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NEW FINDINGS OF THE ENDANGERED SLUG *TURCOMILAX TURKESTANUS* (SIMROTH, 1898) (HETEROBRANCHIA: EUPULMONATA: LIMACIDAE) IN THE NORTHERN TIEN-SHAN

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ABSTRACT: The genus *Turcomilax* (Gastropoda: Heterobranchia: Stylommatophora: Limacidae) includes six species of slugs, which are endemic to the mountain systems of the Tien Shan and Himalayas. Two species, *Turcomilax tzvetkovi* Likharev et Wiktor, 1980 and *Turcomilax turkestanus* (Simroth, 1898), are listed in the Red List of Kazakhstan. The most recent published observation of *Turcomilax turkestanus* dates back to the end of the 1990s. Since then, the area encompassing its range has experienced significant recreational pressure, raising concerns about the potential extinction or drastic population decline of these species. The article reports new findings of *Turcomilax turkestanus* from the Ile Alatau region. Specimens were collected between April and July 2023 and identified based on the anatomical features. New records of *Turcomilax turkestanus* were made in the valley of Prokhodnaya River at altitudes between 1,824 and 1,863 m, in the Butakovsky Pass at 2,762 m and in the Talgar Pass at 3,300 m. These findings represent the first documented records of the species in these gorges and also, they expand the known information about the distribution heights and biotope of this species.

KEY WORDS: Central Asia; endemic species; terrestrial gastropods

INTRODUCTION

The genus *Turcomilax* (Gastropoda: Heterobranchia: Stylommatophora: Limacidae) includes six species of slugs, which are endemic to the mountain systems of the Tien Shan and Himalayas (WIKTOR et al. 1999, BÖSSNECK et al. 2006, SCHILEYKO & RYMZHANOV 2013). Four of these species inhabit the territory of Kazakhstan, with *Turcomilax tzvetkovi* Likharev et Wiktor, 1980 and *Turcomilax turkestanus* (Simroth, 1898) being listed in the national (MITYAEV 2003).

Turcomilax tzvetkovi is currently known from only three records in the neighbouring gorges of the Ile Alatau (Zailiisky Alatau, Trans-Ili Alatau): Teskensu and Turgen. In contrast, *Turcomilax turkestanus* has been documented across a broader area, including the Ile, Kungei, and Terskey Alatau ranges, although its presence is based on approximately a dozen sparse records. This limited dataset precludes a comprehensive understanding of the species' distribution. For instance, it remains uncertain whether *Turcomilax turkestanus* occupies the entire area between the locations of its known occurrences or if it is instead represented by a series of isolated, potentially relict populations. Furthermore, the most recent observation of *Turcomilax turkestanus* dates back to the end of the 1990s. Since then, the area encompassing its range has experienced significant anthropogenic pressure, including overgrazing by livestock, unregulated rec-

reational activities, construction and human-induced fires (NESTEROVA et al. 2017, AMANZHOLOV et al. 2018), raising concerns about the potential extinction or a drastic population decline of these species.

