

GASTROPODS IN BHUTAN, THE GENUS *RAHULA* (PULMONATA: HELICARIONIDAE)

EDMUND GITTENBERGER¹, PEMA LEDA² & SHERUB SHERUB³

¹Naturalis Biodiversity Center, P.O. Box 9517, NL 2300 RA Leiden, The Netherlands

²National Biodiversity Centre, Serbithang, Bhutan

³Ugyen Wangchuck Institute for Conservation and Environment, Bumthang, Bhutan

Abstract Two species of the poorly known genus *Rahula* are described as new to science from Bhutan. These species bridge the distributional gap that hitherto existed between Sikkim in the west and Arunachal Pradesh in the east. Additionally the taxa that are considered *Rahula* species in the literature are listed. On the basis of these data, the fragmentary distribution of the genus, from the E Himalaya southwards to Vietnam, Indonesia and Malaysia, is summarized.

Key words Helicarionidae, *Rahula*, taxonomy, Bhutan, distribution

INTRODUCTION

According to the literature, species of the genus *Rahula* Godwin-Austen, 1907 are found in a large, but fragmented range in Asia, from the eastern Himalaya in NE India southwards. Nearly all species are rare, at least in collections, and many are known by only one or a few specimens from a single locality. Only *R. bascauda* (Benson, 1859) is supposed to occur in a surprisingly large area, from NE India to Myanmar (Godwin-Austen, 1907: 219).

The species are characterised by shells that are only 2–5mm broad, varying considerably in shape, from globular conical with convex sides to conical with slightly concave sides. There may be a more or less prominent, sharp peripheral keel. The umbilicus varies from nearly closed to $\frac{1}{5}$ of the total shell width. The protoconch may be sculptured by radial and spiral elements. The uniting character state is a sculpture of more or less regular, prominent, more or less oblique radial riblets on at least the spire of the shell. Only for one species, viz. *R. koboensis* Godwin-Austen, 1918, incomplete anatomical data are known (Godwin-Austen, 1918). Therefore, *Rahula* may be considered poorly defined, viz. on the basis of conchological characters that are prone to convergence or parallelism.

Here we describe two *Rahula* species from Bhutan as new to science. These species fill the biogeographical gap between the states of Sikkim and Arunachal Pradesh in India along the southern border of the eastern Himalaya.

Furthermore, we present a checklist of all alleged *Rahula* species with references to type localities and additional distributional data.

All specimens are stored at the National Biodiversity Centre in Serbithang, Thimphu, Bhutan, which is abbreviated NBCB.

SYSTEMATICS

Superfamily Helicarionoidea Bourguignat, 1877

Family Helicarionidae Bourguignat, 1877

Genus *Rahula* Godwin-Austen, 1907

Type species, by original designation: *Helix macropleuris* Benson, 1859

Diagnosis Shell c. 5mm or less in height or width, conical with slightly concave to very convex sides, with prominent radial riblets at least above the periphery, which may be sharply keeled; umbilicus very narrow to rather wide.

Rahula kleini n. sp.

Fig. 1

Type material Holotype, NBCB1011.

Type locality Bhutan, district Monggar, 8km ESE of Monggar; 2300m alt.; 27°16'N 91°18'E; E. Gittenberger & Pema Leda leg. 16.iv.2015.

Etymology The specific epithet *kleini* refers to Mr Cornelis Klein, Bhutan's Honorary Consul in the Netherlands and the initiator of the Bhutan Invertebrates Inventory Project.

Diagnosis Shell globular conical, 3mm high, with radial riblets covering the entire teleoconch

