sides: left Simroth gland (lsg) much smaller and less developed. Right Simroth gland (rsg) well-developed and consists of three parts: (i) evaginable part (es) is cylindrical and almost same length as penis; (ii) interconnected duct long, curled, and thin tube; and (iii) secretory part (sp) enlarged and long bulbous shape. Simroth gland retractor muscle (sr) attached at junction of interconnected duct and evaginable part (Fig. 5C).

Female genital pore (fg), anal pore (an), and pulmonary orifice (po) located around 4 to 6 mm from male genital pore in right pedal groove (Figs. 2A, C, 5B). Vagina (vg) short tubular duct. Receptaculum seminis (rs) club-shaped and situated at distal end of vagina. Oviduct (ov) long cylindrical tube. Albumen gland (ag), lobulated hermaphrodite gland (hg), and prostate gland (pg) bound together and undifferentiated (Fig. 5A).

Distribution. *Atopos laidlawi* is known from the type locality in southern Thailand (Collinge, 1902); the new

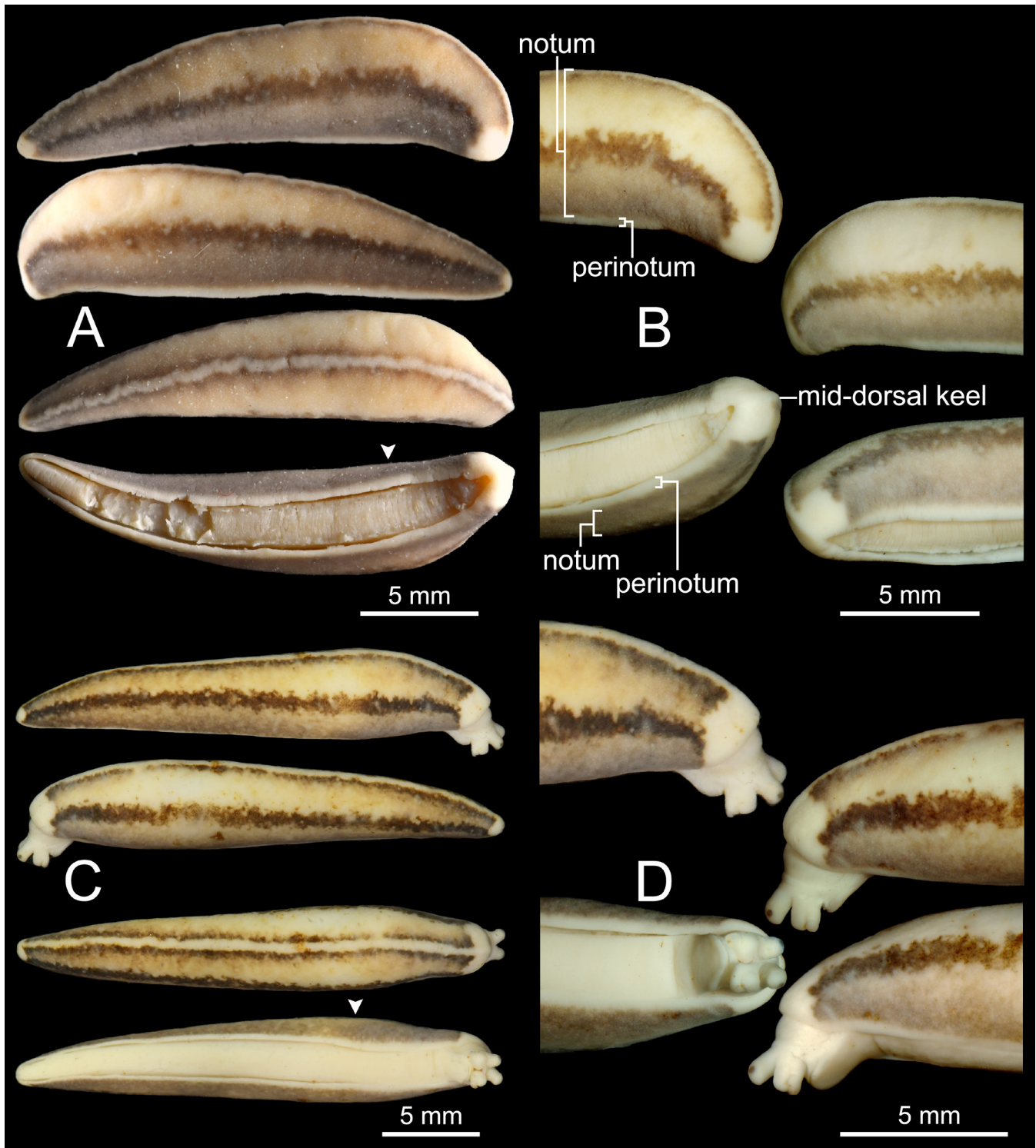


Fig. 2. *Atopos laidlawi* Collinge, 1902. A, B, specimen CUMZ 160201; C, D, specimen CUMZ 160205, Tanintharyi Region. Arrowheads indicate approximate position of female genital pore.

record reported herein is from Tanintharyi Region, southern Myanmar.

Comparative diagnosis. *Atopos laidlawi* can be distinguished from *Atopos rugosus* Collinge, 1902 and *A. graveleyi* by its fairly prominent mid-dorsal keel, mid-dorsal line white and flanked by irregular dark brown stripes, pale yellow and pale brown colours at upper and lower parts of mid-lateral line, respectively, and whitish anterior and posterior ends of notum. In comparison, *A. rugosus* possesses a well-developed

