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Notes on *Pseudopomatias* Möllendorff, 1885 and *Vargapupa* Páll-Gergely, 2015 (Gastropoda: Caenogastropoda: Pupinidae)

Barna Páll-Gergely[1*] & Jozef Grego[2]

Abstract. *Pseudopomatias phrunoi*, new species is described from Myanmar's Kayah State. It is characterised by a slender shell, strongly reflected peristome and three short internal plicae, situated circa half whorl behind the aperture. *Vargapupa biheli viridis*, new subspecies is described from Xianghouang Province, Laos, and characterised by weaker periumbilical keel than the nominotypical subspecies. *Pseudopomatias amoenus* Möllendorff, 1885 is reported for the first time from Laos, and *Pseudopomatias caligosus* Páll-Gergely & Hunyadi, 2018 from Myanmar. *Vargapupa huberi* Thach, 2018 is moved to the synonymy of *Vargapupa oharai* Páll-Gergely in Páll-Gergely et al., 2015.

Key words. systematics, taxonomy, new species, new subspecies, new synonym

INTRODUCTION

The pupinid genus *Pseudopomatias* Möllendorff, 1885 has a high conical or spindle-shaped, regularly ribbed shell, which can be considered plesiomorphic among high-spired terrestrial caenogastropods. The present day *Pseudopomatias* is possibly the oldest known pupinid genus as its morphology is very similar to the recent record of two *Pseudopomatias*(?) species found in 99 million years old Burmese amber (Neubauer et al., 2019).

Pseudopomatias Möllendorff, 1885 is distributed in Asia from the southern Himalaya region to Taiwan. The southernmost species of this genus inhabit the Arakan Mountains in Myanmar, northern Thailand, northern Laos, and northern Vietnam (Páll-Gergely et al., 2015). Three genera are considered closely related based on similar shell shape: *Csomapupa* Páll-Gergely in Páll-Gergely et al., 2015 and *Nodopomatias* Gude, 1921 from the south-eastern Himalaya, and *Vargapupa* Páll-Gergely in Páll-Gergely et al., 2015 from the southern part of northern Vietnam and northern Laos (Páll-Gergely et al., 2015; Páll-Gergely, 2016; Páll-Gergely & Hunyadi, 2018). *Nodopomatias* and *Vargapupa* differ from *Pseudopomatias* by the presence of a periumbilical keel, whereas *Csomapupa* has a more expanded peristome than *Pseudopomatias* and possesses a shallow groove above the suture.

The revision of *Pseudopomatias* and its relatives (Páll-Gergely et al., 2015) revealed that the centre of diversity of these groups is the south-eastern Himalaya region and northern Vietnam. On the other hand, only very few samples are found in China's Guangxi province, which is a centre of diversity of many land snail genera. Furthermore, in spite of intensive collection efforts at the end of 19th century, only few samples have been collected in Myanmar. Although operculate land snails exhibit high levels of endemism compared with pulmonates because of their smaller dispersal abilities (Schilthuizen et al., 2002), two *Pseudopomatias* species were found to inhabit as wide ranges as 1,200 km.

In this paper we describe a new *Pseudopomatias* species from Myanmar, and new *Vargapupa* subspecies from Laos. Furthermore, we report *P. caligosus* Páll-Gergely & Hunyadi, 2018 (originally described from Thailand) from Myanmar for the fist time, and synonymise *Vargapupa huberi* Thach, 2018 with *V. oharai* Páll-Gergely in Páll-Gergely et al., 2015.

MATERIAL AND METHODS

The counting of the shell whorls (to the closest 0.25 whorl) follows Kerney & Cameron (1979: 13). Photographs were taken using a Keyence LHX5000 digital microscope. 10–30 photos were taken of each shell, and merged to create a single image using Photoshop. Measurements were taken using a digital Vernier Calliper.

Abbreviations.
D: Shell diameter
H: Shell height
HNHM: Hungarian Natural History Museum, Budapest, Hungary
JG: Collection Jozef Grego, Banská Bystrica, Slovakia

[1]Plant Protection Institute, Centre for Agricultural Research, Herman Ottó Street 15, Budapest H-1022, Hungary; Email: pall-gergely.barna@agrar.mta.hu, pallgergely2@gmail.com (*corresponding author)