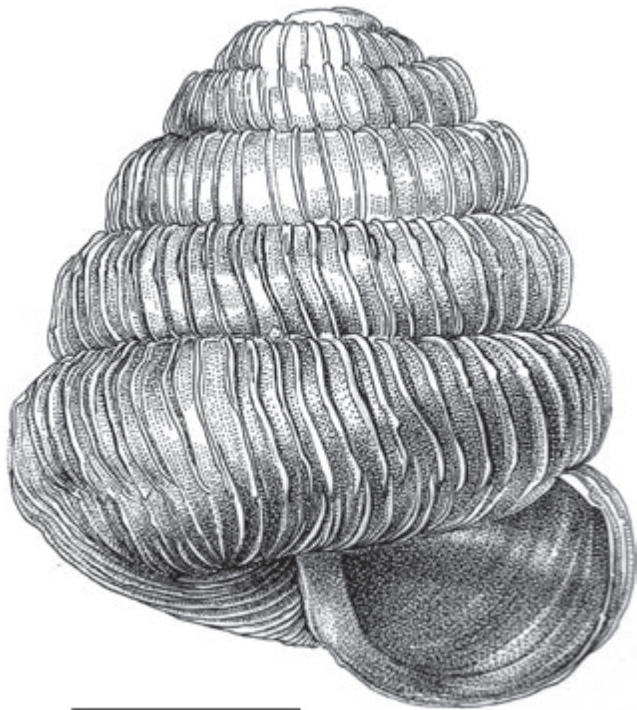


Figure 1 *Rahula kleini* n. sp. Bhutan, district Monggar, 8km ESE. of Monggar; 2300m alt.; 27°16'N 91°18'E; E. Gittenberger & Pema Leda leg. 16.iv.2015. Holotype (NBCB1011).

whorls, without a peripheral keel; umbilicus very narrow.

Description Shell globular conical, slightly higher than broad; with 1¼ protoconch and 5 convex teleoconch whorls, which are separated by a deeply incised suture. Shell greyish but not fresh. Protoconch weathered; teleoconch densely covered with prominent, sharp, erect, radial riblets, c. 9/mm on the body whorl. The riblets run abapically from the suture to shortly below the periphery; slightly less prominent, more narrowly spaced riblets, broadly S-like curved, may be followed from that place to inside the umbilicus. Columellar edge of the aperture reflected, i.e. curved into the very narrow umbilicus, which measures c. 1/17 of the total shell width. Measurements: 3.08×2.76mm.

Discussion Shells of *Rahula daflaensis*, *R. dihingensis* and *R. koboensis* are most similar to this species by their regularly convex whorls without a peripheral keel and by the presence of radial riblets both above and below the periphery. *Rahula kleini* spec. nov. is smaller and relatively higher, with a narrower umbilicus. Only a single

specimen of this characteristic species has been found.

Rahula trongsaensis n. sp.

Fig. 2

Type material Holotype, NBCB1012.

Type locality Bhutan, district Trongsa, Trongsa; 2210m alt.; 27°29'N 90°30'E; E. Gittenberger & Pema Leda leg. 20.iv.2015.

Etymology The specific epithet *trongsaensis* refers to the district Trongsa in central Bhutan.

Diagnosis Shell conical, with radial riblets only above the sharp peripheral keel; umbilicus very narrow.

Description Shell conical with slightly convex sides, broader than high; with c. 4½ somewhat flattened whorls and a very prominent, crenelated peripheral keel, which is accompanied by short concave parts. Shell glossy, light yellowish. Protoconch densely covered with radial riblets and spiral threads. Teleoconch above the keel with low radial riblets, c. 12/mm; shell base below the keel with very fine and dense spiral lines and inconspicuous growth lines and obsolete riblets only. Columellar edge of the aperture reflected, i.e. curved into the umbilicus, which is nearly completely closed, measuring

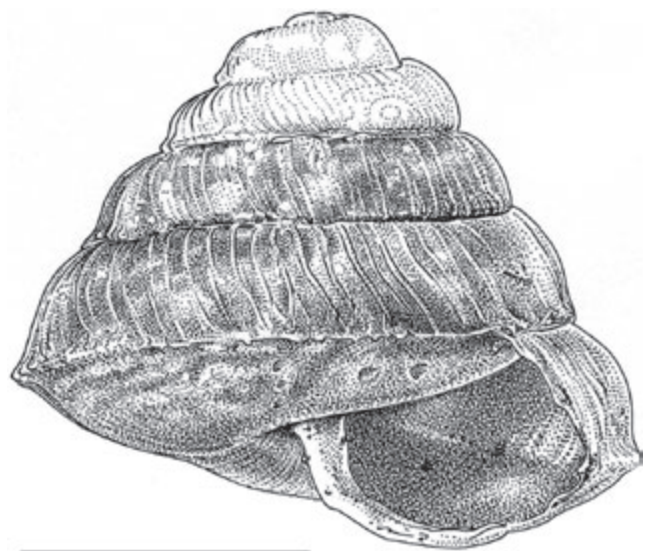


Figure 2 *Rahula trongsaensis* n. sp. Bhutan, district Trongsa, Trongsa; 2210m alt.; 27°29'N 90°30'E; E. Gittenberger & Pema Leda leg. 20.iv.2015. Holotype (NBCB1012).

c. 1/30 of the shell breadth. Measurements: 2.16×1.86mm.

