

## ***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.

## ***Gafaita gafaitensis* gen. et sp.n., новый пресноводный брюхоногий моллюск (Gastropoda: Hydrobiidae) из Марокко**

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**РЕЗЮМЕ:** Дано описание нового рода и вида пресноводных брюхоногих моллюсков *Gafaita gafaitensis* gen. et sp.n. (Gastropoda: Hydrobiidae) из Марокко. Материал получен в результате полевых исследований и проводимых в северо-восточной части Марокко. Приведены фотографии голотипа и паратипов нового вида, а также данные по морфологии пениса. Дана дополнительная информация по аутоэкологии и биотопе нового таксона, а также список сопутствующих ему видов беспозвоночных и позвоночных животных.

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**КЛЮЧЕВЫЕ СЛОВА:** Северная Африка, точка биоразнообразия, родниковая улитка, *Gafaita gafaitensis* gen. et sp.n.

## Introduction

The North African region, Morocco in particular, hosts a unique freshwater malacofauna, 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 malacofauna of Morocco in general, and especially on the family Hydrobiidae *sensu stricto*, with several new taxa discovered and described recently (Glöer *et al.*, 2020a, b; Boulaassafeer *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 north-eastern Morocco has revealed a new genus and species. The new springsnail was discovered in Gafaït 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.i. ammonium, nitrates, orthophosphates and biological oxygen demand (BOD<sub>5</sub>) were measured in the laboratory.

### Study area

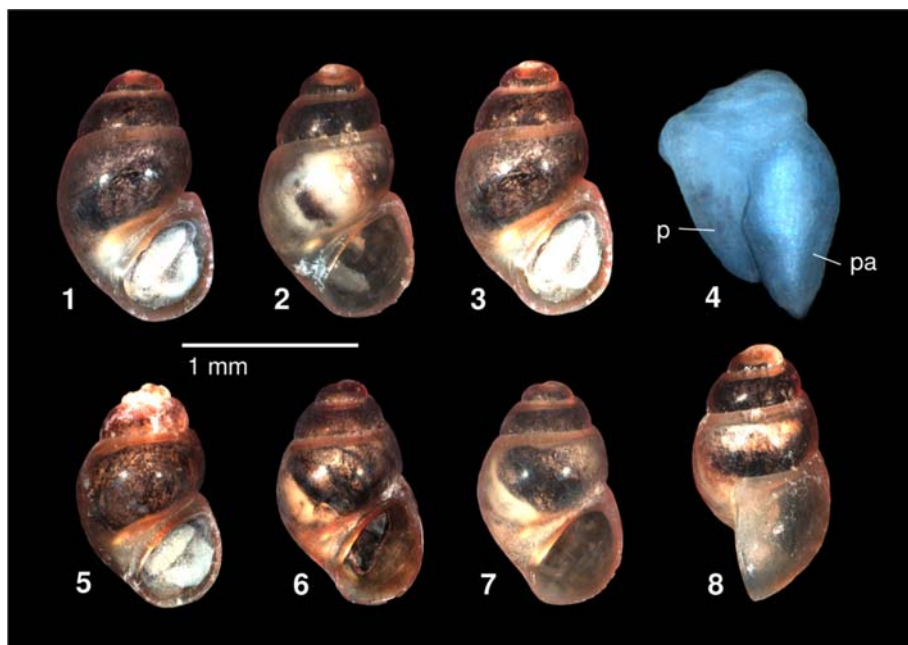
The Za River basin drainage network is located in the north-eastern region of Morocco; it is the main tributary of the Moulouya with an area of 18 000 km<sup>2</sup>. It has its source in the Eastern Highlands and joins Moulouya River at Melga El Ouidane, downstream from the town of Taourirt. It drains 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, semi-arid 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 km<sup>2</sup> (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.



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

Рис. 1–8. *Gafaita gafaitensis* gen. et sp.n. 1, 4 — голотип, 2–3, 5–8 — паратипы, 4 — пенис. Обозначения: p — пенис, pa — вырост пениса.

**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 valvatoid 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; *Pseudamnicola* 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 *Aghbalia* 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).