[2]Horná Mičiná, SK-97401 Banská Bystrica, Slovakia

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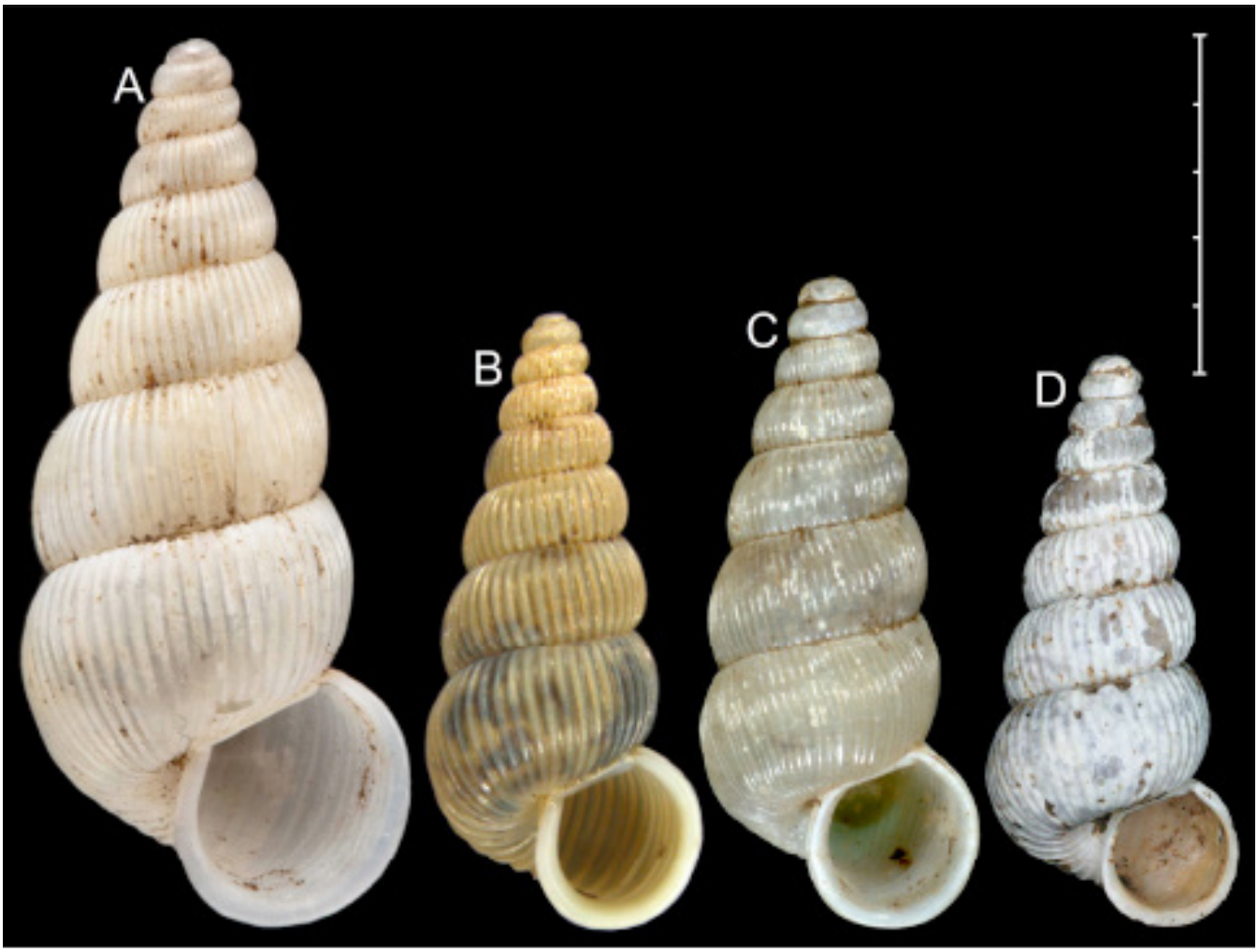

Fig. 1. *Pseudopomatias amoenus* Möllendorff, 1885. A, Tonkin, Muong Hum, probably leg. Messager, NHMUK 1910.1.21.4–6; B, Tonkin, Muong-Hum, between Muong-Hum and the clouds pass, near the latter one, more than 2000 m a.s.l., leg. Messager, MNHN 2012-26995; C, lectotype of *P. amoenus*, SMF 40296; D, specimen from Laos. Scale bar represents 5 mm. Photos: S. Hof (C); B. Páll-Gergely (B, D); H. Taylor (A).

MNHN: Muséum National d'Histoire Naturelle, Paris, France
NHMUK: The Natural History Museum, London, UK
SMF: Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt am Main, Germany
ZRC: Zoological Reference Collection of the Lee Kong Chian Natural History Museum, National University of Singapore

TAXONOMY AND SYSTEMATICS

Family Pupinidae L. Pfeiffer, 1853

Genus *Pseudopomatias* Möllendorff, 1885

Pseudopomatias Möllendorff, 1885: p. 164.

Type species. *Pseudopomatias amoenus* Möllendorff, 1885 by monotypy.

Pseudopomatias amoenus Möllendorff, 1885
(Fig. 1A–D)

Pseudopomatias amoenus Möllendorff, 1885: p. 164.
Pseudopomatias amoenus — Páll-Gergely et al., 2015: 30, figs 5B–D, 6C, 12A–J.

Material examined. 1 corroded shell (H: 8.7 mm), JG/1, Laos, Bolikhamsay prov., foot of isolated limestone hill adjacent to W slopes of Pha Gnotsan massif, Vangxouay Dam to Na Di road, ca 1 km before Na Di, 400 m a.s.l., 18°16.523′N, 104°42.821′E, coll. J. Grego, 18 February 2017.

Remarks. A single, corroded shell of this species was collected in Bolikhamsay Province, which represents the first record of this widespread species in Laos. So far it was known in northern Vietnam, and the Chinese provinces of Yunnan, Sichuan, Chongqing, Hunan, Hubei, and Guangdong (Páll-Gergely et al., 2015). This is a very variable species (Fig. 1A–D), but can be recognised based on the aperture shape (straight parietal part, smoothly angled columellar-parietal transition and sharply angled parietal-palatal transition), the regular ribbing and the turriform shell shape.

