



REVIEW OF THE PUPILLOIDEA OF PAKISTAN (GASTROPODA: EUPULMONATA: COCHLICOPIDAE, CHONDRINIDAE, ORCULIDAE, PYRAMIDULIDAE)

KURT AUFFENBERG^{1*}, RAFAQAT MASROOR², VUKAŠIN GOJŠINA³, BARNA PÁLL-GERGELY⁴

¹ Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611 USA
(e-mail: kurtauffenberg@gmail.com);  <https://orcid.org/0000-0001-9660-6776>

² Pakistan Museum of Natural History, Garden Avenue, Islamabad, Pakistan
(e-mail: rafaqat.masroor78@gmail.com);  <https://orcid.org/0000-0001-6248-546X>

³ Department of Morphology, Systematics and Phylogeny of Animals, University of Belgrade,
Faculty of Biology, Studentski trg 16, 11000, Belgrade, Serbia (e-mail: mr.gojsinavukasin@gmail.com);
 <https://orcid.org/0000-0002-0413-9304>

⁴ Plant Protection Institute, HUN-REN Centre for Agricultural Research, Budapest, Hungary
(e-mail: pallgergely2@gmail.com);  <https://orcid.org/0000-0002-6167-7221>

* corresponding author

ABSTRACT: The land snail fauna of Pakistan is poorly known. During surveys conducted in the summer months of 1990–1992 the Pupilloidea was the most diverse and commonly encountered group of land snails. The Chondrinidae, Cochlicopidae, Orculidae, and Pyramidulidae are reviewed herein. *Sphyradium doliolum* (Bruguière, 1792) is recorded from Pakistan for the first time. New Pakistan records for *Granopupa lapidaria* (Hutton, 1849), *Cochlicopa* cf. *lubrica* (O. F. Müller, 1774), and *Pyramidula humilis* (Benson, 1838) are provided. *Pyramidula* cf. *salimalii* is reported from localities other than the type locality for the first time. An unidentifiable species of *Pyramidula* is also reported.

KEY WORDS: Pulmonata; Pupilloidea; Pakistan; taxonomy

INTRODUCTION

Land snail surveys were conducted by the first author throughout much of Pakistan during 1990–1992; the Pupilloidea being the most commonly encountered group. The pupilloid fauna of Pakistan is remarkably diverse with a broad influence from the Palearctic/Holarctic, particularly at the genus level. POKRYSZKO et al. (2009) reviewed the Truncatellininae Steenberg, 1925, Vertigininae Pilsbry, 1918, Gastrocoptinae Pilsbry, 1918, and

Pupillinae Turton, 1831 (in part), providing morphological and distributional data for 22 species, including descriptions of ten new species. A review of diverse Enidae Woodward, 1903 (1880) will be published in the near future. Toward completion of the review of Pakistan Pupilloidea, Chondrinidae Steenberg, 1925, Cochlicopidae Pilsbry, 1900 (1897), Orculidae Pilsbry, 1918, and Pyramidulidae Kennard et Woodward, 1914 are discussed here.

METHODS AND MATERIALS

In addition to the specimens collected by the first author in the early 1990s, the late WALTER AUFFENBERG (Florida Museum of Natural History),

HAFEEZ REHMAN, ALEEM KHAN, and SHAMIM FAKHRI (Zoological Survey of Pakistan) provided additional specimens.

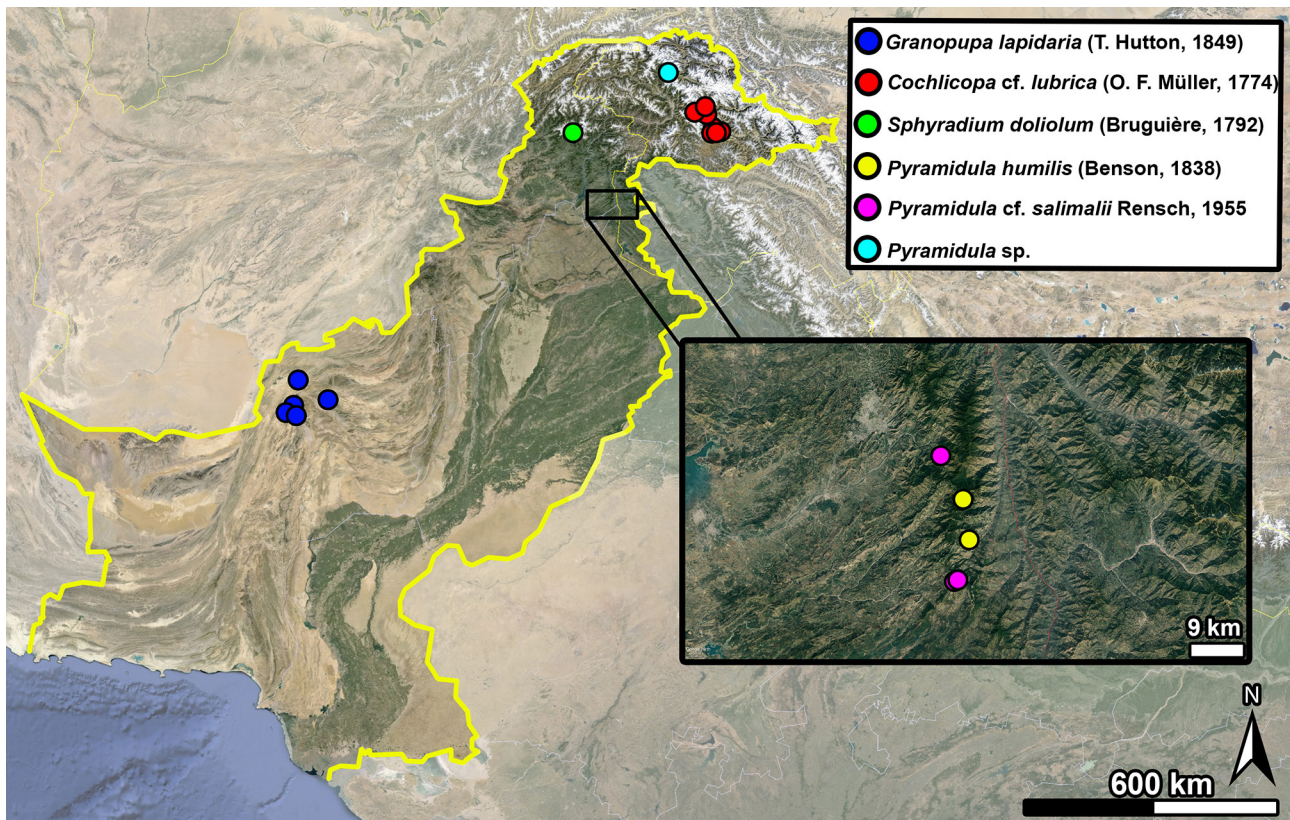


Fig. 1. Localities of Pupilloidea mentioned in this study

The political unit, district is not generally used in collection sites because districts are relatively often divided and renamed due to human population growth. Collection sites are listed as given on the specimen labels, including spellings that are no longer recognised, i.e. Baluchistan is now Balochistan.

About 340 specimens from an estimated 20 localities were examined during this study (Fig. 1). Specimens were collected by hand and/or the taking of soil or leaf litter samples at virtually every locality. The soil and leaf litter samples were later sorted under standard stereo microscopes. All specimens are housed in the Malacology and Invertebrate Zoology collection of the Florida Museum of Natural History, University of Florida, Gainesville. Basic shell meas-

urements and whorl counts follow those of KERNEY et al. (1983: 21). All measurements are given in millimeters (mm).

Photographs were taken using a Nikon SMZ25 digital microscope with Nikon Nis-Elements software.

The following abbreviations are used in the text and figures: FANA – Federally Administered Tribal Areas; former name for modern-day Gilgit-Baltistan and seven newly merged tribal districts of Khyber Pakhtunkhwa Province; H – shell height; NHM, NHMUK – The Natural History Museum, London; UF – Florida Museum of Natural History, University of Florida; UMZC – University of Cambridge Museum of Zoology; W – shell width.

SYSTEMATICS

Chondrinidae Steenberg, 1925

Granariinae Kokshoorn & Gittenberger, 2010

Genus *Granopupa* Boettger, 1889

Granopupa BOETTGER 1889: 249.

Type Species: *Pupa granum* Draparnaud, 1801 (by monotypy).

Distribution. Discontinuous from the Saudi Arabian Peninsula eastward to the borderlands of Pakistan and

Afghanistan (SCHILEYKO 1998: 120; GITTEBERGER et al. 2016).

Remarks. *Granopupa* and *Granaria* Held, 1838 are remarkably similar in shell morphology, particularly the relative positions and sizes of the apertural barriers. GITTEBERGER (1973) discussed two groups within *Granaria*; a western group in Europe (*G. frumentum* (Draparnaud, 1801), *G. variabilis* (Draparnaud, 1801), *G. stabilei* (von Martens, 1865), and *G. braunii* (Rossmässler, 1842)) and an eastern group occurring

from Saudi Arabia to western Pakistan (*G. lapidaria*, *G. persica*, and *G. arabica*). The two groups were differentiated mainly on shell size because the eastern group was known from shells only. GITTENBERGER et al. (2016) reexamined the groups during an analysis of recently collected material of *G. persica*. That study on shell morphology, anatomy, and molecular data, resulted in the eastern group being transferred to *Granopupa*.

Granopupa lapidaria (T. Hutton, 1849)

(Figs 1–7)

Pupa lapidaria HUTTON 1849: 652–653.

Pupa lapidaria Hutton, 1849 – PFEIFFER 1853: 3, 546; THEOBALD 1863: 381; HANLEY & THEOBALD 1874: 40, pl. 100, fig. 10; SOWERBY 1878: 20, pl. 16, fig. 147 (not pl. 4, fig. 32, see PILSBRY 1918: 331).

Pupa (Torquilla) lapidaria (Hutton, 1849) – ADAMS & ADAMS 1855: 169.

Abida (?) *lapidaria* (Hutton, 1849) – PILSBRY 1918: 330–331, pl. 46, fig. 10.

