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REDISCOVERY OF AN ESTABLISHED POPULATION OF THE RED-RIMMED MELANIA *MELANOIDES TUBERCULATA* (MÜLLER, 1774) IN MOROCCO

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Records of *Melanoides tuberculata* (Müller, 1774) in Morocco have been scarce and often based on empty shells only. In this study, we report a new occurrence of this species at the Sidi Hrazem thermal spring in north-central Morocco, where high-density populations were recorded. We also provide an overview of its autoecology and reassess its biogeographical status in Morocco and North Africa.
Keywords: North Africa, thermal waters, freshwater gastropod, Sidi Hrazem thermal waters

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Nalazi vrste *Melanoides tuberculata* (Müller, 1774) u Maroku su rijetki, i često se temelje samo na praznim kućicama. U ovom radu donosimo novi nalaz te vrste u termalnom izvoru Sidi Hrazem, u sjeverno-središnjem Maroku, gdje su zabilježene populacije velikih gustoća. Također donosimo pregled ekologije vrste i ponovnu procjenu njenog biogeografskog statusa u Maroku i sjevernoj Africi.
Ključne riječi: sjeverna Afrika, termalne vode, slatkovodni puževi, termalne vode Sidi Hrazem

INTRODUCTION

In recent years, significant progress has been made in our knowledge of Morocco's freshwater mollusc fauna, with many new species being added to the inventory, including genera and species that are new to science (GLÖER *et al.*, 2020a, b; TAYBI *et al.*, 2021; MABROUKI *et al.*, 2022a, b; BESPALAYA *et al.*, 2024). However, the inventory of Morocco's freshwater gastropod fauna is certainly still incomplete, with many areas yet to be surveyed, particularly in ecologically diverse and hydrologically isolated regions. Continued field investigations are therefore essential to improve our understanding of biodiversity and species distribution patterns in these freshwater systems.

Among freshwater gastropods, the red-rimmed melania *M. tuberculata* is a subtropical species native to Eastern Africa and the Middle East (WILLIAMSON, 1981; PILSBRY & BEQUAERT, 1927). The species is widely recognized as invasive and has been introduced to many parts of

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the world, including Australia, North America, Europe, and the (VOGLER *et al.*, 2012; WELTER-SCHULTES, 2012), where it may have significant ecological impacts on native mollusc communities through competition and habitat alteration (RAW *et al.*, 2016; VAN BOCXLAER *et al.*, 2025).

In Morocco, live populations of *M. tuberculata* were probably first recorded in Figuig at the beginning of the century (GAUTHIER, 1934), and their presence was confirmed by LAAMRANI (1997). However, these populations were not detected in a more recent survey (TAYBI *et al.*, 2017). In this paper, we present new records of this species from the Sidi Hrazem thermal waters in north-central Morocco, where high-density populations were observed. These findings contribute to a better understanding of its current distribution in the country and raise important questions regarding its establishment history. Additionally, we discuss its status in Morocco and North Africa.

MATERIAL AND METHODS

The field studies were carried out in different parts of Morocco since 2014, particularly in the northern part of the country, such as in Sebou river basin (Fig. 1). Quantitative sampling of benthic fauna including gastropods was carried out using a Surber sampler (surface area: 20×25 cm; mesh size: 0.4 mm). Captured species were preserved in 90% ethanol. Conductivity, pH, dissolved oxygen and temperature were measured *in situ* with a multiparametric measuring device (WTW, MultiLine P4). While the biological oxygen demand after 5 days (BOD_5) and nitrate ($N–NO_3$) of the water were measured in the laboratory.

RESULTS

Established populations of *M. tuberculata* were found in the thermal waters of Sidi Hrazem, near the city of Fez in north-central Morocco (see Fig. 1). In this new location, the red-rimmed melania can colonise various habitats, such as springs and rivers, reaching densities of up to thousands of individuals per m² (Fig. 2). It thrives on different substrates, most commonly rock or mud. Many juveniles were encountered during this sampling. Other gastropod species were found at the site, including the invasive *Physella acuta* (Draparnaud, 1805). Tab. 1 presents the mean abundance of *M. tuberculata* and the physico-chemical parameters of the water at each new site.