mid-dorsal keel, yellowish-brown mid-dorsal line, notum dark green decorated with yellowish-brown spots, mid-lateral line absent, and anterior end of notum almost white (Collinge, 1902: pl. 5, figs. 46–48). In contrast, *A. graveleyi* possesses a prominent mid-dorsal keel, dark clove-brown mid-dorsal line, mid-lateral line with pale buff blotches above and clove-brown band below, upper part of mid-lateral line sepia with dark brown blotches and small spots, and lower part of mid-lateral line blue with slaty-black blotches and spots (Ghosh, 1915: pl. 16, fig. 1). Regarding the genitalia,

A. laidlawi has both left and right Simroth glands and an enlarged bulbous secretory part (Fig. 5C), while *A. gravelyi* possesses only the right Simroth gland and a very slender secretory part (Ghosh, 1915: pl. 19, fig. 27).

Remarks. *Atopos laidlawi* was described based on specimens collected during the ‘Skeat Expedition’ in southern Thailand with only a brief description of external morphology (Collinge, 1902). However, the record from Luang Phrabang Province, Laos (see Inkhavilay et al., 2019: figs. 19a, 55a) seemed to differ from the typical by having no off-white colour at the anterior and posterior ends of the notum. The Laotian specimen has a sharp mid-dorsal keel, light brown mid-dorsal line, yellowish-brown notum with tiny black spots, irregular yellowish-brown mid-lateral line, and brown mottling on upper mid-lateral line, which suggest it is more likely to be *A. maximus* than *A. laidlawi*.

***Atopos transversus*, new species**

(Figs. 3, 4C, D, 5D)

Type materials. Holotype: One ethanol-preserved specimen (Fig. 3A, B; length 33 mm, width and height 5 mm) (CUMZ 160202), in a forest among the limestone hills at Montawa Cave, Taunggyi District, Shan State, Myanmar, 20°45'16.8"N 97°01'03.4"E. Paratypes: One ethanol-preserved specimen (Fig. 3C; length 27 mm, width 6 mm, height 5 mm) (CUMZ 160203), same locality as the holotype. One ethanol-preserved specimen (Fig. 3D; length 45 mm, width 8 mm, height 9 mm) (CUMZ 160204), Myin Ma Hti Cave (Pagoda), Kalaw Township, Taunggyi District, Shan State, Myanmar, 20°35'56.3"N 96°36'36.9"E.

