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TWO EXTRAORDINARY ALYCAEID SPECIES FROM NORTHEASTERN INDIA (GASTROPODA: CAENOGASTROPODA: CYCLOPHOROIDEA)

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Cycloryx pemaledai Gittenberger et Sherub, 2022, which was described from northwestern Bhutan, is reported for the first time in Sikkim, India. That species differs from all its congeners by the short R3 (the region between the constriction and the peristome). The differences between the Bhutanese and Indian shells are minimal, therefore the Indian shells are identified as *Cycloryx* cf. *pemaledai*. Furthermore, *Alycaeus himalayae* sp. n. is described from Arunachal Pradesh. This is so far the only *Alycaeus* species inhabiting the Himalayas, and thus, its discovery is a surprise.

Key words: new species, biogeography, taxonomy, shell, Himalaya

INTRODUCTION

The members of the family Alycaeidae are distributed from Southern India to Japan. The Himalayan region is one of the centres of their diversity in terms of the number of species and genera (Páll-Gergely *et al.* 2020, 2021). Investigation of Himalayan Alycaeidae started in the middle of the 19th century (Benson 1857, 1859), and became most intensive at the end of the 19th and the beginning of the 20th centuries (Godwin-Austen 1871, 1874, 1875, 1876, 1882–1920, Möllendorff 1897*a*), while recent investigation benefited from renewed biodiversity research in less explored regions of the world (Aravind & Páll-Gergely 2018).

In this paper, we report *Cycloryx pemaledai* Gittenberger et Sherub, 2022, from India (Sikkim), for the first time, which was originally described from Bhutan. Furthermore, we describe a new species of Alycaeidae, *Alycaeus himalayae* sp. n., from Arunachal Pradesh, India. The latter species is a surprise because all other known *Alycaeus* species are reported from Laos, Vietnam, southern Thailand and Peninsular Malaysia, making this discovery interesting from the geographical point of view.

MATERIAL AND METHODS

Shells were photographed via a Nikon SMZ25 digital microscope with Nikon Nis-Elements software. All shells were measured using a Keyence Digital microscope.

The counting of the shell whorls (to the closest 0.25 whorl) follows Kerney & Cameron (1979: 13). The sculpture of the body whorl along the sutural tube is always different from that of the other regions of the shell (Godwin-Austen 1882–1920), which is because of the presence of microtunnels running to the sutural tube (Páll-Gergely *et al.* 2016). Therefore, three regions of the teleoconch are distinguished following Páll-Gergely *et al.* (2017: fig. 1A, B): Region 1 (R1) – ranges from the beginning of the teleoconch to the beginning of the differently ribbed region where the sutural tube lies; Region 2 (R2) – extends from the differently ribbed area to the constriction; and Region 3 (R3) – ranges from the constriction to the peristome.

Comparisons of the two species discussed herein were mostly done in the NHM and partly using recent literature (Gittenberger *et al.* 2022).

Abbreviations: ATREE: collection of the Ashoka Trust for Research in Ecology and the Environment (Bangalore, India); D: shell width (diameter); H: shell height; NHM: The Natural History Museum (London, UK); ZSI/SRC: Zoological Survey of India, Southern Regional Centre (Chennai, India).

Superfamily Cyclophoroidea Gray, 1847

Cyclophoridae Gray, 1847: 181.

Family Alycaeidae W. T. Blanford, 1864

Alycaeinae W.T. Blanford, 1864: 465.
Alycaeinae – Godwin-Austen, 1886 (1882–1920): 186. (subfamily of Cyclophoridae); Bouchet & Rocroi 2005: 23, 248; Bouchet *et al.* 2017: 28, 340. (subfamily of Cyclophoridae)
Alycaeidae – Kobelt & Möllendorff, 1897: 146; Egorov 2013: 33.

Genus *Cycloryx* Godwin-Austen, 1914

Type species: *Cyclostoma constrictum* Benson, 1851, by original designation.