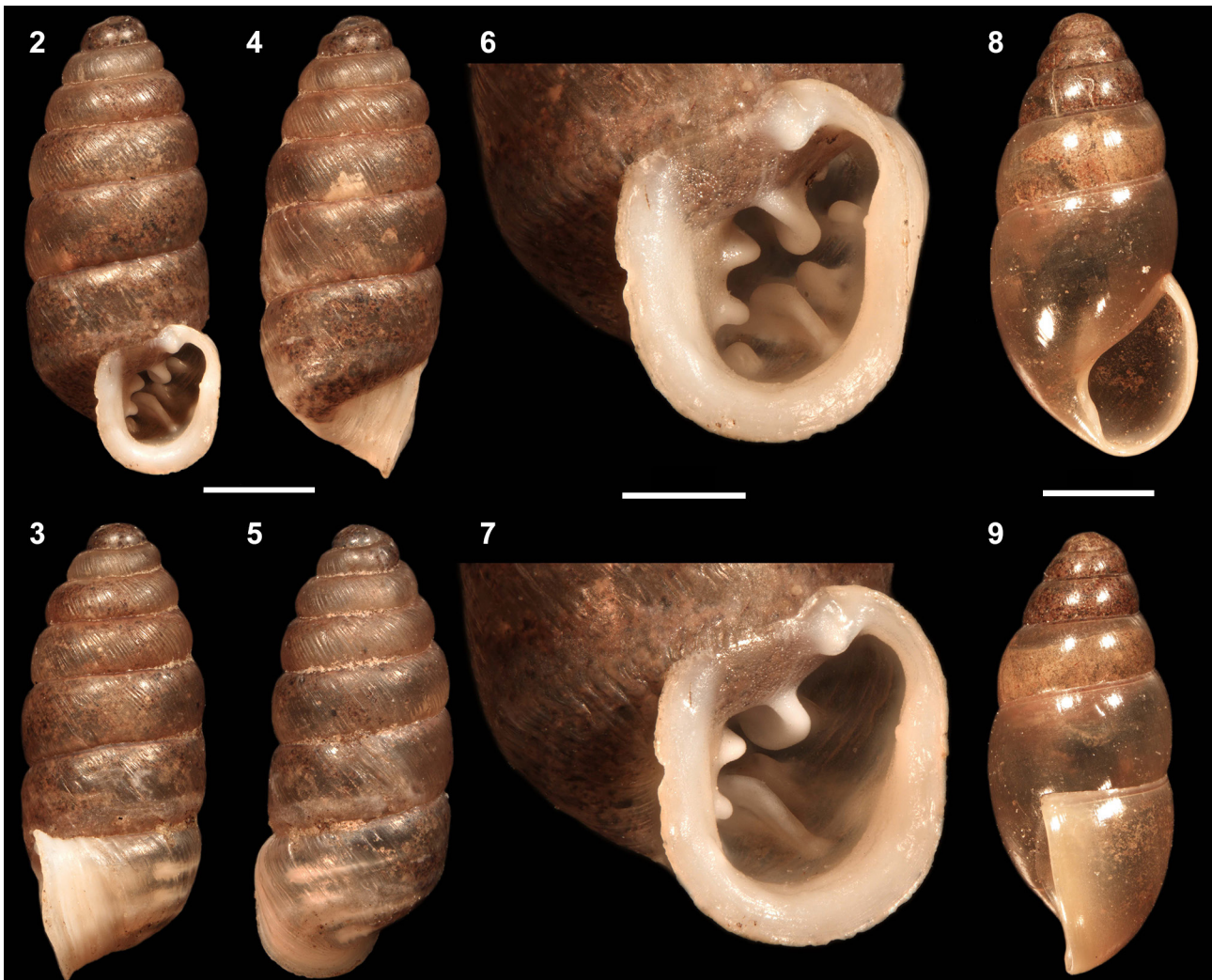
Abida lapidaria (Hutton, 1849) – JAECKEL 1956: 341.

«*Abida*» *lapidaria* (Hutton, 1849) – LIKHAREV & STAROBOGATOV 1967: 180.

Granaria lapidaria (Hutton, 1849) – GITTENBERGER 1973: 42–44, text-figure 10; SOLEM 1979: 16; AUFFENBERG 1997: 256; KOKSHOORN & GITTENBERGER 2010: 9.

Granopupa lapidaria (Hutton, 1849) – GITTENBERGER et al. 2016: 34.

Type specimens. Lectotype (NHMUK 1856.9.15.76/1) (H: 5.8 mm), Paralectotypes (NHMUK 1856.9.15.76/2–4) designated by GITTENBERGER (1973: 42–43, text-fig. 10). These specimens were presented to the Natural History Museum by Captain Thomas Hutton in 1856. The locality is given as Quetta, a city about 50 km north-northwest of the northern Bolan Pass. This is not the type locality given in the original description (see below). The original specimens on which the



Figs 2–9. Chondrinidae and Cochlicopidae of Pakistan: 2–7 – *Granopupa lapidaria* (T. Hutton, 1849); 8–9 – *Cochlicopa* cf. *lubrica* (O. F. Müller, 1774), UF197003, specimen 1. Scale bars 1 mm. All photos: B. PÁLL-GERGELY

species is based were collected by the Army of the Indus during their march into Afghanistan in 1839 (HUTTON 1849) when they traversed the Bolan Pass on their way to Kandahar via Quetta (MACGREGOR 1878). The designation of the type specimens is not disputed. Although the lectotype and paralectotypes were not examined, the specimens collected in these recent surveys are considered typical for the species based on GITTENBERGER (1973) and a photograph of the lectotype provided by NHM.

Type locality. "... under stones among blocks of limestone bordering the desert plain Dusht-i-be-dowlut, at the western end of the Bolan Pass." [Pakistan, Balochistan Province]. This locality cannot be located on modern maps available to us or GITTENBERGER (1973). However, the name could refer to Dasht-e-Lut (Lut Desert), a large desert basin east and northeast of Kerman. The basin is far from the western end of the Bolan Pass, but perhaps the region extending west-northwest from the Bolan Pass to the Lut Desert was under one name in 1839. Nevertheless, from the description provided by HUTTON (1849) and the Army of the Indus' tract described by MACGREGOR (1878: 161–162), we believe the type locality to be the flatland west of Kolpur and south of Spezand below the northern terminus of the Bolan Pass, and not Quetta itself. This area is now known as Dasht (= plain in Persian), Mastung District.

Material examined. Pakistan, Baluchistan Prov., 5.6 km NNW Ziarat, Sandeman Tangi, 2,550 m, 30°24'N, 67°44'E, K. AUFFENBERG, 10 Sept. 1992, KA-1068, UF 202684/1; Pakistan, Baluchistan Prov., 10.2 km NE Quetta, Hanna Lake resort area, 1,940 m, K. AUFFENBERG, 13 Sept. 1992, 30°15'N, 67°06'E, KA-1074, UF 202706/1 + fragment; Pakistan, Baluchistan Prov., Pakistan, Baluchistan Prov., 20 km SW Quetta, Hazarganji - Chiltan National Park, small east-west trending ridge, 1.0 km S rest house, 2,250 m, 30°03'N, 66°53'E, K. AUFFENBERG, 14 Sept. 1992, KA-1077, UF 202714/1; Pakistan, Baluchistan Prov., 21.7 km S Quetta, Alishair village, 1,760 m, K. AUFFENBERG, 17 Sept. 1992, 29°59'N, 66°53'E, KA-1080, UF 202723/3; Pakistan, Baluchistan Prov., 7.5 km N Pishin, 1,530 m, 18 Sept. 1992, 30°39'N, 67°02'E, K. AUFFENBERG, KA-1081, UF 202725/1 fragment.

Description. Shell height 5.2–5.4 mm, shell width 2.3 mm (n = 2), cylindrical, tapering spire, apex blunt; 6.25–6.5 whorls, convex, sutures impressed, umbilicus rimate; apertural lip broadly expanded, very thickened within on adult specimens, not reflected, parietal callus weak; ca. 1 embryonic whorl, sculpture smooth to very finely granulose; spire sculpture of fine axial growth striations, weakening gradually to almost smooth on body whorl; eight apertural barriers, a prominent parietal lamella, a small to prominent angular tooth at upper insertion of out-

er lip, two columellar lamellae, subcolumellar less prominent, four immersed palatal plicae, infrapalatal low and short, lower palatal most prominent, upper palatal lower, suprapalatal slightly less prominent, upper and lower palatal plicae extending forward almost to lip, others more immersed; colour light to darker brown, palatal plicae visible from exterior as lighter in colour, columella, umbilical area, and expanded lip whitish.

Distribution. The species may be restricted to the Afghan/Pakistan borderlands from the Bolan Pass area north to the Kandahar region (HUTTON 1849, JAECKEL 1956, GITTENBERGER 1973, AUFFENBERG 1997, GITTENBERGER et al. 2016, this study). Further collecting may extend the distribution in the wide-ranging similar habitats both north and south of its currently known range (Fig. 1).

Habitat. Found in leaf litter, detritus, and under limestone rocks, beneath shrubs, at bases of small trees, and among grasses at elevations ranging from 1530 to 2550 m often accompanied by *Gastrocopta huttoniana* (Benson, 1849), *Truncatellina himalayana* (Benson, 1863), and *Gibbulinopsis signata* (Mousson, 1873).

Comparative remarks. *Granopupa lapidaria* is most similar in shell morphology to *G. arabica* (Dohrn, 1860) and *G. persica* Gittenberger, 1973, but the apertural barriers of the former are stronger and the apertural lip is more expanded. *Granopupa lapidaria* is also similar to *G. granum* (Draparnaud, 1801), but the latter has less-pronounced apertural barriers, generally more whorls (5^{3/4}–8^{3/4}) with stronger axial riblets, is usually shorter in height (3.1–6.0 mm), and narrower in diameter (1.4–1.8 mm). Pakistan species of *Gastrocopta* Wollaston, 1878 are smaller in size and the apertural barriers are generally marginal, not deeply immersed within the aperture (see POKRYSZKO et al. 2009). The genus *Pupoides* Pfeiffer, 1854 lacks apertural barriers except for the often prominent angular tubercle at the upper insertion of the outer lip.

Remarks. Live specimens of *G. lapidaria* were not collected and further clarification of the species' assignment is not possible. The species was not encountered by the surveys of the Street Expedition (1965), (SOLEM 1979) and LIKHAREV & STAROBOGATOV (1967) in Afghanistan, but brief species accounts are provided in those accounts.