Discussion The conical shell with a very prominent keel and conspicuous radial riblets only above the keel are shared with *Rahula bascauda* and *R. bascaudula*, which have a much wider umbilicus, however, measuring c. 1/5 of the shell breadth. In *R. trongsensis* the keel is accompanied by narrow concave parts of the wall of the shell.

Only a single specimen of this characteristic species has been found. It might be juvenile. Additional whorls would not change the aspect of the umbilicus, however. Only the keel might be less prominent in hypothetical, fully grown shells.

ADDITIONAL SPECIES THAT ARE CLASSIFIED IN *RAHULA*

Widespread, NE. India & Myanmar

Rahula bascauda (Benson, 1859)

Helix bascauda Benson, 1859a: 186 ("Teria Ghát, montium Khasiae" [Khasi Hills]).

Rahula bascauda; Godwin-Austen, 1907: 218, pl. 117 figs 1 ("Teria Ghat"), 1a, 3 ("Jaintia"), 3a., 219 ("Darjiling, Jaintia [25°30'N 92°0'E] and Naga Hills, Dafla Hills, Arakan and Pegu [= Bago, 19°N 96°E]").

Notes This is the only *Rahula* species that is reported from a relatively large range (Godwin-Austen, 1907). It could be considered in *Rahula* the 'prime species' as defined by Gittenberger & Kokshoorn (2008a, b).

NE. India, north of the Brahmaputra

Rahula macropleuris (Benson, 1859)

Helix macropleuris Benson, 1859b: 265 ("valle Rangun, prope Darjiling, rarissime" [Sikkim, c. 27°02'N 88°20'E]).

Rahula macropleuris; Godwin-Austen, 1907: 216 ("Rissom Peak, 6410ft."), pl. 103 fig. 1. Zilch, 1959: 306, fig. 1113.

Rahula corys (Benson, 1859)

Helix corys Benson, 1859b: 265 ("valle Rangun, prope Darjiling, rarissime occurrens" [Sikkim, c. 27°02'N 88°20'E]).

Rahula corys; Godwin-Austen, 1907: 217 figs 1, 4, (Damsang [= Daling]), 5.

Rahula bascaudula Godwin-Austen, 1907

Rahula bascaudula Godwin-Austen, 1907: 219 ("Risett chu and Richila Peak, Daling District" [Sikkim, c. 27°02'N 88°20'E]), pl. 117 fig. 7.

Rahula daflaensis Godwin-Austen, 1907

Rahula daflaensis Godwin-Austen, 1907: 220 ("Dikrang Valley, Dafla Hills" [27°12'N 93°30' E]), pl. 117 fig. 5.

Rahula aborensis Godwin-Austen, 1918

Rahula aborensis Godwin-Austen, 1918a: 597, 598 figs 2A, B ("Sibbum, Yamne Valley, Abor Hills" [28°19'N, 95°9'E]).

Rahula koboensis Godwin-Austen, 1918

Rahula koboensis Godwin -Austen, 1918a: 598 fig. 2C, 599 "*koboensi*" ("Kobo, on the north bank of the Brahmaputra River" [NE. Assam, 27°48'N 95°20'E]). Obviously *koboensi* should be *koboensis*. Godwin-Austen, 1918b: 621, figs 3A–C.

Notes Godwin-Austen (1918a: 599) described the animal as follows: "Foot short, mucous pore at extremity of foot distinct, and a broad peripodial margin." The radula has rows with a tricuspid central tooth, 7 or 8 bicuspid laterals, and c. 30 irregular tri/multicuspid marginals; the jaw has an inconspicuous central projection. The accompanying figures were published later on (Godwin-Austen, 1918b: 621, figs 3A–C).

NE India & Myanmar, south of the Brahmaputra

Rahula dihingensis Godwin-Austen, 1918

Rahula dihingensis Godwin-Austen, 1918a: 598, fig. 2D ("Dihing Valley, Eastern Assam" [27°18'N 95°39'E]).

