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Redescription of *Acmella tersa* (Benson, 1853), the type species of *Acmella* W.T. Blanford, 1869 (Gastropoda: Assimineidae), from Meghalaya, Northeast India

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ABSTRACT

The type species of the assimineid genus *Acmella* W.T. Blanford, 1869 is *Cyclostoma tersum* Benson, 1853, originally described from ‘Musmai’ [Mawsmi], Meghalaya, Northeast India. No specimens from Benson’s type series can be traced, and contemporary shells collected from the type locality in museum collections are extremely worn. It has therefore been impossible to examine shell microsculpture, an important taxonomic character in the diagnosis of species of Assimineidae, using museum specimens. In order to provide better diagnostic characters for the genus *Acmella*, we redescribe and illustrate *Acmella tersa* from newly collected specimens, one of which is designated as the neotype. We also provide a list of all known species attributed to *Acmella*.

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KEYWORDS

Musmai; neotype; taxonomy; systematics

Introduction

The genus *Acmella* W.T. Blanford, 1869 (Caenogastropoda: Truncatelloidea: Assimineidae), has been reported from a large geographical area, ranging from northeastern India through the Andaman Islands and Borneo to the Philippines and Japan (Blanford 1869; Benthem Jutting 1963; Zilch 1967; Fukuda and Mitoki 1995; Vermeulen and Junau 2007; Vermeulen *et al.* 2015; Foon *et al.* 2017; Auffenberg and Páll-Gergely 2020; Páll-Gergely 2020). However, it has not been possible to compare putative *Acmella* species with the type species of the genus, *Cyclostoma tersum* Benson, 1853. Despite extensive searches in the University Museum of Zoology, Cambridge (UMZC), which holds the majority of Benson’s type material, and the Natural History Museum (NHM), London, the type series cannot be located (Preece *et al.* *in press*). A specimen in the ZSI (NZSI M.30156/7), labelled as a ‘type’, has no connection to Benson and cannot be considered part of the type series (Preece *et al.* *in press*). Contemporary reviews of the genus (e.g. Blanford 1869) were similarly unable to examine Benson’s type material, suggesting that it had been lost at an early stage. Blanford instead described fresh shells provided by H.H. Godwin-Austen, which he identified as *Acicula (Acmella) tersa*. The identity of *Acmella tersa*, and the status of *Acmella*, have therefore been uncertain for over 150 years. Recent investigations in the vicinity of the type

locality resulted in the rediscovery of the species, which is here redescribed, providing a stronger basis for the recognition of *Acmella tersa* as a valid species and *Acmella* as a genus.

Materials and methods

Collection site

Specimens were collected from Mawsmi Cave (25.245°N, 91.72405°E), located approximately 6 km south of Cherrapunjee in the East Khasi Hills District of Meghalaya State, Northeast India (Figure 1). Meghalaya shares an international border with Bangladesh to the south and has Assam to the west and north. The cave is part of an extensive network of around 1580 natural limestone caves in the Meghalaya region. Some of these have also yielded assemblages of fossil molluscs dating back to the Miocene (Lyngdoh *et al.* 1999). A band of limestone interstratified with beds of sandstone extends along the southern and eastern border of the Meghalaya plateau (Harries *et al.* 2008). The limestone is not continuous, due to differential tectonic uplift, associated faults and deeply incised river valleys. The southern edge of Meghalaya is characterised by an extensive band of limestone extending approximately 200 km from east to west and 30 km wide (Harries *et al.* 2008). The vegetation immediately surrounding the cave is evergreen forest. The climate is subtropical and mild, with dry