Cochlicopidae Pilsbry, 1900 (1879)

Remarks. ROTH (2003) provided evidence that Cionellidae, Pfeiffer, 1879 has priority over Cochlicopidae Pilsbry, 1900 (1879), but we use the latter based on its far greater usage in the scientific literature (see BOUCHET et al. 2017 for brief discussion). The family is monotypic (see below).



Genus *Cochlicopa* Férussac, 1821

Helix (*Cochlicopa*) FÉRUSSAC 1821: 24.

Type species. *Helix lubrica* O. F. Müller, 1774 (by subsequent designation, BOURGUIGNAT 1856: 197).

Distribution. Holarctic; Canada south to northern Mexico and Eurasia south to Pakistan and Afghanistan and east to Japan (PILSBRY 1948, SCHILEYKO 1998, EGOROV 2008, LIKHAREV & STAROBOGATOV 1967, THOMPSON 2011).

Remarks. ROTH (2003) has shown that *Cochlicopa* Férussac, 1821 has priority over *Cionella* Jeffreys, 1829. The genus consists of 36 species, including 13 fossil taxa. The 11 species described by UVALYEVA (1967, n = 1) and STAROBOGATOV (1996, n = 10) are considered valid by some authors (EGOROV 2008, SYSOEV & SCHILEYKO 2009). However, we rather agree with the latest publication in this topic (BALASHOV 2016), which raises serious concerns about their validity. Following BALASHOV (2016), MOLLUSCABASE (2024) considers the taxa described by UVALIEVA (1967) and STAROBOGATOV (1996) *taxa inquirenda*. Based on molecular and microgeographic analyses, application of a species concept is difficult in the genus (E. GITTENBERGER, personal communication). The genus has a long fossil history in Europe dating from the middle Eocene to the Holocene. See WENZ (1923: 1098), ZILCH (1959–1960: 145) and NORDSIECK (2014: 157–158) for discussions.

Cochlicopa cf. *lubrica* (O. F. Müller, 1774)

(Figs 1, 8–9)

Helix lubrica O. F. MÜLLER 1774: 104.

Cochlicopa lubrica – has been extensively cited in the literature due to its broad distribution.

Material examined. Pakistan, FANA, Skardu Dist., Skardu, Astana area, at bridge at Hargisia Nullah (river), 2,210 m, 35°18'N, 75°39'E, K. AUFFENBERG et al. 29 Aug. 1991, KA-904, UF 196970/1 + 1 juvenile; Pakistan, FANA, Skardu Dist., ca. 21 km NW Skardu, seep along Gilgit-Skardu Rd, 2,210 m, 35°24'N, 75°29'E, K. AUFFENBERG, 29 Aug. 1991, KA-905, UF 196972/2 + 3 juveniles; Pakistan, FANA, Skardu Dist., ca. 25 km NW Skardu, Kachura Village, Shangrilla Resort, 2,220 m, 35°22'N, 75°24'E, K. AUFFENBERG, 28 Aug. 1991, KA-902, UF 196961/ca. 40 + many juveniles; Pakistan, FANA, Skardu Dist., 29.9 km NW Kachura, along Skardu-Gilgit Rd, 2,050 m, 35°36'N, 75°21'E, K. AUFFENBERG, 01 Sept. 1991, KA-910, UF 196998/3 + 3 juveniles); Pakistan, FANA, Skardu Dist., 52.0 km NW Kachura, along Skardu-Gilgit Rd, Triku Village area, 1880 m, 35°37'N, 75°12'E, K. AUFFENBERG, 01 Sept. 1991, KA-912, UF 197003/4 + many juveniles, one adult shell photographed; Pakistan, FANA, Skardu Dist., Buddha Rock area, 2,400 m, 35°18'N, 75°39'E, K. AUFFENBERG, 31

Aug. 1991, KA-909, UF 196992/7 + many juveniles; Pakistan, FANA, Skardu Dist., 22.9 km NW Kachura, along Skardu-Gilgit Rd, 2,050 m, 35°36'N, 75°21'E, K. AUFFENBERG, 01 Sept. 1991, KA-911, UF 197001/3 juvenile shells.

Description. Shell medium-sized for genus, shell height 3.9–6.1 mm, shell width 2–2.3 mm (smallest and largest Pakistani specimens measured); oblong-conoid. Sutures moderately defined. 4.5–5.5 whorls, moderately convex. Apex obtuse. Shell sculpture smooth and glossy throughout. Aperture almost vertical, ovate; lacking barriers. Outer lip evenly curved, narrowly thickened interiorly. Columella curved toward outer lip, constricted toward basal lip. Parietal callus thin and transparent. Shell colour dark yellowish-brown to reddish-brown; lighter yellowish/reddish zone behind outer lip.

Habitats. *Cochlicopa lubrica* (as *Zua lubrica*) was reported by WOODWARD (1956) as “subfossil” and “dead shells” collected in 1847–48 from the alluvial plains of Iskardo (an early spelling of Skardu) and Kashmir. This species was collected in the recent surveys alive and dead under and among rocks in the landscaped grassy gardens of the Shangrilla Resort and among the herbaceous/mossy layer along small, freshwater seeps crossing the Skardu-Gilgit Road; the surrounding habitats are without visible macro-vegetation. It was often accompanied by *Vallonia* spp., *Gastrocopta huttoniana* (Benson, 1849), *Vitrina* sp., *Euconulus* sp., *Hawaiiia* sp. and *Cecilioides* sp.

Comparative remarks. The species cannot be confused with any other Pakistan species due to its very smooth, glossy sculpture.

Remarks. These specimens represent the first country record for the genus since WOODWARD (1856). Identification of *Cochlicopa* species is very difficult, mostly because of the many synonyms recently introduced (STAROBOGATOV 1996 vs BALASHOV 2016), but also, the taxonomy of the genus is far from being resolved so we felt it best not to attempt a species-level identification. These specimens could possibly be assigned to *Cochlicopa lubricella* (Porro, 1838) based on shell width (E. GITTENBERGER, personal communication). The Pakistan specimens are only preliminarily identified as *Cochlicopa lubrica* (O. F. Müller, 1774).

Orculidae Pilsbry, 1918

Orculinae Pilsbry, 1918

Genus *Sphyradium* Charpentier, 1837

Pupa (*Sphyradium*) CHARPENTIER 1837: 15.

Type species. *Bulimus doliolum* Bruguière, 1792 (subsequent designation by ALBERS & MARTENS 1860: 295).

Distribution. The monotypic genus occurs from portions of western and southern Europe, sporadically eastward across Turkey and northern Iran, Ukraine, Turkmenistan, Uzbekistan, Kyrgyzstan, Tajikistan (LIKHAREV & RAMMEL'MEIER 1965: 174, KERNEY et al. 1983, SCHILEYKO 1984: 129–130, 1998: 72, HAUSDORF 1996: 54–56, SVERLOVA 2006, EGOROV 2008: 24, SYSOEV & SCHILEYKO 2009, KANTOR et al. 2009, BALASHOV 2016: 85–86), and south to the northern Swat District, Khyber Pakhtunkhwa Province, Pakistan (this study); not reported from Afghanistan.

Remarks. *Pupa himalayana* Benson, 1863 assigned to *Pupa* (*Sphyradium*) by PFEIFFER & CLESSIN (1881: 352), *Sphyradium* by GUDE (1914: 41), and *Orcula* (*Sphyradium*) by MITRA et al. (2005: 128) is now classified as *Truncatellina himalayana* (Benson, 1863) (POKRYSZKO et al. 2009: 430–431).

See SCHILEYKO (2012) for brief phylogenetic discussion.

Sphyradium doliolum (Bruguière, 1792)

(Figs 1, 10–18)

Bulimus doliolum BRUGUIÈRE 1792: 351.

Sphyradium doliolum has been extensively cited in the literature due to its broad distribution, but synonyms are few; see PILSBRY (1922: 17–25, pl. 2, figs. 1, 2, 4; 1926: 256), HAUSDORF (1996: 54–56, pl. 6, figs. 72–73), and PÁLL-GERGELY et al. (2013: 41–42) for discussions.

Type specimens. unknown

Type locality. “environs de Paris”, [France]

Specimens examined. Pakistan, Khyber Pakhtunkhwa Province, 10 km N Kalam, Matiltan village, 3100m, 17 Sept. 1990, 35°10'N, 72°35'E, W. AUFFENBERG, et al., KA-784, UF 181019/42, mostly juveniles; UF 181020/1, in ethanol.

Description. Shell cylindrical (H: 5.5–5.7 mm, W: 2.3–2.4 mm, n = 2), apex dome-shaped with ca. 8 whorls, embryonic whorls spirally striated, sutures moderately to lightly impressed, penultimate whorl often more narrow than upper whorls, body whorl often flattened laterally behind lip; aperture auricular, often greatly thickened within, columella with two small lamellae, lower stronger, both entering more than one whorl, subequal in size inward, parietal lamella thin, erect, becoming lower toward apertural margin, extending inward over a whorl, becoming lower inward, increasing in height again near inward termination; parietal callus weak, thin; outer lip expanded, particularly basally and toward umbilicus, slightly reflexed, sinuous in lateral view, peripheral area extending further forward; shell often glossy, sculpture of prominent, oblique, axial ribs with periostracal ridges, often ragged, when fresh,

juveniles with epidermal ridges terminating sharply just above suture; umbilicus rimate, partially covered by expanded lip; colour light brown, lighter around umbilicus and behind lip, apertural lip and columella whitish.

Distribution. Same as the genus. Specimens collected in these surveys from the northern Swat region, Khyber Pakhtunkhwa Province represent a new country record (Fig. 1).

Habitat. Mixed oak and cedar open forest, grassy; live specimens found under rocks at 3,100 m elevation. The specimens were collected with *Deroceas laeve* (O. F. Müller, 1774), *Punctum* sp., *Euconulus* sp., *Hawaiiia* sp., and *Truncatellina himalayana* (Benson, 1863).

Comparative remarks. The species cannot be confused with other species in Pakistan due to its unique apertural barriers and internal lamella, domed apex, strong axial ribs, and distinct, ragged periostracum when present. Juveniles can be confused with *Pyramidula* species, but the former has a long parietal lamella, which distinguishes them from similarly shelled species.

Remarks. This Palearctic species was collected at only one site in the northern Swat region, but collecting activities were extremely limited in that area. The species was not found during more extensive collecting to the south and east.

