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First record of the genus *Lagocheilus* W.T. Blanford, 1864 (Caenogastropoda: Cyclophoridae) from the northern Western Ghats, India, with the description of *L. hayaomiyazakii* n. sp.

Amrut Bhosale¹, Tejas Thackeray¹, Dinarzarde C. Raheem^{2,3}, Swapnil Pawar¹ & Akshay Khandekar^{1,4}

- 1 Thackeray Wildlife Foundation, Mumbai, India
- 2 Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka
- 3 Scientific Associate, The Natural History Museum, London, UK
- 4 Department of Zoology, Shivaji University, Kolhapur, India

Corresponding author: A. Khandekar (akshaykhandekar@gmail.com)

Abstract. We describe a new species of *Lagocheilus* from Ratoba Point, Tilari Nagar, Kolhapur District, in the northern Western Ghats of Maharashtra, India. *Lagocheilus hayaomiyazakii* n. sp. can be distinguished from its South Indian and Sri Lankan congeners by a unique combination of shell characters: a conoidal shell with a raised spire, a broad base, and narrow umbilicus; a wide aperture with a clearly expanded lip and a distinct angle where the lip joins the parietal wall; shell sculpture of prominent, widely spaced spiral lirae; and, in juvenile and young adults, a thick periostracum with numerous periostracal hairs. We also describe the living animal, operculum, radula and jaw. This is the first record of the genus *Lagocheilus* from the northern Western Ghats, extending its known distribution range by 540 km north into the Indian Peninsula.

Key words. Hairy land snail, Japonia, Lagocheilus hayaomiyazakii n. sp., taxonomy, Western Ghats

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Introduction

Cyclophoridae J.E. Gray, 1847, one of the extant families of superfamily Cyclophoroidea J.E. Gray, 1847, is distributed across Africa, Asia, Australia, southern Europe and various Pacific islands (Kobelt 1902; Solem 1959; Stanisic 1998; Raheem et al. 2018; Páll-Gergely et al. 2024). It consists of four subfamilies, five tribes and 50 extant genera (Bouchet & Rocroi 2005; Bouchet et al. 2017; MolluscaBase Eds 2025). The taxonomy of certain genera and species within the Cyclophoridae continues to present challenges due to historical nomenclature and unresolved generic boundaries. Nevertheless, recent revisions have successfully resolved some of those longstanding taxonomic uncertainties (Nantarat et al. 2014a; Páll-Gergely et al. 2017, 2020; Cole 2019; Tongkerd et al. 2024). One such taxonomically complex group is the genus Lagocheilus W.T. Blanford, 1864. Lagocheilus was first used by Theobald (1883), but without a formal description. Blanford (1864) cited the genus as "Lagocheilus Theobald, MS." and provided the description and designated Cyclophorus scissimargo W.H. Benson, 1856 as the type species, thereby making the name available (ICZN Articles 12 and 50.1.1). Furthermore, he treated Lagocheilus as a subgenus of Cyclophorus Montfort, 1810, and included 14 described species. Later, Nevill (1878) elevated subgenus Lagocheilus to full generic status, listing 13 species and one variety. Kobelt & Möllendorff (1897) misspelt the genus as Lagochilus (i.e. an unjustified emendation under ICZN Article 32) and recorded 79 species and eight varieties under Lagochilus. Subsequently, Kobelt (1902) treated Lagocheilus as a subgenus of Japonia A.A. Gould, 1859, without a justification and included 92 species with six varieties, and provided a diagnostic key to the subgenus. Yen (1941) pointed out that Kobelt (1902) had never investigated the status of three species of Japonia, namely, J. citharella (A.A. Gould, 1859), J. musiva (A.A. Gould, 1859), and the type species, J. gouldi Kobelt, 1902 (replacement name for Cyclostoma barbata A.A. Gould, 1859, which was a junior homonym of

Cyclostoma barbatum L. Pfeiffer, 1855; Kobelt 1902). Due to the unavailability of the type species of *Japonia*, Yen (1939, 1942) treated the genus as a *nomen dubium*. Consequently, Raheem *et al.* (2014) included two South Indian species in *Lagocheilus*.