Etymology. The specific name ‘*transversus*’ is from the Latin words ‘trans’ meaning across or cross, and ‘versus’ means stripe or line; these refer to the presence of the crossed stripes on its dorsal side.

Diagnosis. Notum yellowish-brown to pale brown with blackish to brownish cross-reticulated stripes without a distinct pattern. Mid-dorsal keel fairly prominent. Light brown mid-dorsal line with scattered tiny blackish spots. Perinotum and foot pale yellow to off-white. Anterior end with small whitish patch.

External characters. Preserved specimen (Fig. 3). Animal narrowly elongated cylindrical and tapering to both ends. Dorsal side with fairly prominent mid-dorsal keel along its entire length. Notum rather smooth, and surface with a uniformly low cluster of small- to medium-sized and randomly scattered papillae. Papillae generally rounded, roughened surfaces and with an area of depressions at the centre (Fig. 4C, D). Anterior end of notum with a small whitish patch. Notum yellowish-brown to pale brown with scattered tiny blackish spots; mid-dorsal line a lighter colour than notum; mid-lateral line absent. Lateral surface of body with irregular and scattered blackish to brownish streaks; sometimes with cross-reticulated stripes. Perinotum narrow with off-white to pale yellow sharp keel; foot narrow, about 2.5-fold narrower than body width (Fig. 3). Anterior notum

covers head region. Head and tentacles off-white; upper tentacle slightly short; lower tentacles short, stout, and bifid.

Genital organs. Male genital pore located at base of lower right tentacle. Atrium long; penis (p) long cylindrical shape and situated at base of right body cavity. Vas deferens (vd) a thin tube, emerging from body wall near the male genital pore before inserting near distal end of penis. Penial retractor muscles (pr) inserted at distal end of penis. Simroth glands present on both sides; left Simroth gland (lsg) much smaller and less developed. Right Simroth gland (rsg) well-developed and consists of three parts: (i) evaginable part (es) is cylindrical shaped and slightly shorter than penis length; (ii) interconnected duct a short, thin, and curled tube; and (iii) secretory part (sp) is cylindrical shaped, curled, long, and slightly larger in diameter than interconnected duct. Simroth gland retractor muscle (sr) attached near distal end of evaginable part (Fig. 5D).

Female genital pore (fg), anal pore (an), and pulmonary orifice (po) located about 4 to 6 mm from male genital pore in right pedal groove (Fig. 3A, C, D). Vagina short tubular duct; receptaculum seminis club-shaped; oviduct a coiled and cylindrical tube. Albumen gland (ag), hermaphrodite gland (hg), and prostate gland (pg) bound together and undifferentiable.

Distribution. *Atopos transversus*, new species, is currently known only from the type locality in Shan State, Myanmar (Fig. 1).

Comparative diagnosis. This new species can be distinguished from *A. laidlawi* and *Atopos punctata* Collinge, 1902 from Thailand, and *A. gravelyi* by having a fairly prominent mid-dorsal keel, light brown mid-dorsal line, yellowish-brown to pale brown notum with blackish to brownish cross-reticulated stripes in a random arrangement, and anterior end with a small whitish patch. In comparison, *A. laidlawi* possesses a fairly prominent mid-dorsal keel, white mid-dorsal line, broad dark brown and irregular margin mid-lateral line, and whitish anterior and posterior ends of notum. In contrast, *A. punctata* has a fairly prominent mid-dorsal keel, light yellow mid-dorsal line, and a yellow notum with scattered black spots (Collinge, 1902: pl. 5, figs. 49–52). Additionally, *A. gravelyi* possesses a prominent mid-dorsal keel, dark clove-brown mid-dorsal line, mid-lateral line with pale buff blotches above and clove-brown band below, upper part of mid-lateral line sepia with dark brown blotches and small spots, and lower part of mid-lateral line blue with slaty-black blotches and spots (Ghosh, 1915: pl. 16, fig. 1). In addition, *A. transversus*, new species, possesses both left and right Simroth glands with curled cylindrical secretory part (Fig. 5D). In comparison, *A. laidlawi* has left and right Simroth glands with an enlarged bulbous secretory part (Fig. 5C), while *A. gravelyi* possesses only the right Simroth gland with a very slender secretory part (Ghosh, 1915: pl. 19, fig. 27).