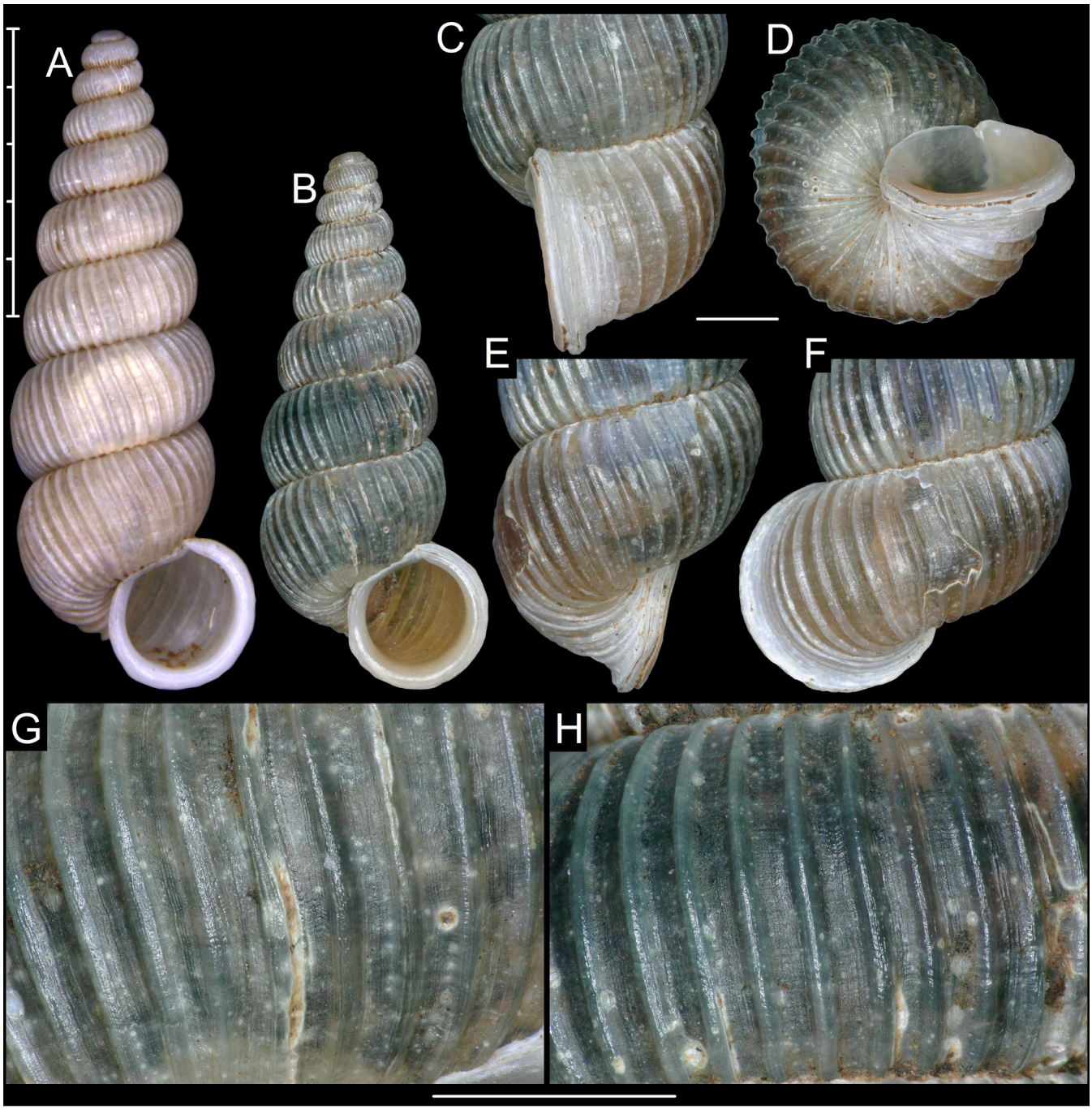

Fig. 2. A, *Pseudopomatias caligosus* Páll-Gergely & Hunyadi, 2018 (holotype from Thailand, HNHM 100176); B–H: *Pseudopomatias caligosus* (specimen from Myanmar). B, entire shell from apertural view; C–F, body whorl from different views; G, sculpture of body whorl from apertural view; H, sculpture of penultimate whorl from apertural view. Scale next to A represents 5 mm, and refers to figs A and B; other two scales represent 1 mm. All photos: B. Páll-Gergely.

Pseudopomatias caligosus Páll-Gergely & Hunyadi, 2018
(Fig. 2A–H)

Pseudopomatias caligosus Páll-Gergely & Hunyadi, 2018: 64, fig. 3.

Material examined. One adult and a juvenile shell, JG/1, Myanmar, Kayah State, Demoso, 36 km west towards Taungoo, 169.5 km milestone, 19°34.660′N, 96°59.845′E, coll. Jozef Grego, 17 May 2019.

Remarks. This species was described from Thailand's Mae Hong Son Province, which is situated ca. 125 km from the new locality. The only notable difference between the adult shell from Myanmar and the type series is that the latter ones have a more reflected outer peristome, and a paler colour. More specimens would be necessary to see whether the differences are stable between the two known populations. However, at the moment, due to general similarity in shell shape, size and sculpture and aperture shape, we consider the specimens from Myanmar conspecific with the Thai *P. caligosus*.