Rahula burrailensis Godwin-Austen, 1918

Rahula burrailensis Godwin-Austen, 1918a: 598 ("Yemai, Lahupa, Naga, N.E. Manipur" [after Burreil=Barail Range, SE Assam/SW Nagaland, c. 25°30'N 93°30'E]), figs 2E, F.

Rahula lhotaensis Godwin-Austen, 1907

Rahula lhotaensis Godwin-Austen, 1907: 220 ("Lhota, Naga Hills, Assam" [26°30'N 94°30' E]), pl. 117 fig. 6.

Rahula manipurensis Godwin-Austen, 1907

Rahula manipurensis Godwin-Austen, 1907: 220 ("Munipur Hills, north-east of valley" [25°N 94°E]), pl. 117 fig. 4.

Rahula polypleuris (Blanford, 1865)

Helix polypleuris Blanford, 1865: 76, 77 ("Arakan hills: rare" [19°0'N 94°30'E]).

Rahula polypleuris; Godwin-Austen, 1907: 218, pl. 117 fig. 2.

Vietnam

Rahula jucunda (Bavay & Dautzenberg, 1912)

Kaliella jucunda Bavay & Dautzenberg, 1912: 15 ("Binh-Lu" [22°19'N 103°37'E] and "Muong-Bo" [22°15'N 103°59'E]), pl. 2 figs 9–12.

Rahula ornatissima (Bavay & Dautzenberg, 1912)

Kaliella ornatissima Bavay & Dautzenberg, 1912: 14 ("Tonkin": "Trinh-Tuong [22°23'N 104°51'E]" and "Binh-Lu" [22°19'N 103°37'E]), pl. 2 figs 13–16.

Sabah and Sarawak

Rahula delopleura Vermeulen, Liew & Schilthuizen, 2015

Rahula delopleura Vermeulen, Liew & Schilthuizen, 2015: 107 ("Malaysia, Sabah, Sandakan Province [5°52'N 118°04'E], Kinabatangan valley, Batu Pangi"=type locality).

Rahula raricostulata (Smith, 1893)

Sitala raricostulata Smith, 1893: 342, 343 ("Busau or Busan, Sarawak"[not located more precisely]: 3°N 115°E), pl. 25 fig.2.

Indonesia

Rahula moolenbeeki Maassen, 2000

Rahula moolenbeeki Maassen, 2000: 145, 146 figs 20, 21 ("N. Sumatra: reserve Tinggi Radja, between

Berastagi and Pematangsiantar, 400m alt., debris of the river Bah Banai" [3°05'N 98°45'E]).

BIOGEOGRAPHY

From the eastern Himalaya, and southwards as far as Myanmar, *Rahula* species are recorded from several areas (Benson, 1859a, b; Blanford, 1865; Blanford & Godwin-Austen, 1908; Godwin-Austen, 1907, 1918). More recently, new records have not been published. The genus is not listed for Nepal (Budha *et al.*, 2015). Northwest and north of the Brahmaputra river, species are known now from Bhutan and India, viz. the states of Sikkim and Arunachal Pradesh-India (Dafla Hills, Abor Hills). South of the Brahmaputra the genus is represented in India, Meghalaya (Khasi & Jaintia Hills), Assam, Nagaland and Manipur, and more to the south in Myanmar, Arakan and Pegu (= Bago). Much further to the south and southeast, a *Rahula* species has been reported from Indonesia (Sumatra) (Maassen, 2000), two species were described from Malaysia (Sabah and Sarawak) (Smith, 1893; Vermeulen *et al.*, 2015), and two species from Vietnam (Bavay & Dautzenberg, 1912). The emerging biogeographical pattern (Fig. 3) is eastern Himalayan and SE Asian, with large disjunctions. It recalls the pattern shown, for example, by *Pseudopomatias* Möllendorff, 1885 (Gastropoda: Pupinidae), which is also known from the E Himalaya, from Sikkim eastwards, including Bhutan (unpublished observation), and southeastwards to Myanmar and Vietnam (Páll-Gergely *et al.*, 2015). A similar pattern is shown by the combined, maybe sister-taxa *Rhaphaulus* L. Pfeiffer 1856 and *Streptaulus* Benson 1857 (Pupinidae), which also reach from Sikkim and Bhutan (unpublished observation: *S. blanfordi* Benson, 1857) southeastwards to Borneo (Páll-Gergely *et al.* (2014: 571, fig. 15).