Pyramidulidae Kennard & Woodward, 1914

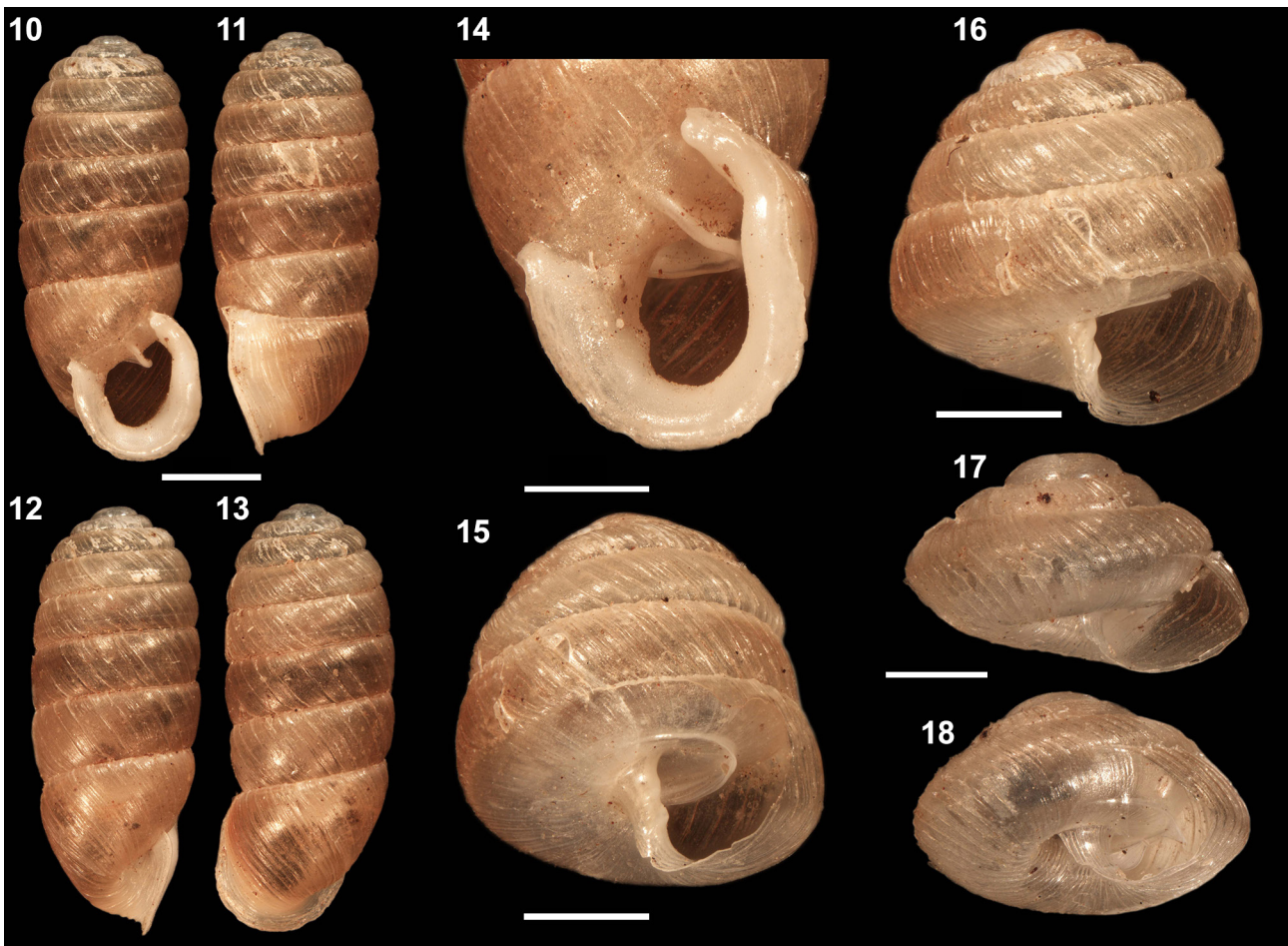
Genus *Pyramidula* Fitzinger, 1833

Pyramidula FITZINGER 1833: 95.

Type species. *Helix rupestris* Draparnaud, 1801, by monotypy.

Distribution. The genus occurs from Western Europe east through Central and East Asia (KERNEY et al. 1983, EGOROV 2008, SYSOEV & SCHILEYKO 2009, BALASHOV & GURAL-SVERLOVA 2011, BALASHOV 2016), Japan (PILSBRY & HIRASE 1902), and Taiwan (HWANG 2015) and south with disjunct populations through Nepal (*Pyramidula kuznetsovi* Schileyko et Balashov, 2012), and the Indian Peninsula (*P. euphthalus* (Blanford et Blanford, 1861) (RAHEEM et al. 2014)) to the highlands of Sri Lanka (*P. halyi* (Jousseau, 1894) (NAGGS & RAHEEM 2000)); not recorded from the Philippines, Borneo, and mainland Southeast Asia. GITTENBERGER et al. (1980: 12) indicate that *Pyramidula javana* (Möllendorff, 1897) from Java, Bali, and Lombok, Indonesia needs to be revised as it may be related to *Toltecia pusilla* (Lowe, 1831) (= *Paralaoma servilis* (Shuttleworth, 1852)) (Punctidae).

Remarks. Recent studies on European populations of *Pyramidula* have provided critical data required to resolve their complex taxonomies (GITTENBERGER & BANK 1996, MARTÍNEZ-ORTI et al. 2007, KIRCHNER



Figs 10–18. Orculidae of Pakistan, *Sphyradium doliolum* (Bruguière, 1792): 10–14 – UF181019, specimen 1; 15–16 – UF181019, specimen 2; 17–18 – UF181019, specimen 3. Scale bars 1 mm. All photos: B. PÁLL-GERGELY

et al. 2016, RAZKIN et al. 2016a, b, HORSÁKOVÁ et al. 2022). The intensive morphologic and genetic studies have better defined these species that have high inter- and infra-specific shell variability. Study of Asiatic species may reveal similar morphologic and taxonomic trends. This variation, as well as a simple reproductive anatomy, makes identification difficult.

Three distinct morphotypes of *Pyramidula* were collected in Pakistan during the surveys discussed here. One is fairly confidently assigned to *P. humilis* (Benson, 1838) based solely on shell morphology. One is tentatively identified as *P. cf. salimalii* Rensch, 1955 (originally described as *P. rupestris salimalii*) and one species as *Pyramidula* sp. Although we believe populations with unique combinations of conchological characters may be primarily defined on the basis of shell morphology, we are reluctant to introduce new taxa at this time (see below for discussions). Two of the species discussed here appear to be limestone obligates, but the third appears not to be so restricted. The scattered and often remote limestone regions of the western Himalaya, Pakistan, and Afghanistan may reveal undescribed species of

Pyramidula with diversity similar to that found in Europe, i.e. cryptic species.

In Pakistan *Pyramidula* species can be confused with *Euconulus fulvus* (O. F. Müller, 1774) (Euconulidae) and *Kaliella nana* (T. Hutton, 1838) (Helicarionidae), but the former is more broadly umbilicate, has distinct axial riblets, and fewer whorls.

Pyramidula humilis (Benson, 1838)

(Figs 1, 19–30)

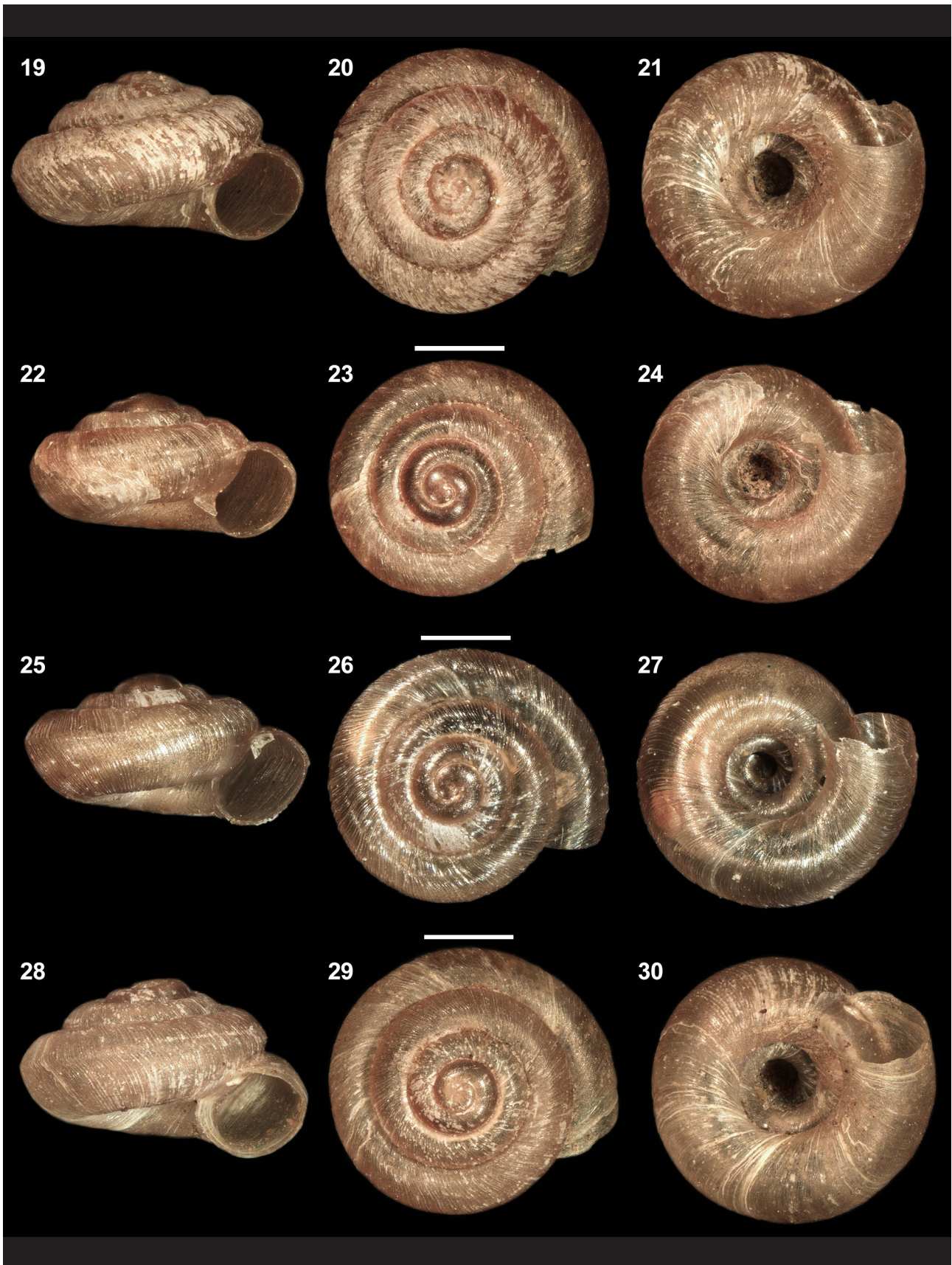
Helix humilis BENSON 1838: 217.