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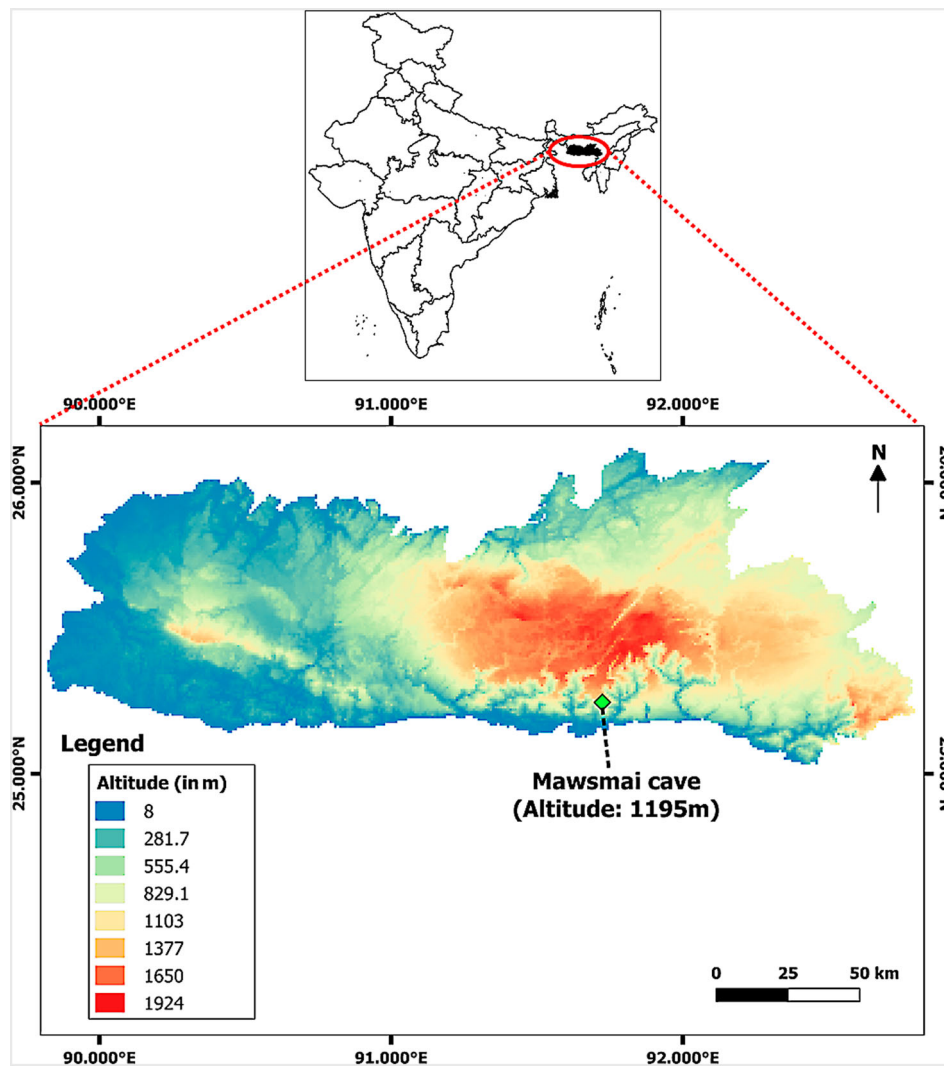


Figure 1. Map showing the location of Mawsmai cave in Meghalaya, northeastern India.

conditions prevailing outside of the May to October monsoon season, when torrential rains give rise to the highest recorded rainfall in the world (>11,000 mm per year). The coldest month is January.

The snails were collected from the walls of the cave by hand and were stored in vials for later identification. In the laboratory, the specimens were washed carefully with water to remove sediment from the shell and examined under a Nikon Stereo-microscope (SMZ1270). The images were taken using a Keyence Digital microscope (VHX-6000 series). The various shell measurements (Figure 2) were acquired using ImageJ (version 1.8.0_112).

Abbreviations

Institutional. ATREE: Ashoka Trust for Research in Ecology and the Environment (Bengaluru, India); NHM: the Natural History Museum (London, UK); NHMUK: when citing registered material deposited in the NHM; UMZC: University Museum of Zoology (Cambridge, UK), ZSI/WGRC: Zoological Survey of India,

Western Ghat Regional Centre (Kerala, India); NZSI: when citing registered material deposited in the ZSI.