ACKNOWLEDGEMENTS

We wish to thank Mrs. I. van Noortwijk, who made the drawings of shells for this article and Mr. E.-J. Bosch, who provided the map. We are also grateful to Dr Barna Páll-Gergely and an anonymous referee for improvements of the manuscript. This work has been supported by the Global Exploration Fund of the National Geographic Society (grant GEFNE 131–14) and the Bhutan Trust Fund for Environmental

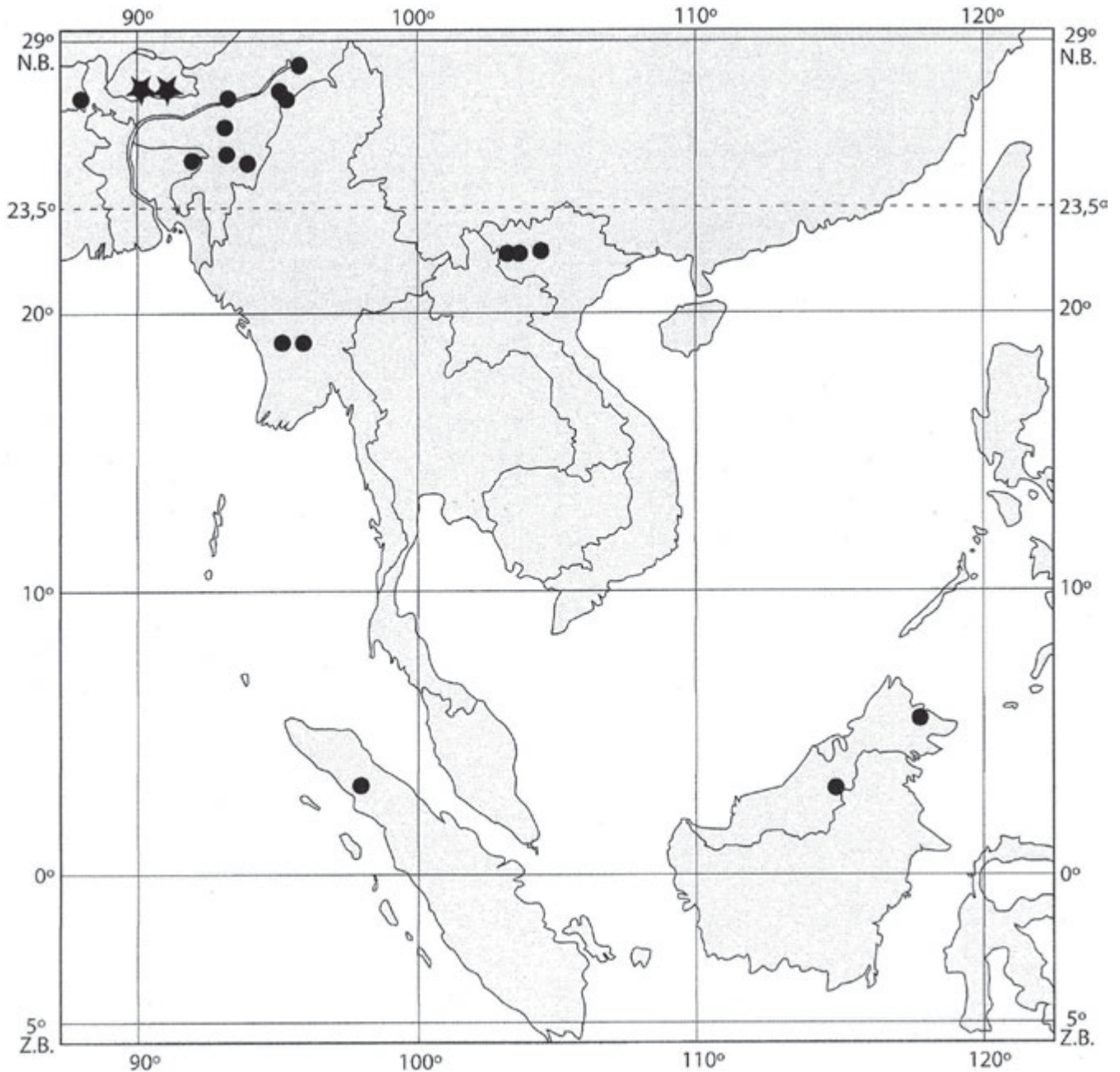


Figure 3 New records of *Rahula* from Bhutan (stars) and records known from the literature (dots).