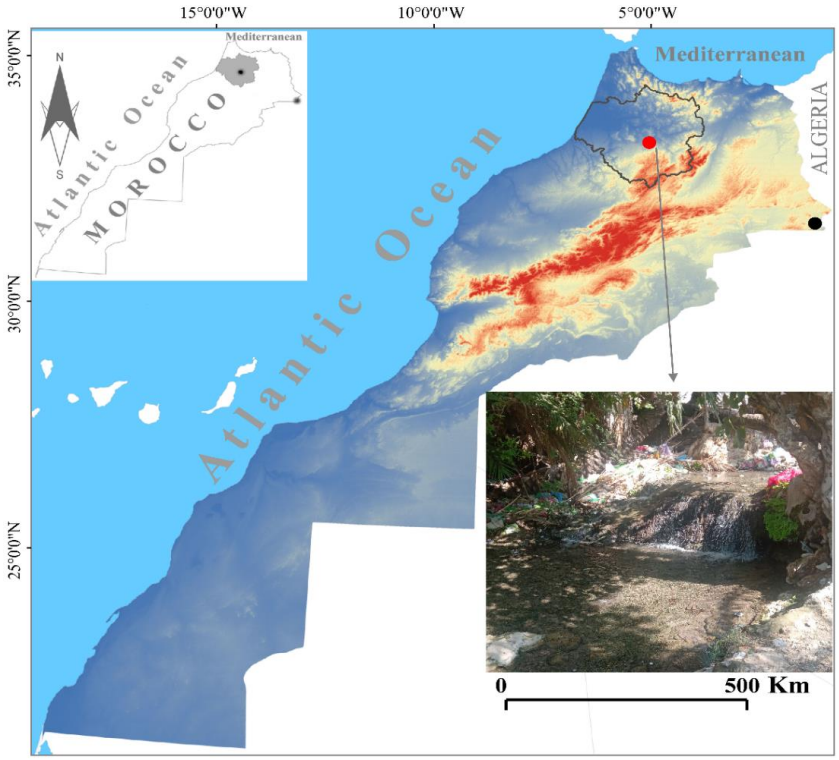

Fig. 1. Confirmed records of *M. tuberculata* in Morocco (old record black, new record with habitat within Sebou river basin in red).

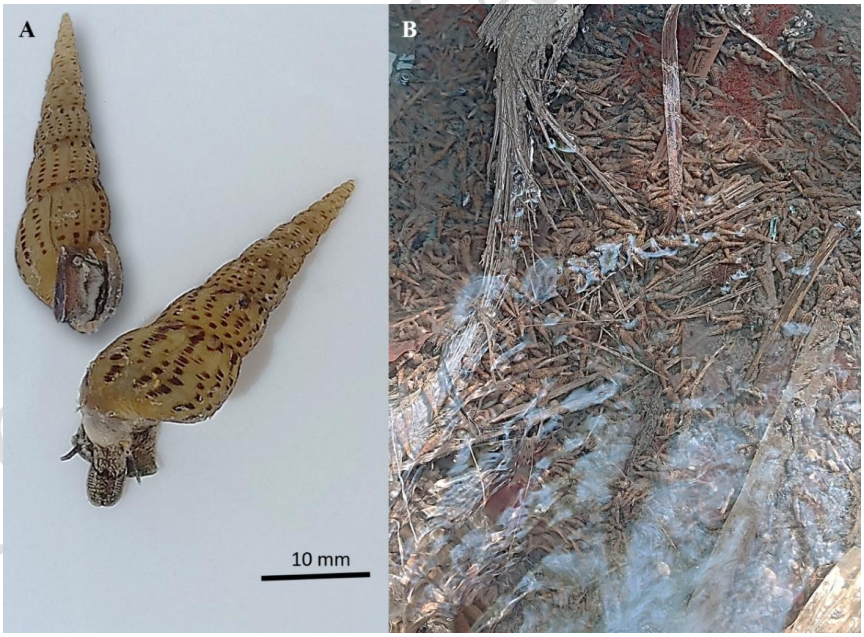

Fig. 2. Live specimens of *M. tuberculata* (A), High population density *in situ* (B).