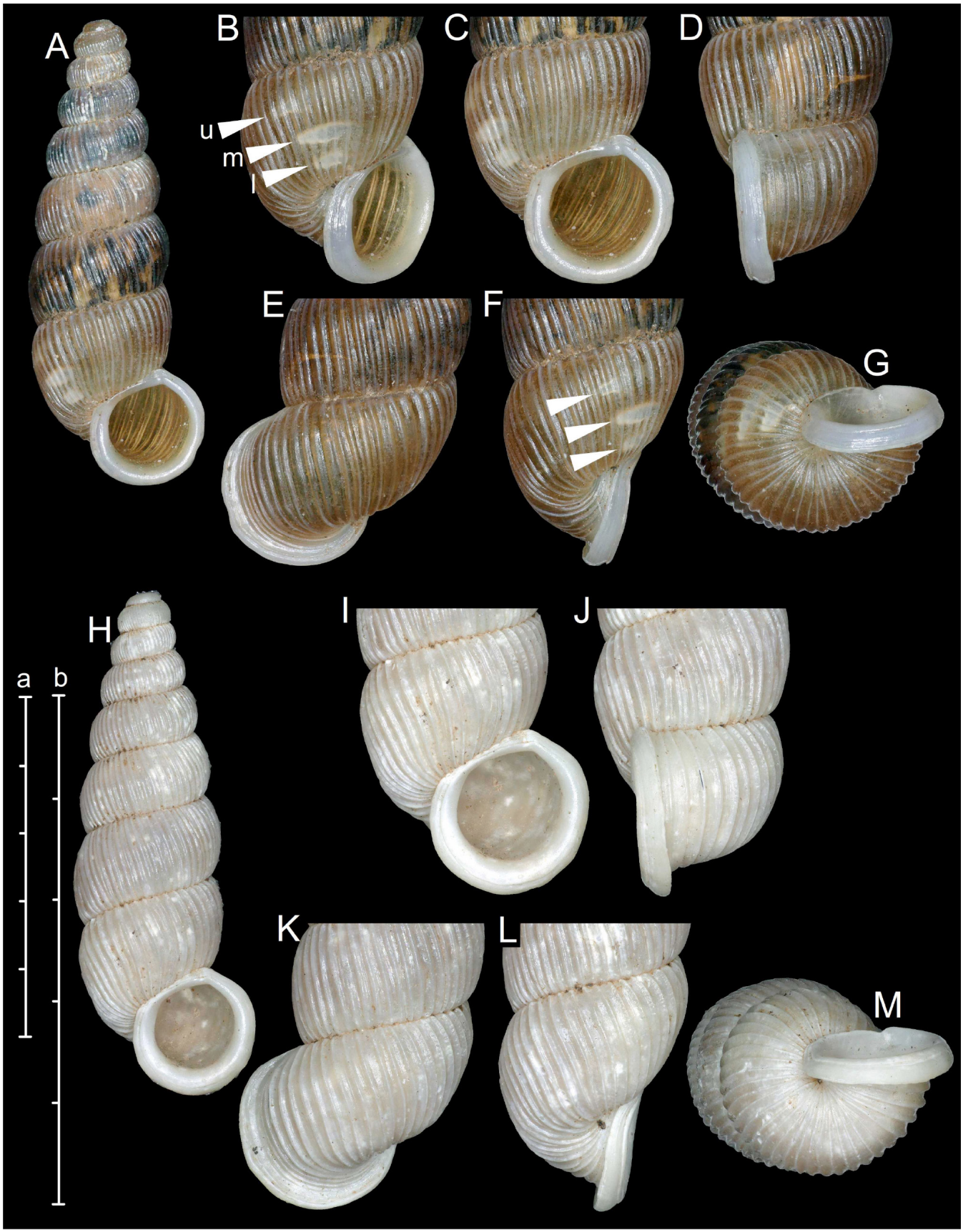

Fig. 3. *Pseudopomatias phrunoi*, new species. A–G, holotype (HNHM 104396); H–M, paratype (HNHM 104398a). Arrows show the inner plicae. Abbreviations: l: lower plica; m: middle plica; u: upper plica. Scale 'a' refers to images of the whole shell, scale 'b' refers to images of the body whorl, both scales represent 5 mm. All photos: B. Páll-Gergely.

