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Gyliotrachela cultura, a new species of terrestrial microsnail (Gastropoda: Eupulmonata: Vertiginidae) from Thailand

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Abstract. A new species of terrestrial microsnail, *Gyliotrachela cultura*, from a limestone karst within the integrated agricultural area in Loei province, Northeastern Thailand, is described based on the shell and radula morphology, and genital system. This new species differs from its closest congener *G. saraburiensis* in both number and position of apertural barriers. An infraparietal lamella, interpalatal plicae, two infrapalatal plicae, a subcolumellar lamella are present in the new species while three infraparietal, two supracolumellar, three subcolumellar, five infrapalatal, three interpalatal, five suprapalatal, and two parallel barriers are present in *G. saraburiensis*.

Key words. *Gyliotrachela*, Vertiginidae, microsnail, northeastern Thailand

INTRODUCTION

The trumpet microsnails of the genus *Gyliotrachela* Tomlin, 1930, were classified in the infraorder Pupilloidea (Orthurethra), family Vertiginidae Fitzinger, 1833, based on their shell morphology (van Benthem Jutting, 1950; Panha & Burch, 2005; Sutcharit et al., 2018). Most *Gyliotrachela* species have a dark reddish-brown, umbilicated, and opaque trumpet-shaped shell with a conical spire comprising approximately 4–5 well-rounded whorls, deep suture, almost vertically extended and expanded aperture bearing large columellar, parietal, upper and lower teeth (van Benthem Jutting, 1949; Panha & Burch, 2005). *Gyliotrachela* species are widely distributed from Myanmar, Thailand, Malaysia, Indonesia, Vietnam, Cambodia, and Australia (van Benthem Jutting, 1950, 1962; Solem, 1981; Panha et al., 2004; Panha & Burch, 2005; Tongkerd et al., 2013; Fig. 1 and Table 1). Previous taxonomic studies on *Gyliotrachela* were mainly based only on shell morphology while the radula morphology and genital system remain mostly unknown. In this paper, an undescribed species, *Gyliotrachela cultura*, from Loei province, northeastern Thailand is proposed as new to science based on shell morphology. The radula and genital system of a member of this genus from Thailand are reported for the first time in this paper.

MATERIAL AND METHODS

Ten specimens comprising seven empty shells and three living snails, were collected in June 2021 from an integrated agriculture area (17°34′43.020″N, 101°51′04.020″E), at an elevation of about 352 metres MSL in Mueang Loei District, Loei Province, Northeastern Thailand (Fig. 1). Empty shells were cleaned and air-dried. Shells were digitally photographed using a Cannon MP-E with macro lens. Scanning Electron Microscopy used was LEO 1450 VP, at the Microscopic Center, Faculty of Science, Burapha University. Shell terminology (e.g., whorl number, apertural barrier teeth) follows Panha & Burch (2005). Shell measurements (in mm) namely shell height (SH), shell width (SW), aperture height (AH), and aperture width (AW) were taken as minimum-maximum values (mean ± standard deviation) using digital vernier calipers (Electronic Digital Caliper S.H) and Image J 1.47v programme.

The radula was extracted by boiling the dead snail in a small test tube filled with 1.0% w/v of NaOH for 1–2 minutes. The contents of the test tube were then transferred into a small petri dish. Radula was removed under a stereomicroscope and washed in 3 changes of distilled water, 3 minutes per rinse, and then dehydrated in a series of 10%, 30%, 50% and 70% v/v ethyl alcohol respectively, 5 minutes in each concentration, and then air-dried on a stub for scanning electron micrography. Adult snails were dissected under a stereomicroscope to examine the genital system. Taxonomic identification was based mainly on Panha & Burch (2005) and Tongkerd et al. (2013).

Type materials in this study were deposited in the following institutions: Natural History Museum of Loei Rajabhat University, Loei Province, Thailand (NHLRU); Zoological and Research Collection of Burapha University, Chonburi Province, Thailand (ZRCBUU).