Although *Atopos transversus*, new species, has notum colouration and cross-reticulated stripes remarkably similar to those of *Atopos kempii* Ghosh, 1913 and *Atopos aborensis*

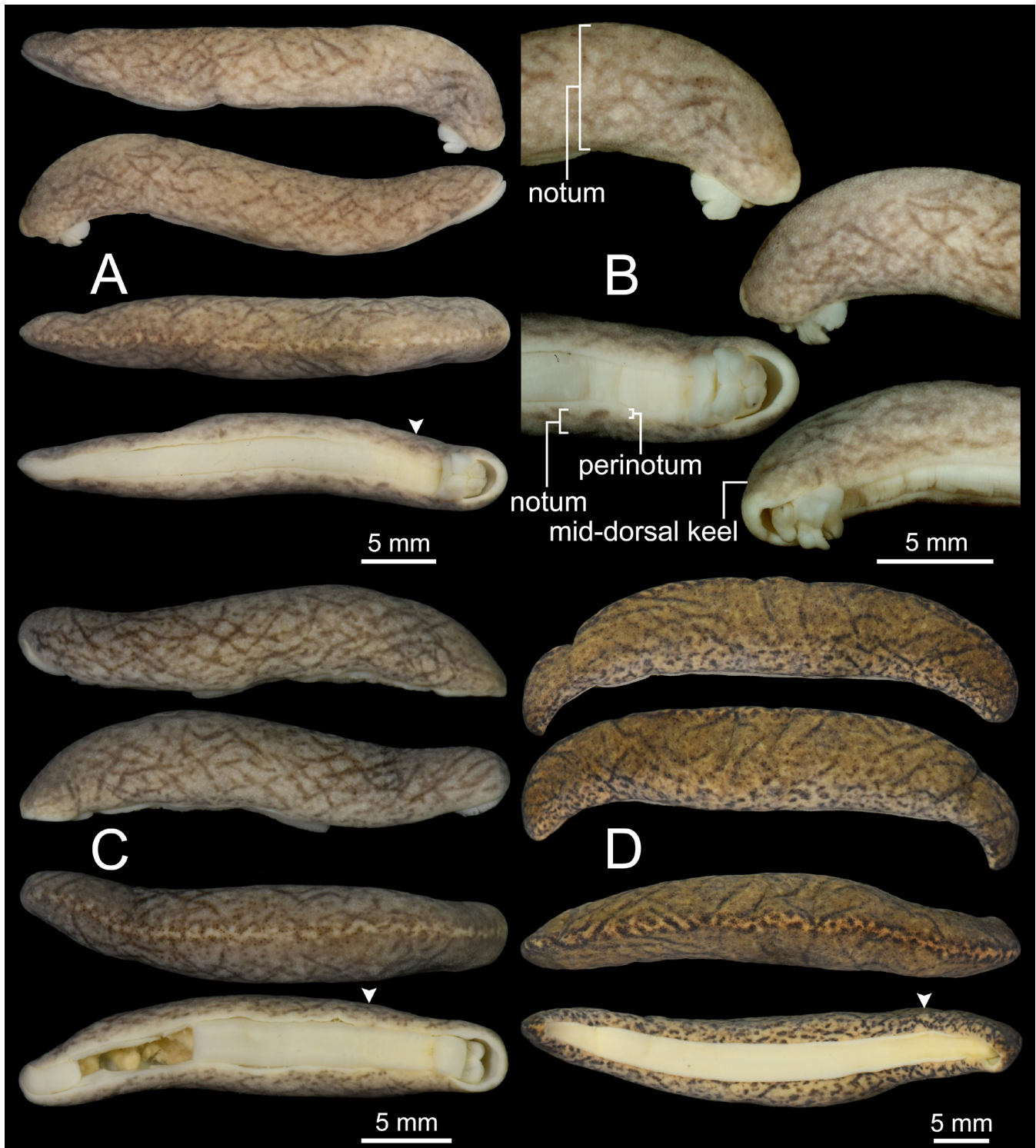


Fig. 3. *Atopos transversus*, new species. A, B, holotype CUMZ 160202, Montawa Cave, Taunggyi District, Shan State; C, paratype CUMZ 160203, Montawa Cave, Taunggyi District, Shan State; D, paratype CUMZ 160204, Myin Ma Hti Cave (Pagoda), Taunggyi District, Shan State. Arrowheads indicate approximate position of female genital pore.

(Ghosh, 1913) from Abor Hills, India, this new species can be distinguished from the Indian species by having yellowish-brown to pale brown notum decorated with scattered blackish to brownish cross-reticulated stripes, a small whitish patch at anterior end, and pale yellow to off-white foot. In comparison, *A. kempii* exhibits a light straw notum with scattered dark blue cross-reticulated stripes, minute dark blue dots in the interspaces of cross-reticulated stripes, and a light-yellow foot (Ghosh, 1913: pl. 10, fig. 1); whereas *A. aborensis* possesses

a sepia notum with blackish dots and cross-reticulated stripes, and a lamp-black foot (Ghosh, 1913: pl. 13, fig. 1). Regarding the genitalia characters, *A. transversus*, new species, possesses both left and right Simroth glands, and the right gland is composed of three parts: evaginable part, interconnected duct, and secretory part (Fig. 5D), whereas *A. kempii* and *A. aborensis* have only a right Simroth gland that consists of an evaginable part and an elongated free portion (= indistinguishable between interconnected duct