Conservation (grant MB0149Y15). We also thank the Program Director and head of the Biodiversity Information Management Program of the National Biodiversity Centre, Dr Tashi Yangzome Dorji, who contributed in various ways to this project.

REFERENCES

- BAVAY A & DAUTZENBERG P 1912 Description de coquilles nouvelles de l'Indo-Chine *Journal de Conchyliologie* 60: 1–54.
- BENSON WH 1859a XXI. – Descriptions of new species of *Helix*, *Streptaxis*, and *Vitrina*, collected by Mr. W. Theobald jun., in Burmah, the Khasia Hills, and Hindustan *The Annals and Magazine of Natural History* (3) 3 (15): 184–189.
- BENSON WH 1859b XXVIII. – Descriptions of new Helicidae contained in the Darjiling collections of Messrs. W.T. and H.F. Blanford *The Annals and Magazine of Natural History* (3) 3 (16): 265–273.
- BLANFORD WT 1865 Contributions to Indian malacology, No. V. Descriptions of new land shells from Arakan, Pegu, and Ava; with notes on the distribution of described species *Journal of the Asiatic Society of Bengal* 34, 2-Physical Science 2: 66–105.

- BLANFORD WT & GODWIN-AUSTEN HH 1908 Mollusca. Testacellidae and Zonitidae *The fauna of British India, including Ceylon and Burma*. Taylor and Francis, London. xxxii, 311 pp.
- BUDHA PB, NAGGS F & BACKELJAU T 2015 Annotated checklist of the terrestrial gastropods of Nepal *ZooKeys* **492**: 1–48.
- GITTENBERGER E & KOKSHOORN B 2008a. Evolutionary inequality: comparing phylogenetic relationships with other biological properties. In S MORRIS & A VOSLOO Molecules to migration: the pressures of life [4th CPB Meeting in Africa: MARA 2008]: 603–611.
- GITTENBERGER E & KOKSHOORN B 2008b. Evolutionary inequality in *Chondrina* and *Arianta* (Gastropoda: Pulmonata): ‘prime’ and ‘remnant’ species. In B KOKSHOORN Resolving riddles and presenting new puzzles in Chondrinidae phylogenetics: 59–64.
- GODWIN-AUSTEN HH 1907 Land and freshwater Mollusca of India, including South Arabia, Baluchistan, Afghanistan, Kashmir, Nepal, Burmah, Pegu, Tenasserim, Malay peninsula, Ceylon, and other islands of the Indian Ocean **2** (10): 147–238, pls 101–117.
- GODWIN-AUSTEN HH 1918a XLVIII. Mollusca, VIII. Macrochlaminae (In part) *Records of the Indian Museum* **8** [Zoological results of the Abor expedition 1911/1912](11): 581–600, pls.51–54.
- GODWIN-AUSTEN HH 1918b XLIX. Mollusca, IX. *Records of the Indian Museum* **8** [Zoological results of the Abor expedition 1911/1912](11): 601–621.
- MAASSEN WJM 2000 Notes on terrestrial molluscs of Sumatra, Indonesia, with descriptions of ten new species (Gastropoda, Prosobranchia & Pulmonata) *Basteria* **64**: 137–150.
- PÁLL-GERGELY B, FEHÉR Z, HUNYADI A & ASAMI T 2015 Revision of the genus *Pseudopomatias* and its relatives (Gastropoda: Cyclophoroidea: Pupinidae) *Zootaxa* **3937** (1): 1–49.
- PÁLL-GERGELY B, HUNYADI A & MAASSEN WJM 2014 Review of *Rhaphaulus* L. Pfeiffer 1856 and *Streptaulus* Benson 1857 species with description of *R. tonkinensis* n. sp. from Vietnam (Gastropoda: Pupinidae) *Journal of Conchology* **41** (5): 565–573.
- SMITH EA 1893 Descriptions of new species of land-shells from Borneo *Journal of the Linnean Society (Zoology)* **24**: 341–352.
- VERMEULEN JJ, LIEW T-S & Schilthuizen M 2015 Additions to the knowledge of the land snails of Sabah (Malaysia, Borneo), including 48 new species *ZooKeys* **531**: 1–139.