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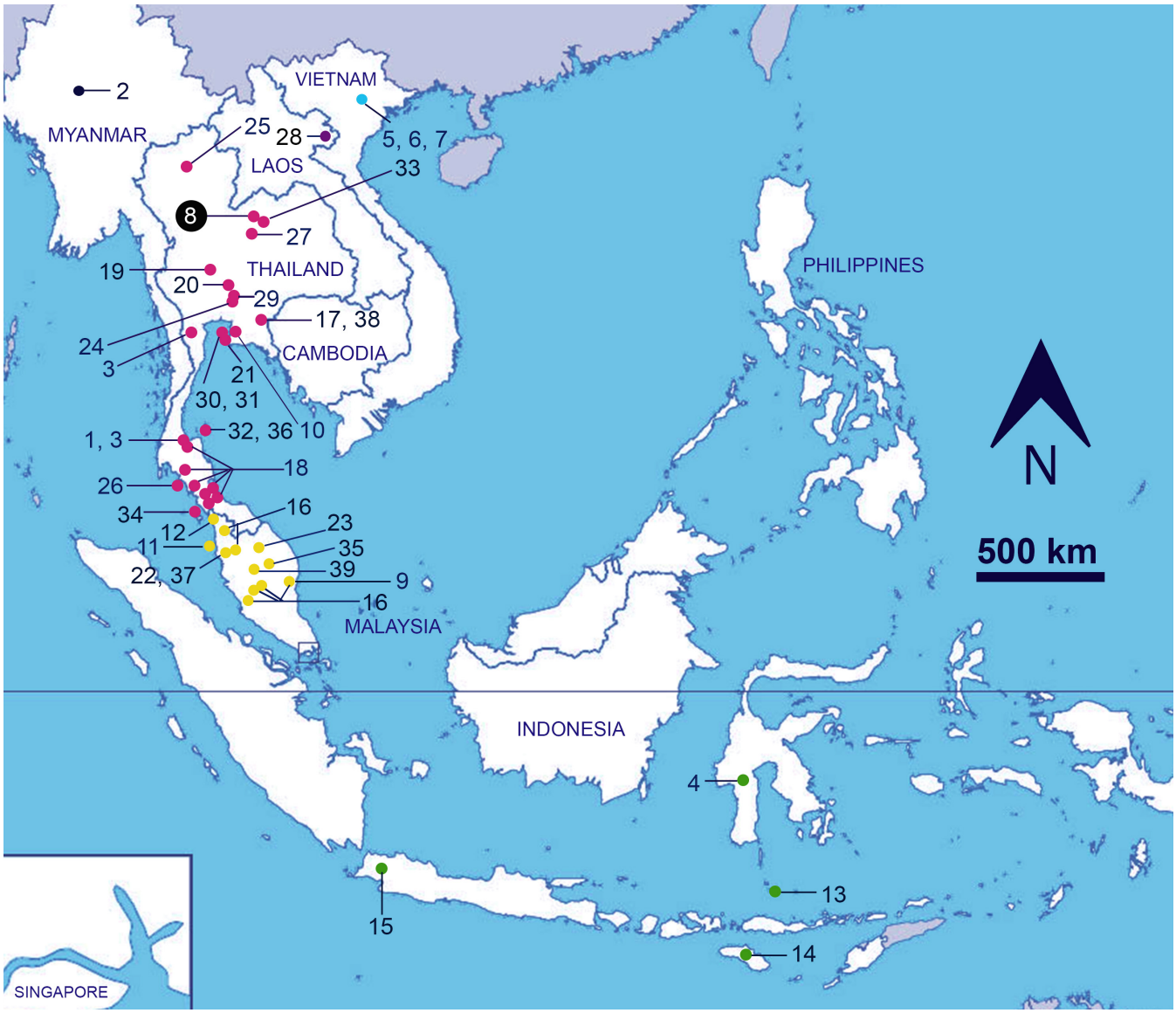

Fig. 1. Map of Southeast Asia showing the type localities of the known *Gyliotrachela* spp. The numbers correspond to the species numbers listed in Table 1.

TAXONOMY

Family Vertiginidae Fitzinger, 1833

Genus *Gyliotrachela* Tomlin, 1930

Gyliauchen Pilsbry, 1917a: 210 [non *Gyliauchen* Nicoll, 1915].
Gyliotrachela Tomlin, 1930: 24 [nom. nov. for *Gyliauchen* Pilsbry, 1917]; Schileyko, 1998: 140–141.
Schileyko, 2011: 2.

Type species. *Gyliotrachela hungerfordiana* (Möllendorff, 1891), by original designation.

Gyliotrachela cultura, new species
(Figs. 2–5A, 6)

Material examined. Holotype (NHLRU011), Thailand, Loei province, agriculture area in Mueang Loei District (17°34′43.020″N, 101°51′04.020″E), coll. K. Tanmuangpak, 15 June 2021. Paratypes: NHLRU012, four specimens preserved in 70% alcohol (dissected for genital system and radula); NHLRU013, three shells; ZRCBUU 0750, three shells, all paratypes collected from the same location as holotype, coll. K. Tanmuangpak, 3 June 2021.

Measurements. Holotype. SH = 2.11 mm, SW = 2.65 mm. AH 1.65 mm, AW 1.15 mm.
Paratypes (3 measured specimens). SH = 2.15–2.25 mm (2.18±0.06 mm), SW = 2.50–2.80 mm (2.65±0.12 mm), AH = 1.45–1.70 mm (1.56±1.12), AW = 1.12–1.25 mm (1.18±0.06). See Table 2.