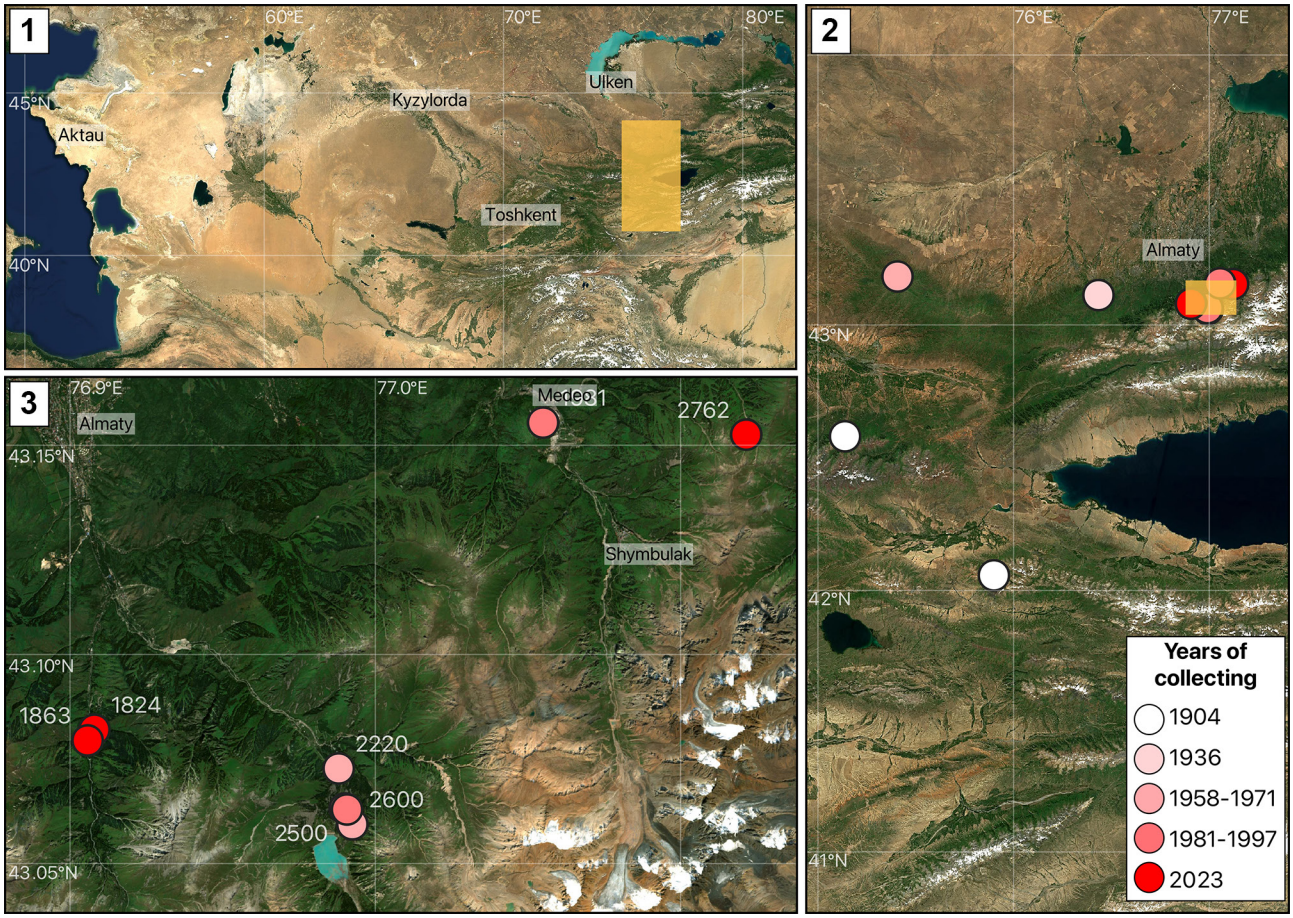
New findings of *Turcomilax turkestanus* were made in 2023 in Ile Alatau. In this work we provide an account of these findings.

MATERIALS AND METHODS

Materials were collected from April to July of 2023 in the Ile Alatau (Figs 1–3). The slugs were fixed in 96% ethanol with a further change of ethanol to prevent dilution of the concentration. The specimens were identified according to the handbooks by LIKHAREV & WIKTOR (1980) and SCHILEYKO & RYMZHANOV (2013) based on anatomical features, such as the morphology of the penis.

In addition to recently obtained material, collections of Zoological Institute of Russian Academy of Sciences (ZIN, hereafter) were examined to confirm previous records of the species.

A map of the species records, based on our own collections, ZIN collections and bibliographic sources (SIMROTH 1898, 1910, LIKHAREV & WIKTOR 1980, UVALYEVA 1999, SCHILEYKO & RYMZHANOV 2013), was constructed in QGIS 3.28.2 with Sentinel-2 satellite map as a background (Figs 1–3). Collected specimens are stored in the collection of the Institute of Zoology of Kazakhstan (IZK). Detailed information about localities and collection numbers is given in the species description.