Helix humilis Benson, 1838 – PFEIFFER 1847: 106; REEVE 1851: pl. 133, species 825; PFEIFFER 1853: 322–323, pl. 129, fig. 28; HANLEY & THEOBALD 1873: 28, pl. 61, figs 4–6.

Helix (Patula) humilis Benson, 1838 – PFEIFFER 1856: 125; ALBERS & VON MARTENS 1860: 86; NEVILL 1878a: 66, NEVILL 1878b: 18.

Vallonia humilis (Benson, 1838) – THEOBALD 1881: 49. *Patula (Discus) humilis* (Benson, 1838) – PFEIFFER & CLESSIN 1881: 90.

Helix (Patula (Discus)) humilis Benson, 1838 – TRYON 1887: 22, pl. 3, figs 4–6.



Figs 19–30. Pyramidulidae of Pakistan, *Pyramidula humilis* (Benson, 1838): 19–21 – UF197290, specimen 1; 22–24 – UF197290, specimen 2; 25–27 – UF197309; 28–30 – UF521533, specimen 1. Scale bars 1 mm. All photos: B. PÁLL-GERGELY

Pyramidula humilis (Benson, 1838) – PILSBRY 1893: 44; GODWIN-AUSTEN 1899: 262; GUDE 1914: 43; AUFFENBERG 1997: 258; KUZNETSOV & SCHILEYKO 1997: 135; MITRA et al. 2005: 129; RAMAKRISHNA et al. 2010: 126; PREECE et al. 2022: 157, fig. 70G.
Helix (*Vallonia* ?) *humilis* – GODWIN-AUSTEN 1914: 330, pl. 50, figs. 5 a, b (radula), pl. 158, fig. 1 (shell).

Type material. Lectotype (UMZC I.102010), designated by PREECE et al. (2022): “*Discus humilis* Hutton.” from “Simla”).

Type locality. Simla [Shimla, Himachal Pradesh, India]

Material examined. Pakistan, Khyber Pakhtunkhwa Prov., 0.8 km S Khaira Gali, along road to Murree, 2,250 m, 33°58'48.0"N, 73°23'42.0"E, K. AUFFENBERG, 18 Sept. 1991, KA-988, UF 197309/1 (H: 2.0 mm, W: 3.8 mm), UF 197308 in alcohol; same data as preceding, UF 521533/17; Pakistan, Khyber Pakhtunkhwa Prov., Ayubia National Park, Dunga Gali, 2,340 m, 34°03'00.0"N, 73°25'01.2"E, 18 Sept. 1991, K. AUFFENBERG et al., KA-983–984, UF 197290/45.

Description. Shell light yellowish to greyish in colour throughout; size medium for genus (up to H: 2.6, W: 1.7 mm), depressed, somewhat glossy, 3.4–4.25 whorls, convex, increasing slowly in size, last 0.5 whorl descends regularly toward the aperture, sutures well-impressed, periphery rounded (usually) to slightly angulated, 1.1–1.25 nuclear whorls with spiral striations that fade near the teleoconch giving way to fine axial growth striations resulting in a silky surface; aperture roundish; parietal callus very weak or lacking, transparent; simple apertural lip, not reflected or thickened, fragile; umbilicus open and deep, ca. 1/2 width of base.

Habitat. “On moist rocks, on wet dead leaves, and at the roots of shrubs in the khads [valleys]” (HUTTON & BENSON 1838); “... on trees at Tandiani” (THEOBALD 1881). Found during these surveys on limestone boulders, in solution pits and in cracks and crevices, often aggregated, and among shaded litter and soil on conifer forest floor at 2,250–2,350 m in elevation. Specimens were found accompanied by *Anadenus altivagus* (Theobald, 1862), and *Tanychlamys* sp.

Comparative remarks. *Pyramidula humilis* can be distinguished from its congener, *P. cf. salimalii* (see below) by its lower shell and much broader umbilicus. Furthermore, *P. cf. salimalii* is darker (brownish instead of yellowish), has a glossier shell surface and less dense and less regularly arranged radial lines.

Distribution. *Pyramidula humilis* occurs in limestone regions of northwestern India (HUTTON & BENSON 1838, HANLEY & THEOBALD 1876, TRYON 1887, GODWIN-AUSTEN 1899, RENSCH 1955, ZILCH 1962, DEY & MITRA 2000, MITRA et al. 2005) and the Galyat Range, Murree Hills, Pir Pangal Mountains of

eastern central Pakistan (NEVILL 1878b, THEOBALD 1881, GODWIN-AUSTEN 1899, AUFFENBERG 1997, this study, see Fig. 1). A single, dead specimen was reported from a grassy rockslide the Shivapuri-Nagarjun National Park, Kathmandu District, Nepal (KHANAL & BUDHA 2013, BUDHA et al. 2015) and KUZNETSOV & SCHILEYKO (1997) report the species from Annapurna National Park in western Nepal.

Remarks. This species' occurrence in such close proximity (ca. 4 km straight-line distance) to that of specimens assigned to *Pyramidula cf. salimalii* in Pakistan is interesting. Further collecting in the region is suggested.

The figure in HANLEY & THEOBALD (1873, pl. 61, figs 4–6) depicts a specimen with a wider umbilicus than typical specimens of the species. We cannot explain this difference at this time.

The following footnote is included with the species' description (HUTTON & BENSON 1838: 217): “A reversed variety of this shell occurs at Fágú, [18 km E Shimla, Himachal Pradesh] in decayed trees, differing thus in habits from the dextral species which affects rocks and dead leaves principally. The shell is of four whorls exclusive of apex, finely wrinkled by the lines of growth; umbilicus discovering the previous whorls. – Diameter 1½ lines [ca. 3.2 mm]. In all respects resembling the dextral shell.” A lot of four sinistral specimens from Jagoo [= Fágú] (leg: Capt. T. HUTTON) is housed in the Natural History Museum (NHMUK 1856.9.15.45). Also, NEVILL (1878: 66) mentions a series of sinistral specimens in the Indian Museum collected by F. STOLICZKA at “Chur, near Simla.” The status of these populations is unknown.

Pyramidula cf. salimalii Rensch, 1955

(Figs 1, 31–36)

Pyramidula rupestris salimalii RENSCH 1955: 166.

Pyramidula rupestris salimalii – ZILCH 1962: 232, pl. 7, fig. 7.

Types examined. Holotype: SMF 153481, Chakrata (Uttarakhand) – Deoband (Uttar Pradesh) area of northern India at ca. 8,000–10,000 ft. (ca. 2,450–3,050 m) above sea level (photographs in RENSCH (1955) and ZILCH (1962) examined). (Holotype and Paratypes: SMF 153494/15 not physically examined).

Additional specimens examined. Pakistan, Khyber Pakhtunkhwa Province, Nathia Gali, slope behind Green's Hilltop Hotel, 2,480 m, 34°07'N, 73°22'E, K. AUFFENBERG et al., 16 Sept. 1991, KA-980, UF 197268/1 very small juvenile, identification questionable; Pakistan, Punjab Prov., Murree Hills, 2.0 km SW Murree, wooded stream, 2,000 m, 33°55'N, 73°24'E, K. AUFFENBERG et al., 20 Sept. 1990, KA-802, UF 181088/164, mostly subadults and juveniles; Pakistan, Punjab Prov., Murree Hills, N slope Murree Mt.,

2.8 km E Sunny Banks, hiking trail to Kashmir Point, 2,050 m, 33°55'N, 73°24'E (in Khyber Pakhtunkhwa Prov. via Google Earth), K. AUFFENBERG et al., 20 Sept. 1991, KA-998, UF 197351/1.

Description of UF shells. Shell reddish brown to dark brown in colour throughout; size medium for genus (up to H: 2 mm × W: 2.7 mm), helicoid to depressed helicoid, 4.25–4.75 whorls, thin shelled, fragile, periphery bluntly angulated, 0.75–1.0 embryonic whorls, sutures well-impressed, last 0.75 whorl descends regularly toward aperture; aperture small, roundish (1.4 mm H, 1.4 mm W); parietal callus very weak or lacking; simple apertural lip, not reflected or thickened; umbilicus open and deep, ca. 1/3 width of base; shell sculpture of rather strong, somewhat

regular axial growth wrinkles, often weaker on base, some striations with fine axial periostracal ridges along top.

Habitat. This species was collected alive in these surveys on shaded, mossy limestone boulders and oak tree trunks in mixed hardwood and conifer forests at elevations ranging from 2,000 to 2,480 m. *Cylindrophaedusa waageni* (Stoliczka, 1872), *Tanychlamys* spp., *Bensonies monticola* (Benson, 1838), *Kaliella* spp. and others accompanied this species.

Comparative remarks. *Pyramidula humilis* has a wider umbilicus, a lighter colour (rather greyish-yellowish, while this species is reddish brown) and a finer, silky sculpture (rather ribbed/wrinkled in this species), which is most prominent on the ventral side.



Figs 31–39. Pyramidulidae of Pakistan: 31–33 – *Pyramidula* cf. *salimalii* Rensch, 1955, UF181088, specimen 1; 34–36 – *Pyramidula* cf. *salimalii* UF181088, specimen 2; 37–39 – *Pyramidula* sp. UF197097, specimen 1. Scale bars 1 mm



Pyramidula kuznetsovi from Nepal often (not always) has a scalariform shell shape, has a much narrower umbilicus than this species, and has a finer sculpture, most prominently different on the ventral side.