Diagnosis. Shell small, trumpet-shaped last whorl with free short tuba, peristome expanded; aperture with 26 teeth, the angular lamella, parietal lamella, upper and lower palatal plicae, and columellar lamella being most prominent.

Description. Shell morphology. Shell minute, helicoid, dextral, brown, with 4¼ to 4½ whorls, spire tall, last whorl with short free trumpet shaped tuba (Fig. 2A, G). Protoconch

Table 1. Species and distribution of *Gyliotrachela* spp. in Thailand and adjacent countries.

No.	Species name	Distribution												References
		Myanmar	Laos	Vietnam	Malaysia	Indonesia	Philippines	Thailand						
								North	Northeast	East	Central	West	South	
1	*G. adela* Thompson & Upatham, 1997												✓	1, 2
2	*G. bensoniana* (Blanford, 1863)	✓												3, 4, 5
3	*G. burchi* Panha, 1997											✓	✓	2, 6
4	*G. concreta* van Benthem Jutting, 1949					✓								7
5	*G. crossei* (Morlet, 1885)			✓										1, 8
6	*G. crossei brevituba* (Möllendorff, 1901)			✓										1, 9
7	*G. crossei endodonta* (Möllendorff, 1901)			✓										1, 10
8	*G. cultura*, new species								✓					This study
9	*G. depressispira* van Benthem Jutting, 1949				✓									11, 12
10	*G. diarmaidi* Panha & Burch, 2003									✓				2, 13
11	*G. dohertyi* (Fulton, 1899)				✓									14
12	*G. emergens* van Benthem Jutting, 1950				✓									7, 12
13	*G. everetti* (E. A. Smith, 1896)					✓								15, 16
14	*G. everetti mixta* Rensch, 1932					✓								17
15	*G. fruhstorferi* (Möllendorff, 1897)					✓								18
16	*G. hungerfordiana* (Möllendorff, 1891)				✓									12, 19, 20
17	*G. khaochakan* Panha & Burch, 2003									✓				2, 13
18	*G. khaochongensis* Panha, 1997												✓	2, 21
19	*G. khaowongensis* (Panha, 1998)										✓			2, 27
20	*G. khaowongkot* Panha & Burch, 2004										✓			2, 22
21	*G. kohrin* Panha & Burch, 2003									✓				2, 13
22	*G. luctans* van Benthem Jutting, 1950				✓									12, 19

No.	Species name	Distribution												References
		Myanmar	Laos	Vietnam	Malaysia	Indonesia	Philippines	Thailand						
								North	Northeast	East	Central	West	South	
23	*G. modesta* van Benthem Jutting, 1950				✓									12, 19
24	*G. muaklekensis* (Panha & Burch, 2002)										✓			2, 23
25	*G. muangon* Panha & Burch, 2004							✓						2, 22
26	*G. phoca* Tongkerd & Panha. 2013												✓	24
27	*G. phupaman* (Panha & Burch, 2002)								✓					2, 25
28	*G. plesiolopa* Inkhavilay & Panha, 2016		✓											26
29	*G. saraburiensis* Panha & Burch, 2003										✓			2, 6
30	*G. sichang* (Panha & Burch, 2002)									✓				2, 25
31	*G. srirachaensis* Panha & Burch, 2004									✓				2, 22
32	*G. striolata* (Möllendorff, 1895)												✓	15, 24
33	*G. surakiti* Panha & Burch, 2003								✓					2, 13
34	*G. tarutao* (Panha & Burch, 2002)												✓	2, 23
35	*G. transitans helioscopia* van Benthem Jutting, 1950				✓									7, 12
36	*G. transitans transitans* (Möllendorff, 1894)												✓	1, 15, 24
37	*G. transitans venusta* van Benthem Jutting, 1950				✓									7, 12
38	*G. tridentatus* Panha & Burch, 2004									✓				2, 22
39	*G. troglodytes* van Benthem Jutting, 1950				✓									7, 12

References: 1 = Thompson & Upatham (1997), 2 = Panha & Burch (2005), 3 = Blanford (1863), 4 = Gude (1914), 5 = Pilsbry (1917a), 6 = Panha (1997a), 7 = van Benthem Jutting (1949), 8 = Inkhavilay et al. (2019), 9 = Möllendorff (1901a), 10 = Möllendorff (1901b), 11 = van Benthem Jutting (1950), 12 = Maassen (2001), 13 = Burch et al. (2003), 14 = Pilsbry (1917b), 15 = Vermeulen & Whitten (1998), 16 = Smith (1896), 17 = Rensch (1932), 18 = van Benthem Jutting (1952), 19 = van Benthem Jutting (1950), 20 = Möllendorff (1891), 21 = Panha (1997b), 22 = Panha et al. (2004), 23 = Panha & Burch (2002b), 24 = Tongkerd et al. (2013), 25 = Panha & Burch (2002a), 26 = Inkhavilay et al. (2016), 27 = Panha (1997c)

Table 2. Shell dimensions of the holotype of *Gyliotrachela cultura*, new species, compared with three measured paratype specimens.