Measurements. AA = Angle of aperture, AH = Aperture height, ApA = Aperture area, APWH = Antepenultimate whorl height, APWD = Antepenultimate whorl diameter without aperture, APWDA = Antepenultimate whorl diameter with aperture, AW = Aperture width, LWH = Last whorl height PrW = Protoconch width, PWH = Penultimate whorl height, PWD = Penultimate whorl diameter without aperture, PWDA = Penultimate whorl diameter with aperture, RI = Ribs inclination, SH = Shell height, SI = Suture Inclination, SpH = Spire height, SpW = Spire width, SW = Shell width, WSABW = Width of the suture above the body whorl, WSAPW = Width of the suture above the penultimate whorl, WSAAW = Width of the suture above the antepenultimate whorl.

Systematics

Family Assimineidae Adams & Adams, 1856
Subfamily Ekadantinae W.T. Blanford, 1869
Genus *Acmella* W.T. Blanford, 1869

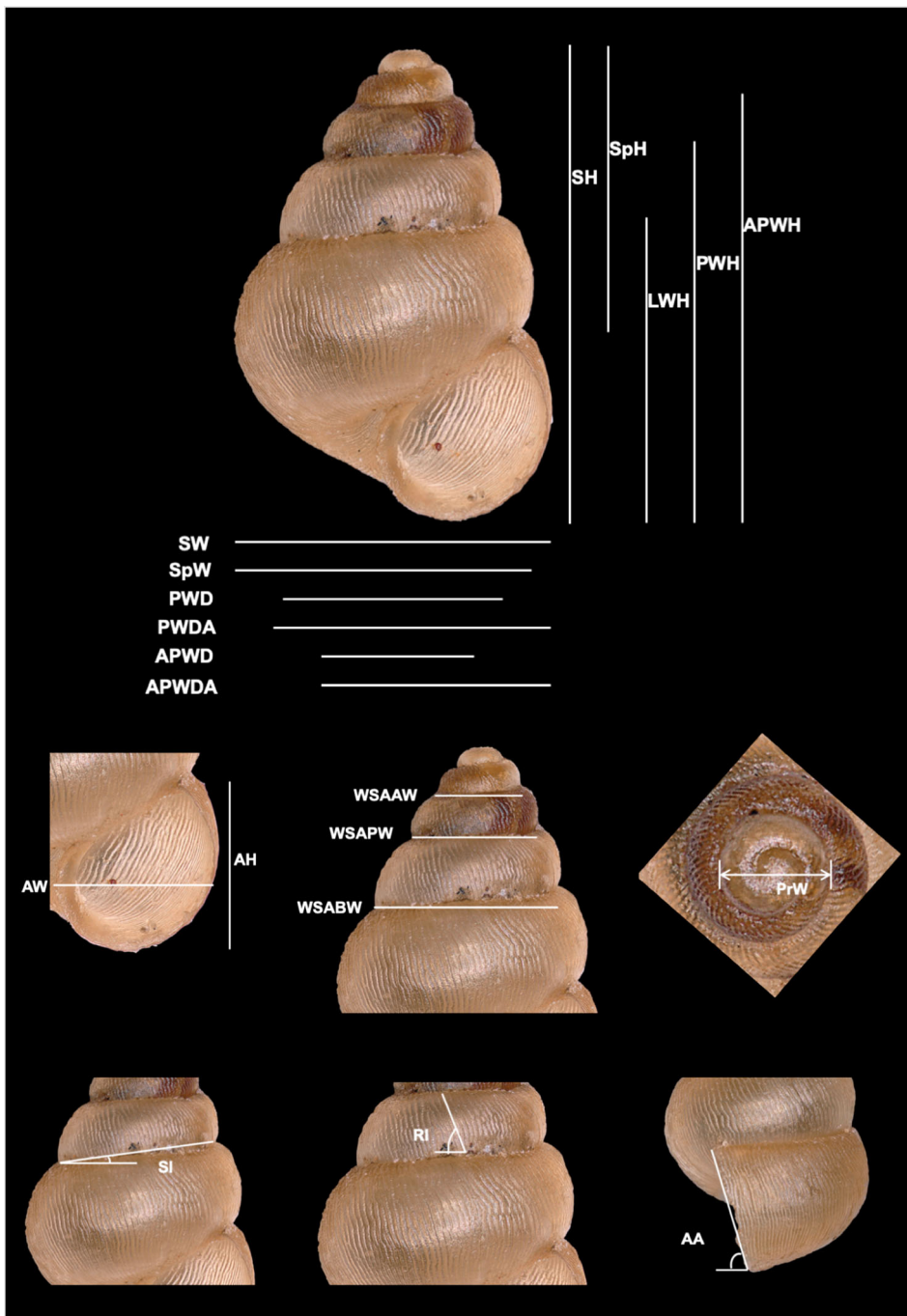


Figure 2. Shell measurements used in the description of the species.

Acicula (Acmella) W.T. Blanford, 1869: 178

Acmella.— W.T. Blanford, 1870: 370; Nevill 1878: 251; Vermeulen *et al.* 2015: 6.

Type species *Cyclostoma tersum* Benson, 1853 by monotypy

Remarks

A proper diagnosis of the genus can be only written following a full generic revision. Based on published literature, a review of the species hitherto included in *Acmella* shows that they are all minute and ovoid-conical in shape, but are very diverse in terms of

shell sculpture, and inhabit an enormously wide area from the Himalaya to the Philippines and Japan. This suggests that *Acmella* species as currently understood might belong to multiple genera. Due to the small size and morphologically rather simple shell, one of the most obvious differences between species is shell sculpture. Species with radial, converging ribs (e.g. '*Acmella* sp.' in Foon *et al.* 2017, and the group of *Acmella* with 'radial sculpture predominant' in Vermeulen *et al.* 2015) appear to be typical; the taxonomic status of all other species is in need of revision.

Acmella tersa (Benson, 1853)
(Figures 2, 3)