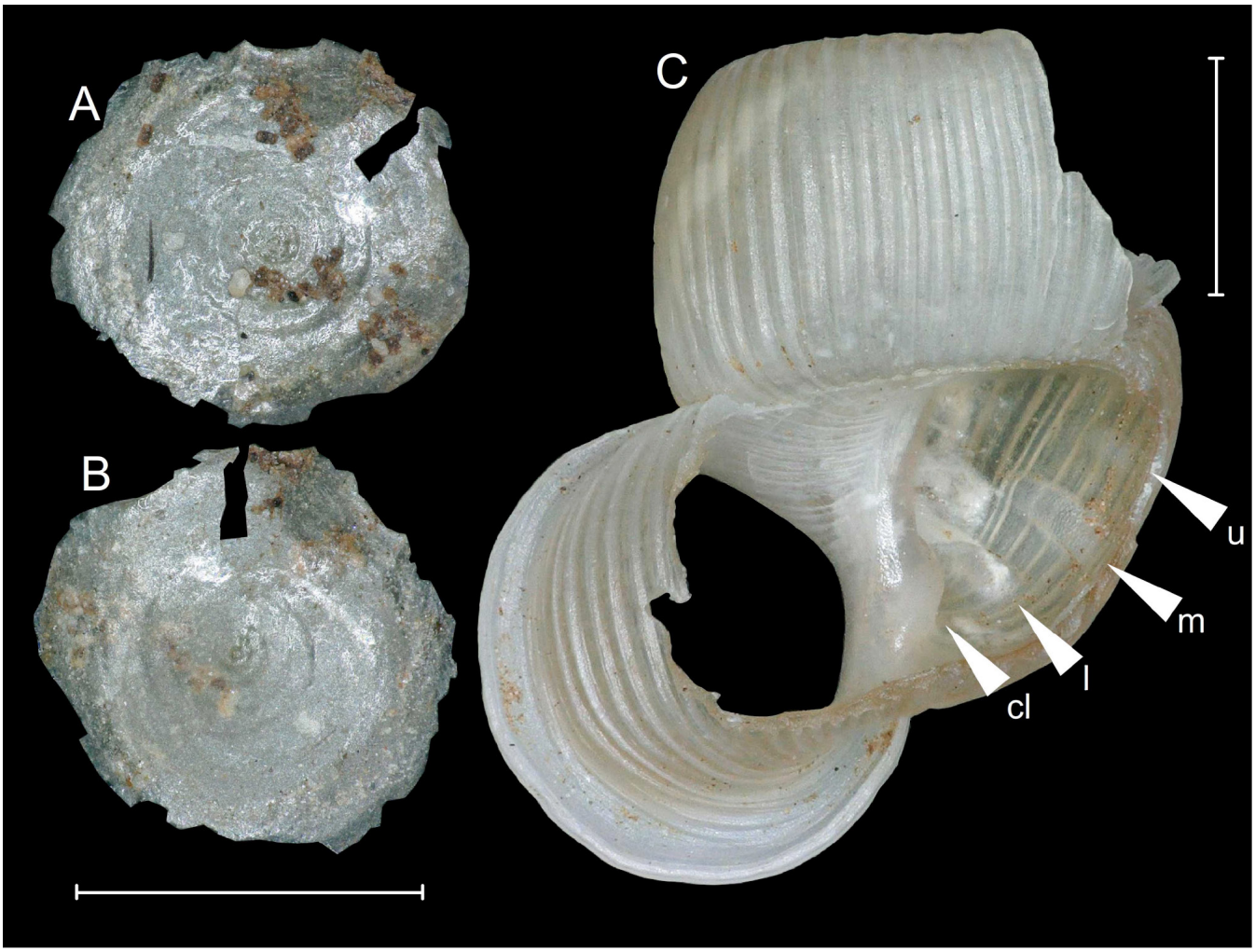

Fig. 4. Outer (A) and inner (B) side of the operculum and plicae (C) of *Pseudopomatias phrunoi*, new species Abbreviations: cl: columellar lamella; l: lower plica; m: middle plica; u: upper plica. Specimen A–B, HNHM 104398b; C, HNHM 104398b. Scale bars represent 1 mm.

***Pseudopomatias phrunoi*, new species**
(Figs. 3, 4)

Type material. Holotype (H: 7.1 mm, D: 2.6 mm, Figs 3A–G) (HNHM 104396), Myanmar, Kayah State, Hpruso distr., Maw Thi Do Village, Entrance of Phruno River Cave, 19°22.744′N, 97°2.570′E, coll. J. Grego, 12 December 2019; figured paratype (HNHM 104398a, Figs 3H–M), same data as holotype; figured operculum, paratype (HNHM 104398b, Figs 4A–B) same data as holotype; figured paratype (HNHM 104398b, Fig. 4C) same data as holotype; 2 paratypes (SMF 356926), same data as holotype; 2 paratypes (NHMUK 20190574), same data as holotype; 1 paratype (ZRC.MOL.015632), same data as holotype; 13 paratypes (JG/13), 8 juvenile shells (not paratypes, JG/8), same data as holotype; 9 paratypes (JG/9), Myanmar, Kayah State, Hpruso distr., Maw Thi Do, road towards Han Li Village, Rocks above bridge over Phruno River, 19°23.011′N, 97°2.108′E, coll. J. Grego, 12 December 2019; 9 juvenile shells (not paratypes, JG/9), same data as preceding; 4 paratypes (JG/4), Myanmar, Kayah State, Hpruso distr., Maw Thi Do, road towards Han Li Village, under bridge over Phruno River, 19°22.966′N, 97°2.153′E, leg. J. Grego, 12 December 2019; 3 juvenile shells (not paratypes, JG/3), same data as preceding.

Diagnosis. A small to medium sized, brownish, slender turriform-spindle shaped species with strong ribs, strongly reflexed peristome and plicae half whorl behind the peristome.

Description. Shell yellowish corneous to reddish brown, slender turriform to slightly spindle-shaped, last two whorls are widest in apertural view; body whorl not exactly rounded but slightly flattened (most clearly visible from lateral view, Fig. 3D, 3J); whorls 8.5–9.75, moderately bulging; boundary between protoconch and teleoconch hardly discernible, supposed size of protoconch ca. 2 whorls; first half whorl of protoconch smooth, all other whorls of protoconch and teleoconch regularly ribbed (even behind peristome); ribs blunt, triangular in cross section, no additional fine surface structure visible; aperture rounded with smooth (not angled) columellar-parietal and slightly angled parietal-palatal transitions; peristome white, strongly reflected, consisting of a thinner, slightly protruding inner peristome and a thicker and reflected outer peristome; boundary between inner and outer peristomes relatively clearly visible (e.g., Fig. 3F, 3L); parietal callus well developed, but slimmer than other parts of peristome; three short plicae situated approximately half whorl behind peristome (ca. above the umbilicus) (Figs. 3B, 3F, 4C); lowest two plicae positioned equally deep in

the spire (measured by the radial ribs on the outside of the shell), upper one situated somewhat more anteriorly (i.e., closer to the aperture); lowest plica (the one situated closes to umbilicus) short, but elevated, middle one ca. twice as long as lowest one, also elevated; uppermost one weaker (less elevated than other two); plicae correspond with a low, blunt columellar lamella, which is visible only after opening the shell; operculum probably stops before (anterior to) plicae and lamella; umbilicus present, very slightly open, slit-like.