Currently, the genus Lagocheilus comprises 106 species (MolluscaBase Eds 2021) and is distributed across Cambodia, South China, India, Indonesia, Laos, Malaysia, Myanmar, Papua New Guinea, the Philippines, Sri Lanka, Thailand, and Vietnam (Nevill 1878; Möllendorff 1885; Kobelt & Möllendorff 1897; Benthem Jutting 1948; Raheem et al. 2014; MolluscaBase Eds 2021). Twelve species of Lagocheilus are distributed in India (nine species) and Sri Lanka (three species). Among the Indian species, six are known from mainland India: L. daflaensis Godwin-Austen, 1917, L. oakesi Godwin-Austen, 1918, L. sikhimensis Godwin-Austen, 1917, and L. tomotremus (W.H. Benson, 1857) from Northeast India, and L. malleatus (W.T. Blanford & H.F. Blanford, 1861) and L. shiplayi (L. Pfeiffer, 1857) from South India. The remaining three species, L. galatheae (Mörch, 1872), L. warnefordianus G. Nevill, 1878, and L. wuellerstorfianus (Zelebor, 1867), are known only from the Andaman and Nicobar Islands.

Despite a long history of study of the Indian land-snail fauna (e.g. Blanford & Godwin-Austen 1908; Gude 1914,

1921), our understanding of the taxonomic diversity of snail fauna of the northern Western Ghats is poor, with much of the region remaining largely unexplored (Raheem et al. 2014: fig. 6; Bhosale et al. 2021, 2022, 2025a). During our ongoing surveys of previously unstudied areas of the northern Western Ghats, we collected a new land-snail species from semi-evergreen forest at Ratoba Point, Tilari Nagar, Kolhapur District, Maharashtra. Detailed morphological studies of this snail indicates that it is a new species of Japonia or Lagocheilus (both of which have to date not been reported from the northern Western Ghats). The taxonomic status of Japonia is uncertain (Yen 1941; Raheem et al. 2014), so we include the new species in the genus Lagocheilus and provide a detailed description of the shell, operculum, living animals, radula, and jaw.

MATERIALS AND METHODS

We collected 12 specimens (10 live individuals and two shells) of the new species from Ratoba Point, Kodali, Tilari Nagar, Kohapur District, Maharashtra State, India (Fig. 1). Live individuals were photographed soon after the collection. Two individuals died after photography, so the shells were cleaned (NRC-AA-9580, 9581) and kept dry. The live individuals were euthanized following the American

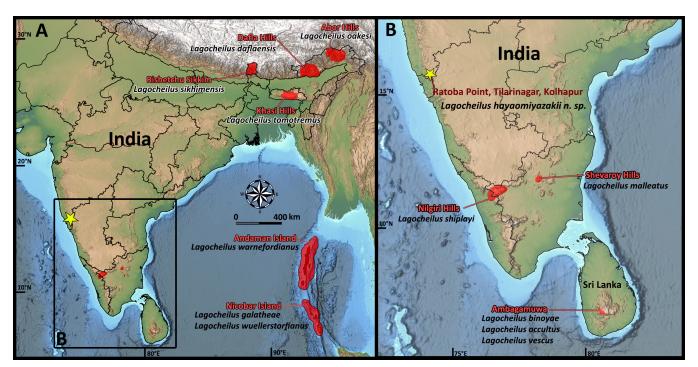


Figure 1. Distribution of the genus *Lagocheilus* in (**A**) South Asia and (**B**) in Peninsular India and Sri Lanka (sources: Raheem *et al.* 2014; MolluscaBase Eds 2021). Red shading indicates the type localities (non-precise, generalised localities in the original descriptions) of the different species; the yellow star denotes the type locality of *L. hayaomiyazakii* n. sp. (Source of map: https://www.ncei.noaa.gov).