Type specimens	SH (mm)	SW (mm)	AH (mm)	AW (mm)
Holotype (NHLRU011)	2.11	2.65	1.65	1.15
Paratype (NHLRU012)	2.25	2.80	1.70	1.25
Paratype (ZRCBUU0750)	2.20	2.65	1.45	1.20
Paratype (ZRCBUU0751)	2.15	2.50	1.50	1.12
Average±S.D.	2.18±0.60	2.65±0.12	1.56±1.12	1.18±0.06

Table 3. Comparative anatomy of genital system of *Gyliotrachela cultura*, new species, and *G. depressispira.*

Genital organs	Characteristics	
	***Gyliotrachela cultura*, new species**	***Gyliotrachela depressispira***
Penis	Cylindrical and large	Bears corrugations
Penial sheath	No penial sheath	No penial sheath
Epiphallic retractor caecum	Bulged and curved, attached to anterior portion of epiphallus	Not reported
Vas deferens	Long, slender tube, entering epiphallus apically	Loops forward and backward and enlarges somewhat before entering the upper end of the penis
Vagina and Free oviduct	Cylindrical, vagina shorter than free oviduct	Not reported
Gametolytic sac	Very long, anterior portion bulge and connected to vagina, central portion more slender and long, distal end bulged and curved	Very long, slender, bursa copulatrix is spherical in shape
Uterus	Very large, with very thin prostate gland	Not reported
Hermaphroditic duct	Loosely convolute	Lower region is swollen and highly convoluted, and in almost
Albumen gland	Yellowish and large	Not reported
Dart apparatus	Absent	Absent

microsculpture consisting of mesh-like, reticulated sculpture (Fig. 2B), 1¼ to 1½ whorls slowly and continually increasing in size to the teleoconch whorls (Fig. 2C, I). Teleoconch 3 to 3½ whorls. Spire conical with rounded upper whorls; last whorl largest, and bluntly keeled at the periphery. Surface covered with fine mesh-like reticulated sculpture composed of even spiral striae crossed by uneven oblique growth lines (Fig. 2A, E). Suture deeply impressed. Aperture irregularly rounded. Peristome free, continuous, broadly expanded. The microsculpture of apertural wall consists of dense and fine granules. There are five major barriers in the aperture, the parietal lamella, angular lamella, upper and lower palatal plica lamellae, and columellar lamella, which are high, narrow, and elongated. In addition, there are numerous smaller barriers, an infraparietal lamella, interpalatal plicae, two infrapalatal plicae, and subcolumellar lamellae. The angular lamella and the upper palatal plica are located on the inner rim of the peristome, while all other barriers are located rather deep in the aperture. All barrier surfaces are also granulose (Fig. 2F). Umbilicus is deep and widely open (Fig. 2D, J).

Radula morphology. Central tooth (C) small, unicuspid, triangular. Lateral teeth (L) irregularly bicuspid and consisting of a large internal cusp and shorter outer cusp. Five laterals are present on each side of central tooth; first tooth being largest, other teeth sequentially smaller, respectively. Eight marginal teeth (M) rather irregularly bicuspid; internal cusp larger than outer cusp. Radula formula: 8:5:1:5:8. See Fig. 3.

Genital system. Atrium (at) shorter than vagina. Penis (p) cylindrical and large, half the length of epiphallus, and without penial sheath. Epiphallus (e) connected to distal end of penis. Epiphallus shorter than vas deferens, anterior portion cylindrical shape and bulged, central portion more slender than anterior, posterior portion rather bulged. Epiphallic retractor caecum (erc) bulged and curved, attached to anterior portion of epiphallus. Penial retractor muscle (pr) slender and thin, connected with anterior portion of epiphallus. Vas deferens (vd) long, slender tube, entering epiphallus apically. Vagina (v) and free oviduct (fo) cylindrical; vagina shorter than free oviduct. Gametolytic sac (gs) very long, anterior portion bulged and connected to vagina, central portion