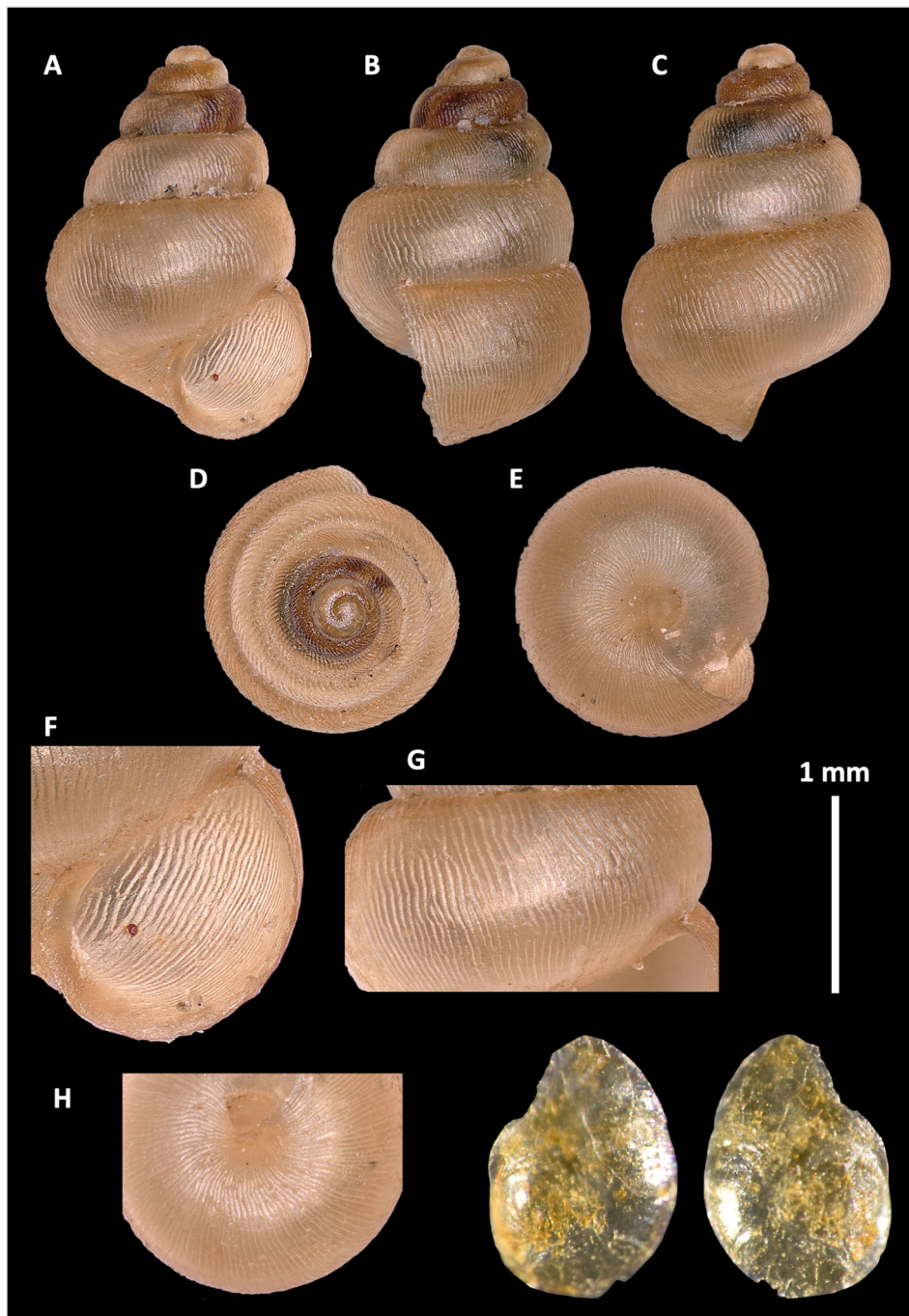


Figure 3. A–H: Neotype of *Acmella tersa* (Benson, 1853) from Mawsmai cave (ZSI/WGRC/I.RINV. 14959); I–J: operculum of another specimen from the same locality. Scale refers to parts A–E only.

Cyclostoma tersum Benson, 1853: 285

Cyclostomus? tersus.— Pfeiffer, 1854: 93

Hydrocena tersa.— Benson, 1856: 232; Pfeiffer 1858: 158

Acicula (Acmella) tersa.— Blanford, 1869: 178, pl. 16, fig. 2

Acmella tersa.— Theobald and Stoliczka 1872: 333; Hanley and Theobald 1874 [in 1870–1876]: 48, pl. 117, fig. 1; Nevill 1878: 251; Kobelt and Möllendorff, 1898: 153

Georissa tersa.— Pfeiffer, 1876: 292

Neotype. Mawsmai Cave, Meghalaya, India. 25.245°N, 91.72405°E, altitude 1195 m a.s.l., 4th August, 2018.

Leg. Nipu Kumar Das, N.A. Aravind and Anushree Jadhav (Specimen code A1, ZSI/WGRC/I.R-INV. 14959, Figure 3).