Veterinary Medical Association (2020) guidelines and preserved in 80% ethanol for anatomical study. A single whole individual was preserved in absolute ethanol and stored at −20 °C for possible future molecular work (measurements excluded). The periostracum of two shells (NRC-AA-9580, 9581) were removed by scrubbing with forceps to study the underlying colour pattern. Specimens were photographed under a Zeiss Stemi 305 stereo-zoom microscope at a range of focal planes and focus-stacked using CombineZP v. 1.0. The morphological comparison of the new species is restricted to the South Indian and Sri Lankan congeners. Comparative morphological studies were done by comparing the new species with photographic images of the types, as provided by Raheem et al. (2014), Preece et al. (2022), and downloaded from the website of the Natural History Museum, London (NHMUK, https://data.nhm.ac.uk/). Shell morphological terminology follows Cox (1960), and whorl counts follow Kerney & Cameron (1979). The radula and jaw were prepared following Geiger et al. (2007); the operculum was cleaned with a soft paintbrush and stored in absolute ethanol; and the shell was cleaned with a soft paintbrush and prepared according to Murtey & Ramasamy (2016) to retain the structural integrity of the periostracal hairs. All samples were mounted on carbon tape, coated with gold and photographed on a TESCAN VEGA3 scanning electron microscope (SEM). The type material of the new species was deposited in the Museum and Research Collection Facility of the National Centre for Biological Sciences (NCBS), Bengaluru, India.

RESULTS

Family Cyclophoridae J.E. Gray, 1847 Genus *Lagocheilus* W.T. Blanford, 1864

Lagocheilus hayaomiyazakii n. sp.

Figures 2–7

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Type locality. Ratoba Point, Kodali, Tilari Nagar, Kolhapur District, Maharashtra State, India (15°47′08.7″N, 74°09′50.4′E), *c*. 730 m a.s.l.

Type material. Holotype: NRC-AA-9576, adult male (height 4.81 mm, width 4.75 mm), coll. A. Bhosale and S. Pawar, 23 June 2025.

Paratypes: NRC-AA-9577-9579 (3 adult females), NRC-AA-9599-9601 (2 adult females, 1 adult male), from type locality with same collection data as holotype. NRC-

AA-9580, NRC-AA-9581, NRC-AA-9602, and NRC-AA-9603 (four shells), from type locality with same collection data except coll. 6 October 2024.

Etymology. The specific epithet is a Latinised patronym honouring Hayao Miyazaki (b. 1941), a renowned Japanese animator, filmmaker, and co-founder of Studio Ghibli; the new species is named after him in recognition of his contribution to animation films.

The suggested English common name is Tilari hairy snail.

Diagnosis. The new species can be diagnosed from its South Indian and Sri Lanka congeners by the following combination of shell characters: a conoidal shell with a raised spire, broad base and narrow umbilicus; a wide aperture with a clearly expanded lip and a distinct angle where the lip joins the parietal wall; shell sculpture of prominent widely spaced spiral lirae; and numerous hairs on the periostracum of juvenile and young adult shells.

Comparison with South Indian and Sri Lankan congeners. As is clear from Table 1 and Figure 3, Lagocheilus hayaomiyazakii n. sp. can be readily distinguished from its South Indian and Sri Lankan congeners by the shape of aperture, which has a pointed apex in the new species but is rounded in all the other species. From the South Indian L. malleatus, it can also be distinguished by its smaller size and periostracal hairs; these differences have to be critically evaluated with fresh material of L. malleatus because the only material currently available for this species are the lectotype and paralectotype, both of which are heavily worn and exhibit damaged apertural margins.

The new species is easily separable from the other South Indian species *L. shiplayi* because the latter has a depressed turbinate shell with a wide umbilicus whereas *L. hayaomiyazakii* n. sp. has a conoidal shell with a raised spire. Shell shape is also a key character for distinguishing the new species from the three Sri Lankan species, which have a more depressed, turbinate form and wider umbilicus than *L. hayaomiyazakii* n. sp.; the three Sri Lankan species also have very different shell sculpture and/or periostracal morphology to the new species.

Description. Shell small (4.17–5.60 mm high, 4.16–5.23 mm wide), conoidal, broad-based, with 4½–4% regularly increasing whorls. Spire raised with obtuse apex; suture well marked. Protoconch with 1¾–2 whorls (Fig. 4A, B) and four or five raised spiral lirae (Fig. 4C). Body whorl stout, slightly descending, rounded at periphery, with 10–14 spiral lirae between suture and umbilicus (7–10 spiral lirae at and above periphery, and 3–6 below periphery). Aperture subcircular and distinctly angled at junction of apertural lip and