Distribution. Known from Uttarakhand and Uttar Pradesh, northern India and from the two northeastern Pakistan localities mentioned above (Fig. 1). The distance between the two Pakistan populations is ca. 22 km.

Remarks. The type specimens were collected in association with *P. humilis* but are characterised by the more conoid shell (H: 2.0–2.5 mm, W: 2.5–2.9 mm), and narrower umbilicus (RENSCH 1955: 166–167; ZILCH 1962: 232, pl. 7, fig. 7).

We believe this taxon should be elevated to species level since it can be distinguished from *Pyramidula humilis* and a close relationship to the European *P. rupestris* is untenable. Although the UF material was collected ca. 550 km northwest of the type locality of *P. salimalii*, the key traits (conical shell, relatively narrow umbilicus, wrinkled shell surface) are similar. Therefore, the UF shells are provisionally identified here as *P. cf. salimalii*.

***Pyramidula* sp.**

(Figs 1, 37–39)

Material examined. Pakistan, Khyber Pakhtunkhwa Prov., 36.8 SW Karimabad, stream on N side of Rakaposhi Mountain, just W Kasimabad village, 2,000 m, 36°15'N, 74°31'E, K. AUFFENBERG, et al., KA-928, UF 197097/1 fragment.

Remarks. This single, broken shell has a very narrow umbilicus. Its colour and sculpture is most similar to *Pyramidula* cf. *salimalii*, but the latter species has a slight keel on the body whorl. *Pyramidula kuznetsovi* has a similar narrow umbilicus, but most specimens are keeled and higher spired. This may be a new species, but the material is insufficient for description. This was the only *Pyramidula* found in these surveys in a non-limestone area (Fig. 1). This specimen was accompanied by numerous species, including *Pupilla satparanica* Pokryszko et Auffenberg, 2009, *P. annandalei* Pilsbry, 1921, *Gastrocopta huttoniana* (Benson, 1849), *Vallonia ladacensis* (G. Nevill, 1878) and others.

DISCUSSION

The Pupilloidea is the most diverse group of terrestrial mollusks in Pakistan. POKRYSZKO et al. (2009) studied several genera, providing locality records, habitats, and the description of ten new species. The fauna is most greatly influenced at the genus level by the Palearctic/Holarctic, not the western Indomalayan Realm of UDVARDY (1975).

South-central Asia is one of the most biologically diverse regions of the world. Yet, most of this vast mountainous area remains inadequately surveyed for terrestrial mollusks due to its harsh terrain, periodic political unrest, as well as a general lack of trained malacologists. The land snail surveys made in Pakistan during 1990–1992 make clear that further collecting activity is required and suggests that many more species remain to be collected and described.

ACKNOWLEDGEMENTS

We thank J. SLAPCINSKY of the Florida Museum of Natural History, University of Florida for access to specimens; J. ABLETT of the NHM for assistance with specimens under his care and photographs; F. NAGGS

(NHM), for providing critical literature and information concerning specimens at the NHM; R. PREECE, Museum of Zoology, University of Cambridge for photographs; R. EGOROV, Lobnya, Russia for literature and translation; E. GITTEBERGER, Naturalis Biodiversity Center, Leiden for literature and comments in his review of the manuscript; the late H. G. LEE of Jacksonville, Florida and BARRY ROTH of San Francisco, California for discussions and support; H. REHMAN, S. FAHKRI, and A. KHAN, Zoological Survey of Pakistan, Karachi, provided every type of logistical service. The Pakistan non-marine mollusk surveys were funded by the Division of International Conservation, U. S. Fish and Wildlife Service to the late W. AUFFENBERG, Florida Museum of Natural History, University of Florida, and the Thomas LaDue McGinty Fund, Florida Museum of Natural History, University of Florida Foundation. This study was supported by the Hungarian Research Fund (OTKA FK 135262) and the Bolyai Research Scholarship of the Hungarian Academy of Sciences to BPG and by the Serbian Ministry of Science, Technological Development and Innovations (Contract No. 451-03-66/2024-03/200178) to VG.



REFERENCES

- ADAMS H., ADAMS A. 1854–1858. The genera of recent Mollusca arranged according to their organization. 2: 1–661, John Van Voorst, London.
<https://doi.org/10.5962/bhl.title.4772>
- ALBERS J. C., MARTENS E. VON 1860. Die Heliceen nach natürlicher Verwandtschaft systematisch geordnet von Joh. Christ. Albers. 2nd Edition. W. Engelmann, Leipzig.
<https://doi.org/10.5962/bhl.title.11218>
- AUFFENBERG K. 1997. The biogeography of the land snails of Pakistan. In: MUFTI S. A., WOODS C. A., HASAN S. A. (eds). Biodiversity of Pakistan. Pakistan Museum of Natural History, Islamabad and Florida Museum of Natural History, Gainesville. pp. 253–275.
- BALASHOV I. A. 2016. Conservation of Terrestrial Molluscs in Ukraine. National Academy of Sciences of Ukraine, I. I. Schmalhausen Institute of Zoology, Kyiv. [in Russian]
- BALASHOV I. A., GURAL-SVERLOVA N. V. 2011. Terrestrial molluscs of the genus *Pyramidula* (Pyramidulidae, Pulmonata, Gastropoda) in East Europe, Central Asia, and adjacent territories. Zoologicheskii Zhurnal 90: 1423–1430. [in Russian]
- BENSON W. H. 1849. Descriptions of four new Asiatic species of the genus *Pupa* of Draparnaud. Annals and Magazine of Natural History 4(20): 125–128.
<https://www.biodiversitylibrary.org/page/18686649>
- BENSON W. H. 1863. Characters of new operculate landshells from the Andamans, and of Indian and Burmese species of *Pupa*. Annals and Magazine of Natural History ser. 3, 12(72): 425–429.
<https://www.biodiversitylibrary.org/page/27660148>
- BLANFORD W. T., BLANFORD H. F. 1861. Contributions to Indian Malacology, No. II. Journal of the Asiatic Society of Bengal 30: 347–366.
<https://www.biodiversitylibrary.org/page/51028435#page/374/mode/lup>
- BOETTGER O. 1889. Die Entwicklung der *Pupa*-Arten des Mittelrheingebietes in Zeit und Raum. Jahrbücher des Nassauischen Vereins für Naturkunde 42: 225–327.
- BOUCHET P., ROCROI J. P., HAUSDORF B., KAIM A., KANO Y., NÜTZEL A., PARKHAEV P., SCHRÖDL M., STRONG E. E. 2017. Revised classification, nomenclator and typification of gastropod and monoplacophoran families. Malacologia 61: 1–526.
<https://doi.org/10.4002/040.061.0201>
- BOURGUIGNAT J. R. 1853–1856. Aménités Malacologiques. Tome premier. J. B. Baillière, Paris. viii + 255 pp., 21 pls. (1): 1–15 (1853); (2): 17–54, pl. 1 (1854); (3): 55–86, pls. 2–5, 1 table (1855); (4): 87–106, pls. 6–7 (1855); (5): 107–129, pls. 8–9 (1856); (6): 131–150, pls. 10–11 (1856); (7): 151–164, pls. 12–13 (1856); (8): 165–255, i–viii, pls. 14–21 (1856).
- BRUGUIÈRE J. G. 1792. Encyclopédie méthodique. Histoire naturelle des vers. Tome premier. Panckoucke, Paris.
<https://doi.org/10.5962/bhl.title.49857>
- BUDHA P. B., NAGGS F., BACKELJAU T. 2015. Annotated checklist of the terrestrial gastropods of Nepal. ZooKeys 492: 1–48.
<https://doi.org/10.3897/zookeys.492.9175>
- CHARPENTIER J. DE 1837. Catalogue des mollusques terrestres et fluviatiles de la Suisse. Formant la seconde partie de la faune Helvétique. Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft für die Gesamten Naturwissenschaften. Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles 1 (2): 1–28.
- DEY A., MITRA S. C. 2000. Molluscs of the Himalaya. Records of the Zoological Survey of India 98: 5–50.
<https://doi.org/10.26515/rzsi/v98/i2/2000/159672>
- DRAPARNAUD J. P. R. 1801. Tableau des Mollusques Terrestres et Fluviatiles de la France. Renaud, Bossange, Masson & Besson, Paris.
<https://doi.org/10.5962/bhl.title.40947>
- EGOROV R. 2008. Treasure of Russian shells. Illustrated catalogue of the recent terrestrial molluscs of Russia and adjacent regions. Colus-Doverie, Moscow.
- FÉRUSSAC A. E. J. D’AUDEBARD DE 1821–1822. Tableaux systématiques des animaux mollusques suivis d’un Prodrôme général pour tous les mollusques terrestres ou fluviatiles vivants ou fossils. Première partie, Tableaux systématiques généraux, i–xlvii. Deuxième partie, Tableaux particuliers des mollusques terrestres et fluviatiles, Classe des Gastéropodes. 1, Tableau de la famille de limaces, pp. 1–28. 2, Tableau de la famille des limaçons, pp. 1–92. 3, Tableau de la famille des auricules, pp. 93–114. A. Bertrand, Paris.
<https://doi.org/10.5962/bhl.title.10558>
- FITZINGER L. I. 1833. Systematisches Verzeichniss de im Erzherzogthume Oesterreich vorkommenden Weichthiere, als Prodrôm einer Fauna desselben. Beiträge zur Landeskunde Oesterreich’s unter der Enns, 3: 88–122.
<https://doi.org/10.5962/bhl.title.10037>
- GITTENBERGER E. 1973. Beiträge zur Kenntnis der Pupillacea III. Chondrininae. Zoologische Verhandlungen 127: 3–267.
- GITTENBERGER E., BANK R. A. 1996. A new start in *Pyramidula* (Gastropoda, Pulmonata: Pyramidulidae). Basteria 60: 71–78.
- GITTENBERGER E., KOKSHOORN B., BÖSSNECK U., REIJNEN T., GROENENBERG D. S. J. 2016. *Granopupa* in Iran, monophyly, and the fossil Granariinae (Gastrocopta, Pulmonata, Chondrinidae). Zookeys 592: 27–37.
<https://doi.org/10.3897/zookeys.592.7907>
- GITTENBERGER E., MENKHORST H. P. M. G., RAVEN J. G. M. 1980. New data on four European terrestrial gastropods. Basteria 44: 11–16.
- GODWIN-AUSTEN H. H. 1882–1920. Land and fresh-water Mollusca of India, including South Arabia, Balochistan, Afghanistan, Kashmir, Nepal, Burmah, Pegu, Tenasserim, Malay Peninsula, Ceylon, and oth-