Operculum (Fig. 4A, B). A single operculum was found in an empty shell. It is thin, proteinaceous ("horny"), multispiral, inner surface (Fig. 4B) with a very small central nipple.

Measurements (in mm). H = 7.1–10.1, D = 2.7–3.2 (n = 5).

Differential diagnosis. *Pseudopomatias phrunoi*, new species differs from the nearby occurring *P. caligosus* by the more slender shell, the less bulging whorls, more expanded peristome, the lack of fine spiral striation between the ribs, and the presence of plicae approximately a half whorl behind the peristome. Internal plicae were reported in *P. reischuetzi* Páll-Gergely in Páll-Gergely et al., 2015 from the Naga Hills, India, *P. linanprietoae* Páll-Gergely in Páll-Gergely et al., 2015 from Laos, and *P. nitens* from China and Vietnam. *Pseudopomatias linanprietoae* is probably the most similar to *P. phrunoi*, new species due to its strongly reflected peristome, but it has a wider triangular shell than that of *P. phrunoi*, new species with more bulging whorls, the plicae are situated closer to the peristome (ca. quarter whorl behind), and are arranged differently. *Pseudopomatias reischuetzi* has a more corpulent shell, a peristome that is not reflected, and the palatal part of its aperture is very long and straight, resulting in a nearly triangular aperture shape. *Pseudopomatias nitens* has a wider shell, a comparatively larger aperture, and a not or only slightly reflected peristome.

Etymology. This species is named after the Phruno River, which flows near the known localities.

Genus *Vargapupa* Páll-Gergely in Páll-Gergely et al., 2015

Vargapupa Páll-Gergely in Páll-Gergely et al., 2015: p. 42.

Type species. *Vargapupa oharai* Páll-Gergely in Páll-Gergely et al., 2015, by original designation.

Vargapupa biheli Páll-Gergely in Páll-Gergely et al., 2015

Vargapupa biheli Páll-Gergely in Páll-Gergely et al., 2015: 42, fig. 8D.

Vargapupa biheli viridis, new subspecies
(Fig. 5A–L)

Type material. Holotype (H: 10.2 mm, D: 3.6 mm, Figs 5A–F) (HNHM 104398), Laos, Xianghouang prov., ca. 4 km SW of Ban Khong, cliffs foot above larger vertical cave, 1,230 m a.s.l., 19°22.670′N, 102°58.742′E, coll. J. Grego, 23 February 2017; figured paratype (HNHM 104399, Figs 5G–L), same data as for holotype; 2 paratypes (SMF 326927), same data as for holotype; 2 paratypes (NHMUK 20190575), same data as for holotype; 1 paratype (ZRC.MOL.015633), same data as for holotype; 47 paratypes (JG/47), same data as for holotype; 2 juvenile shells (not paratypes, JG/2), same data as for holotype; 1 paratype broken to two parts (JG/1), Laos, Xianghouang prov., Caverns among boulders at large sinkhole below small settlements (5 houses about 6 km SW of Bang Knong), 1,060 m a.s.l., 19°23.251′N, 102°58.498′E, coll. J. Grego, 23 February 2017.

Diagnosis. A subspecies of *Vargapupa biheli* with greenish shell colour and weaker periumbilical keel.

Measurements (in mm). H = 8.4–11, D = 3.4–3.7 (n = 7).

Differential diagnosis. *Vargapupa biheli viridis*, new subspecies differs from the nominotypical subspecies (Fig. 5M–Q) by the lower, slightly denser ribs and weaker keel. The keel of *Vargapupa biheli viridis* is less clearly visible from standard apertural view (i.e., more visible in *Vargapupa biheli biheli*), and it is overall less elevated, and less marked by deep sutures on both sides. Fresh shells of the new subspecies are semitransparent greenish. Although we had no possibility to examine fresh shells of the nominotypical subspecies, the reddish colouration of the apical whorls of some shells, such as the holotype, indicates that fresh shells might have a reddish brown colour.

The differences mentioned between *Vargapupa humilis* Páll-Gergely, 2016 and *V. biheli* are true to the new subspecies as well. These are the following: *Vargapupa biheli* has a much stronger keel, a slender triangular shell (rather spindle-shaped in *V. humilis*), a less oblique peristome to the shell axis and a somewhat rectangular aperture (nearly rounded, teardrop-shaped in *V. humilis*).

Remarks. We initially considered to handling the two subspecies as species in their own right. However, due to the similar size, shape and the lack of fresh specimens of *V. biheli biheli*, we rather keep the new taxon on a subspecific level.

Etymology. The name "viridis" refers to the greenish colour of fresh shells of the new subspecies.