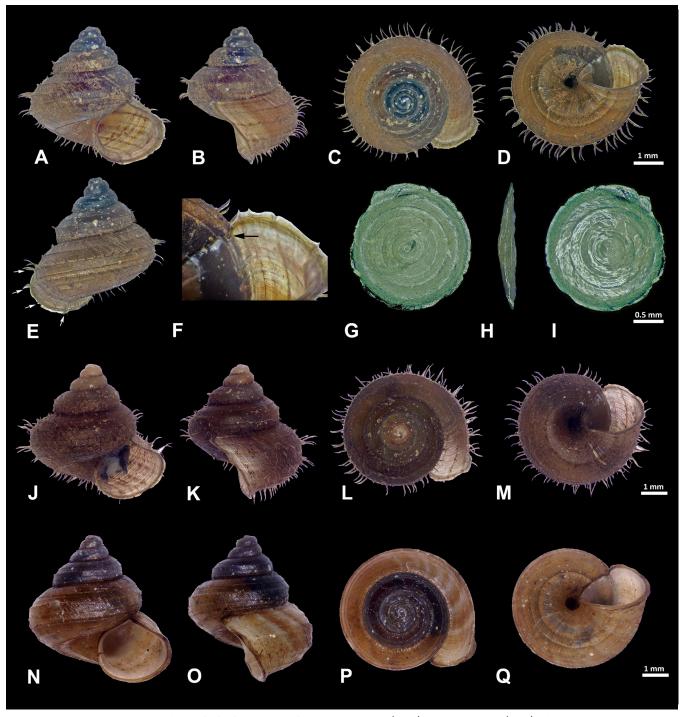


Figure 2. Shell and operculum of *Lagocheilus hayaomiyazakii* n. sp. **A–I**, shell (**A–F**) and operculum (**G–I**) of holotype NRC-AA-9576. **J–M**, shell of paratype NRC-AA-9580, after removal of periostracum. **F**, detail of upper margin of the aperture. White arrows in **E** indicate the spiral rows of periostracal hairs; the black arrow in **F** shows the apertural notch. **G**, outer surface. **I**, inner surface. **H**, lateral view.

parietal wall; this junction marked by a small but noticeable notch (Fig. 2A, J, N). Apertural lip narrowly but noticeably expanded. Umbilicus open but narrow. Periostracum (when present) thick, fibrous, and brown to yellowish brown. Un-

derlying shell colour and pattern obscured by periostracum; without periostracum (when rubbed off using forceps in two shells), shell pale brown, with the last ¼ whorl marked by 5–7 oblique white bands (Fig. 2P). When intact, peri-

Table 1. Shell key characters of South Indian and Sri Lankan *Lagocheilus*. The data for *L. malleatus* are incomplete because both shells examined had a damaged aperture and worn periostracum. Unless stated otherwise, the data presented are based on the following material: *L. malleatus*, NHMUK 20110212, NHMUK 1875.03.06.22/1; *L. shiplayi*, NHMUK 20110216/1-2, NHMUK 20110217/1-2; *L. binoyae*, NHMUK 1958.1.14.26-28; *L. occultus*, NHMUK 1958.1.14.29-30, *L. vescus*, NHMUK 1958.1.14.13-16, NHMUK 1958.1.14.22; and *L. hayaomiyazakii* n. sp., NRC-AA-9576 (holotype), NRC-AA-9577–9579 (3 preserved individuals), NRC-AA-9580 and NRC-AA-9581 (2 shells), NRC-AA-9602 and NRC-AA-9603 (2 shells).

Species	Shell height (H) and width (W) (mm)	Shape and no. of whorls	Apertural margin	Width of umbilicus	Sculpture	Periostracal hairs
L. malleatus	H: 5.71–6.14; W: 5.88–6.29 (n = 2)	Conoidal and broad based; raised spire (whorls 5–51/4)	?	Narrow	Widely spaced spiral lirae; irregular colabral striae	?
L. shiplayi	H: 2.87–5.34; W: 5.47–11.45 (n = 4)	Depressed, low spire (whorls $3\frac{1}{4}-4\frac{1}{2}$)	Not expanded	Wide	Spiral lirae absent; irregular colabral striae	Absent
L. binoyae	H: 3.77–4.68; W: 4.43–6.02 (n = 3)	Turbinate, low spire (whorls 3¾-4)	Not expanded	Moderate	Numerous close spiral striae over- lain by more distant spiral periostra- cal ribs; colabral striae overlain by more distant radial periostracal ribs	Present in young speci- mens
L. occultus	H: 3.58–3.84; W: 3.90–4.21 (n = 2)	Turbinate; raised spire (whorls 4½-4¾)	Not expanded	Moderate	Prominent widely spaced spiral lirae; colabral striae	Present in young specimens
L. vescus	H: 5.57–8.05; W: 7.34–10.22 (n = 5)	Turbinate, low spire (whorls 3¾-4¼)	Not expanded	Moderate	Numerous close spiral lirae; colabral striae	Absent
•	H: 4.17–5.60; W: 4.16–5.23 (n = 11)	Conoidal, broad based with wide aperture; raised spire (whorls 4½–4¾)	Expanded to form narrow lip	Narrow	Prominent widely spaced spiral lirae; colabral striae	Present in young speci- mens