- er islands of the Indian Ocean, pts. 1–3. Taylor and Francis London. VI+257+ 442+65 pp., 165 pls. (pt. 1: 1882: pp. I–VI, 1–66, pls. 1–12; 1883: pp. 67–164, pls. 13–42; 1884: pls. 43–51; 1886: pp. 165–206; 1887: pls. 52–62; 1888: pp. 207–257; pt. 2: 1897: pp. 1–46, pls. 63–69; 1898: pp. 47–86, pls. 70–82; 1899: pp. 87–146, pls. 83–100; 1907: pp. 147–238, pls. 101–117; 1910: pp. 239–310, pls. 118–132; 1914: pp. 311–442, pls. 133–158; pt. 3: 1920: pp. 1–65, pls. 159–165).
<https://doi.org/10.5962/bhl.title.18138>
- GODWIN-AUSTEN H. H. 1899. Address of the President. Proceedings of the Malacological Society of London 3: 241–262.
- GUDE G. K. 1914. The fauna of British India, including Ceylon and Burma. Mollusca, Pt. 2 (Trochomorphidae – Janellidae). Taylor and Francis, London.
<https://doi.org/10.5962/bhl.title.48423>
- HANLEY S., THEOBALD W. 1870–1876. Conchologica Indica: Illustrations of the Land and Freshwater Shells of British India. L. Reeve & Co., London.
<https://doi.org/10.5962/bhl.title.120669>
- HAUSDORF B. 1996. Die Orculidae Asiens (Gastropoda: Stylommatophora). Archiv für Molluskenkunde 125: 1–86.
<https://doi.org/10.1127/arch.moll/125/1996/1>
- HELD F. 1838. Notizen über die Weichthiere Bayerns. Isis (Oken) 30: 901–919.
- HORSÁKOVÁ V., LÍZNAROVÁ E., RAZKIN O., NEKOLA J. C., HORSÁK M. 2022. Deciphering “cryptic” nature of European rock-dwelling *Pyramidula* snails (Gastropoda: Stylommatophora). Contributions to Zoology 91: 230–260.
<https://doi.org/10.1163/18759866-bja10032>
- HUTTON T. 1849. Notices of some land and fresh water shells occurring in Afghanistan. Journal of the Asiatic Society of Bengal 18: 649–661, 967.
- HUTTON T., BENSON W. H. 1838. On the land and fresh-water shells of the western Himalaya. Journal of the Asiatic Society of Bengal 7: 211–218.
- HWANG C. C. 2015. A new subspecies of land snail genus *Pyramidula* Fitzinger, 1833 (Gastropoda: Pyramidulidae) from south Taiwan. Shellfish Journal 38: 31–39.
- JAECKEL S. 1956. Des Weichtiere (Mollusca) der Afghanistan Expedition (1952 und 1953) J. Klapperichs. Mitteilungen aus dem Zoologischen Museum in Berlin 32: 337–353.
- JOUSSEAUME F. 1894. Mollusques recueillis a Ceylan par M. E. Simon, et revision générale des espèces terrestres et fluviolacustres de cette ile. Mémoire de la Société Zoologique de France 7: 264–330.
- KANTOR Y. I., VINARSKI M. V., SCHILEYKO A. A., SYSOEV A. V. 2009. Catalogue of the continental mollusks of Russia and adjacent territories. Version 2.1. (Published online April 27, 2009).
- KENNARD A. S., WOODWARD B. B. 1914. Notes on the changes necessary in the “List of British non-marine Mollusca”. Taylor & Francis, London.
- KERNEY M. P., CAMERON R. A. D., JUNGBLUTH J. H. 1983. Die Landschnecken Nord- und Mitteleuropas: Ein Bestimmungsbuch für Biologen und Naturfreunde. Paul Parey, Hamburg und Berlin.
- KHANAL S., BUDHA P. B. 2013. Terrestrial gastropod fauna of Nagarjun Forest, Shivapuri-Nagarjun National Park, Kathmandu, Nepal. Journal of Institute of Science and Technology, Tribhuvan University 18: 113–119.
- KIRCHNER S., HARL J., KRUCKENHAUSER L., DUDA M., SATTMANN H., HARING E. 2016. Phylogeography and systematics of *Pyramidula* (Pulmonata: Pyramidulidae) in the eastern Alps: still a taxonomic challenge. Journal of Molluscan Studies 82: 110–121.
<https://doi.org/10.1093/mollus/eyv047>
- KOKSHOORN B., GITTENBERGER E. 2010. Chondrinidae taxonomy revisited: new synonymies, new taxa, and a checklist of species and subspecies (Mollusca: Gastropoda: Pulmonata). Zootaxa 2539: 1–62.
<https://doi.org/10.11646/zootaxa.2539.1.1>
- KUZNETSOV A. G., SCHILEYKO A. A. 1997. New data on Enidae (Gastropoda, Pulmonata) of Nepal. Ruthenica 7: 133–140.
- LOWE R. T. 1831. Primitiae faunae et florum Maderae et Portus Sancti; sive species quaedam novae vel hactenus minus rite cognitae animalium et plantarum in his insulis degentium breviter descriptae. Transactions of the Cambridge Philosophical Society 4: 1–70.
<https://www.biodiversitylibrary.org/page/13265840>
- LIKHAREV I. M., RAMMELMEIER E. S. 1965. Terrestrial Mollusks of the Fauna of the U.S.S.R. Academy of Sciences of the U.S.S.R., Zoological Institute, 574 pp. (English edition, Israel Program for Scientific Translations, Jerusalem, 1962, 2nd Impression).
- LIKHAREV I. M., STAROBOGATOV Y. I. 1967. On the molluscan fauna of Afghanistan. Trudy Zoologicheskogo Instituta Akademii nauk SSSR 42: 159–197. [in Russian]
- MACGREGOR C. M. 1878. Routes in Asia, Section IV; Being a compilation, from all available sources of routes in Persia and Balochistan. Government Printing, Calcutta.
- MARTENS E. VON 1865. Mollusca. In: GÜNTHER A. C. L. G. (ed.). The record of zoological literature. Volume 1. J. van Voorst, London, pp. 189–250.
- MARTÍNEZ-ORTI A., GÓMEZ-MOLINER B. J., PRIETO C. E. 2007. El género *Pyramidula* Fitzinger 1833 (Gastropoda, Pulmonata) en la Península Ibérica. Iberus, 25: 77–87.
<https://doi.org/10.5281/zenodo.4532889>
- MITRA S. C., DEY A., RAMAKRISHNA 2005. Pictorial Handbook: Indian Land Snails (selected species). Zoological Survey of India, Kolkata.
- MOLLUSCABASE eds. 2024. MolluscaBase. Available online at <https://www.molluscabase.org> (accessed 2 February 2024).
<https://doi.org/10.14284/448>
- MÖLLENDORFF O. F. VON 1897. Neue Landschnecken von Java. Nachrichtenblatt der Deutschen Malakozoologischen Gesellschaft 29(5–6, 7–8): 57–72, 89–97.
<https://biodiversitylibrary.org/page/28228249>
- MÜLLER O. F. 1774. Vermium terrestrium et fluviatilium, seu animalium infusorium, Helminthicorum, et tes-