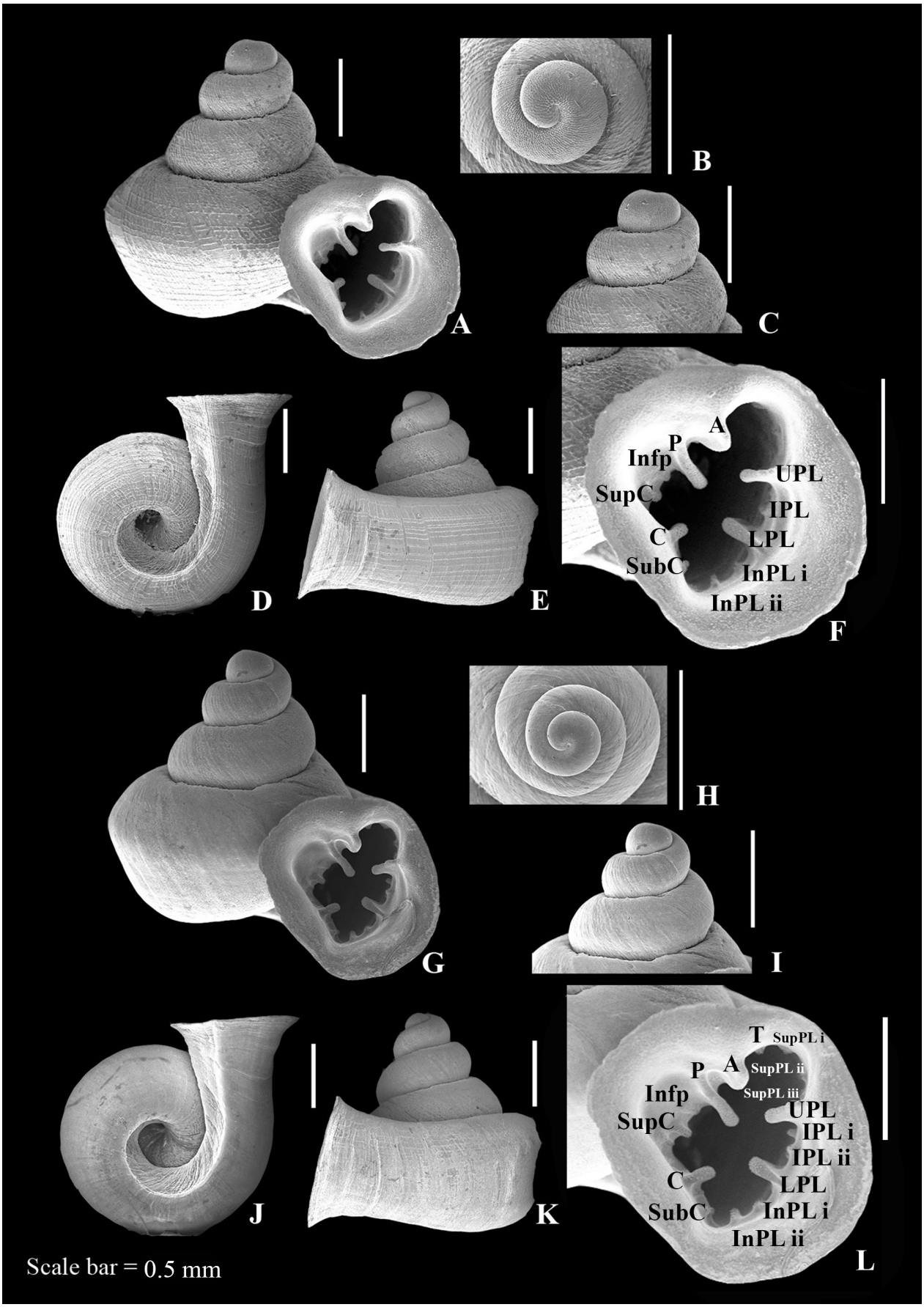

Fig. 2. *Gyliotrachela cultura*, new species. A–F, holotype (NHLRU011), apertural view (A), protoconch (B, C), basal view (D), lateral view (E), and apertural teeth detail (F). G–L, paratype (ZRCBUU 0750), apertural view (G), protoconch (H, I), basal view (J), lateral view (K), and apertural teeth detail (L). Abbreviations for apertural teeth: P = parietal lamella; A = angular lamella; T = twin; SupPL = suprapalatal plica; UPL = upper palatal plica; IPL = interpalatal plicae; LPL = lower palatal plica; InPL = infrapalatal plica; SubC = subcollumellar lamella; C = columellar lamella; SupC = supracolumellar plica; Infp = infraparietal lamella.