ostracum accentuates underlying sculpture of shell, which consists of close, irregular colabral (growth) striae and bold, widely spaced spiral lirae (Figs 2A, E, J, N, 4A, B, D). Periostracum bearing numerous "periostracal hairs" (sensu Bottjer 1981; Neubauer et al. 2019) of varying length, some of which have clearly been broken; absence of hairs on some parts of an otherwise "hairy" shell suggests that some hairs have been lost. Most hairs arranged in widely spaced spiral rows, with longest and most prominent hairs (up to 0.6 mm long), linear-lanceolate in shape (Fig. 2A, C), and occurring on four spiral lirae on last whorl (Fig. 2E) and later part of the penultimate whorl. Shortest hairs (0.1 or 0.2 mm long) on early whorls.

Operculum thin, slightly concave (Fig. 2H), corneous, and translucent, with flat outer surface (whorls of operculum not raised), covered with a proteinaceous layer in two

specimens (NRC-AA-9600 and NRC-AA-9580); multispiral with seven or eight whorls (Figs 2G, 4G), and inner surface with indistinct nucleus (Figs 2I, 4H).

Animal greyish white, with short, pointed tail with slitshaped mucus pore (Fig. 5A, B). Tentacles with dark eyespots at outer base, greyish with darker tip and gradually becoming paler towards base. Penis behind right eye; in life, penis elongate, curved, and conduplicate in position (Fig. 5C); penis elongate-pentagonal when unfolded (in preservation) (Fig. 5D).

Radula (NRC-AA-9577) taenioglossate, with seven teeth in each row (2-1-1-1-2). Central tooth pentacuspid; median cusp larger, and bluntly pointed, with two smaller cusps on each side. Lateral teeth tetracuspid; outer cusp and inner two cusps smaller, whereas second cusp from outside much larger (in some rows much longer) than others. Inner