Tab. 1. Mean abundance of *M. tuberculata* and mean value of the water parameters measured at the sampling locality.

Sampling site	Abundance (m^2)	Temperature (°C)	pH	Conductivity ($\mu s.cm^{-1}$)	Disolved oxygen ($mg.l^{-1}$)	BOD_5 ($mg.l^{-1}$)	Nitrate ($mg.l^{-1}$)
Sidi Harazem 34°01'41.6"N 4°53'03.7"W	540	27	6.9	1024	7.2	6.45	2.5

DISCUSSION

In this paper, we confirm the presence of the red-rimmed melania in Morocco. High-density populations were recorded in north-central Morocco at the Sidi Hrazem thermal spring and adjacent river, which are part of the Sebou River Basin, one of Morocco's major permanent hydrosystems. It is noteworthy that the area surrounding the Sidi Hrazem thermal station was extensively surveyed in 1998, during which this species was not included in the regional malacofaunal inventory (BERRADY *et al.,* 2000).

The Sebou river basin is indeed the main hotspot for freshwater biological invasion in the country, with many species deliberately introduced to natural habitats via the aquarium trade (TAYBI *et al.,* 2023; MABROUKI *et al.,* 2023, 2025). Many other invasive and alien species have recently been found in the same area where *M. tuberculata* was discovered. These include the guppy *Poecilia reticulata* (Peters, 1859), the mosquitofish *Gambusia holbrooki* (GIRARD, 1859), the Asian anchor worm (*Lernaea cyprinacea* Linnaeus, 1758) and the alien gastropod *P. acuta* (TAYBI *et al.,* 2024; EL CAIDI *et al.,* 2025a, b).

In 2023, *M. tuberculata* was previously listed among the freshwater alien animal species in Morocco (TAYBI *et al.,* 2023). However, this classification remains debatable. Although human-mediated translocation of the species between different river basins and ecoregions within the country cannot be excluded - particularly given that it is one of the most widely traded freshwater aquarium snails - there is substantial evidence supporting its native status in North Africa (BROWN, 2002). This highlights the difficulty of distinguishing between long-established native populations and more recent introductions, especially for species with high ecological plasticity and broad environmental tolerance (LEMOINE *et al.,* 2016; BUCKLEY & CATFORD, 2016). Furthermore, the occurrence of *M. tuberculata* in thermally stable habitats, such as the Sidi Hrazem spring, may reflect ecological preferences consistent with its known distribution in subtropical and warm environments. Nevertheless, while the species is currently regarded as native, its precise biogeographical status in Morocco remains uncertain and should be further investigated using integrative approaches combining morphological, ecological, and molecular data. Additionally, these newly recorded high-density populations should be monitored, regardless of whether the species is native or not. At high population densities, *M. tuberculata* can exert significant ecological effects on freshwater ecosystems. In particular, dense populations may strongly influence benthic community structure through intensive grazing on available microphytobenthos, potentially altering trophic dynamics and resource availability for native species (RAW *et al.,* 2016). Moreover, beyond their direct ecological impacts, high-density populations of *M. tuberculata* may also have epidemiological

significance. This species is widely recognized as an intermediate host for several digenean trematodes in freshwater systems, including parasites of medical and veterinary importance (MADSEN & FRANDSEN, 1989; POINTIER *et al.*, 1993; DERRAIK, 2008). Some of these parasites may affect fish and wildlife, and in certain cases indirectly impact human health through complex aquatic life cycles. Given its ability to reach very high population densities and its tolerance to a wide range of environmental conditions, *M. tuberculata* may contribute to the maintenance and transmission of parasite life cycles in suitable habitats. This aspect further emphasizes the need for continued monitoring of its populations, particularly in thermally stable environments that may facilitate its persistence and spread.

Human activities are increasingly impacting freshwater ecosystems and biodiversity in Morocco. Freshwater habitats are among the most threatened ecosystems, particularly due to water pollution in densely populated regions, the leaching of contaminants such as water-soluble fertilizers through permeable soils, and the growing pressure from biological invasions. Strengthening research and long-term monitoring efforts is therefore essential to improve biodiversity conservation and inform effective management strategies in these vulnerable systems.

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