Remarks: The genera *Pincerna* (type species: *Alycaeus liratula* Preston, 1907) and *Cycloryx* Godwin-Austen, 1914 have been synonymized because of their similar conchological traits, such as the ovately conoid shells shape, the regular ribbing on the upper whorls and the short sutural tube (Páll-Gergely 2017), and this classification was followed in the genus-level revision of the Alycaeidae (Páll-Gergely *et al.* 2020). Later, Gittenberger *et al.* (2022) treated the Bhutanese species as *Cycloryx* based on our unpublished molecular data. The Chinese, Lao, and Vietnamese species are maintained as *Pincerna* until molecular data become available (Páll-Gergely 2023), but the Himalayan species certainly belong to *Cycloryx*.

Cycloryx cf. *pemaledai* Gittenberger et Sherub, 2022 (Fig. 1)

Cycloryx pemaledai Gittenberger et Sherub in Gittenberger *et al.*, 2022: 76, figs 2, 9.

Material examined: India, North Sikkim, 2 km north of Lachen, towards Gurudongmar Lake, 27.74487°N, 88.54439°E, altitude 2749 m a.s.l., leg. Aravind N.A., 27 November 2019, locality code: "SOIL-75 Sikkim (AR)" (2 shells, ATREE/2019/LS6001, ATREE/2019/LS6002).

Description of the Indian shells: Shell conical ovoid, yellowish-ochre, whorls 3.75–4, bulging, separated by a deep suture; protoconch consisting of ca. 1.5 whorls, finely granulate, with some faint spiral striae in Specimen2; R1 consisting of 2.1–2.25 whorls, finely, regularly ribbed, ribs thread-like, there are ca. 32 ribs on last half whorl of R1, rib density rather uniform on entire R1; area between ribs with extremely fine spiral striation except for the terminal ca. quarter whorl of R1, where spiral striae are replaced by a granular surface; R2 nearly smooth, with 10–14 breathing tunnels, spiral striation re-appears on

Fig. 1. *Cycloryx* cf. *pemaledai* Gittenberger et Sherub, 2022 from Sikkim, India (Specimen1). (Photos: B. Páll-Gergely)

R2 in Specimen1, but not in Specimen2; tube short, relatively thick; breathing tunnels are more closely spaced than ribs at the end of R1; transition between R1 and R2 visible due to change in rib morphology, and the slight change in rib density, but inconspicuous; transition between R2 and R3 indicated by a shallow constriction; R2 and R3 less than quarter whorl together, R2 slightly longer than R3; R3 shorter than that of any other *Cycloryx* species, with 4–5 thread-like ribs, R3 ribs similar in morphology to R1ribs, near the suture curved backwards; spiral striation nearly (but not entirely) absent on R3, there are some additional microscopic radial lines between the R3 ribs; aperture only slightly oblique to shell axis in lateral view, rounded; peristome very thin, inner peristome slightly expanded, outer peristome only visible as a reflected lobe above umbilicus; umbilicus open, rounded, very narrow, partly covered by lobe-like reflected outer peristome, but above and below the lobe is a narrow slit which makes umbilicus visible.

Measurements: H = 3.3–3.6 mm, D = 2.7–3 mm.

Operculum and anatomy: Unknown.

Differential diagnosis: Differs from all congeners by the shorter R3. Similarly high-spired species (*C. elegans*, *C. khungoensis*, *C. constrictus*, *C. costatus*) are smaller, and the only one which is similar in size (*C. tenellus*) is known from the Shan Hills and has different sculpture (initial whorls smooth, end of R1 with widely-spaced ribs).

Distribution and ecology: This species was described from northeastern Bhutan, and its current record from Sikkim is the first record for India. The distance between the two known localities is approximately 115 km in a straight line. The snails in India were collected from the soil and leaf litter samples from the slopes with lots of moss, dry litter and shrubs. The habitat is covered with *Rhododendron* shrubs along the slopes, at an altitude of ca. 2750 m a.s.l.

Remarks: Our specimens from Sikkim largely match with typical *Cycloryx pemaledai* described from northeastern Bhutan in terms of general shell shape (including the characteristically short R3 for this species) and rib density. However, based on the photos in the original description, the Indian shells are slightly wider with more rounded whorls. Nevertheless, we do not interpret these differences as sufficient for species-level distinction.