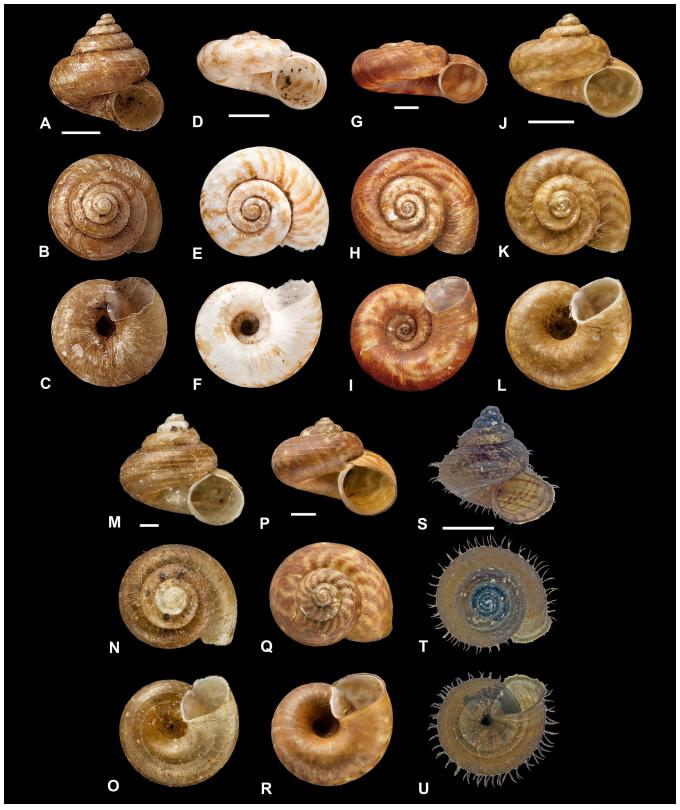


Figure 3. Shell of South Indian and Sri Lankan *Lagocheilus* species. **A–C**, *L. malleatus* from the Beddome collection (NHMUK 1875. 03.06.22/1). **D–F**, *L. shiplayi* lectotype (NHMUK 20110216/1). **G–I**, *L. shiplayi* from the Barnacle collection (NHMUK 20110217/1). **J–L**, *L. binoyae* syntype (NHMUK 1958.1.14.26). **M–O**, *L. occultus* syntype (NHMUK 1958.1.14.29). **P–R**, *L. vescus* syntype (NHMUK 1958.1.14.13). **S–U**, *L. hayaomiyazakii* n. sp., holotype (NRC-AA-9576). A–R © The Trustees of the Natural History Museum, London.

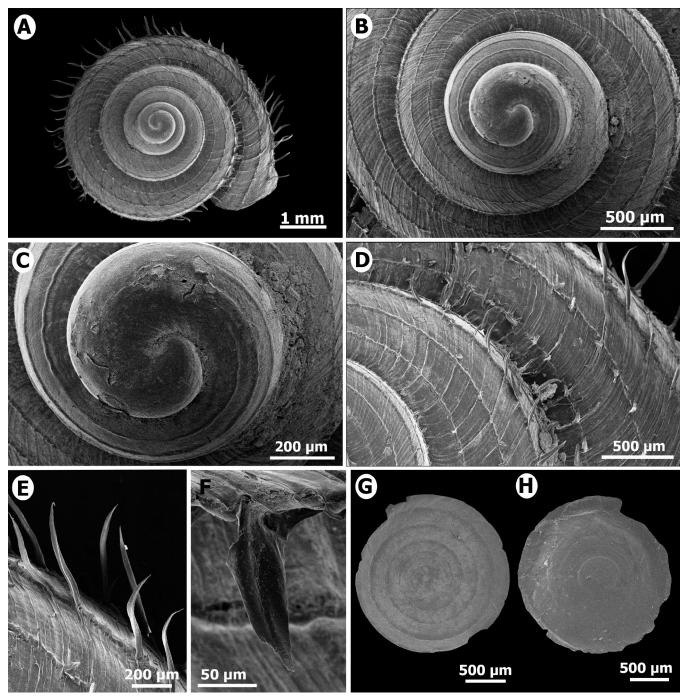


Figure 4. SEM images of the shell (**A**, **B**), sculpture (**C**, **D**), periostracal hairs (**E**, **F**) and operculum (**G**, **H**) of *Lagocheilus hayaomiyazakii* n. sp. **A**–**F**, paratype NRC-AA-9577. **H**, paratype NRC-AA-9578. **A**, dorsal view of shell. **B**, early whorls of shell. **C**, sculpture of protoconch. **D**, sculpture of teleconch. **E**, **F**, Periostracal hairs on periphery (**E**), and suture demarcating body and penultimate whorls (**F**). **G**, Outer surface. **H**, Inner surface.

marginal teeth with four cusps; middle two cusps larger than others. Outer marginal teeth tricuspid, long, and pointed (Fig. 6A, B).

Jaw (NRC-AA-9577) composed of two symmetrical triangular sections joined at the middle region with a deep

groove (Fig. 6C, F); jaw simple, thin, with serrated cutting edges (Fig. 6C, D); sculptured with regular and irregular square to rectangular plates varying in size (Fig. 6D–F).

Distribution and natural history. Lagocheilus hayaomiyazakii n. sp. is currently known only from its type locality

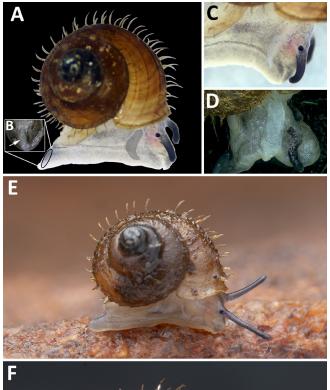




Figure 5. Living and preserved examples of *Lagocheilus hayaomiyazakii* n. sp. **A–D**, male, holotype NRC-AA-9576. **A**, adult male with fully developed penis highlighted with light-grey shading. **B**, closeup of tail in preserved specimen, showing slit-like mucus pore marked by white arrow. **C**, conduplicate position of penis in living snail. **D**, elongate-pentagonal penis (unfolded with forceps) in preserved specimen. **E**, male, paratype NRC-AA-9601. **F**, female, paratype NRC-AA-9600.