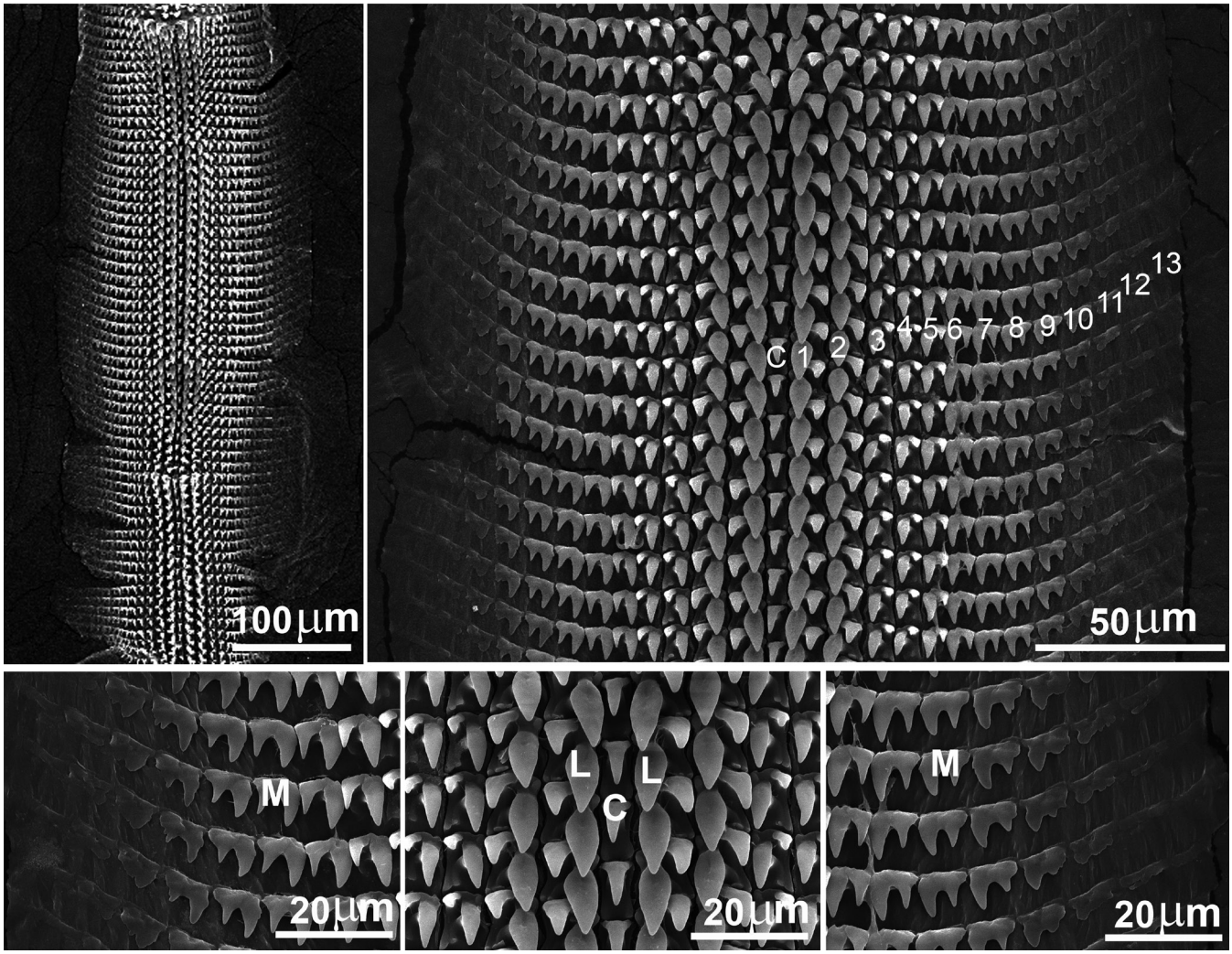

Fig. 3. Radula morphology of *Gyliotrachela cultura*, new species, paratype (NHLRU012). Abbreviations: C = central tooth; L = lateral teeth; M = marginal teeth.