Material examined

Type material. See above. *Other material*. Same data as neotype, four additional specimens: (Specimen Code A2: ZSI/WGRC/I.R-INV. 15153, Specimen code A3: ZSI/WGRC/I.R-INV.15154, Specimen code A4: ATREE/LS/001, Specimen code A5: ATREE/LS/002); Khasi Hills, NZSI M.30156/7 (1 shell, labelled as 'type'); NHMUK 1888.12.4.306, single shell from the William Theobald

collection labelled 'Acmella tersa Benson, Khasi Hills'; NHMUK 1903.vii.i.2455, twenty-three shells from the H.H. Godwin-Austen collection, one of which is glued to a small card, labelled 'Acmella tersa W. Blf., Cherra Poonjee during the rains (G.A.)' with another label 'Acmella tersa W. Blf. 261, Cherra Poongee'. One of these specimens is not *Acmella tersa*; NHMUK 1891.3.17.936–937, two shells labelled 'Acmella tersa Benson, 70b, Cherra Poonjee, G. Nevill'; NHMUK 20210009, four shells from the H.H. Godwin-Austen collection labelled 'Acicula Acmella tersa Bs'; NHMUK 20210340, six shells from the H.H. Godwin-Austen collection labelled 'Acmella tersa Bs., Cherrapunji, duplicates' and 20210341, three shells from the E.R. Sykes collection labelled 'Acmella tersa Blanf., Cherra'.

Reason for designating a neotype

ICZN Art. 75.3 (ICZN 1999) lists several qualifying conditions that must be met when designating a neotype. Here we include statements to fulfil these requirements.

In the absence of type specimens of *Acmella tersa*, there is an exceptional need to designate a neotype in order to fix the taxonomic status of the nominal taxon. Several *Acmella* species have been described from an extremely wide geographic area (India to Japan) in the last one and a half centuries without reference to the type species of the genus. Differences amongst these species, primarily in the shell sculpture, could result in the recognition of several distinct genera within the current concept of *Acmella*. However, this would only be possible once the taxonomic status of the type species has been clarified. For this reason, we propose the designation of a neotype for *A. tersa*. The newly collected *Acmella tersa* specimens, including the neotype, match the original description of *Cyclostoma tersum* in all aspects (size, shell and aperture shape, number of whorls, sculpture), and were collected at the type locality.

Redescription

Shell minute, shape typical assimineid (conical to ovoid); whorls 4.5–5; colour brownish corneous, shell somewhat semi-transparent; protoconch finely granulose, teleoconch with irregular, rather strong, somewhat wavy ribs, some of which may converge; aperture prosocline, only slightly oblique to shell axis from lateral view, elongate ovoid with pointed parieto-palatal angle; peristome sharp, not expanded; umbilicus narrow, nearly closed.

Operculum. Blanford (1869: 178) examined specimens provided by Godwin-Austen (who also sent him diagrams of the animal, operculum and radula),

describing the operculum as 'horny, extremely thin, and very difficult to isolate; it appears to be paucispiral'. We can confirm the observations of Blanford (1869). Measurements of the operculum are: H: 0.667, W: 0.480. H/W: 1.389.

Dimensions. (In mm, $n = 5$). SH 2.14–2.38 (SE 0.05), SW 1.45–1.66 (SE 0.042), SH/SW 1.41–1.57 (SE 0.027), AH 0.83–0.94 (SE 0.024), AW 0.78–0.89 (SE 0.02), AH/AW 1.05–1.09 (SE 0.007), ApA 0.3–0.38 (SE 0.015), AA 66.59–73.4 (SE 1.208), SpH 1.3–1.52 (SE 0.036), SpW 1.35–1.54 (SE 0.039), LWH 1.38–1.55 (SE 0.033), PWH 1.72–1.9 (SE 0.035), PWD 1–1.18 (SE 0.031), PWDA 1.26–1.46 (SE 0.038), APWH 1.94–2.17 (SE 0.042), APWD 0.68–0.82 (SE 0.024), APWDA 1.07–1.23 (SE 0.03), WSABW 1–1.14 (SE 0.033), WSAPW 0.65–0.77 (SE 0.022), WSAAW 0.42–0.51 (SE 0.014), SI 6.56–9.01 (SE 0.41), RI 65.88–70.92 (SE 1.025), PrW 0.36–0.39 (SE 0.006).