Distribution. The new subspecies is known from two nearby sites, practically a single population in Xianghouang Province, Laos.

Vargapupa oharai Páll-Gergely, 2015
(Fig. 6A, B)

Vargapupa oharai Páll-Gergely in Páll-Gergely et al., 2015: 42, Fig. 8C.

Vargapupa huberi Thach, 2018: 22, figs 147–151, 153 (lower image) 154 (right image) **new synonym**

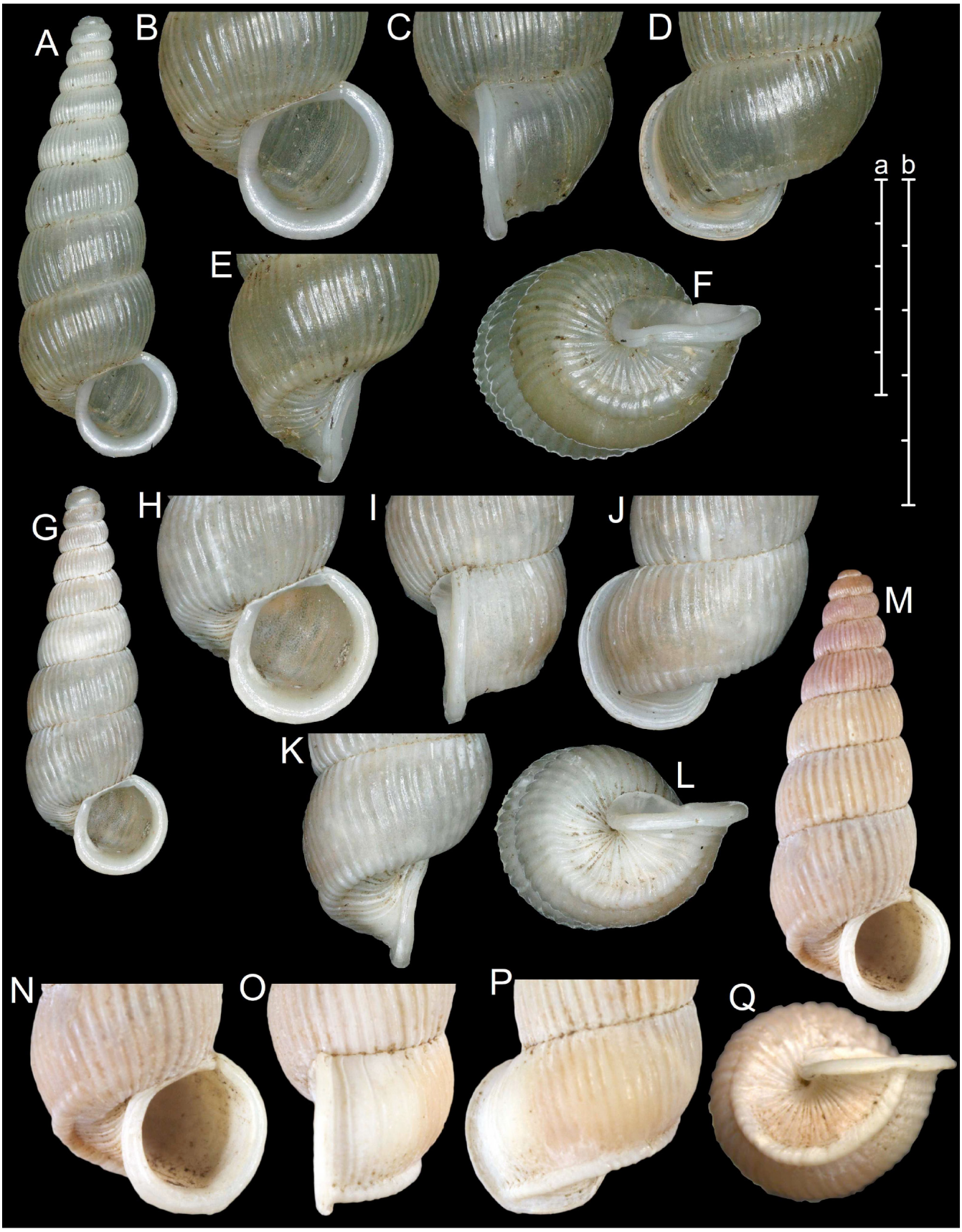

Fig. 5. A–F, *Vargapupa biheli viridis*, new subspecies (holotype, HNHM 104398); G–L, *Vargapupa biheli viridis*, new subspecies (paratype, HNHM 104399); M–Q, *Vargapupa biheli biheli* Páll-Gergely, 2015 (holotype, MNHN-IM-2012–27020). Scale 'a' refers to images of the whole shell, scale 'b' refers to images of the body whorl, both scales represent 5 mm.