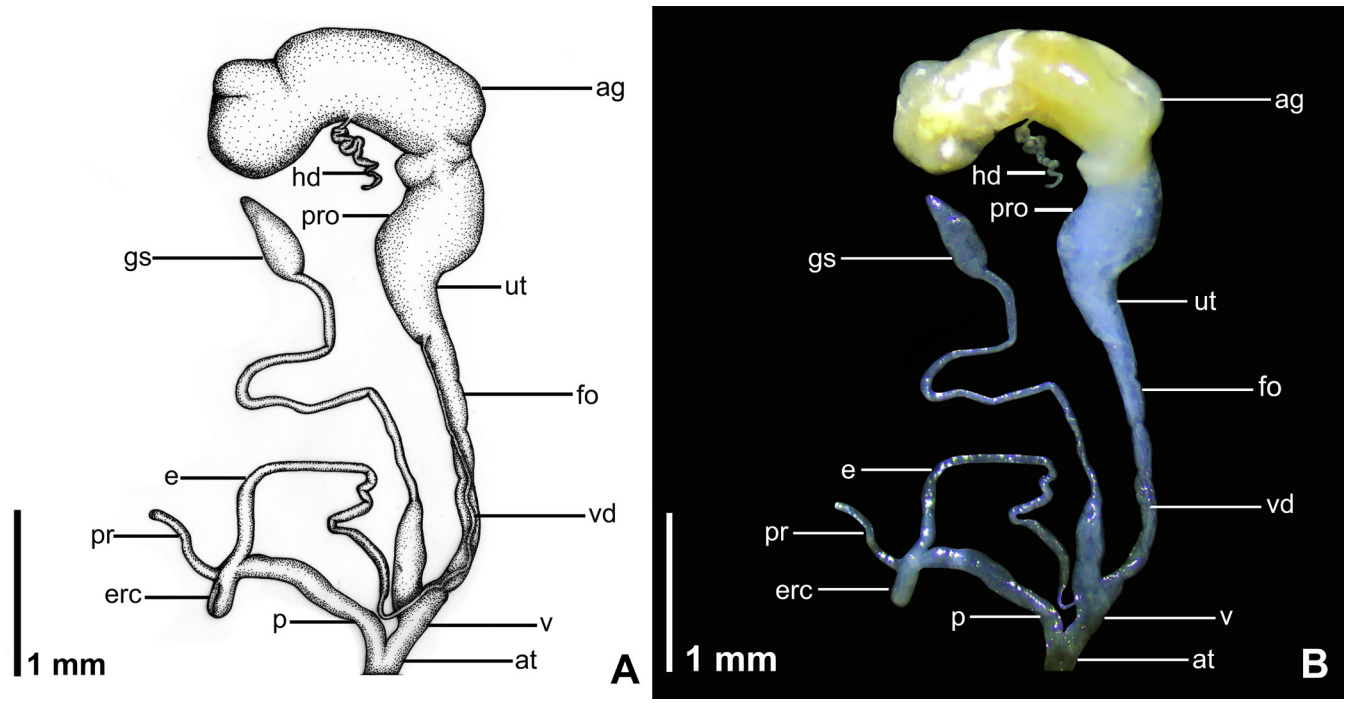

Fig. 4. Genital system of *Gyliotrachela cultura*, new species. A, schematic drawing of genital system; B, genital system (paratype, NHLRU012). Abbreviations: ag = albumin gland; at = atrium; e = epiphallus; erc = epiphallic retractor caecum; fo = free oviduct; hd = hermaphroditic duct; p = penis; pr = penial retractor muscle; pro = prostate; gs = gametolytic sac; ut = uterus; v = vagina; vd = vas deferens.