Ecology

The original specimens were found in 'tree moss at Musmai, near Cherra-poonjee' (Benson 1853: 285). The newly collected specimens came from the surface of moist limestone rocks approximately 4–5 m inside the entrance of Mawsmay Cave. At this point the cave was almost dark with the exception of a few artificial lights.

Distribution

This species is known only from the vicinity of the type locality (India: Musmai [=Mawsmay], near Cherrapunjee [=Cherrapunjee], Khasi Hills, Assam [present-day Meghalaya State]).

Conservation status

The presence of large numbers of tourists at the only known locality for this minute species of snail potentially poses a significant threat. Furthermore, in order to improve the 'aesthetics' of the cave, paving and cementing have been undertaken near the entrance and artificial lighting has been installed to improve visibility for visitors. Consequently, this species has been assessed as Critically Endangered (CR) B1 and B2 according to IUCN criteria (IUCN 2012).

However, similar investigations of microgastropod faunas in neighbouring caves, and in the general area, have yet to be undertaken and the true distribution of the species is currently unknown. Historical specimens in the NHM suggest that it was relatively common in the nineteenth century, at least in the vicinity of Cherrapunji and Mawsmay, but there has since been extensive limestone quarrying and deforestation in this area, which will undoubtedly have had a

Table 1. Locality and sculpture of species assigned to *Acmella*. Those with typical *Acmella* sculpture are marked with an asterisk.

Species	Locality	Sculpture	Source
<i>A. bauensis</i> Marzuki, T. S. Liew & Mohd- Azlan, 2021	Borneo	very finely reticulated	Marzuki <i>et al.</i> (2021)
<i>A. bilamellata</i> (van Benthem Jutting, 1958)	Sumba	glossy	Páll-Gergely (2020)
<i>A. caelata</i> Vermeulen & Junau, 2007	Borneo	spiral lines	Vermeulen and Junau (2007)
<i>A. conica</i> Vermeulen & Junau, 2007	Borneo	weak spiral lines	Vermeulen and Junau (2007)
* <i>A. cyrtoglyphe</i> Vermeulen, Liew & Schilthuizen, 2015	Borneo	radial, irregular + weak spiral	Vermeulen <i>et al.</i> (2015)
<i>A. decolor</i> O. Boettger, 1891	Banda Islands	'matte glossy' with reddish brown spiral bands	Boettger (1891)
<i>A. gradata</i> Möllendorff, 1895	Philippines	glossy	Zilch (1967)
<i>A. hyalina</i> Theobald & Stoliczka, 1872	Myanmar	'smooth'	Theobald and Stoliczka (1872)
<i>A. isseliana</i> (Tapparone Canefri, 1883)	West Papua	unknown	Tapparone Canefri (1883)
<i>A. mellilla</i> Godwin-Austen, 1895	Andaman Ids	radial lines	Godwin-Austen (1895)
<i>A. minima</i> (Habe, 1942)	Japan	smooth	Fukuda and Mitoki (1995)
<i>A. minutissima</i> (Maassen, 2000)	Sumatra	stronger spiral + weaker radial	Maassen (2000)
<i>A. moreletiana</i> Nevill, 1878	Nicobar Ids	spiral lines	Nevill (1878)
<i>A. nana</i> Vermeulen, Liew & Schilthuizen, 2015	Borneo	spiral lines	Vermeulen <i>et al.</i> (2015)
<i>A. obtusa</i> Vermeulen & Junau, 2007	Borneo	spiral lines	Vermeulen and Junau (2007)
<i>A. ovoidea</i> Vermeulen, Liew & Schilthuizen, 2015	Borneo	weak spiral lines	Vermeulen <i>et al.</i> (2015)
<i>A. parvicostata</i> van Benthem Jutting, 1963	West New Guinea	unknown	van Benthem Jutting (1963)
<i>A. pirinthella</i> van Benthem Jutting, 1963	West New Guinea	unknown	van Benthem Jutting (1963)
<i>A. polita</i> Möllendorff, 1887	Philippines	glossy	Zilch (1967)
<i>A. pusilla</i> Quadras & Möllendorff, 1895	Philippines	glossy	Zilch (1967)
<i>A. regularis</i> (Quadras & Möllendorff, 1895)	Philippines	finely reticulated	Auffenberg and Páll-Gergely (2020)
<i>A. roepstorffiana</i> Nevill, 1878	Nicobar Ids	'regularly, closely, evenly striated'	Nevill (1878)
<i>A. striata</i> Vermeulen, Liew & Schilthuizen, 2015	Borneo	dense spiral striation + growth lines/ribs	Vermeulen <i>et al.</i> (2015)
<i>A. subcancellata</i> Vermeulen, Liew & Schilthuizen, 2015	Borneo	spiral striation + growth lines/ribs	Vermeulen <i>et al.</i> (2015)
<i>A. subglabrata</i> (Möllendorff, 1887)	Philippines	finely reticulated	Auffenberg and Páll-Gergely (2020)
<i>A. sutteri</i> van Benthem Jutting, 1958	Sumba	striated	van Benthem Jutting (1958)
* <i>A. tersa</i> (Benson, 1853)	India, Meghalaya	radial, irregular	this study
<i>A. trachypleura</i> Vermeulen, Luu, Theary & Anker, 2019	Southern Vietnam	radial, irregular	Vermeulen <i>et al.</i> (2019)
<i>A. turritella</i> (Möllendorff, 1893)	Philippines	finely reticulated	Auffenberg and Páll-Gergely (2020)
* <i>A. umbilicata</i> Vermeulen, Liew & Schilthuizen, 2015	Borneo	radial, irregular + weak spiral	Vermeulen <i>et al.</i> (2015)
<i>A. unilamellata</i> (Benthem Jutting, 1958)	Sumba	Glossy	Páll-Gergely (2020)