(Ratoba Point, Kodali, Tilari Nagar, Kolhapur District in Maharashtra, India) at an elevation of 730 m a.s.l. It was moderately plentiful in a semi-evergreen forest patch. Live individuals were active on moss-covered boulders, on rocks at the bases of trees, and on rocks surrounded by leaf litter during the daytime (1100–1400 h). Additionally, two empty shells were found under a rock and leaf litter (Fig. 7). The new species is diminutive, and the colour of the shell resembles the surrounding rocks. Additionally, the shell is often

covered in mud, making it challenging to see. Live individuals of the new species were observed during the monsoon season (June and July), along with other land snails, such as the eupulmonates *Varadia amboliensis* Bhosale, Thackeray, Muley & Raheem, 2021 and species of *Ariophanta* Des Moulins, 1829, *Eurychlamys* Godwin-Austen, 1899, *Glessula* E. von Martens, 1860, and *Perrottetia* Kobelt, 1905, as well as cyclophorid land snails like *Cyclophorus* and *Cyathopoma* W.T. Blanford & H.F. Blanford, 1861.

Discussion

The genus Lagocheilus is distinguished by a spirally lirate shell and a small notch at the junction of the apertural margin and parietal wall of the shell (Blanford 1864), characteristics also included in Kobelt's (1902) diagnostic key. Among the nine Indian species of Lagocheilus, these distinctive features are readily discernible in the images of type materials and/or explicitly mentioned in the original descriptions of five species. In three species (L. malleatus, L. oakesi, and L. sikhimensis), the presence or absence of the apertural notch is uncertain, neither figures of the type specimens nor mentioned in their original descriptions, and in L. shiplayi both characters are absent. Similarly, among three Sri Lankan Lagocheilus species, the apertural notch is present in *L. occultus* but absent in *L. binoyae* and *L. vescus*. This variability raises the question of which characters have taxonomic value for identifying the genus or if the genus is monotypic. A comprehensive taxonomic revision with freshly collected topotypic material, supported by molecular data, is necessary to clarify the relationships and morphological characters of this group.

In addition to Lagocheilus hayaomiyazakii n. sp., periostracal hairs are also present in species of several other cyclophoroidean genera, such as Craspedotropis W.T. Blanford, 1864, Cyathopoma, Mychopoma W.T. Blanford, 1869, Scabrina W.T. Blanford, 1863, and Spiraculum Pearson, 1833, among others. Numerous studies have suggested that the periostracal hair fulfils a diverse range of functions, such as defence against predators (Webb 1950), camouflage by trapping soil and debris (Pilsbry 1940), seed and pollen transport, and as a mechanism for reducing shell damage when falling (Neubauer et al. 2019). In the new species, we found that when the shell was stored in dry conditions, the periostracal hairs were either lost or easily broke when handled (paratype NRC-AA-9580, 9581) or became bent or flattened against the shell's surface. On the application of a drop of water, the hairs reverted to their original position. We also noted that when a dry shell, either with or without

