**Gafaita gafaitensis** gen. et sp.n. a new hydrobiid snail (Gastropoda: Hydrobiidae) from Morocco

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**Abstract:** As a result of recent field surveys conducted in the North-eastern part of Morocco, a description of a new springsnail **Gafaita gafaitensis** gen. et sp.n. (Gastropoda: Hydrobiidae) Morocco is provided. Photos of the holotype and paratypes are presented in addition to an illustration of the penis morphology. Further information on the autecology and habitat of the new taxon as well as on the accompanying invertebrate and vertebrate species is also provided.

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**Key Words:** North Africa, biodiversity hotspot, springsnail, **Gafaita gafaitensis** gen. et sp.n.
Introduction

The North African region, Morocco in particular, hosts a unique freshwater malacoфаuna, characterised by a high level of endemism with many relic genera and species (Gomes-dos-Santos et al., 2019; Sousa et al., 2019; Mabrouki et al., 2022a).

The family Hydrobiidae Stimpson, 1865 commonly known as springsnails, is one of the most widespread and richest in species of freshwater molluscs throughout the Mediterranean region (Glöer, 2019). Most of its members are obvious crenophilous, typically found in river sources and springs, many of which are also stygobionts. Their distribution is limited by their stenotherm condition (Oscoz et al., 2011; Glöer, 2022).

In the last years, there has been a significant advancement of knowledge on the surface water malacoфаuna of Morocco in general, and especially on the family Hydrobiidae sensu stricto, with several new taxa discovered and described recently (Gloër et al., 2020a, b; Boulaasaafser et al., 2021; Mabrouki et al., 2020, 2021, 2022b, c; Taybi et al., 2021, 2022a, b, c). This paper is a direct continuation of this series of discoveries. New research conducted recently in northeastern Morocco has revealed a new genus and species. The new springsnail was discovered in Gafait oasis, a spring located in the High Plateaus of Morocco, belonging to Za River basin. The aim of our work is to describe the springsnail under discussion.

Material and methods

Sampling

Field surveys were conducted since 2014 (still ongoing), in which several localities were prospected along the northern part of Morocco. Most of these sampling sites were visited several times. Our goal was to prospect all the existing micro-habitats in each sampling site. The samples of benthic fauna were collected by a kick net and clamps. The samples have been fixed in 75% ethanol.

The dissections and measurements of the genital organs and the shells were carried out using a stereomicroscope (Leica M205C) with a digital camera (Leica DMC5400). The type material is currently stored in the Zoological Museum of Hamburg (ZMH), in addition to six individuals stored in the collection of the corresponding author.

Conductivity, pH, and dissolved oxygen were measured in situ with a multiparametric measuring device (WTW, Multi-Line P4). The other parameters e.g. ammonium, nitrates, orthophosphates and biological oxygen demand (BOD₅) were measured in the laboratory.

Study area

The Za River basin drainage network is located in the north-eastern region of Morocco; it is the main tributary of the Moulouya with an area of 18 000 km². It has its source in the Eastern Highlands and joins Moulouya River at Melga El Ouidane, downstream from the town of Taourirt. It drains the southern and western part of the Horsts chain, and it crosses from upstream to downstream the arid Mediterranean bioclimatic stage in the High Plateaus, semiarid in the Horsts and arid range in the Taourirt region (Bensaad et al., 2017; Mabrouki et al., 2016).

The High Plateaus is a vast territory also called high-plains. It is the Moroccan part of the so-called Moroccan-Oranian plateau, which extends roughly between the Tellian chain to the north and the eastern and Saharan High Atlas to the south. The High Plateaus of eastern Morocco constitutes a fairly well-defined geographical unit, it extends over an area of 30 000 km² (El Harradji, 1997). Rainfall rates in the region range from 230 to 280 mm/year, with an average value of 255 mm/year. The significant rainfall falls in December and April, while July and August are the driest months. The average temperature is 16.4 °C, with the minimum values of 4 °C in January and the maximum of 42 °C in August (Mabrouki et al., 2016).

Results

Phylum Mollusca Cuvier, 1795
Class Gastropoda Cuvier, 1795
Superorder Caenogastropoda Cox, 1960
Superfamily Truncatelloidea Gray, 1840
Family Hydrobiidae Stimpson, 1865

Gafaita gen.n. Figs 1–8.
Fig 1–8. Gafaita gafaitensis gen. et sp.n. 1, 4 — holotype, 2–3, 5–8 — paratypes, 4 — penis. Abbreviations: p — penis, pa — penial appendix.


**TYPE SPECIES.** *Gafaita gafaitensis* sp.n. (see description below).

**DIAGNOSIS.** The reddish-yellowish shell is elongated; whose border of the aperture is slightly sinuated to the top from lateral view. Body is pigmented and eyespots are present. The penis is triangular with a triangular appendix; the penial appendix is larger than the penis itself.