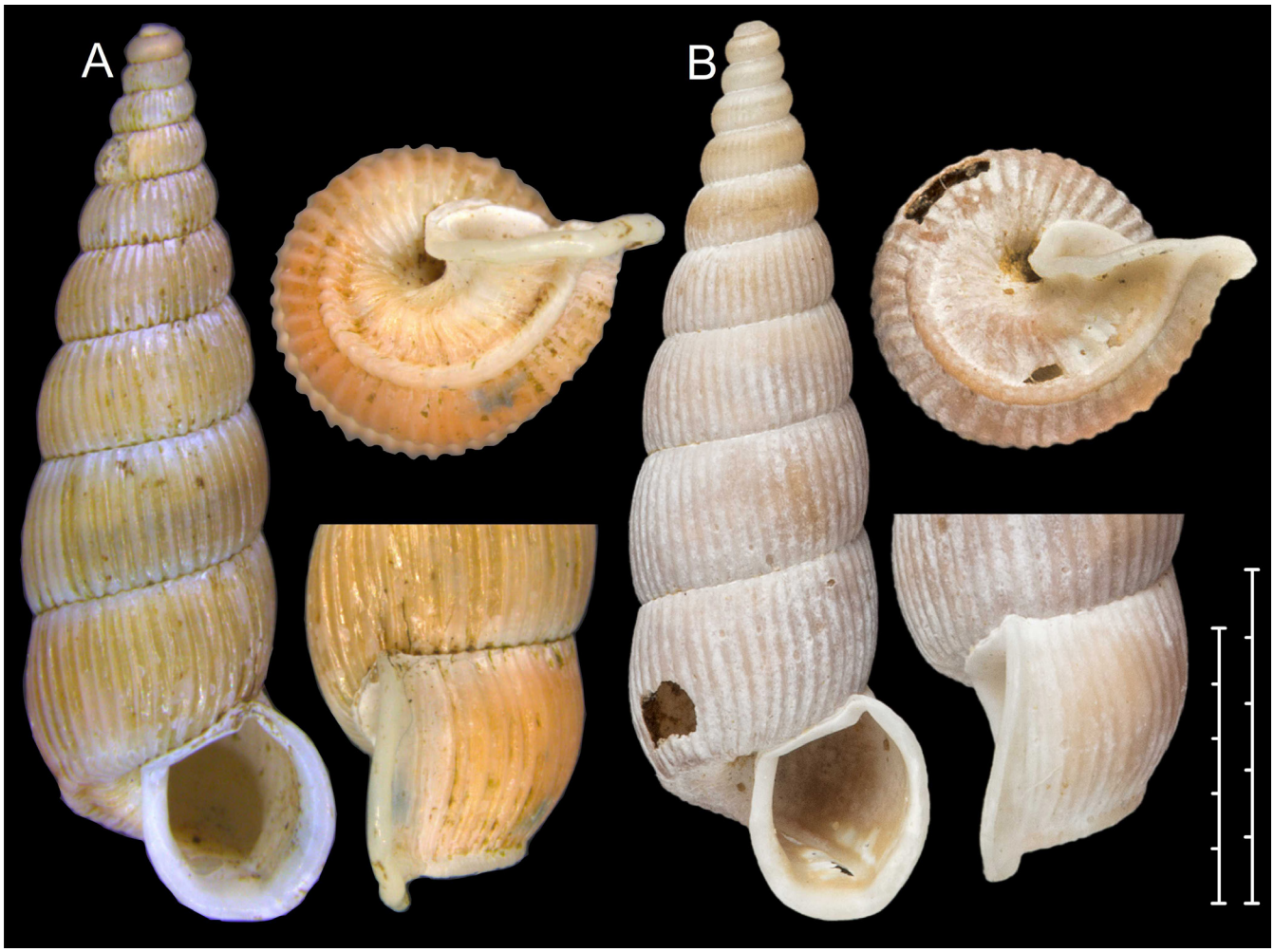

Fig. 6. *Vargapupa oharai* Páll-Gergely, 2015. A, Holotype (HNHM 98837); B, Holotype of *Vargapupa huberi* Thach, 2018 (NHMUK 20180251). Photos: A, B. Páll-Gergely; B, Kevin Webb (NHM). Scale bars = 5 mm; the smaller one refers to the photos of the whole shell, the larger one refers to the photos showing the lateral and basal side of the shells.

Remarks. The type series of *V. huberi* were collected in Vietnam's Ninh Binh Province, similarly to the ones of *V. oharai*. The differences given by Thach (2018) are the following: (1) The early whorls of *V. huberi* are more inflated and suture is more constricted than in *V. oharai*. To demonstrate this, Thach provides photos of the upper whorls of the two taxa. The differences are not visible on the two photos. Moreover, the image of *V. huberi* is more strongly enlarged than that of *V. oharai*, probably in order to support Thach's claim. Furthermore, the illustrated specimen of *V. huberi* seemingly has a groove, probably caused by a physical damage in early juvenile stage. Therefore, it does not seem to be suitable for comparison. Examination of the holotype of *V. huberi* revealed that the apical whorls are normally developed. Thus, the provided image (Thach, 2018: fig. 154 on page 98) are somehow modified and do not show the original condition of the shell. (2) The aperture deviates more to the right of shell axis in *V. huberi* than in *V. oharai*. Looking at the provided images, this statements also does not seem to be true. Moreover, none of the photos of *V. huberi* show the shell in the same orientation as *V. oharai*, and the photo of *V. oharai* (Thach, 2018: Fig. 152 therein), is compressed from apex to base compared to the original one (Páll-Gergely et al., 2015, Fig. 8C therein). (3) The outer lip of the aperture is more angulated, the umbilical area is broader, bordered by stronger and well visible keel (that is more exposed to frontal side). This, again, does not seem to be true based on the provided photos, at least not in a magnitude that would be meaningful for species distinction. Consequently, we regard *Vargapupa huberi* to be a synonym of *Vargapupa oharai* because no distinguishing characters can be detected between the two.

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