Genus *Alycaeus* Gray, 1850

Type species: *Cyclostoma gibbum* Eydoux, 1838 [= *Alycaeus eydouxi* Venmans, 1956]).

Remarks: Among the genera distributed in the Himalayas, it cannot be included in *Dicharax* Kobelt & Möllendorff, 1900 (type species: *Alycaeus hebes* Benson, 1857) because *Dicharax* species are mostly depressed (not conical) and nearly all species lack spiral striation (but there are exceptions, see e.g. Páll-Gergely *et al.* 2021). *Cycloryx* species are much smaller, with dominant radial sculpture and a very short R2. *Metalycaeus* Pilsbry, 1900 (type species: *Alycaeus melanopoma* Pilsbry, 1900 = *Alycaeus nipponensis* Reinhardt, 1877) species are

characterized by a spirally striated protoconch. The only possible candidate would be *Chamalycaeus* Möllendorff, 1897b (type species: *Alycaeus fruhstorferi* Möllendorff, 1897*b*), which also lack spiral striation on the protoconch, but *Chamalycaeus* species are usually not conical, are mostly whitish, and possess stronger radial sculpture.

Based on the general shell and aperture shape and the long R2, this new species fits perfectly in the genus *Alycaeus*. Nevertheless, *Alycaeus* species are only known from southern Thailand, Peninsular Malaysia, northern and central Laos and northern and central Vietnam (Páll-Gergely *et al*. 2020, Páll-Gergely 2023). *Pincerna mouhoti* (L. Pfeiffer, 1862) and *Pincerna vanbuensis* (Bavay et Dautzenberg, 1900), inhabiting northern Laos and northern Vietnam (see Fig. 4), may belong to *Alycaeus*, but has been included in the genus *Pincerna* in the latest revision. Therefore, *A. himalayae* sp. n. is so far the westernmost distribution of the genus.

Alycaeus himalayae sp. n.

http://zoobank.org/B31A16F4-C4AB-4B0A-AFB7-3611293CFDCC

(Figs 2–3)

Material examined: India, Arunachal Pradesh, East Siang District, Yemsing, 28.136632°N, 95.012876°E, 514 m a.s.l., leg. N.A. Aravind & Surya Narayanan, 27 April 2022 (holotype ZSI/SRC LM 1045 + paratype in ethanol ZSI/SRC LM 1046). Holotype measurements: D: 7.4 mm, H: 6.1 mm.

Diagnosis: An *Alycaeus* species with light yellow colour, and a trumpet-like calcareous projection on the outer side of the operculum.

Description: Shell shape slightly concave conical, apex acute, colour light yellowish; whorls 5.25, rather regularly increasing with the exception of the last whorl, which dominates the appearance of the shell with its width; protoconch consisting of ca. 2 whorls, elevated, high-spire, finely granular (fig. 3D); R2 of ca. 2.75 whorls, its first ca. half whorl rather granular, but fine, irregular ribbing and even finer spiral striation also discernible; rib density increases towards end of R1, but on the last ca. 0.5–1 R1 whorl spiral striation nearly disappears; R2 inflated, with ca. 50 ribs; R2 ribs higher than R1 ones, and more conspicuous due to white breathing tunnels (Fig. 3C); R2+R3 approximately half whorl together, of comparable length, and are separated by a shallow constriction; R3 with a long central swelling; R3 sculpture is characterized by irregular, mostly fine radial growth lines (although there are some stronger ribs in the middle), no spiral striation visible; aperture strongly oblique to shell axis, peristome strongly expanded, boundary between inner and outer peristomes clearly visible under microscope (Fig. 3A); inner peristome not protruding, it is smeared onto reflected outer peristome; umbilicus rounded, relatively narrow, shows all whorls.

Measurements: H = 7.3–7.4 mm, D = 6.1 mm.

Operculum: Outer surface glossy, with an elevated, trumpet-like calcareous elevation in the middle. It is clearly visible that this trumpet-like projection is a result of the rolling of an elevated lamina, because the overlapping edges of the lamina are visible, and at their meeting point the trumpet is lower (Fig. 3B).