Body pigmentation and eyespots can separate the new genus from the stygobic ones (*e.g.* *Mahrazia* Mabrouki, Taybi et Glöer, 2022; *Heideella* Backhuys et Boeters, 1974), and the elongated shell can separate it from the valavatoid ones (*e.g.* *Fessia* Glöer, Mabrouki et Taybi, 2020; *Ifrania* Glöer, Mabrouki et Taybi, 2020... etc) and from the other genera with conic-ovate-spherical shells (*e.g.* *Mercuria* Boeters, 1971; *Pseudammicola* Paulucci, 1878).

*Gafaita* gen.n. can be distinguished from the similar looking species from Tunisia, described as *Bullaregia tunisiensis* (Khalloufi, Béjaoui et Delicado, 2017), by the characteristic of the shell and penis morphology, the latter has a straight border of the aperture from lateral view, and the penis is long and slim. The genus *Corrosella* Boeters, 1970 which occurs in Morocco, has a triangular penis without penial appendices and the apex of the shells is often corroded. And finally, the recently described *Aghbali* Glöer, Mabrouki et Taybi, 2020 and *Znassela* Taybi, Glöer et Mabrouki, 2023, which occur also in Morocco, have a penis with two penial appendices and larger shells (Taybi *et al.*, 2023).

The penis morphology is characteristic to this species, not known among any other hydrobiid species. This feature justifies the description of a new genus, as it is acknowledged that hydrobiid genera can be identified by dint of the shell shape in combination with the penis morphology (Radoman, 1983; Szarowska, 2006; Glöer, 2022).

**ETYMOLOGY.** Named after the type locality.

**Gafaita gafaitensis** sp.n.

MATERIAL examined: holotype, 14 paratypes in ethanol, from type locality. Holotype: Shell 1.45 mm high and 0.93 mm broad from type locality (ZMH 141467). Paratypes: 6 paratypes in ethanol, ZMH 141468, 2 in ethanol in coll. Glöer and 6 specimens in coll. Mabrouki.

**LOCUS TYPICUS:** Gafait, Jerada province, Oriental region, Morocco (34°13’7.12” N 2°28’34.13” W).
Gafaita gafaitensis gen. et sp.n. a new hydrobiid snail from Morocco

ETYMOLOGY. Named after the type locality.

DESCRIPTION. The reddish-yellowish shell is ovate with 4.5 slightly convex whorls which are separated by a shallow suture. The aperture is ovate, tapered at the top. The peristome is sharp, from lateral view slightly sinuated at the top. The umbilicus is closed. The shell is 1.31–1.48 mm high and 0.86–0.9 mm broad. The shell measurements (N = 14) are presented in Table 1 (in mm).

Male copulatory organ. The triangular penis (left) has one large triangular appendix (right).

HABITAT. Gafait, Guefaït or Tgafait (34°13′7.12″N 2°28′34.13″W) is an oasis which is located in the rural municipality of the province of Jerada, in the Oriental region of Morocco (Fig. 9). Located in the high plateaus, the spring of Gafait belongs to Za River basin, being one of the main tributaries of the Moulouya River on the right bank. The spring is located at an altitude of 718 m. It joins Za River a few meters away. The major bed of the stream is wide with a wet section of 15 m and a slight slope.

The banks are natural and vertical with sparse shrubby shore vegetation, sometimes forming a sparse riparian forest consisting of tamarix (Tamarix sp), reed (Phragmites australis Steud., 1841), oleander (Nerium oleander L., 1753) and rush (Juncus sp) in addition to some wild jujube trees (Ziziphus lotus Lam., 1789). Despite the average light conditions, periphyton and filamentous algae grow very well on the substrate. The bottom substrate is made up by blocks, stones, pebbles and gravel with medium clogging and little plant debris.

The analysis of the physicochemical parameters of the water, such as ammonium and BOD₅ (Biological oxygen demand), revealed a good environmental quality of the habitat (Table 2), according to the

<table>
<thead>
<tr>
<th>Shell measurements</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell height</td>
<td>1.4</td>
<td>1.5</td>
<td>1.45</td>
<td>0.04</td>
</tr>
<tr>
<td>Aperture height</td>
<td>0.62</td>
<td>0.68</td>
<td>0.65</td>
<td>0.02</td>
</tr>
<tr>
<td>Spire height</td>
<td>0.77</td>
<td>0.85</td>
<td>0.8</td>
<td>0.01</td>
</tr>
<tr>
<td>Shell width</td>
<td>0.8</td>
<td>0.9</td>
<td>0.88</td>
<td>0.01</td>
</tr>
<tr>
<td>Aperture width</td>
<td>0.49</td>
<td>0.54</td>
<td>0.51</td>
<td>0.01</td>
</tr>
</tbody>
</table>

N = 14; the measurement accuracy is 0.05.