Table 1. Shell measurements (in mm) of *Gafaita gafaitensis* sp.n.  
Таблица 1. Промеры раковины (в мм) *Gafaita gafaitensis* sp.n.

Shell measurements	Min	Max	Mean	sd
Shell height	1.4	1.5	1.45	0.04
Aperture height	0.62	0.68	0.65	0.02
Spire height	0.77	0.85	0.8	0.01
Shell width	0.8	0.9	0.88	0.01
Aperture width	0.49	0.54	0.51	0.01

N = 14; the measurement accuracy is 0.05.

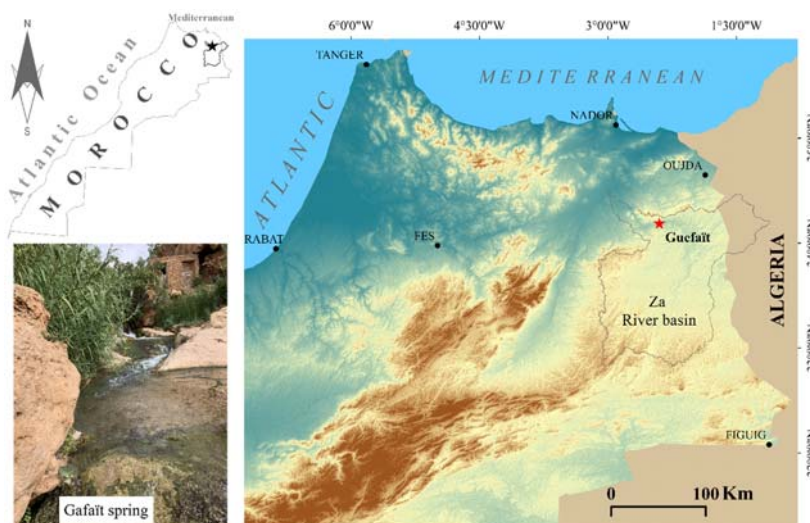


Fig. 9. Habitat and location (red star) of the type locality of *Gafaita gafaitensis* gen. et sp.n.  
Рис. 9. Местообитание и типовое местонахождение (звездочка) *Gafaita gafaitensis* gen. et sp.n.

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, Guefait 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 BOD<sub>5</sub> (Biological oxygen demand), revealed a good environmental quality of the habitat (Table 2), according to the

Table 2. Mean for the physical and chemical water parameters measured at the sampling locality (Gafaït oasis, Za River, Morocco), and their standards (according to MSWG).

Таблица 2. Средние показатели физических и химических параметрах воды в типовом местообитании (оазис Gafaït, река Za, Марокко), в соотношении с местными государственными стандартами (MSWG).

Factor	pH	Conductivity	Disolved oxygen	BOD <sub>5</sub>	Ammonium
Mean	7.9	650 $\mu\text{Scm}^{-1}$	7,5 $\text{mg.l}^{-1}$	3.15 $\text{mg.l}^{-1}$	0.012 $\text{mg.l}^{-1}$
MSWG	6.5–8.5	100–1300 $\mu\text{Scm}^{-1}$	> 7–5 $\text{mg.l}^{-1}$	< 3–5 $\text{mg.l}^{-1}$	< 0.1–0.5 $\text{mg.l}^{-1}$

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 Gafaït area, which may co-occur with *Gafaïta gafaïtensis* 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. praemorosa* (Linnaeus, 1758); Decapoda: *Potamon algeriense* (Herbst, 1785), *Atyaephyra desmarestii* (Millet, 1831); Ephemeroptera larvae: *Baetis* spp., *Ecdyonurus rothschildi* (Navàs, 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., *Hexatoma* sp., *Simulium* sp. and *Prosimulium* sp. (Taybi *et al.*, 2018, 2019; Mabrouki *et al.*, 2019a). The aquatic vertebrates that can be found in Gafaït are fish species e.g. *Carasobarbus* 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>

<http://zoobank.org/urn:lsid:zoobank.org:pub:837AB6FA-9C30-402A-AF42-913902783D3C>

## 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 Gafaït 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 Gafaït 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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