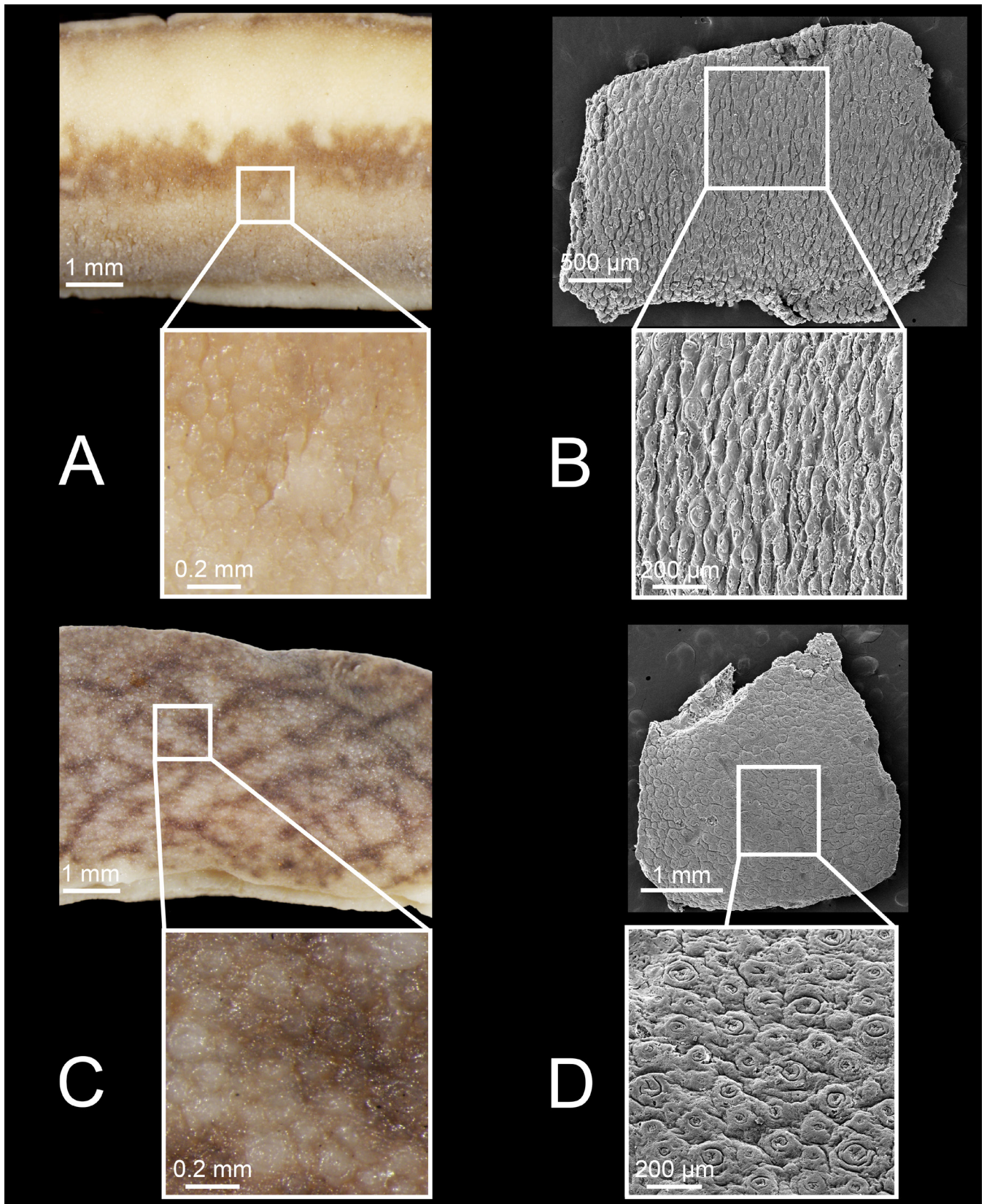


Fig. 4. Microphotographs and SEM images at right side of notum at approximately $\frac{1}{3}$ of body length from the head and with small inset of papillae of: A, B, *Atopos laidlawi*, specimen CUMZ 160201, Tanintharyi Region; C, D, *Atopos transversus*, new species, paratype CUMZ 160203, Montawa Cave, Taunggyi District, Shan State. The dorsal side of specimen is positioned superiorly, and the anterior end is positioned to the right.