Figs 1–3. Collection sites of *Turcomilax turkestanus*. Points coloured gradually according to the year of collection, from white (earliest, 1904) to red (latest, 2023). Numbers next to the points indicate the altitude of each record

RESULTS

Superfamily Limacoidea Batsch, 1789
Family Limacidae Batsch, 1789
Genus *Turcomilax* Simroth, 1901

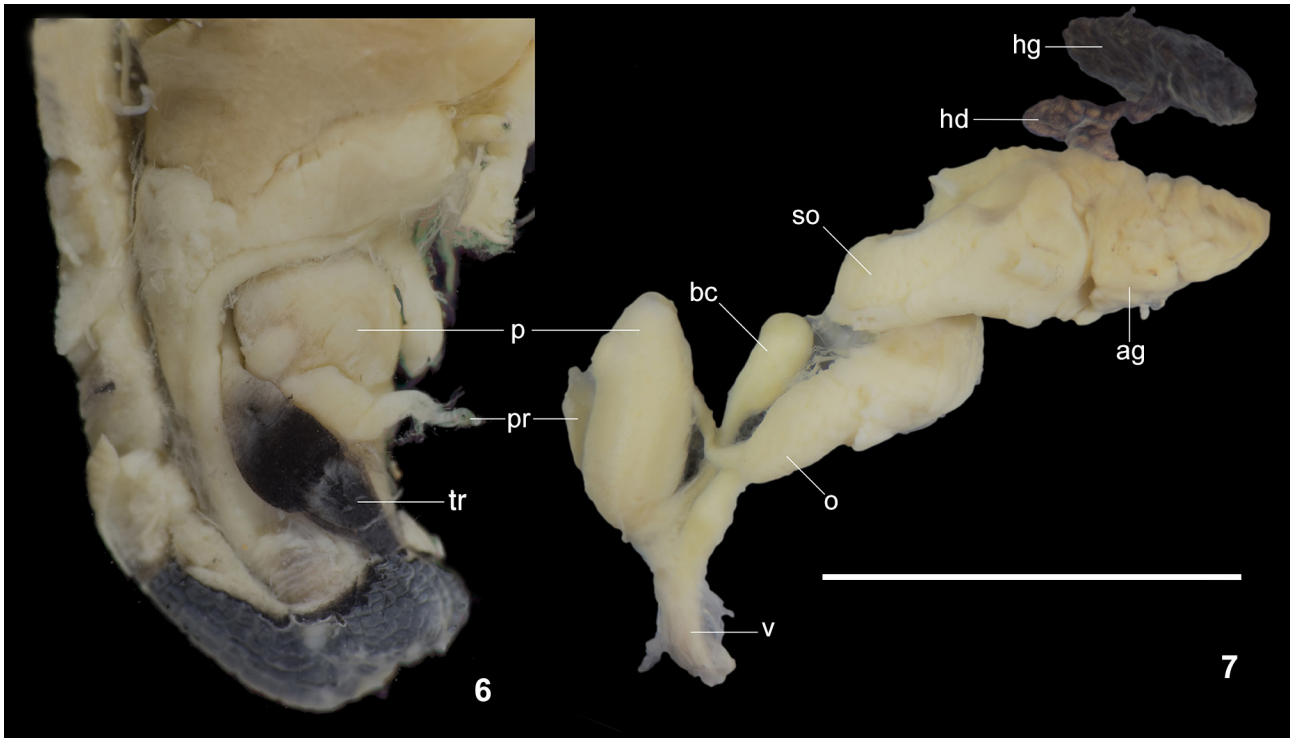
Turcomilax turkestanus (Simroth, 1898)

(Figs 4–7)

Material. 1 specimen (dissected), 12.04.2023, IZK-Mol-352, spring in the Prokhodnaya River valley, 43.0820°N, 76.9079°E, 1,824 m; 4 specimens (1 dissected), IZK-Mol-354, 22.06.2023, Prokhodnaya River valley, 43.0794°N, 76.9057°E, 1,863 m; 7 specimens (1 dissected), 18.07.2023, IZK-Mol-355, Butakovsky Pass, 43.1525°N, 77.1215°E, 2,762 m; 1 specimen (dissected), 08.07.2023, IZK-Mol-420, Talgar Pass, 43.1256°N, 77.1172°E, 3,300 m.