significant impact. Establishing protected status for this species is therefore important.

Discussion

The genus *Acmella* is represented in India by four species: *Acmella tersa* (Benson, 1853) (type species) from Meghalaya, *A. moreletiana* Nevill, 1878 and *A. roepstorffiana* Nevill, 1878, both from the Nicobar Islands (Nevill 1878), and *Acmella mellilla* Godwin-Austen, 1895 from the Andaman Islands. These are listed in Table 1, together with all other *Acmella* species found in the literature. It is highly probable that more intensive sampling across NE India and in Myanmar will yield species of *Acmella* additional to those currently known. *Cyclostoma milium* Benson, 1853 was classified in *Acmella* by Gude (1921), but examination of Benson's original specimen revealed that it is not a caenogastropod but a pulmonate belonging to the genus *Angustopila* Jochum, Slapnik & Páll-Gergely, 2014 (Gastrocoptidae, Hypselostomatinae), thus precluding its retention in *Acmella* (Preece *et al.* in press).

Currently, only *Acmella cyrtoglyphe* Vermeulen *et al.*, 2015 and *A. umbilicata* Vermeulen *et al.*, 2015, both

from Borneo (Table 1), are known to possess typical sculpture observed in the type species, *A. tersa* (converging radial ribs on the last adult whorl). It therefore appears that only these three species belong to *Acmella* sensu stricto, although in such a supposedly widely distributed group it could also be a convergent character. Further investigation may show that this characteristic sculpture occurs in other Indian species.

Acmella trachypleura Vermeulen *et al.*, 2019 also has a predominantly radial sculpture, but the radial ribs do not converge. *Acmella moreletiana* and *A. roepstorffiana* may belong to another genus since they possess sculpture that differs significantly from the type species of *Acmella* (see Table 1).

Mawsmi Cave is one of the most popular tourist attractions in Meghalaya and therefore increasingly affected by human impacts. Given the highly restricted known distribution of *Acmella tersa*, this poses a significant threat to the survival of this rare microsnail.

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