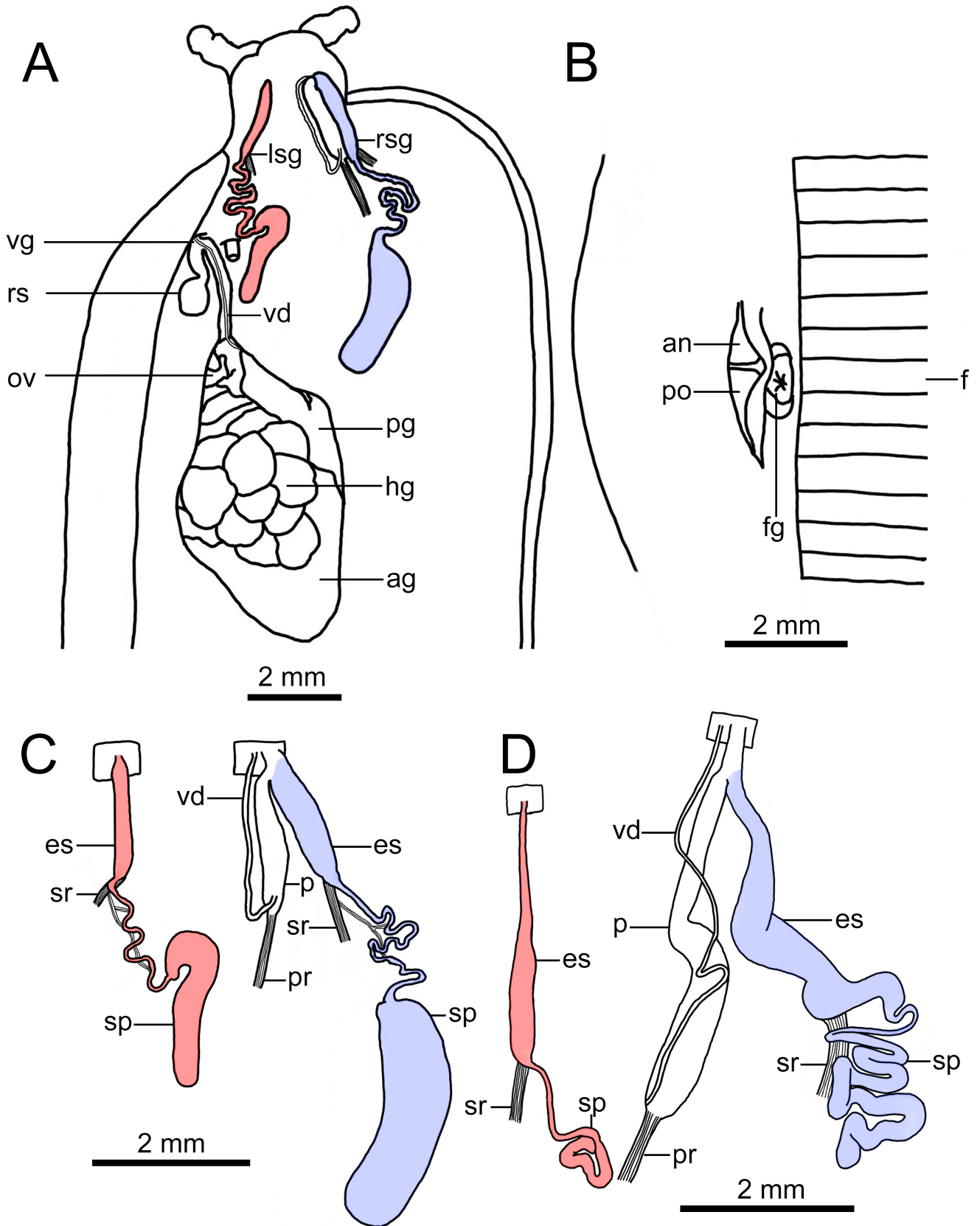


Fig. 5. A–C, *Atopos laidlawi*, specimen CUMZ 160205, Tanintharyi Region. A, schematic drawing showing the arrangement of reproductive organs; B, female pore, anal pore, and pulmonary orifice; C, male genitalia consist of left Simroth gland on the left, and right Simroth gland and penis on the right; D, male genitalia of *Atopos transversus*, new species, paratype CUMZ 160204, Myin Ma Hti Cave (Pagoda), Taunggyi District, Shan State, left Simroth gland on the left, and right Simroth gland and penis on the right. Abbreviations: ag, albumen gland; an, anal pore; es, evaginable part of the Simroth gland; f, foot; fg, female genital pore; hg, hermaphrodite gland; lsg, left Simroth gland; ov, oviduct; p, penis; pg, prostate gland; po, pulmonary orifice; pr, penial retractor muscle; rs, receptaculum seminis; rsg, right Simroth gland; sp, secretory part of the Simroth gland; sr, Simroth gland retractor muscle; vd, vas deferens; vg, vagina. Red and blue colours indicate left Simroth gland and right Simroth gland respectively, which consist of three parts: evaginable part (es), interconnected duct, and secretory part (sp).

and secretory part). In addition, *A. kempii* has an evaginable part that is slightly shorter than the penis, and a very long free portion, whereas *A. aborensis* possesses an evaginable part approximately the same length as the penis, and a short free portion (Ghosh, 1913: pl. 12, fig. 27, pl. 13, fig. 10).