- taceorum, non marinorum, succincta historia. Vol. 2. Heineck & Faber, Copenhagen & Leipzig.
<https://doi.org/10.5962/bhl.title.46299>
- NAGGS F., RAHEEM D. 2000. Land snail diversity in Sri Lanka: an illustrated guide prepared for the launch of the Darwin Initiative Programme. London.
- NEVILL G. 1878a. Hand List of Mollusca in the Indian Museum. Part 1. Gastropoda. Pulmonata and Prosobranchia – Neurobranchia. Calcutta.
<https://doi.org/10.5962/bhl.title.11957>
- NEVILL G. 1878b. Scientific results of the Second Yarkand Mission; based upon the collections and notes of the late Ferdinand Stoliczka Ph.D. Mollusca. 1–21, 1 pl. Government of India, Calcutta.
<https://doi.org/10.5962/bhl.title.168314>
- NORDSIECK H. 2014. Annotated check-list of the genera of fossil land snails (Gastropoda: Stylommatophora) of western and central Europe (Cretaceous – Pliocene), with description of new taxa. *Archiv für Molluskenkunde* 143: 153–185.
- PÁLL-GERGELY B., DELI T., IRIKOV A., HARL J. 2013. Subgeneric division of the genus *Orcula* Held, 1837 with remarks on Romanian orculid data (Gastropoda, Pulmonata, Orculidae). *ZooKeys* 301: 25–49.
<https://doi.org/10.3897/zookeys.301.5304>
- PFEIFFER L. 1846. *Symbolae ad historiam Heliceorum*. Vol. III. Cassellis.
<https://doi.org/10.5962/bhl.title.11903>
- PFEIFFER L. 1847. (1847–1848). *Monographia Heliceorum viventium. Sistens descriptiones systematicas et criticas omnium huius familiae generum et specierum hodie cognitarum*. Volumen primum. (1): 1–160 [1847, < 8 September]; (2): 161–320 [1847, > 27 September]; (3): i–xxxii, 321–484 [1848, < 23 June]. F. A. Brockhaus, Lipsiae.
- PFEIFFER L. 1853. *Monographia Heliceorum Viventium Sistens Descriptiones Systematicas et Criticas Omnium Huius Familiae Generum et Specierum Hodie Cognitarum*. 3: viii + 1–711, F. A. Brockhaus, Leipzig.
<https://doi.org/10.5962/bhl.title.12727>
- PFEIFFER L. 1856. Versuch einer Anordnung der Heliceen nach natürlichen Gruppen. *Malakozoologische Blätter* 2: 112–185.
- PFEIFFER L., CLESSIN S. 1881. *Nomenclator Heliceorum Viventium quo Continentur Nomina Omnium huius Familiae Generum et Specierum hodie Cognitarum*. 617 pp., Theodor Fischer, Cassel.
<https://doi.org/10.5962/bhl.title.13177>
- PILSBRY H. A. 1893–1895. *Manual of Conchology. Structural and Systematic. With illustrations of the species. Second series: Pulmonata. Vol. IX. Guide to the Study of Helices*. xlviii + 366 pp., 71 pls. (1893: pp. 1–48, pls. 1–14; 1894: pp. 49–160, pls. 15–40; 1895: pp. 161–335, pls. 41–71, i–xlviii, Index to Helices, 126 pp.).
<https://doi.org/10.5962/bhl.title.6534>
- PILSBRY H. A. 1900. On the zoological position of *Partula* and *Achatinella*. *Proceedings of the Academy of Natural Sciences of Philadelphia* 52: 561–567.
<https://www.biodiversitylibrary.org/page/24694441>
- PILSBRY H. A. 1916–1918. *Manual of conchology, structural and systematic, with illustrations of the species. Ser. 2, Pulmonata. Vol. 24: Pupillidae (Gastrocoptinae). Manual of Conchology (2)14: 113–256, pls. 14–38.*
<https://www.biodiversitylibrary.org/page/1295231>
- PILSBRY H. A. 1922–1926. *Manual of Conchology. Structural and Systematic. With illustrations of the species. Second series: Pulmonata. Vol. XXVII. Pupillidae: Orculinae, Pagodulinae, Acanthinulinae, Etc.* Academy of Natural Sciences, Philadelphia.
- PILSBRY H. A. 1948. *Land Mollusca of North America (north of Mexico)*. The Academy of Natural Sciences of Philadelphia, Monographs, Academy of Natural Sciences, Philadelphia.
- PILSBRY H. A., HIRASE Y. 1902. Notices of new Japanese land snails. *The Nautilus* 16: 75–80.
- POKRYSZKO B. M., AUFFENBERG K., HLAVÁČ J. Č., NAGGS F. 2009. Pupilloidea of Pakistan (Gastropoda: Pulmonata): Truncatellinae, Vertigininae, Gastrocoptinae, Pupillinae (in part). *Annales Zoologici* 59: 423–458.
<https://doi.org/10.3161/000345409X484847>
- PREECE R. C., WHITE T. S., RAHEEM D. C., KETCHUM H., ABLETT J., TAYLOR H., WEBB K., NAGGS F. 2022. William Benson and the golden age of malacology in British India: Biography, illustrated catalogue and evaluation of his molluscan types. *Tropical Natural History*. No. 6: Supplement: 1–434.
- RAHEEM D. C., TAYLOR H., ABLETT J., PREECE R. C., ARAVIND N. C., NAGGS F. 2014. A Systematic Revision of the Land Snails of the Western Ghats of India. Supplement 4. *Tropical Natural History*, Chulalongkorn University of Natural History, Bangkok.
- RAMAKRISHNA, MITRA S. C., DEY A. 2010. Annotated checklist of Indian land molluscs. *Zoological Survey of India, Occasional Papers No. 306: 1–359*, Kolkata.
- RAZKIN O., SONET G., BREUGELMANS K., MADEIRA M. J., GÓMEZ-MOLINER B. J., BACKELJAU T. 2016a. Species limits, interspecific hybridization and phylogeny in the cryptic land snail complex *Pyramidula*: the power of RADseq data. *Molecular Phylogenetics and Evolution* 101: 267–278.
<https://doi.org/10.1016/j.ympev.2016.05.002>
- RAZKIN O., GÓMEZ-MOLINER B. J., VARDINOYANNIS K., MARTÍNEZ-ORTI A., MADEIRA M. J. 2016b. Species delimitation for cryptic species complexes: case study of *Pyramidula* (Gastropoda, Pulmonata). *Zoologica Scripta* 46: 55–72.
<https://doi.org/10.1111/zsc.12192>
- ROSSMÄSSLER E. A. 1842. *Iconographie der Land- & Süßwasser- Mollusken, mit vorzüglicher Berücksichtigung der europäischen noch nicht abgebildeten Arten*. (1) 2 (5) [11]: I–IV + 1–15, pl. 51–55 [June 1842]. Arnoldische Buchhandlung, Dresden und Leipzig.
<https://biodiversitylibrary.org/page/24986222>
- REEVE L. A. 1851. *Conchologia Iconica: or, Illustrations of the Shells of Molluscous Animals. Vol. 7, Monograph of the genus Helix*. Reeve Brothers, London.
<https://doi.org/10.5962/bhl.title.8129>



- RENSCH I. 1955. On some Indian land snails. *Journal of the Bombay Natural History Society* 53: 163–176.
- ROTH B. 2003. *Cochlicopa* Férussac, 1821, not *Cionella* Jeffreys, 1829; Cionellidae Clessin, 1879, not Cochlicopidae Pilsbry, 1900 (Gastropoda: Pulmonata: Stylommatophora). *The Veliger* 46: 183–185.
- SCHILEYKO A. A. 1984. Terrestrial molluscs of the suborder Pupillina of the USSR fauna (Gastropoda, Pulmonata, Geophila). In: *Fauna SSSR, Novaya serya, No. 130, vol. III (3), Nauka, Leningrad*. [in Russian]
- SCHILEYKO A. A. 1998. Treatise on recent terrestrial pulmonate molluscs. Part 1: Achatinellidae, Amastridae, Orculidae, Strobilopsidae, Spelaodiscidae, Valloniidae, Cochlicopidae, Pupillidae, Chondriniidae, Pyramidulidae. *Ruthenica, Supplement 2*: 1–399.
- SCHILEYKO A. A. 2012. On the anatomy of Orculidae with special reference to the spermatophores (Gastropoda, Pulmonata, Stylommatophora). *Ruthenica* 22: 141–158.
- SCHILEYKO A. A., BALASHOV I. A. 2012. *Pyramidula kuznetsovi* sp. nov. a new species of land mollusc from Nepal (Pulmonata, Pyramidulidae). *Ruthenica* 22: 41–45.
- SHUTTLEWORTH R. J. 1852. Diagnosen einiger neuen Mollusken aus den Canarischen Inseln. *Mittheilungen der Naturforschenden Gesellschaft in Bern 1852 (241/242)*: 137–146.
<https://www.biodiversitylibrary.org/page/11568233>
- SOLEM G. A. 1979. Some mollusks from Afghanistan. *Fieldiana, Zoology, new series* 1: 1–89.
<https://doi.org/10.5962/bhl.title.3037>
- SOWERBY G. B. II. 1878. *Conchologia Iconica: or, Illustrations of the Shells of Molluscous Animals. vol. 20. Monograph of the Genus Pupa*. Reeve Brothers, London.
<https://doi.org/10.5962/bhl.title.8129>
- STAROBOGATOV Ya. I. 1996. Eurasiatic species of the genus *Cochlicopa* (Gastropoda, Pulmonata, Cochlicopidae). *Ruthenica* 5: 105–129.
- STEENBERG C. M. 1925. Études sur l'anatomie et la systématique des Maillots (Fam. Pupillidae s. lat.). *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening i København* 80: 1–216, pl. 1–34.
<https://www.biodiversitylibrary.org/page/60462441>
- STOLICZKA F. 1872. Postscript to the Monograph of Himalayan and Barmese Clausiliae. *The Journal of the Asiatic Society of Bengal, Part II*, 41: 207–210.
<https://www.biodiversitylibrary.org/page/52805682>
- SVERLOVA N. V. 2006. On the distribution of some species of land molluscs in the territory of Ukraine. *Ruthenica* 16: 119–139. [in Russian]
- SYSOEV A. V., SCHILEYKO A. A. 2009. Land snails and slugs of Russia and adjacent countries. *Pensoft Series Faunistica*. Pensoft Publishing, Sofia, Bulgaria.
- THEOBALD W. 1862. Notes of a trip from Simla to the Spiti Valley and Chomoriri (Tshomoriri) Lake during the months of July, August and September, 1861. *Journal of the Asiatic Society of Bengal* 31: 480–527.
- THEOBALD W. 1863. Notes on the distribution of Indian terrestrial Gasteropoda considered with reference to its leaning on the origin of species. *Journal of the Asiatic Society of Bengal*, 32: 354–382.
- THEOBALD W. 1881. List of the Mollusca from the hills between Mari and Tandiani. *Journal and Proceedings of the Asiatic Society of Bengal* 50, pt. 2(1): 44–49.
- THOMPSON F. G. 2011. An annotated checklist and bibliography of the land and freshwater snails of México and Central America. *Florida Museum of Natural History Bulletin* 50: 1–299.
- TRYON G. W. 1887. *Manual of Conchology; Structural and Systematic. With Illustrations of the Species, Second Series, vol. III, Helicidae: vol. 1. Academy of Natural Sciences, Philadelphia*.
<https://doi.org/10.5962/bhl.title.6534>
- TURTON W. 1831. *A manual of the land and fresh-water shells of the British Islands, arranged according to the more modern system of classification; and described from perfect specimens in the author's cabinet: with coloured plates of every species, viii + 152 + 16 pp.): Index of English names), 9 unnumbered plates*. Longman, Rees, Orme, Brown, & Green, London.
<https://biodiversitylibrary.org/page/26222467>
- UDVARDY M. D. F. 1975. Biogeographical provinces of the Indomalayan Realm, western part and eastern part. Revised maps for classification of the biogeographical provinces of the World. UNESCO Man and the Biosphere Programme, Project no. 8. IUCN Occasional Paper No. 18.
- UVALYEVA K. K. 1967. New species of land mollusks from southern Altai. *Trudy Zoologicheskogo Instituta AN SSR* 42: 213–220. [in Russian]
- WOODWARD S. P. 1856. On the land and freshwater shells of Kashmir and Tibet, collected by Dr. T. Thomson. *Proceedings of the Zoological Society of London* 24: 185–187.
- WOODWARD B. B. 1903. List of British non-marine Mollusca. *Journal of Conchology* 10: 352–367.
- ZILCH A. 1959–1960. *Gastropoda. Teil 2: Euthyneura. Handbuch der Paläozoologie, 6. Borntraeger, Berlin*.
- ZILCH A. 1962. Die Type und Typoide des Natur-Museums Senckenberg, 27: Mollusca, Pupillacea 1 (Amastridae, Cochlicopidae, Pyramidulidae). *Archiv für Molluskenkunde* 91: 219–236.

Received: March 25th, 2024

Revised: May 17th, 2024

Accepted: May 21st, 2024

Published on-line: June 19th, 2024