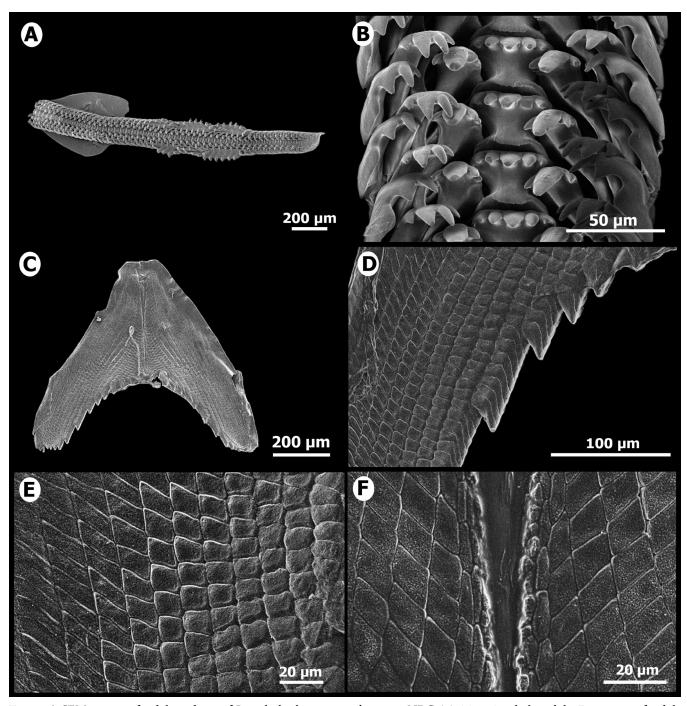


Figure 6. SEM images of radula and jaw of *Lagocheilus hayaomiyazakii* n. sp., NRC-AA-9577. **A**, whole radula. **B**, portion of radula showing several rows of teeth. **C**, jaw. **D**, serrated cutting edges of jaw. **E**, right-side of jaw showing irregular square to rectangular plates. **F**, central region of jaw showing regular to irregular rectangular plates.

hairs, came into contact with water, the water tended to ascend towards the shell's apex (A. Bhosale, personal observation). We think this is because the intricate sculpture on the shell and periostracum, which creates microcapillary spaces, appear to facilitate the upward movement of water.

While the lack of periostracal hairs in *L. malleatus* may be artefactual (i.e. an effect of inadequate sampling), the material available for *L. shiplayi* suggests that this species, like the Sri Lankan *L. vescus*, does actually lack periostracal hairs (although a thick periostracum is present in both species).

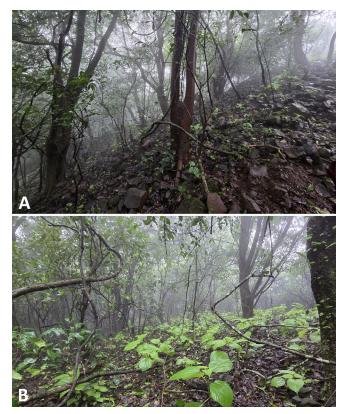


Figure 7. A, B, semi-evergreen forest habitat of *Lagocheilus hayao-miyazakii* n. sp., at Ratoba Point, Kodali, Tilari Nagar, Kolhapur District, Maharashtra, India.

In this respect, it is important to note that some cyclophorid genera do include species with periostracal hairs as well as those lacking periostracal hairs (e.g. *Pterocyclos* W.H. Benson, 1832 and *Cyathopoma*; D. Raheem and A. Bhosale personal observations) and that some cyclophorid taxa, such as *Pterocyclos*, have hairs in the juvenile and/or early-adult stage but not later in their development (A. Bhosale and D. Raheem personal observations). For the purposes of species identification, we do need more clarification on this, so further study of more/new comparative material is required.

Radulae of the South Indian Lagocheilus species are not available for detailed study, but comparison with two southeast Asian Lagocheilus species, L. buginensis P. Sarasin & F. Sarasin, 1899 and L. pachytropis Möllendorff, 1896, which were illustrated by Sarasin & Sarasin (1899), shows that all radulae of all three species have teeth with sharply pointed cups. The operculum of the new species is similar to L. buginensis (Sarasin & Sarasin 1899: pl. 7 fig. 81) but varies in having seven or eight whorls vs eight or nine whorls in L. buginensis. The jaw of the new species is sculptured with irregular, square to rectangular plates. This characteristic is unique among the cyclophoroidean genera (Venmans

1956; Nantarat et al. 2014b, 2019; Bhosale et al. 2025a, b).

Lagocheilus hayaomiyazakii n. sp. is the tenth species of the genus recorded so far from India, the third species of this genus reported from Peninsular India, and only the second species known from the Western Ghats. Additionally, this is the first time this genus has been recorded from the northern Western Ghats of Maharashtra, thus extending the known distribution of the genus in the Western Ghats 540 km northwards. The snail fauna of vast expanses of forest habitat across the Western and Eastern Ghats has not been explored, and it is likely that systematic fine-scale sampling of these areas will yield further new species of Lagocheilus.

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