External morphology. The colouration of the slugs is black (Fig. 4), occasionally grey-brown with lighter sides (Fig. 5). Although the frequency of grey-brown colouration is not reported in the literature, it is certainly less common (Likharev & Wiktor 1980). Documented records of such slugs are known only

Figs 4–5. External appearance of *Turcomilax turkestanus*: 4 – specimen IZK-Mol-420; 5 – specimen IZK-Mol-354. Scale bar 30 mm



Figs 6–7. Anatomical features of *Turcomilax turkestanus*: 6 – specimen IZK-Mol-355, 7 – specimen IZK-Mol-420. Abbreviations: ag – albumen gland; bc – bursa copulatrix; hd – hermaphrodite duct; hg – hermaphrodite gland; o – oviduct; p – penis; pr – penis retractor muscle; so – spermoviduct; tr – tentacle retractor; v – vagina. Scale bar 10 mm

in the Aksai Gorge of the Ile Alatau (Schileyko & Rymzhanov 2013). The sole is white, gradually transitioning to black along the edges. The body length reaches up to 36 mm, with the mantle occupying approximately one-third of the body length and appearing angular at the posterior end. *Turcomilax turkestanus* cannot be reliably distinguished from other *Turcomilax* species based on external characteristics; identification is based on the structure of the penis in adult specimens.

Anatomy. The tentacle retractor (tr) crosses over the penis (p) (Fig. 6). The penis is short, bean-shaped, and narrower at distal end. The hermaphrodite gland (hg) is oval, black, and embedded in digestive gland. The albumen gland (ag) is large and yellow. The bursa copulatrix (bc) is pear-shaped, its duct inserts into the distal (closer to the vagina) part of the penis. The oviduct (o) is cream-coloured, inserts into the proximal part of the penis (Fig. 7).

Distribution. Kazakhstan (Ile Alatau, Kungei Alatau, Kordai Pass), Kyrgyzstan (Karakol, Kungei Alatoo) (Simroth 1910, Schileyko & Rymzhanov 2013, this paper).

Ecology. In our study specimens were found on a mountain slope, coniferous litter under pine trees, and along riverbanks at elevations from 1,824 to 3,300 m a.s.l. According to the literature, *Turcomilax turkestanus* lives among rocks and large stones, along steep, damp slopes and mountain riverbanks (Schileyko & Rymzhanov 2013).

DISCUSSION

The morphology of the examined specimens matches the collection materials and literature data. Only slight variation in the size and shape of the penis was observed among the specimens; however, all generally conform to the characteristic bean-shaped morphology described in the literature.

The original description of *Turcomilax turkestanus* (Simroth 1898) does not include precise information on the collection sites of this species, referring only to "Turkestan", an old geographical term historically used for Central Asia. A later publication by the same author (Simroth 1910) provides information about two finds of this species in the southern Tien Shan in the territory of modern Kyrgyzstan. The first documented discovery of *Turcomilax turkestanus* in the Ile Alatau was made in 1936 in the Kargaly Gorge (Tzvetkov 1940), no data on altitude and biotope were recorded. Subsequent finds were reported in the gorge of the Big Almaty Lake (Bolshoe Almatinskoe Ozero, Ülken Almaty Köli) between 1962 and 1997 at altitudes ranging from 2,220 to 2,500 m, but the biotope is known for only one record – on the slopes under stones (ZIN collection, Schileyko & Rymzhanov 2013). Since then, there have been no further records of *Turcomilax turkestanus* in this region. Also, records of the genus *Turcomilax* were presented by Uvalyeva (1990, 1999), but the studies lack precise locality data. Overall, the research efforts of terrestrial gastropods in the Tien Shan are complicated due to incomplete or fragmented data (Aitzhanova 2023).

In this study, *Turcomilax turkestanus* was recorded for the first time in the Prokhodnaya River valley, Butakovsky Pass, and Talgar Pass, expanding the known distribution range of the species. The finding at the Talgar Pass, at an elevation of 3,300 m, represents the highest documented occurrence of this species to date. The mountainous regions of Central Asia have a high percentage of endemism due to their unique geological history. The genus *Turcomilax* may represent part of the relict fauna of the Tien Shan, as its distribution and ecological patterns align with those seen in other endemic species of the region (Li et al. 2016, Wang et al. 2016). Areas such as Ili Valley and Tarim Basin, adjacent to the south and east of the range of *Turcomilax turkestanus*, have been identified as refugia in the studies on plants and vertebrates (Meng et al. 2007, Zhang et al. 2008, Shan et al. 2011). While the areas within the range *Turcomilax turkestanus* have not yet been investigated, they could potentially represent another refugium, offering insights into the dispersal history and evolution of the region's fauna.

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