Fig. 9. Habitat and location (red star) of the type locality of Gafaita gafaitensis gen. et sp.n. Рис. 9. Местообитание и типовое местонахождение (звездочка) Gafaita gafaitensis gen. et sp.n.
Table 2. Mean for the physical and chemical water parameters measured at the sampling locality (Gafait oasis, Za River, Morocco), and their standards (according to MSWG).

<table>
<thead>
<tr>
<th>Factor</th>
<th>pH</th>
<th>Conductivity</th>
<th>Dissolved oxygen</th>
<th>BOD5</th>
<th>Ammonium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>7.9</td>
<td>650 µScm⁻¹</td>
<td>7.5 mg.l⁻¹</td>
<td>3.15 mg.l⁻¹</td>
<td>0.012 mg.l⁻¹</td>
</tr>
<tr>
<td>MSWG 6.5–8.5</td>
<td>100–1300 µScm⁻¹</td>
<td>&gt; 7–5 mg.l⁻¹</td>
<td>&lt; 3–5 mg.l⁻¹</td>
<td>&lt; 0.1–0.5 mg.l⁻¹</td>
<td></td>
</tr>
</tbody>
</table>

Moroccan surface water guidelines of good quality (MSWG). However, because it is located in a rural, agricultural and tourist environment (the source is located near the tourist lodge), this locality is very disturbed by human activity, especially in summer.

ASSOCIATED SPECIES. Thanks to previous studies, the aquatic invertebrate fauna of Gafait area, which may co-occur with Gafaita gafaitensis gen. et sp.n. is well known, presented by Annelida: Helobdella stagnalis (Linnaeus, 1758), Placobdella costata (F. Müller, 1846); Mollusca: Physella acuta (Draparnaud, 1805), Ancylus sp., Theodoxus sp, Melanopsis costellata (Ferussac, 1823), M. praemorsa (Linnaeus, 1758); Decapoda: Potamon algeriense (Herbst, 1785), Atyaeaphyra desmaretti (Millet, 1831); Ephemeroptera larvae: Baetis spp., Ecdyonurus rothschildi (Navás, 1929); Trichoptera larvae: Hydropsyche spp., Hydroptila sp., Agraylea sp.; Odonata larvae: Anax sp., Onychogomphus uncatus (Charpentier, 1840). In addition to different dipteran larvae e.g. Limnophora sp., Hexatomia sp., Simulium sp. and Prosimulium sp. (Taybi et al., 2018, 2019; Mabrouki et al., 2019a). The aquatic vertebrates that can be found in Gafait are fish species e.g. Carassobarbus sp. and Gambusia holbrooki Girard, 1859; and amphibians e.g. Pelophylax saharicus (Hartert, 1913) (Mabrouki et al., 2019b; Taybi et al., 2020a).

NOMENCLATURAL ACTS: This work and the nomenclatural acts it contains have been registered in ZooBank. The ZooBank Life Science Identifiers (LSID) for this publication is:

http://zoobank.org/urn:lsid:zoobank.org:pub:F96AC354-772F-44BB-ACB1-F8EDC7536C48

Discussion

Our findings raise the known biodiversity of the family Hydrobiidae sensu stricto in Morocco to 21 genera (Mabrouki et al., 2023, Taybi et al., 2023). Discoveries of new hydrobiids snails will certainly increase with further studies and investigations in Morocco or in North Africa as whole, such endeavours are actually a stringent need. Because of their limited dispersal abilities and high degree of habitat specialization, most of these springsnails are narrow-range endemics and face a high risk of extinction (Radea et al., 2021).

Water resources in Morocco are limited because of the semi-arid climate that characterises most of its territory, and the prevalence of drought periods. The problem is exacerbated by freshwater ecosystems that are degraded as a result of a range of human activities, including physical alteration through channelization and impoundments that affected the hydrology and benthic habitat (Berrahou et al., 2001; Mabrouki et al., 2019a; Taybi et al., 2020b). Za River basin, to which Gafait spring belongs, is particularly affected by this problem, and it is one of the most threatened Moroccan rivers by water pollution arising from towns and cities, but also from polluted mine and agricultural runoff (Bensaad et al., 2017; Mabrouki et al., 2016; Taybi et al., 2016).

Although Gafait spring is spared from liquid pollution, it is subject to big anthropogenic pressure which manifests by diversion of large quantities of water, particularly during the dry seasons when the use of surface water is considerably accentuated. To this is added the modification of the banks caused by agricultural and tourist practices and by the extraction of the ground substrate.

Disclosure statement
No potential conflict of interest was reported by the authors.

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