Differential diagnosis: This new species differs from all other Himalayan alycaeid species by the yellowish, conical shell. The most similar shell in the vicinity is *Stomacosmethis spratti* (Godwin-Austen, 1888) from Shan States, Myanmar, but it has a short sutural tube. *Alycaeus himalayae* sp. n. differs from all other *Alycaeus* species by the characteristic trumpet-like projection on the outer side of the operculum. Additional comparisons with other *Alycaeus* species are not necessary because each *Alycaeus* species have its own characteristic features that would distinguish it from this new species.

Etymology: The specific epithet himalayae refers to the Himalayan distribution of this species, which is a surprise as all other known *Alycaeus* so far reported from southeast Asia.

Fig. 2. Holotype of *Alycaeus himalayae* sp. n. (Photos: B. Páll-Gergely)

Distribution and ecology: This new species is known only from the type locality (Fig. 4). *Alycaeus himalayae* sp. n. was collected from the entrance of a small limestone cave next to the road from Yemsing to Pangi. The snails were found in the wet cave wall amongst mosses and dripping water. Along with *Alycaeus himalayae* sp. n., other alycaeids and ariophantids were found. The surrounding vegetation is an evergreen forest with a thick canopy cover.

Remarks: The characteristic calcareous trumpet-like projection on the operculum seems to be unique for this species, but similar elevated structures are known in the Alycaeidae. For example, *Stomacosmethis kuekenthali* (P. Sarasin et F. Sarasin, 1899) from Sulawesi and *S. porcilliferus* (Bollinger, 1918) from eastern Borneo have elevated, trumpet-like projections, but in those two

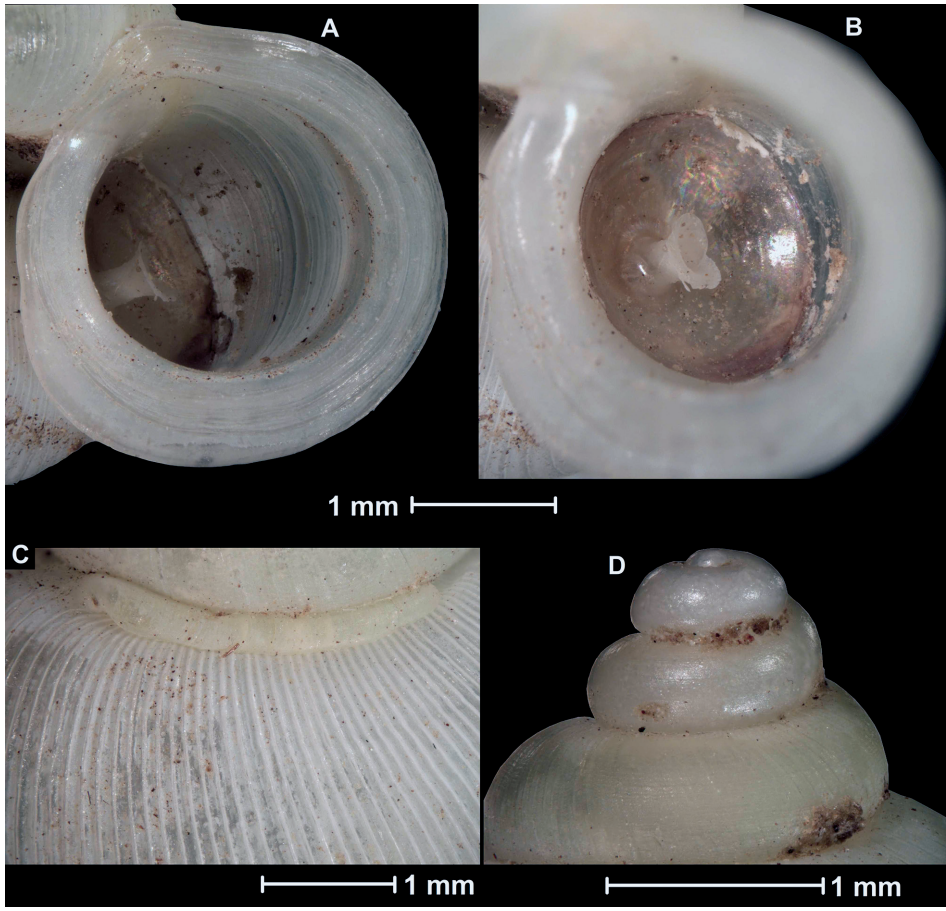

Fig. 3. Operculum (A, B), sculpture of R2 (C) and protoconch (D) of the holotype of *Alycaeus himalayae* sp. n. (Photos: B. Páll-Gergely)