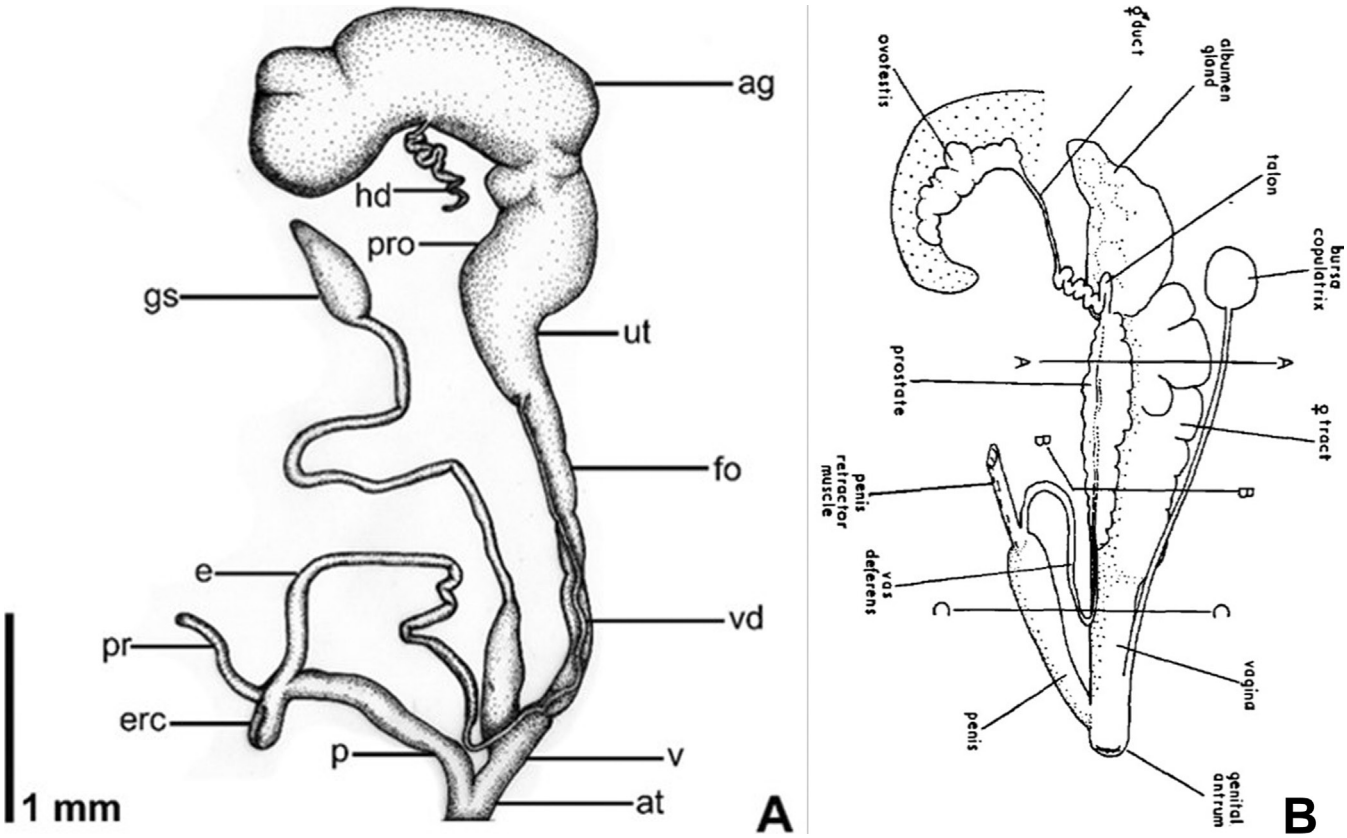

Fig. 5. Comparison of the genital systems of *Gyliotrachela cultura*, new species (A), and *Gyliotrachela depressispira* (B [after Berry, 1963]).

Fig. 6. Live *Gyliotrachela cultura*, new species, in situ.

more slender and long, distal end bulged and curved. The sac usually appears whitish in colour. Uterus (u) very large, with very thin prostate gland adhering to it. Hermaphroditic duct (hd) loosely convolute. Albumen gland (ag) yellowish and large. Dart apparatus absent. See Fig. 4.

Animal and ecology. Living animals have a cream-coloured body and foot, while the head and tentacles are dark grey, with black eyes located at the tip of the ocular tentacles (Fig. 6). Snails were found hanging on the wall or gliding on leaves or plant debris in the limestone hill.

Differential diagnosis. *Gyliotrachela cultura* is very similar in shell form to the central Thailand species, *G. saraburiensis*, but the two can be distinguished by the number and position of the apertural barriers. *Gyliotrachela cultura* has an infraparietal lamella, interpalatal plica, two infrapalatal plicae, and a subcolumellar lamella, while *G. saraburiensis* has three infraparietals, two supracolumellar, three subcolumellar, five infrapalatals, three interpalatals, five suprapalatals, two parallels, and an additional barrier that is located deeply between the parietal and angular lamellae.

Type locality. Agricultural areas in Mueang Loei District, Loei Province, Thailand.

Etymology. The specific epithet "*cultura*" refers to agriculture, where this new species was discovered.

Distribution. Only known from the type locality thus far.

DISCUSSION

Gyliotrachela cultura, new species, is the third species of the genus reported from northeastern Thailand. The other two northeastern species, namely *G. phuphaman* and *G. surakiti*, are completely different in shell morphology, and in particular their shell shape and apertural barriers. *Gyliotrachela cultura* closely resembles *G. saraburiensis* from central Thailand in shell shape, but differs in their apertural barriers and geographic distribution. The latter seems to be limited to central Thailand (Panha & Burch, 2005), while this new species appears to be limited to northeastern Thailand. Some variation was observed for the shell surface of *G. cultura*, such as the nearly smooth protoconch and lack of reticulated sculpture of the teleoconch (Fig. 2B, C, H, I), which may have been caused by weathering or erosion of the shell surface. Variations in the small barriers of the aperture was also observed, and some specimens having three suprapalatal and two interpalatal plicae instead.

The genital system of *G. depressispira* van Benthem Jutting, 1949, from a limestone area in Bukit Chintamani, Pahang, Malaysia, reported by Berry (1963) shows some similarity to *G. cultura*, but some characteristics of that species such as shape of penis, gametolytic sac, and the presence of epiphallic retractor caecum differ (Table 3 and Fig. 5). However, anatomical data from other congeneric species are non-existent and would be needed to fill in the knowledge gaps in this group.

Incidentally, the general shape of the radula teeth of *G. cultura* is very similar to that of the genus *Aulacospira* Möllendorff, 1890, but their formulae are different; 8:5:1:5:8 in *G. cultura* versus 7–8:4:1:4:7–8 in *Aulacospira* spp. (see Dumrongrojwattana & Tanmuangpak, 2020). Compared with the genital system of *Aulacospira* spp., *G. cultura* has a more cylindrical-shaped penis, which is relatively shorter and smaller, and the epiphallus is more elongated with a cylindrical shape.

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