In addition, this new species also differs from *Atopos semperi* Simroth, 1891 from the Philippines and *Atopos leuckarti* Simroth, 1891 from Indonesia in having yellowish-brown to pale brown notum decorated with scattered blackish to brownish cross-reticulated stripes. In comparison, *A. semperi* exhibits a yellowish-red notum with blackish-violet cross-reticulated stripes, while *A. leuckarti* possesses a reddish-yellow notum with blackish-red cross-reticulated stripes (Simroth, 1891: pl. 37, figs. 1, 2). Furthermore, *A. transversus*, new species, has the right Simroth gland larger than the left gland, and the right gland has a short-interconnected duct and long cylindrical secretory part (Fig. 5D), while *A. semperi* possesses left and right Simroth glands of approximately the same size, and the right gland has a very long-interconnected duct and elongated bulbous secretory part (Simroth, 1891: pl. 37, figs. 16, 20).

Remarks. Comparing specimens from the two localities, the notum and cross stripes of the new species have slightly different colours. Specimens from Montawa Cave (Fig. 3A, C) possess a pale brown notum with brownish cross-reticulated stripes, whereas the specimen from Myin Ma Hti Cave (Pagoda) (Fig. 3D) possesses a yellowish-brown notum with blackish cross-reticulated stripes, which we consider to be an intraspecific morphological variation.

DISCUSSION

Rathouisiid slugs of the genus *Atopos* were found in only a few areas during our expedition. The low number of *Atopos* species recorded in Myanmar likely persists due to the dearth of specimens examined. Intensive field surveys should prioritise the dry zone in the central region, the Arakan-Yoma ranges in the western region, and the mountains in Kachin State adjacent to the Abor Hills, as no *Atopos* species have yet been reported from there. Additionally, the Shan plateau in eastern Myanmar warrants further investigation, as Páll-Gergely & Hunyadi (2022) observed a scraped hole on the shell of *Dicharax spatiosus* Páll-Gergely & Hunyadi, 2022, a cyclophorid microsnail from Pinlaung, Shan State, which was probably caused by an *Atopos* slug. This shell-boring behavior was also documented in *Atopos rapax* Vermeulen & Liew, 2022, which preyed on *Plectostoma* Adams, 1865, diplommatinid microsnails from Borneo (Vermeulen & Liew, 2022). The carnivorous slug performs a direct entry into the shell aperture of juvenile prey with incomplete shell structures or scrapes a hole in less densely ribbed areas of adult prey that have thicker and more intricate shell sculptures (Schilthuizen et al., 2006; Schilthuizen & Liew, 2008; Liew & Schilthuizen, 2014).

Presently, the family Rathouisiidae consists of four genera. Two of these genera, *Barkeriella* Manganelli, Lesicki,

Benocci, Barbato, Misericocchi, Pieńkowska & Giusti, 2022 (in Manganelli et al., 2023) from Italy (It is probably from Southeast Asia, but it was first described from a greenhouse in Italy) and *Rathouisia* Heude, 1884 from South-East China possess tritrematous genitalia (three genital pores): male, oviductal, and vaginal pores (Wu et al., 2006; Manganelli et al., 2023). In contrast, *Atopos* from South-East Asia and *Granulilimax* Minato, 1989 from Japan possess ditrematous genitalia (two genital pores): male and female (vaginal) pores (Barker, 2001; Hayase et al., 2018; Manganelli et al., 2023). Despite superficial similarities in their ditrematous reproductive systems, *Atopos* and *Granulilimax* can be distinguished by characteristics of the notum. *Atopos* exhibit an isosceles triangular body shape, prominent mid-dorsal keel, and an elliptical body shape that tapers towards both ends. In contrast, *Granulilimax* has a slender and cylindrical body, dorsal side round (without mid-dorsal keel) and possesses a longitudinal dark brown stripe on each side of the notum that join at the anterior (head) and posterior (tail) ends (Minato, 1989).

This study contributes to our understanding of the rathouisiid slug diversity in Myanmar, uncovering a previously undescribed species. However, a comprehensive species list for Southeast Asia remains elusive. Further investigation of mitochondrial DNA sequences combined with anatomical investigation of specimens from across the region is necessary to accurately delineate species boundaries. Future studies should examine multiple specimens to determine intraspecific variation in the external morphology and genitalia. This will be instrumental in developing effective conservation strategies and resource management plans for these ecologically important invertebrates.

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