species the edge of the trumpet is thickened and reflected, and they are seemingly not made of a single rolled lamina, while the edge of the trumpet is sharp and not reflected in the new species, and it is made of a single rolled lamina. Furthermore, *Dicharax bison* Páll-Gergely et Hunyadi, 2017 (described in Páll-Gergely *et al.* 2017) also has an elevated funnel-shaped projection on the outer side of the operculum, but it is clearly made of the multispiral outer lamina. It seems that the morphologically somewhat similar trumpet- or funnel-shaped projections on the outer side of the operculum of various alycaeid species are not homologous with each other, and probably developed multiple times during the evolution of this family.

DISCUSSION

The report of new species of *Alycaeus* from Arunachal Pradesh in India throws some very interesting biogeographic questions about the real extent of its distribution in south and southeast Asia. This also calls for further ex-

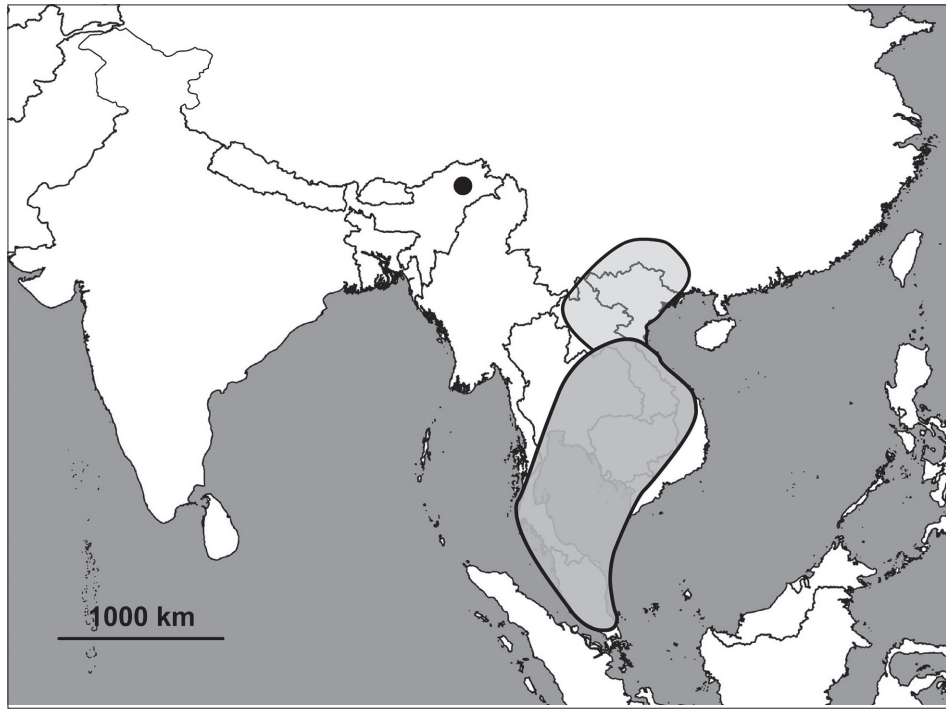

Fig. 4. Distribution of the genus *Alycaeus* Gray, 1850 (based on Páll-Gergely *et al.* 2020 and Páll-Gergely 2023). Dark grey area: *Alycaeus* s. str., Light grey area: distribution of *Pincerna mouhoti* (L. Pfeiffer, 1862) and *Pincerna vanbuensis* (Bavay et Dautzenberg, 1900), which may belong in *Alycaeus*. Black spot: Type locality of *Alycaeus himalayae* sp. n.

tensive field surveys in northeast India, which might yield many more such surprises. *Alycaeus himalayae* sp. n., was collected from a roadside limestone cave which needs to be protected and conserved.

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